SCDOT

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

CONSTRUCTION MANUAL

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

May 2004

NOTICE

Registration Form and Notice of Needed Revisions

Complete and return this registration form to receive revisions to this *Manual*. SCDOT employees are not required to submit this form because updates will be routed via internal mail or the Department Intranet. Mail or fax this form to:

Director of Construction
South Carolina Department of Transportation
P.O. Box 191
955 Park Street
Columbia, South Carolina 29202

Company/Organization Name:____________________________________
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Street Address:____
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State:____________________________ Zip Code:__________________
Telephone Number: (_______)____________________________________
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Select desired Method of Notification for updates to this *Manual*:

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FOREWORD

The S*CDOT Construction Manual* is an operational manual of the South Carolina Department of Transportation (SCDOT). It defines the criteria and procedures to be used by engineering personnel in the administration of construction contracts.

The *Manual* was prepared and is maintained by the Office of the Director of Construction under the authority of, and at the direction of, the State Highway Engineer.

Although the *Manual* follows the general outline of the *Standard Specifications*, it is not a specification and should not be interpreted as such. Any section references are specific to this *Manual* unless otherwise noted.

Suggestions and/or comments for improvement, clarification, correction, and/or inclusion of material in the *Manual* are welcome. Please forward your comments to the Director of Construction using the Registration Form and Notice of Needed Revisions in the front of this *Manual*.

The instructions and procedures in this *Manual* are written and intended for use by Construction Engineers, Technicians and Inspectors. The *Manual* is available via the Internet or may be purchased from SCDOT.

The *Manual* will be revised as methods, materials, policies, procedures, specifications and the industry change. SCDOT will make revisions to the *Manual* available to SCDOT employees through intra-Department mail and the Intranet. The general public will be notified via the SCDOT Internet Web Site.

It is the *Manual* holder's responsibility to keep the *Manual* up to date.

ACKNOWLEDGEMENTS

I would like to extend my personal gratitude to the following Team Members who spent many hours beyond their normal day-to-day duties in developing a much-needed update to the *SCDOT Construction Manual*:

- Lindy Hallman – Road Construction Engineer – SCDOT

- Charles Eleazer – Assistant Construction Engineer – SCDOT
- Tim Lindberg – Assistant Construction Engineer – SCDOT
- Robert Dickinson – Assistant District Construction Engineer – SCDOT
- P. E. “Eddie” Felker – Resident Construction Engineer – SCDOT
- Chad Hawkins – Asphalt Materials Engineer – SCDOT
- Jay Hawkins – Quality Management Engineer – SCDOT
- Andy Johnson – State Pavement Design Engineer – SCDOT
- Mike Lockman – Geotechnical Materials Engineer – SCDOT
- Charles Matthews – Bridge Construction Engineer – SCDOT
- John McCarter – District Construction Engineer – SCDOT
- Bill Smyer – Quality Manager – SCDOT
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I would like to especially thank Lindy Hallman for the many hours he spent providing excellent project oversight and coordinating meetings to produce a top-quality *Manual*. Also, with special thanks to Randall Burks of Roy Jorgensen Associates for his expertise in guiding the Department’s decision-making process through the Information Engineering Phase and in managing the preparation of the *Manual* during the Development Phase of the project. For all SCDOT and FHWA staff who contributed their expertise to update the *SCDOT Construction Manual*, I extend my personal thanks.

Danny R. Shealy
Director of Construction
South Carolina Department of Transportation

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Section 101
General Guidelines

101.1 PURPOSE AND ORGANIZATION OF THE *MANUAL*

The *SCDOT Construction Manual* has been prepared to provide the Resident Construction Engineer and SCDOT Inspectors with guidance in performing their day-to-day duties. The *Manual* is not a contractual document. The *Manual* is based on current SCDOT policies and procedures. Division 100 provides guidance on Contract administration from project start to closure; Divisions 200 through 800 provide inspection guidance for Contract pay items; Appendix A provides a descriptive table of SCDOT Construction Forms typically used by SCDOT construction personnel; Appendix B provides information on SCDOT Sample Identification Cards; Appendix C presents typical SCDOT Sampling and Testing Procedures; and Appendix D provides miscellaneous technical information that is typically used in construction. The *Manual* also includes a comprehensive Glossary and Subject Index of key acronyms, terms and definitions. SCDOT construction personnel are expected to become familiar with and employ the content of this *Manual* in conjunction with previous experience and sound engineering judgment. When situations are encountered that are not specifically addressed in this *Manual*, seek the advice of a supervisor.

101.2 SCDOT ORGANIZATION AND PERSONNEL CONSIDERATIONS

101.2.1 <u>Central Office</u>

101.2.1.1 Executive Level

With respect to construction, the executive level of the Department consists of the Executive Director, State Highway Engineer and Deputy State Highway Engineer. The Director of Construction and District Engineering Administrators report directly to the Deputy State Highway Engineer.

101.2.1.2 Program Manager

Most SCDOT construction projects will have a Program Manager from the Program Management Section who is directly responsible for the project until the Contract is closed. Generally, contracts include a 5% contingency. For changes that exceed the budgeted amount, contact the Program Manager.

101.2.1.3 Construction Operations

Figure 101A presents an organizational chart of SCDOT construction operations. The Director of Construction is directly responsible for the following SCDOT construction operations and reports directly to the Deputy State Highway Engineer:

1. Road Construction. The Road Construction Engineer in the Central Office is responsible for Statewide road construction projects that are not directly related to bridge structures. The Construction Applications Manager reports directly to the Road Construction Engineer and is responsible for the implementation and maintenance of construction support software, including BAMS/DSS, PES/LAS, Bid Express, Expedite and SiteManager. The Assistant Construction Engineers in the Central Office report directly to the Road Construction Engineer and provide support on road construction issues to District and field personnel and directly interface with FHWA Engineers on Federal-aid projects.

2. Bridge Construction. The Bridge Construction Engineer in the Central Office is responsible for Statewide construction of structures. The Assistant Construction Engineers in the Central Office report directly to the Bridge Construction Engineer, provide support on structural issues to District and field personnel, and directly interface with FHWA Engineers on Federal-aid projects.

3. Contract Administration. Contract Administration is responsible for administering contracts Statewide for SCDOT road and bridge construction projects through project closure.

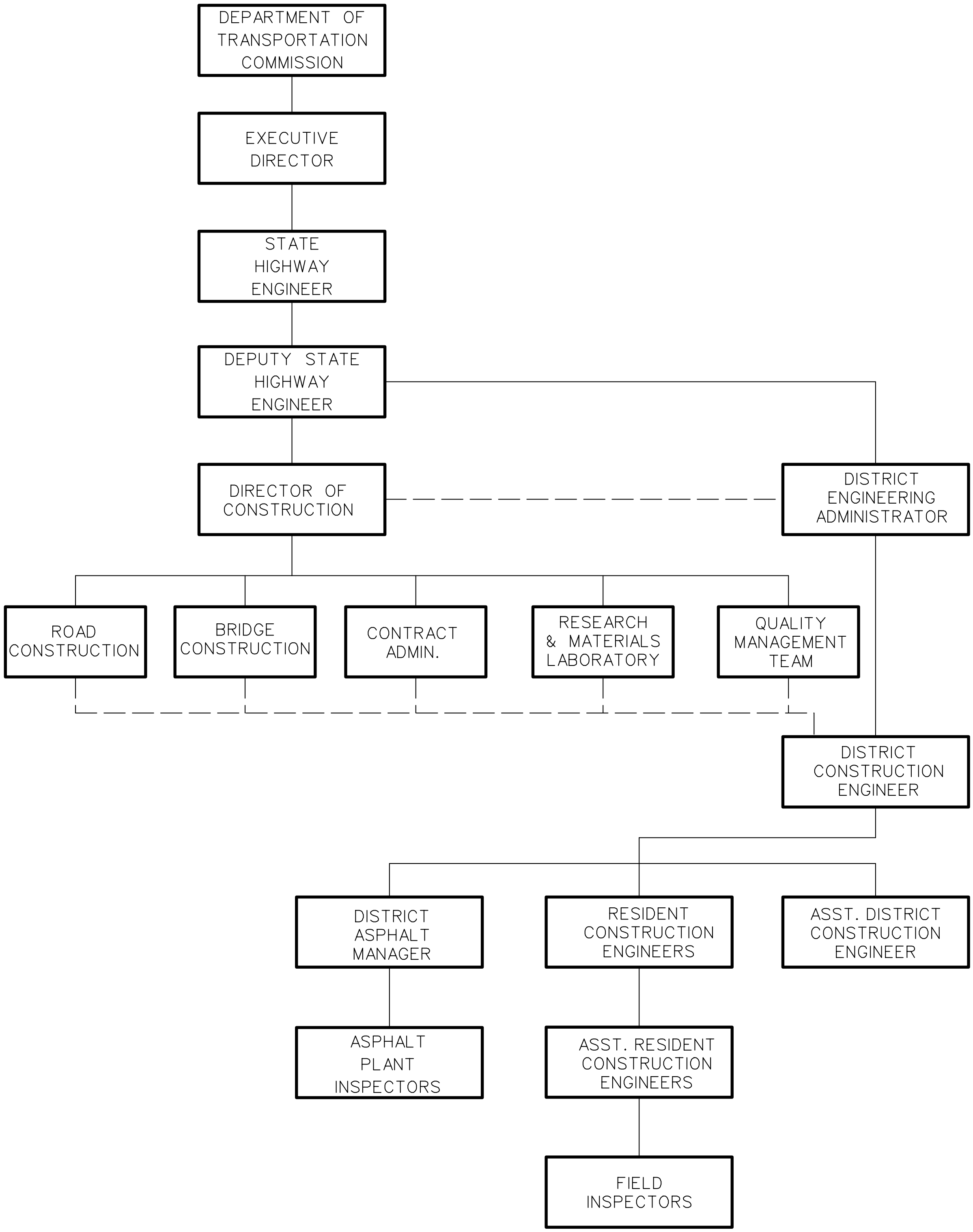
4. Research and Materials Laboratory. The Research and Materials Engineer is responsible for establishing policies and procedures for approval of material sources and the sampling and testing of all materials used Statewide on SCDOT road and bridge projects.

5. Quality Management Team. The Quality Management Team is responsible for the review of construction management and engineering inspection duties performed on SCDOT projects. These reviews provide for adherence to and standardization of SCDOT requirements.

101.2.2 District Office

101.2.2.1 District Engineering Administrator

The State of South Carolina is divided into seven engineering Districts with a District Engineering Administrator in each District. All construction work within each District is the responsibility of the District Engineering Administrator. The District Engineering Administrator is responsible for ensuring that roads and bridges are constructed as specified in the Contract and for ensuring they are adequately maintained upon acceptance from contractors. The authority and responsibilities of the District Engineering Administrator are as delegated by the State Highway Engineer.



ORGANIZATION OF SCDOT CONSTRUCTION OPERATIONS
Figure 101A

101.2.2.2 District Construction Engineer

Each of the seven Districts within the State has at least one District Construction Engineer who reports directly to the District Engineering Administrator. The Assistant District Construction Engineer, if assigned, reports to the District Construction Engineer. The District Construction Engineer is responsible for the District Asphalt Manager and the Resident Construction Engineers within the District. Typical duties of the District Construction Engineer include:

- supervising the work of the Resident Construction Engineer;
- making regular visits to project sites to ensure that the work is being performed in accordance with the requirements of the Contract Plans and Specifications, including Special Provisions;
- ensuring that a sufficient number of samples and tests are being performed;
- ensuring that field and office records of the Resident Construction Engineer are being properly maintained;
- checking the status of As-Built Plans and ensuring they are being prepared on schedule;
- assisting with or making final construction inspections, as assigned by the District Engineering Administrator;
- ensuring that engineering equipment is being properly cared for;
- ensuring that good public relations are being carried out by SCDOT personnel; and
- other duties as assigned by the District Engineering Administrator.

101.2.2.3 District Asphalt Manager

The District Asphalt Manager reports to the District Construction Engineer, or assigned assistant. The District Asphalt Manager is responsible for the Asphalt Plant Inspectors. The District Asphalt Manager will be HMA Level 3 certified, as required by the Department. Typical duties of the District Asphalt Manager include:

- maintaining close contact with plant and roadway personnel;
- making notations of any problems found by the Contractor or SCDOT;
- resolving project problems as quickly as practical;
- checking all computations of roadway and plant reports and tickets;
- notifying the Contractor as soon as problems are noted;
- keeping the Resident Construction Engineer apprised of any problems and corrections;
- forwarding all paperwork to the Resident Construction Engineer for preparing estimates;
- processing check samples and immediately notifying the Contractor;
- maintaining daily records of all samples obtained and how they compared;
- ensuring pay factor sheets are complete and accurate; and
- other duties as assigned by the District Construction Engineer.

101.2.2.4 Asphalt Plant Inspector

The Asphalt Plant Inspector reports to the District Asphalt Manager. Asphalt Plant Inspectors are HMA Level 1 certified, as required by the Department. Typical duties of the Asphalt Plant Inspector include:

- visiting the plant site as needed;
- reviewing the Contractor's plant reports;
- monitoring all plant activities while on site;
- monitoring at least one entire test during the site visit;
- checking with the Contractor on any problems encountered;
- noting any deficiencies spotted by SCDOT personnel;
- obtaining bag samples for testing;
- verifying roadway cores and plant cores;
- checking the lime flow with Contractor;
- checking trucks and truck beds while on site;
- distributing reports as they are completed; and
- other duties as assigned by the District Asphalt Manager.

101.2.3 <u>County Level</u>

101.2.3.1 Resident Construction Engineer

Each District Office has jurisdiction over multiple counties within the State. At the project level, the Resident Construction Engineer has an office representing one or more counties within the District, depending on the size and construction activity in the area. Resident Construction Engineers are responsible for their office facilities and the construction projects assigned to them by the District Engineering Administrator. The Resident Construction Engineer is the SCDOT representative at the job site and reports to the District Construction Engineer. Depending on the level of construction activity, Assistant Resident Construction Engineers may be assigned. The typical duties of the Resident Construction Engineer include, but are not limited to:

- ensuring courteous and professional relations with local property owners and the public;

- ensuring that contractors and subcontractors are treated impartially by SCDOT personnel;

- having a thorough working knowledge of project requirements and the details of the Contract Plans and Specifications, including Special Provisions;

- assigning duties to SCDOT Inspectors and ensuring they understand how to carry out their assigned duties;

- ensuring SCDOT Inspectors are on duty at all required times and checking their activities for satisfactory performance (e.g., setting construction stakes, sampling and testing materials, inspecting items of work);

- regularly reviewing field notes and the Daily Work Reports of SCDOT Inspectors to ensure that adequate records are being maintained as the work progresses;

- maintaining complete and accurate contractual records of project activities and ensuring that all required written reports are promptly and properly furnished;

- maintaining contractual records in such condition that they may clearly and easily be followed by personnel unfamiliar with the project;

- monitoring the project schedule and supervising the timely preparation of As-Built Plans;

- ensuring compliance of material, equipment and work, regularly spot checking all phases of the work on the project;

- assessing the work on pay items for acceptance and directly interfacing with the Contractor Superintendent to resolve any problems encountered;

- ensuring the timely computation of pay item quantities upon acceptance of the work, approving the Daily Work Reports and preparing the Monthly Pay Estimate; and

- other duties as assigned by the District Construction Engineer.

The Resident Construction Engineer prepares Monthly Pay Estimates for each pay item as the work progresses. The Contractor is required to sign off on these Estimates for payment. If the Contract Plans are changed during construction, they are modified and prepared as As-Built Plans. By using this method of administration, the Resident Construction Engineer will not be required to compute final pay quantities at project completion, but must submit with the As-Built Plans the required final project documentation (e.g., Asphalt Recap Sheets, Pile Data Sheets). See Section 110.2 for additional information on As-Built Plans and required documentation.

101.2.3.2 SCDOT Inspector

SCDOT Inspectors report to the Resident Construction Engineer and are directly involved in the construction of road and bridge projects. SCDOT Inspectors include engineering technicians, surveyors, plant inspectors, roadway inspectors and bridge inspectors. Typical duties of SCDOT Inspectors include, but are not limited to:

- monitoring erosion control;
- monitoring Contractor activities on road and bridge construction projects;
- monitoring traffic control for adherence to requirements;
- monitoring the Contractor's checks for material application rate and yield;
- monitoring the Contractor's reports for accuracy;
- monitoring placement of material, as directed by Resident Construction Engineer;
- maintaining Daily Work Reports of Contractor activities;
- noting any deficiencies found by Contractor or SCDOT personnel;
- performing required sampling and testing of work and materials;
- accepting or rejecting materials, equipment and work;

- recording accepted pay item quantities in the Daily Work Report; and
- other duties as assigned by the Resident Construction Engineer.

101.2.4 Personnel Policy

101.2.4.1 Rules and Regulations

SCDOT employees are governed by the Department's Personnel Rules and Regulations, which are furnished to all supervisors. Meetings will be held periodically by supervisors to familiarize SCDOT employees with current Department policy. Policy changes and updates will be disseminated to employees by memorandum through their supervisor. Any questions regarding personnel policy should be directed through the proper channels.

101.2.4.2 Integrity

Absolute integrity on the part of SCDOT personnel is essential, if public confidence is to be maintained. Excessive fraternization between SCDOT employees and Contractor personnel is discouraged. Refer to the publication *Guide to the South Carolina State Ethics Act* for additional information.

101.2.4.3 Training and Certification

SCDOT requires formal training and certification to ensure that personnel are properly qualified to perform their respective duties. The Technician Certification Program is generally based on input from representatives from SCDOT, FHWA and the industry. SCDOT typically has a third party, such as a State University, administer the coursework and examinations, for which a Certification of Qualification will be issued upon successful completion. On-the-job trainees will be trained under the direct supervision of a certified technician. Because certification demonstrates competency with procedures unique to South Carolina, reciprocity with other agencies is generally not permitted. See the Department's Technician Certification policy on the SCDOT Intranet Website for additional information.

101.2.4.4 Intra-Department Cooperation

Good relationships with fellow employees and with other departments within SCDOT are of vital concern. All SCDOT employees should be working in a professional manner toward a common goal. An understanding and appreciation of the functions of other SCDOT departments is a valuable asset. Written or verbal instructions are given regularly to the Resident Construction Engineer, and this information should be transmitted to other SCDOT personnel in a timely manner. A bulletin board in each office is suggested. The Resident Construction Engineer should keep the District Construction Engineer informed of any unusual condition or circumstances that may arise. This can be performed by letter, facsimile, e-mail, telephone or during visits to the project site.

101.2.4.5 Public Relations

SCDOT construction personnel are under the critical public eye, such as adjacent property owners, local residents and passing motorists. It is essential that all SCDOT employees conduct themselves in a manner that will command the respect and confidence of the public. The public will ask SCDOT representatives many questions during the construction of a project. All questions should be answered as accurately and as courteously as possible. Questions that cannot be answered should be referred to a supervisor, or to other sections of the Department, if necessary. Adjacent property owners are always concerned with the construction work to be performed within the limits of their property. A problem that may seem minor to an SCDOT employee may be of grave concern to the property owner. Any issues should be addressed promptly and courteously with the property owner involved. See Section 101.7.3 for information on SCDOT's policy concerning the media.

101.2.5 <u>Safety</u>

101.2.5.1 General

Accidents are not only costly to the employee and the Department, but result in pain, disability and possibly death. Employees should be safety conscious at all times, both as to proper driving and safe working conditions. One should be aware of the potential hazards in each duty performed and take every precaution to prevent injuries. Resident Construction Engineers should have monthly meetings with all employees under their supervision to discuss safe driving and working conditions. At these meetings, it is advisable to discuss any accidents that may have occurred to determine their cause and what steps could have been taken to prevent these accidents.

101.2.5.2 Safe Driving

Employees should realize that, because they are employed by the State and driving State-owned vehicles, the public is observing their driving practices and is prone to criticize employees of the Department for all violations whether they are minor in nature or serious. All employees are, therefore, urged to set a good example for the traveling public. Employees should know and observe all laws.

101.2.5.3 Surveying

When a survey party is working on a heavily traveled highway, it is necessary to have signs or flaggers to direct traffic. If signs are in place, they should be the proper distance ahead of the survey party so as to warn traffic of its presence on the highway. If placed too far in advance of a survey party, signs lose their effectiveness. When flaggers are used, they should wear the proper colored clothing, be furnished with proper flagging equipment, and be given instructions on the proper method of directing traffic. Part 6 of the *MUTCD* addresses proper flagging attire and techniques. When using such tools as axes, hammers or bush axes, adequate space should be maintained between personnel so that there will be no danger of being struck by these tools. When cutting overhead, care must be taken to prevent limbs or other foreign matter from causing injury. All employees should be alert for snakes and insects, particularly in areas where there is heavy growth. When working near power lines, extreme care should be exercised so as not to come in contact with electrical wires. Remember that chains and metallic tapes are conductors of electricity and should never be allowed to touch electrical wires.

101.2.5.4 Medical Treatment

In case of injury, seek medical treatment promptly. A minor injury may become infected if medical treatment is not provided and may result in painful and costly injuries. First-aid kits are available from the Supply Depot. These should be obtained and kept in a convenient location for use if and when needed. Resident Construction Engineers should be familiar with necessary forms to be submitted in the event of injuries and ensure that these reports are submitted promptly with all necessary information furnished. Complete and process OSHA Form 300, SCDOT Form 12A, SCDOT Form 12B and SCDOT Form 576, as appropriate, for personnel injuries and motor vehicle accidents.

101.2.5.5 Safety Equipment

Personal protective equipment (e.g., hard hats, vests, boots) will be made available to all SCDOT personnel. SCDOT personnel will wear only hard hats and safety vests bearing the SCDOT seal. Contractor personnel must not wear SCDOT hats or vests. Consult the *Employee Safety Manual* for current policies.

101.2.5.6 Nuclear Density Gauges

101.2.5.6.1 General Guidelines

Nuclear density gauges are used by certified technicians to test the density of materials on the project. Adhere to the following guidelines:

- Do not operate a nuclear density gauge unless you are certified and authorized to do so.
- Keep unauthorized personnel away from the nuclear density gauge.
- Follow the established operating procedures when using the nuclear density gauge.
- Maintain the nuclear density gauge in the "SAFE" position when stored or not in use.
- Ensure that the nuclear density gauge is properly secured when stored or not in use.
- Ensure that the nuclear density gauge is stored in an approved location.

Contact the Research and Materials Laboratory Radiation Protection Officer for any needed assistance. See the *SCDOT Guide Instruction Manual for Inspectors of Earthwork and Base Course Construction* for additional information on nuclear density gauges.

101.2.5.6.2 Certification and Licensing Considerations

Only certified technicians are permitted to operate and transport nuclear density gauges. The use and transport of nuclear density gauges also require licensing by SCDHEC, because misuse or mishandling of these devices can pose hazards to personnel and the environment.

101.2.5.6.3 Transporting and Storage Considerations

In preparing the nuclear density gauge for transport or storage, or if it is necessary to leave the gauge unattended for any length of time, lock the source rod in the "SAFE" position, place the gauge in its transport case and lock the case. When not in use, the nuclear density gauge must be stored behind two locked doors. The lock on the transport case does not count as one of these locks. The storage area cannot be in a regularly occupied work area. All storage areas must be approved by the Central Laboratory Radiation Protection Officer and must be posted with the proper signage and notices. When transporting the nuclear density gauge, it must be placed in the rear area of an SUV or vehicle (e.g., trunk). The folder containing the Bill of Lading and the SCDHEC Radioactive Material License must be kept with the nuclear density gauge at all times. Each day the gauge is used, complete SCDOT Form 100.08 – Monthly Report of Testing Activities with Nuclear Gauge. At the end of each month, forward a copy of Form 100.08 to the Research and Materials Laboratory Engineer, which is due no later than the 15th of the month. Carefully adhere to these reporting requirements. Non-compliance will result in penalties imposed by SCDHEC.

101.2.5.6.4 Emergency Procedures

If a nuclear density gauge is involved in a vehicular crash, is lost or stolen, gets crushed by heavy equipment, is dropped from a moving vehicle or is damaged in another mishap that could damage or break the source rod:

- stop any vehicle that may have collided with the gauge and which could possibly have radiation contamination on tires, cleats or tracks;
- do not move the gauge or any of its parts;
- use rope or colored survey marking tape to cordon off the area for a distance of 20 feet from the gauge and any of its scattered parts;
- post SCDOT personnel outside the cordoned area to prevent others from walking through the site; and
- immediately notify the Research and Materials Laboratory personnel by calling the numbers listed on the Emergency Telephone List for Central Laboratory Personnel. They will then decide if it is necessary to call the Department of Health and Environmental Control Emergency Radiological Assistance.

For other non-emergency incidents (e.g., source rod being jammed in an unshielded position, source rod coming out of gauge, malfunction of the gauge), contact the Research and Materials Laboratory for assistance.

101.3 PROJECT DEVELOPMENT CONSIDERATIONS

101.3.1 <u>Constructability Review</u>

101.3.1.1 Purpose of the Review

Prior to construction, SCDOT construction personnel will participate in a Constructability Review for the following types of projects:

- Interstate and interchange reconstruction or widening projects;
- non-Interstate projects with an estimated construction cost over $25 million;
- projects that are considered sensitive, innovative or have multi-stage construction; and
- other projects, as directed by the Program Manager.

During the meeting, the Constructability Review Team will discuss key issues related to the construction of the project, including:

- traffic staging requirements and impacts on construction activities;
- materials availability and procurement time;
- availability of on- and off-site storage and staging areas;
- equipment access and the need for additional access;
- types of waste that may be encountered and availability of disposal areas;
- utility conflicts and the potential for project delays; and
- geotechnical issues and environmental obligations.

The objective of the Constructability Review is to ensure:

- the project, as detailed in the Contract Plans and Specifications, can be constructed using standard construction methods, materials and techniques;

- the Contract Plans and Specifications will provide the Contractor with clear and concise information that can be utilized to prepare a competitive, cost-effective bid; and

- the project, when constructed in accordance with the Contract Plans and Specifications, will result in a project that can be maintained in a cost-effective manner by SCDOT over the life of the project.

101.3.1.2 Constructability Review Team

The Constructability Review Team will consist of the Program Manager, Designer, personnel from the Director of Construction’s Office, the appropriate District Construction Office, the FHWA, and one or more contracting firms representing the construction industry.

101.3.1.3 Selection of Contracting Firms Representing the Industry

The Director of Construction will be responsible for contacting and selecting one or more contracting firms representing the construction industry to participate in the Constructability Review. Invitations are distributed annually and selection for involvement is generally performed on a rotational basis.

101.3.1.4 Meeting Coordination and Scheduling

The Constructability Review will be held at the project site and should only require one full day of participation. The meeting will be scheduled after the Design Field Review but before the final Right-of-Way Plans are completed. The Program Manager will be responsible for coordinating and scheduling the meeting. A representative of the Director of Construction's Office will facilitate the meeting.

101.3.1.5 Constructability Review Report

The Constructability Review Report will be forwarded to the Road, or Bridge, Construction Engineer responsible for the project and will include the final recommendations of the Constructability Review Team. The Resident Construction Engineer and Inspectors assigned to the project should carefully review the Report prior to the Preconstruction Conference.

101.4 PROCUREMENT AND USE OF SCDOT EQUIPMENT

101.4.1 <u>Motor Vehicles</u>

101.4.1.1 General

Motor vehicles are assigned to the Resident Construction Engineer, as deemed necessary by the District Engineering Administrator, and may be transferred from one Resident Construction Engineer to another. The Resident Construction Engineer is responsible for assigning a responsible driver to the vehicle. Although other SCDOT personnel may drive the vehicle, the responsible driver will ensure the proper service, maintenance and care of the vehicle. Service and repair work may be obtained at any SCDOT Maintenance Shop or at the SCDOT Equipment Depot in Columbia, South Carolina. However, the Maintenance Shop in the county in which the vehicle is principally used usually performs such work.

101.4.1.2 Care of Motor Vehicles

There is wide variation in manufacturers' recommendations for periodic servicing of automotive vehicles. The frequency of servicing should be controlled by the conditions under which the vehicle is operated. For this reason, periodic servicing and a preventive maintenance program will be carried out as prescribed by the District Engineering Administrator or the Director of Supply and Equipment. In the absence of such a prescribed program, the manufacturer's recommendations are to be followed. The Resident Construction Engineer and the responsible driver assigned to the vehicle will ensure that the vehicle is kept clean and properly serviced, arranging with the Maintenance Shop for such service work to be performed. Remember that the Maintenance Shop will not always be able to service equipment upon request due to other scheduled work; however, a satisfactory appointment can usually be arranged.

101.4.1.3 Use of Motor Vehicles

Motor vehicles assigned to Resident Construction Engineers are intended for official use only and may not be operated for personal use. Vehicles will usually be parked at the Resident Construction Engineer's office or at the Maintenance Shop at night. In some cases, however, where it is considered most advantageous to the Department, employees may, at the recommendation of the District Engineering Administrator and by approval of the Executive Director, be permitted to drive vehicles home at night. When this is permitted, the driver of the vehicle will be expected to take reasonable precautions to protect the vehicle from damage and vandalism. The driver of any motor vehicle is expected to care for it as though it were personal property. Negligent operation or willful abuse may result in penalizing the driver for all or part of any loss sustained. A vehicle trip log should be maintained for each vehicle.

101.4.2 Equipment and Supplies

101.4.2.1 Acquisition of Equipment and Supplies

Requests for acquisition of SCDOT supplies and equipment should follow the most current procurement procedures.

101.4.2.2 Expendable and Non-Expendable Equipment

All equipment owned by SCDOT is categorized as either expendable or non-expendable. In general, expendable equipment is confined to low-cost units that have rather limited service lives. Where any appreciable capital investment is involved, equipment is classified as non-expendable and will be securely controlled to impose strict custodial accountability on employees to whom the equipment is assigned. When non-expendable equipment is purchased, the Supply and Equipment Division will assign an SCDOT property number to the equipment, and a Property Receipt (Form 557) will be prepared. After being signed by the custodian of the property, copies of the Property Receipt will be properly distributed. Once accountability has been assigned to the custodian, responsibility for the equipment can be relieved by properly executing either a Property Transfer (Form 524) or a Property Disposal Authorization (Form 529). See Section 101.4.2.4 for additional information on disposal of equipment. Equipment custodians will be held fully accountable for the proper use and care of the equipment assigned to them. See Section 101.4.1 for information on motor vehicles.

101.4.2.3 Equipment Inventory

Annually, on June 30th, a complete field inventory will be made of all SCDOT non-expendable equipment. Equipment custodians will receive a list from the Director of Finance for checking and certifying all non-expendable equipment assigned to them. Expendable equipment will be reported on Form 3055B at the same time. Equipment custodians must maintain accurate records of equipment, especially copies of Property Receipts (Form 557), Property Transfers (Form 524) and Property Disposal Authorizations (Form 529) for non-expendable equipment.

101.4.2.4 Disposal of Equipment

Non-expendable equipment may be disposed of by junking or salvaging useable parts, by trading in when purchasing new equipment or by selling outright in an advertised sale. Disposal of the equipment must be processed using a Property Disposal Authorization (Form 529), which will be prepared by the Director of Supply and Equipment and approved by the Executive Director. To initiate the process, the custodian will prepare a Request to Dispose of Accountable Property (Form 3024) for review and approval. As a rule, most equipment assigned to Resident Construction Engineers will be turned in to either the Equipment Depot or to the Office Supply Room for disposal. Under such circumstances, the Custodian is relieved of accountability through the execution of a Property Transfer (Form 524).

101.5 DOCUMENTATION CONSIDERATIONS

101.5.1 Purpose

To ensure compliance before payment is made to the Contractor, the Resident Construction Engineer and the SCDOT Inspectors are responsible for documenting the day-to-day accounts of the work in progress. The information collected and documented serves two purposes:

- to assess contractual compliance with respect to legal issues, scope of work, control of materials and project schedule; and
- to determine the quantity to pay the Contractor for progress on the pay item.

Although both types of information are necessary, they serve different purposes. For example, an SCDOT Inspector could measure and document a quantity for payment; but without the required test results, SCDOT has no way of knowing if the work and materials for the pay item warrant payment in terms of acceptability. In other words, the test results could have conceivably shown that the work and materials measured warranted rejection, not acceptance and payment. Such project records must be accurate and detailed, because they are the only means by which SCDOT can ensure that a project has been constructed as specified. In addition, these project records are critical for project closure and may become important evidence in assigning responsibility for project incidents and determining time, money and liability if a claim is filed.

101.5.2 SiteManager and SCDOT Construction Forms

SCDOT uses SiteManager for Contract administration. SiteManager is an AASHTO computer application that is used to administer construction contracts and facilitates the gathering and maintenance of critical contract records. SCDOT Inspectors are primarily responsible for processing the Daily Work Reports, and Resident Construction Engineers are responsible for processing and approving the Daily Work Reports and Monthly Pay Estimates. SiteManager will maintain a running track of quantities paid and pending, and payment may be initiated once the Resident Construction Engineer approves the Daily Work Reports and generates the Monthly Pay Estimate. In addition, various types of construction forms are required by the Department to supplement the information that is entered into SiteManager. Become familiar with the SCDOT Construction Forms that are required for Contract administration, inspection and sampling and testing and make certain they are legible and thoroughly and accurately prepared. Also consider the benefits of gathering data using digital and video cameras. Such information will be especially useful if a claim or litigation is anticipated. Unless otherwise directed, hard-copy documents will be retained by the Resident Construction Engineer and referenced, as appropriate, in the Daily Work Report. See Section 101.6 for additional information on the use of SiteManager. See Appendix A for a descriptive table of the SCDOT Construction Forms typically used by SCDOT construction personnel.

101.5.3 Documentation for Payment

In general, the Resident Construction Engineer and SCDOT Inspectors must review the Contract and clearly understand, for each pay item:

- key points of inspection;
- acceptance criteria;
- applicable deductions for non-compliance;
- criteria for rejection;
- unit of measurement used to determine the quantity for payment;
- measurements that need to be obtained to calculate the quantity;
- location where the measurements need to be obtained (i.e., field or plans);
- work and materials that should not be measured separately for payment;
- calculations required for determining progress payments; and
- supplemental documents required (i.e., delivery tickets, invoices).

Improper payment documentation may cause administrative delays and difficulties with Contractors. The importance of clearly understanding the method of measurement and basis of payment for each pay item in the Contract cannot be overemphasized. Notwithstanding the responsibilities of SCDOT personnel, this information must be clearly communicated to the Contractor at the Preconstruction Conference. Most Contract pay items will be defined in the *Standard Specifications*; however, as SCDOT policy and methods change, Contract documents may contain overriding criteria in the Supplemental Specifications and Special Provisions.

101.6 SITEMANAGER CONSIDERATIONS

101.6.1 Daily Work Reports

101.6.1.1 General

The Daily Work Reports should begin on the date of the Notice to Proceed. A Daily Work Report should be completed for each day of the project, from the Notice to Proceed until the charging of time is stopped. If additional work is performed on the project (e.g., corrective work, punch list items, etc.), a Daily Work Report also should be completed for each day that such work is performed.

101.6.1.2 Information Tab

Use the following guidelines to complete the information under the Information Tab:

1. General DWR Information. Displays specific information for the Daily Work Report, including Contract ID, Inspector name and date.

2. Locked. This field indicates that the current monthly estimate has been approved. A locked Daily Work Report can not be edited.

3. Authorized. This field indicates whether or not the Daily Work Report has been authorized by the Resident Construction Engineer. The date of authorization will be displayed. An authorized Daily Work Report can not be edited.

4. Weather Conditions. Enter the weather conditions for the day.

5. No Work Items Installed / No Contractors on Site / No Daily Staff on Site. This will indicate whether or not there is information under any of the subject tabs. Note: This checkbox is not always accurate. If a user adds an item and then deletes it, the checkbox will remain empty. Please double-check these boxes to confirm that they are correct.

6. Work Suspended. This feature suspends time charged to the Contractor. Do not use this feature.

7. Remarks. As needed, enter remarks in text box on the right after selecting the appropriate category.

101.6.1.3 Contractor Tab

Use the following guidelines to complete the information under the Contractor Tab:

1. General DWR Information. Displays specific information for the Daily Work Report, including Contract ID, Inspector name and date.

2. Contractor. Use this function to indicate the contractors that are present on the job site. Additional contractors can be added by clicking the New button. Contractors must be included in this window in order to credit their installation of items under the Work Item Tab. All contractors that are present on the jobsite for that given day are to be selected.

3. Supervisor / Foreman Name. Use this location to select the supervisors that were present on the job site. Additional supervisors can be added by clicking the New button.

4. Personnel Type. Use this location to select the personnel types present on the job site. Additional personnel types can be added by clicking the New button.

101.6.1.4 Contractor Equipment Tab

Use the following guidelines to complete the information under the Contractor Equipment Tab:

1. General DWR Information. Displays specific information for the Daily Work Report, including Contract ID, Inspector name and date.

2. Contractor. Use this location to select the contractors that were present on the job site.

3. Equipment ID / Description. Use this location to select the equipment on the job site. Additional equipment can be added by clicking the New button.

101.6.1.5 Daily Staff Tab

Use the following guidelines to complete the information under the Daily Staff Tab:

1. General DWR Information. Displays specific information for the Daily Work Report, including Contract ID, Inspector name and date.

2. Staff. All SCDOT personnel present on the job site are to be entered. New staff members can be added by clicking the New button. Any visitors such as FHWA, consultants, etc. can be entered in the Remarks box.

3. S / C. Use this location to identify the employee as a staff member or consultant.

4. Staff Information. Use this function to input Inspector's hours.

101.6.1.6 Work Items Tab

Use the following guidelines to complete the information under the Work Items Tab:

1. General DWR Information. Displays specific information for the Daily Work Report, including Contract ID, Inspector name and date.

2. General Item Description. Displays the project number, line item number, item code, description, unit price, status and unit type of the present item. This information is loaded into the system with the basic Contract data after award or is entered via a Change Order.

3. Quantity Installed to Date / Quantity Paid to Date. Both of these fields display the quantity of the present item that has been approved and included on an Estimate. The quantity displayed will only apply to the particular project number listed above, not the total Contract quantity for this item.

4. Bid Quantity. This field displays the original Contract quantity.

5. Current Contract Quantity. This field displays the original Contract quantity in addition to any quantity added to the Contract via an approved Change Order.

6. Pay to Plan Quantity. This field primarily applies to lump sum items. Items identified as Pay to Plan Quantity will not allow the system to pay for any quantity in excess of the bid quantity.

7. Location List. This field allows users to enter multiple locations for the same item on one screen. A new location can be entered by clicking on New from this zone and entering the new information.

8. Placed Quantity. Use this field to enter the quantity placed in a particular location.

9. Contractor. This is a drop-down list displaying all contractors who have been approved to install this item and have been added to the Contractor Tab.

10. Plan Page Number. Use this field if referring to a particular page in the plan sheet.

11. Reference Document. Use this field if attaching a reference document.

12. Location. Each individual location installed should be entered in this field.

13. Measured Indicator. Use this field if the installation of this item quantity was measured.

14. Station Numbers. Use this field to enter station numbers, "from" and "to", offset (i.e., "lt" or "rt" for left or right) and distances. Information pertaining to stations, offsets and distances are required for all applicable items. All roadway items should be referenced to station numbers and bridge items may be referenced to bent numbers.

101.6.2 Diaries

101.6.2.1 Approval of Daily Work Reports

The Resident Construction Engineer will use the Diary window to review and approve the Daily Work Reports submitted by SCDOT Inspectors. Once reviewed and approved, the Resident Construction Engineer will check the Approve box on the Diary window. All quantities approved by the Resident Construction Engineer will be included in the next Estimate, provided that the date of the Daily Work Report date is no later than the period end date of the Estimate. A Daily Work Report cannot be edited once approved. If the Daily Work Report has already been approved and editing is necessary, consult the Resident Construction Engineer. Daily Work Reports are irrevocably locked once the estimate they are included in is approved.

101.6.2.2 Charging Contract Time

Each time a Diary is created by entering a date and saving the Diary, a day is charged to the Contractor. A Daily Work Report does not have to be approved for a day to be charged. If a Diary has been created, but a day should not be charged (e.g., before Notice to Proceed date, waiting on punch-list items), the Resident Construction Engineer should click on the Charge Tab on the Diary window and make that day a No Charge day. Diaries must be completed for each charged day beginning with the Notice to Proceed and continuing through the Substantial Work Complete Date at a minimum.

101.6.2.3 Changing the Status of Existing Diaries

When a Diary is created, a day is automatically charged to the Contractor. Once an estimate is generated and approved, a Diary cannot be altered from the Diary window. However, the Resident Construction Engineer can change the status of a Diary to a Charge or No Charge day by using the Diary Adjustments window. To adjust a Diary, the user must first open the Diary Adjustments window and open the Contract and the day to be adjusted via the Open button. Once the individual Diary has been opened, the user can enter the new status and reason code and reason (e.g., prior to Notice to Proceed date, waiting on punch-list items). This window is often used to correct a day charged to the Contractor that should not have been charged.

101.6.3 Change Orders

101.6.3.1 Explanations and Reason Codes

SCDOT personnel who create a Change Order in SiteManager for a Supplemental Agreement or Contract Modification Request must provide an explanation and Reason Code that accurately describes why the Change Order is necessary. This information is critical, because Contract Administration analyzes this data for recurring changes to improve SCDOT's planning process, thus avoiding such changes in the future. Prior to the use of SiteManager, it was not unusual to prepare a single Change Order for the purpose of adding multiple items of work for a variety of reasons. This practice must not be used when creating Change Orders in SiteManager, because it causes administrative delays and defeats the purpose of using the integrated database.

The Reason Code selected for the Change Order must correspond to the explanation and accurately apply to the items of work listed on the Change Order. Before creating a Change Order in SiteManager, review and organize each subject item of work under an appropriate Reason Code. Create one Change Order for each Reason Code identified, listing only those items of work that apply to the Reason Code selected. A full set of Reason Codes is available in SiteManager. Contact Contract Administration with any suggested improvements or additions. Consider the following Reason Codes when creating Change Orders in SiteManager:

1. Claims Settlement. This Reason Code is mostly self-explanatory. If the Contractor pursued a claim on the Contract and the Department completed a Change Order to pay the claim, use this Reason Code, which is applicable if the Department settled the claim internally, if the claim went to a dispute review board or if the claim was concluded through litigation.

2. Contract Time Adjustment. This Reason Code may need to be broken up into more refined categories, because there are a number of reasons that Contract time

adjustments may be justified (e.g., utility delays, utility accommodations, changes to traffic control, allowable work hours, allowable lane closures, additional work or quantities). The use of this Reason Code assumes that a time adjustment is the only function of the Change Order, which is not the typical case. Until Contract Administration and the SiteManager Administrator can effectively refine this Reason Code, ensure that the explanation provides the appropriate details.

3. Cost Savings Proposal/Suggestion. This Reason code pertains to Change Orders initiated as a result of a Value Engineering Proposal submitted by the Contractor.

4. Decreasing/Increasing Quantities. Use this Reason Code when actual and bid quantities for items of work in the original Contract vary to the extent that it is reasonable to adjust the Contract quantities. Overrun and underrun items are included to offset each other to avoid increasing the original Contract amount.

5. Deleting/Adding Items. Use this Reason Code when it is necessary to delete or add completed items of work and their respective quantities. Such items are usually incidental in nature. This Reason Code should not be used when the basis is a significant change to construction or an error in the Contract Plans and Specifications.

6. Design Oversights. This Reason Code should only be used when an error or oversight in the Contract Plans and Specifications has been discovered that could have been foreseen during the design phase. Do not use this Reason Code for changes that arise from field conditions or conflicts that could not have been reasonably anticipated during design. It is anticipated that this category will be further refined. Contact the SiteManager Administrator for additional information.

7. Extension. Use this Reason Code only when the items and quantities are required because of an approved extension request. An extension request must be processed through the proper SCDOT channels and approved by the State Highway Engineer. The Change Order will establish the extension work for administration in SiteManager and will become a supporting document to the approved extension request.

8. Final Quantity Adjustment. This Reason Code should be used only when an audit of the reported quantities or Contractor concurrence of final quantities requires adjustment.

9. Force Account. Work performed on a Force Account Basis will ultimately need to be resolved by negotiating unit prices with the Contractor for the items under dispute. The negotiations must be supported by cost data collected during the actual prosecution of the disputed work. As such, this Reason Code and the Force Account function under the Change Order header in SiteManager must be used to establish, track and resolve the items, quantities and unit prices for the disputed work.

10. Incentive/Disincentive Payment. Use this Reason Code to create a Change Order only when it is necessary to establish an authorized incentive/disincentive payment schedule that is not in the original Contract. Otherwise, use SiteManager's Contract Adjustment or Line Item Adjustment functions for incentive/disincentive payments.

11. Modification by Construction Personnel. This Reason Code should be used when construction personnel encounter field conditions that necessitate changes to the work

or when the District prefers changes to the original design. If the change is due to a condition that could have been reasonably foreseen during the design phase, use the Design Oversights Reason Code.

12. Plan Revision. Use this Reason Code when the Change Order is required to accommodate changes to the work that are shown in a revision to the Contract Plans that has been issued by the Director of Construction. Note, however, if the revision has been issued due to a field modification or design oversight, other Reason Codes will apply (e.g., Design Oversights). Ensure that the proper one is used. Plan Revision applies to changes to typical sections and right-of-way areas that arise from late right-of-way settlements or from public or political requests to revise the original design.

13. Price Adjustment. If conditions are encountered that significantly affect the scope or the work and a price adjustment is warranted, use this Reason Code. This Code generally will apply when major items of work (see Section 101.33 of the *Standard Specifications*) are affected; however, other items may be considered as well. Do not use this Reason Code for price adjustments related to Fuel or Asphalt Price Indices, which will already be authorized in the original Contract provisions. Rather, use SiteManager's Contract Adjustment or Line Item Adjustment functions to adjust payment.

14. Traffic Control Modification. When traffic situations encountered during construction require a change to the Traffic Control Plans and the change results in revised costs to the Contractor, this Reason Code should be used.

15. Other. This Reason Code should be used sparingly and only when the basis for the change cannot be categorized with previously established Reason Codes. When used, however, ensure that the explanation provides adequate detail of the basis for the change. Contract Administration will coordinate with the SiteManager Administrator to create an additional Reason Code, if warranted.

101.6.3.2 Item Quantity and Price

Change Order functions are located on the Change Order Header window. If the quantity of an existing item is being changed, the Overrun/Underrun box should be checked. If the price of an existing item is being changed, or a new item is added, the Extra Work box should be checked.

101.6.3.3 Classification and Approval

Contract changes are classified as either minor or major. Minor changes are those which revise the total Contract amount by no more than $50,000, enforce penalties (e.g., price reductions) in accordance with the Contract Specifications or revise Contract time due to the scope or difficulty of the additional work. All other Contract changes will be classified as major, including Contract time extensions due to weather and utilities. The administration of Federal-aid projects will be based on the FHWA/SCDOT Agreement. Change orders on all Federal oversight projects must be approved by the FHWA (see Figure 107A).

A Change Order under $25,000 with no time adjustment can be processed and approved by the Resident Construction Engineer. If the amount of the Change Order is between $25,000 and $50,000, with or without a time adjustment due to an increase in the scope of work, the District Engineering Administrator must approve the Change Order. All other Change Orders will be considered major (e.g., over $50,000 or with time adjustments due to utility delays, weather, etc.) and must be approved by the Director of Construction. If a Change Order is deemed major, the Resident Construction Engineer will be required to click the check box for Override Approval Rules and manually establish the approval chain as follows:

- Resident Construction Engineer,
- District Construction Engineer,
- District Engineering Administrator,
- Assistant Construction Engineer,
- State Road or Bridge Construction Engineer,
- Director of Construction, and
- FHWA, for Federal oversight projects.

101.6.3.4 Contract Extension Approval

Additional projects will be added to the Contract only after approval by the State Highway Engineer. Once approved, the Assistant Construction Engineer in Columbia will create the project in SiteManager. It will then be the responsibility of the Resident Construction Engineer to create a Change Order adding the items of the project to the Contract. Once items are included in the Change Order contact the Assistant Construction Engineer to establish the funding for the work. See Section 104.4 for additional information.

101.6.3.5 Contractor Concurrence

Once the prices on a Change Order have been agreed upon by the Resident Construction Engineer and the Contractor, the Resident Construction Engineer should create a listing of the prices, quantities, explanations, Reason Codes, etc., and the listing should be signed by the Resident Construction Engineer and the Contractor.

101.6.4 <u>Estimates</u>

101.6.4.1 Generating Estimates

Estimates can only be generated by the first level of approval (i.e., Resident Construction Engineer). Prior to generating an Estimate, the Resident Construction Engineer should check all Diaries to make sure all days are accounted for. From the Generate Estimate window, the ending date should be entered and the type of Estimate should be selected (i.e., Progress, Final, Supplemental), and, finally, the Generate button should be clicked to submit the estimate.

101.6.4.2 Approving Estimates

The Estimate can be approved by up to five levels of approval. From the Approve Estimate window, select the desired Contract from the list box. Select the desired estimate and click the Approved check box for the appropriate level. Click the Save button.

101.6.4.3 Deleting Estimates

From the Estimate History window, select the estimate. Click the Delete button on the toolbar at the top of the page. The user can only delete Pending estimates. Once the estimate has been approved, it cannot be deleted.

101.6.4.4 Final Estimates

To generate the Final Estimate, all Progress Estimates must be approved. All discrepancies must be resolved before the Final Estimate can be approved. To generate an Estimate, select the Final button on the Generate Estimate panel.

101.6.4.5 Estimate Routing

Estimates will be routed as follows:

1. Monthly Estimates. The original signed copy of the Summary to Contractor Report should be mailed to the Contracts Engineer. A copy of the Summary to Contractor Report should be faxed to Accounting.

2. Final Estimate. The original signed copy of the Summary to Contractor Report and the Item Quantity Report should be mailed to the Contracts Engineer.

3. Contractor. A copy of the Summary to Contractor and the Item Quantity Report should be mailed to the Prime Contractor for all Monthly Estimates and for the Final Estimate. Complete SCDOT Form 100.05 – Contractor Concurrence and Prompt Payment.

101.6.5 Payrolls

The first time a Contractor's payroll is recorded, the Contractor must first be selected from the Services / Choose Keys option on the menu bar. Once selected, the user will enter the Date Received, Ending Date, and Select the Certified check box. No payrolls can be entered until the Work Begin Date has been submitted via the Director of Construction Intranet Page. Users are not required to enter individual employee information on subsequent tabs. Payrolls should be certified for the Prime Contractor every week throughout the life of the Contract. Subcontractors, on the other hand, should only be certified for the weeks that they are on site. If a Prime Contractor is not present for a given week, the user must complete the certification process as mentioned above and click the No Employee Hours Worked check box. To see all payrolls entered for a given Contractor, click on the Open button and select the Contractor. The pick list will display all payrolls entered for that Contractor, if that payroll has been certified.

101.6.6 <u>Stockpiles</u>

101.6.6.1 Creating Stockpiles

To create a stockpile in SiteManager, the stockpiled material must first be in compliance with the Contract Specifications. Before payment to the Contractor can be made for a stockpile, it is to be entered in the Stockpiles window in SiteManager, making sure to enter the invoice number, the correct information on the form and the Initial Invoice Payment.

101.6.6.2 Installation of Items

The stockpile amount paid to the Contractor will be displayed on the front sheet of the Summary to Contractor Report, minus any quantities installed that estimate period. The per-unit amount previously paid to the Contractor will continue to be subtracted from the total Stockpile amount as items are installed. This will continue for each stockpile until each one has been depleted and the amount on the front sheet reaches zero.

101.6.6.3 Closing Stockpiles

If a stockpile is to be manually closed out, the user should click on Services and then Close out Balance. This will subtract the remaining dollar amount for that stockpile from the Summary to Contractor report.

101.6.6.4 Replenishing Stockpiles

If a stockpile is replenished, the user must click on Services and then Replenish Material, entering the required information. This should be done instead of creating a new stockpile for that item.

101.7 RESOURCE AND COMMUNICATION CONSIDERATIONS

101.7.1 <u>Revisions to the *Manual*</u>

Recommended changes or additions (e.g., errata, enhancements) to the *Construction Manual* will be received by the Director of Construction. Upon receipt, the recommendations will be reviewed by the Evaluation Committee, which is comprised of SCDOT and FHWA personnel. If approved, updates to the publications will be provided. This is a recurring process that is scheduled as deemed necessary by the Director of Construction. Updates will be made available through the SCDOT Intranet and Internet Web Sites, electronic mail and standard mail, as appropriate.

101.7.2 SCDOT Intranet and Internet Web Site

Most of the Department's information applicable to construction projects is maintained in electronic format on the SCDOT Intranet and Internet Web Site. Significant other information about specific SCDOT operations is also available. The SCDOT Intranet is also used quite frequently during the administration of a construction Contract to communicate between Central, District and Resident Offices (e.g., Material Test Reports).

101.7.3 Inquiries from the Media

Because transportation facilities and services provided by SCDOT are vital to the citizens of South Carolina, the Department receives numerous inquiries from the media regarding the status of various projects, funding, regulations, etc. To ensure that the most accurate and current information is always provided to the media, whether it be newspaper, radio or TV, media inquiries concerning the issues of highway funding, new projects, project updates and any issues that could be considered controversial or sensitive should be referred to the Director of Communications. The Director will be responsible for contacting the appropriate individuals to obtain the information requested and then discussing the issue with either the State Highway Engineer or Director of Construction before contacting the media. An exception to this procedure is answering routine questions regarding construction operations. Another exception to this policy is public meetings where information is provided to the public and the media and where questions are answered face-to-face. This procedure also pertains to press releases. The Communications Office will write and distribute all press releases, except those addressing traffic operations or weekly construction and / or maintenance notices that are routinely provided to the media by District or Resident Offices.

101.7.4 Public Notification

101.7.4.1 Construction Projects

To keep the traveling public informed of construction projects and any delays or closures associated with construction projects, each District should inform the Communications Office by e-mail on a weekly basis. This information should include a listing of construction projects in the District with any lane closures, road closings or special circumstances that may cause traffic delays. The Office will publicize this information and place it on the SCDOT Internet Web Site. This list should be updated every week or, if a special situation occurs, it should be updated as soon as practical.

101.7.4.2 Bridge Replacement Projects

SCDOT requires that the public, legislators and other local officials be properly notified of bridge closings and replacement projects. This notification will be provided through press releases, letters and similar methods. Once a bridge replacement project is let to Contract and awarded, District personnel will send the information to the Communications Office so that a proper notification can be prepared. The following information is required:

- County, route and crossing;
- local road name and/or local bridge name;
- whether the bridge is to be closed or whether traffic will be maintained during construction (explain if traffic will be maintained by off alignment, detour bridge or staging);
- date of expected closure; and
- approximate length of closure and/or completion date.

Other methods of notifying the public may also be used on a case-by-case basis, such as signs, letters to property owners, etc. Figure 101B presents the distribution list that should be used for press releases.

Item	Responsible Office
Local Newspaper(s)/Media outlets	Communications – News Release
City, County and/or Regional Chamber of Commerce	Communications – News Release
US Senator(s) and/or US Representative(s)	District Engineering Administrator – Letter from State Highway Engineer
State Senator(s) and Representative(s)	District Engineering Administrator – Letter from State Highway Engineer
SCDOT District Commissioner	District Engineering Administrator – Letter from State Highway Engineer
COG and MPO Representatives (as appropriate)	District Engineering Administrator
Chairman of the County Council	District Engineering Administrator
County Administrator/Manager	District Engineering Administrator
County Planner	District Engineering Administrator
Chairman of City Council	District Engineering Administrator
Mayor (if different from above)	District Engineering Administrator
City Planner and/or Manager	District Engineering Administrator
Emergency Response Personnel and School Districts	District Engineering Administrator
Local US Post Office	District Engineering Administrator

DISTRIBUTION LIST FOR PRESS RELEASES
Figure 101B

Section 102
Bidding Requirements and Conditions

Section 102 of the *Standard Specifications* governs the requirements and conditions under which bids may be accepted from prospective bidders. Contract Administration, under the Director of Construction, will be responsible for administering the provisions of Section 102. Construction contracts estimated to cost $10,000 or more will be advertised for at least 3 weeks in one or more daily newspapers. If warranted, however, SCDOT may advertise for a longer period and in other publications. The advertisement will be prepared by Contract Administration and signed by the Director of Construction. The advertisement will include the time and place bids will be received, the Project Number or File Number, a brief description of the work, the cost of plans and proposals for each project, prequalification requirements and whether or not a mandatory pre-bid conference will be held.

102.1 PREQUALIFICATION

Section 102.01 of the *Standard Specifications* governs the prequalification of bidders and licensing of contractors. Unless stated otherwise in the advertisement, all prospective bidders must be prequalified with SCDOT prior to bidding. To improve the quality of contracting, SCDOT construction personnel who experience performance problems with a Contractor or subcontractor should document and report the situation to the Director of Construction.

102.2 CONTENTS OF PROPOSAL FORMS

Section 102.02 of the *Standard Specifications* defines the proposal content that will be provided by SCDOT. The proposal form will show the approximate quantities of work to be performed, the time in which the work must be completed, the date, place and time of opening bids, the amount and character of the Proposal Guarantee and any special provisions pertinent to the project.

102.3 INTERPRETATION OF QUANTITIES

Section 102.03 of the *Standard Specifications* governs the interpretation of quantities. The quantities listed in the Contract are based on an engineering estimate and are for bidding purposes only. SCDOT Inspectors must document for payment only those quantities that have been incorporated into the work and accepted by the Department.

102.4 EXAMINATION OF PLANS, SPECIFICATIONS, ETC.

102.4.1 Pre-Bid Conference

If SCDOT specifies a mandatory pre-bid conference, the time and location of the conference will appear in the advertisement. In such cases, bids will only be accepted from prequalified bidders that attended the pre-bid conference. The Program Manager will be responsible for coordinating and facilitating the conference.

102.4.2 Project Examination

In accordance with Section 102.04 of the *Standard Specifications*, it is the responsibility of each prospective bidder to carefully examine the site of the proposed work. Bidders sometimes ask questions requiring the interpretation of contractual documents. In such cases, SCDOT personnel should inform the bidder to bid on the job as the documents are written. Do not provide statements regarding contractual intent. If revisions to Contract Plans and Specifications have been published and distributed, ensure that bidders are equally informed. Document the minutes of each meeting.

102.5 PREPARATION OF PROPOSAL

All bids submitted to SCDOT must be completed on the official proposal form furnished to the Contractor by the Department. Section 102.05 of the *Standard Specifications* defines how the proposal should be prepared and submitted to the Department for consideration.

102.6 ELECTRONIC BIDDING SYSTEM

Section 102.06 of the *Standard Specifications* governs the procedures for using the Electronic Bidding System and the Schedule of Price Sheets provided by the Department to prepare bids for construction projects. The EBS program is available on the SCDOT Internet Web Site. Contact Contract Administration for additional information on how SCDOT receives and processes electronic bids.

102.7 COUNTERPROPOSALS

Section 102.07 of the *Standard Specifications* governs the contractual provisions of counterproposals.

102.8 QUALIFYING LETTERS PROHIBITED

Section 102.08 of the *Standard Specifications* prohibits the submission of qualifying letters with proposals.

102.9 IRREGULAR PROPOSALS

Section 102.09 of the *Standard Specifications* defines what SCDOT will consider to be an irregular proposal. Once let, if the Resident Construction Engineer or an SCDOT Inspector discovers an irregularity in the Contract (e.g., a unit bid price that appears to be materially unbalanced to the detriment of the Department), the Resident Construction Engineer should immediately notify Contract Administration.

102.10 PROPOSAL GUARANTEE

No proposal will be considered unless accompanied by a Proposal Guarantee of the character and amount indicated in the proposal form. Section 102.10 of the *Standard Specifications* defines the requirements of the Proposal Guarantee and requires that each Proposal Guarantee be submitted in the form of a Bid Bond on a properly executed SCDOT Form 674.

102.11 DELIVERY OF PROPOSALS

Section 102.11 of the *Standard Specifications* provides detailed instructions on how to submit the proposal for consideration by the Department.

102.12 WITHDRAWAL OF PROPOSALS

Section 102.12 of the *Standard Specifications* governs the provisions of withdrawing proposals once submitted to the Department.

102.13 PUBLIC OPENING OF PROPOSALS

SCDOT personnel in Contract Administration, under the Director of Construction, will be responsible for coordinating and facilitating the letting. Proposals will be opened and read publicly at the time and place indicated in the proposal form, at which time bidders or their authorized agents are urged to be present.

102.14 DISQUALIFICATION OF BIDDERS

Section 102.14 of the *Standard Specifications* defines the criteria for which the Department will disqualify a bidder.

Section 103
Award and Execution of Contract

The procedures for determining the successful bidder and entering into the Contract are governed by Section 103 of the *Standard Specifications*. Contract Administration, under the Director of Construction, is responsible for administering the provisions of Section 103.

103.1 CONSIDERATION OF PROPOSALS

The provisions of Section 103.01 of the *Standard Specifications* govern how SCDOT will evaluate, accept or reject proposals once they have been opened and read.

103.2 AWARD OF CONTRACT

Section 103.02 of the *Standard Specifications* governs the provisions of awarding the Contract to the successful bidder. The Contract will be awarded to the lowest responsible bidder whose proposal complies with all prescribed requirements. Unless the low bidder agrees to a delay, or unless there exists a Special Provision to the contrary, the award must be made within 30 days after the opening of bids. The Notice of Award will be prepared by Contract Administration, signed by the Director of Construction and forwarded to the successful bidder.

103.3 CANCELLATION OF AWARD

Section 103.03 of the *Standard Specifications* provides for the right of SCDOT to cancel the award without liability to the Department.

103.4 RETURN OF PROPOSAL GUARANTEE

In accordance with Section 103.04 of the *Standard Specifications*, proposal guaranties will be retained by SCDOT until a Contract with the successful bidder has been properly executed. SCDOT then will destroy or dispose of the proposal guaranties as requested in the bidders' proposals.

103.5 BOND REQUIREMENTS

Section 103.05 of the *Standard Specifications* defines the type and value of bonds that are required by the successful bidder prior to executing the Contract.

103.6 EXECUTION AND APPROVAL OF CONTRACT

Section 103.06 of the *Standard Specifications* defines the requirements for executing and approving of the Contract, which must occur within 20 days after the Notice of Award.

103.7 FAILURE TO EXECUTE CONTRACT AND FILE BOND

In accordance with the provisions of Section 103.07 of the *Standard Specifications*, if the successful bidder fails to execute the Contact and file the required bonds within 20 days after the Notice of Award, such failure is just cause for annulment of the award and forfeiture of the bidder's Proposal Guarantee.

103.8 CONTRACTOR'S LIABILITY INSURANCE

Section 103.08 of the *Standard Specifications* defines the type and amount of coverage for liability insurance that must be provided by the Contractor. Required Certificates of Insurance must be filed with Contract Administration prior to starting work on the project.

103.9 DEFERRAL AND CANCELLATION OF CONTRACT

Once the Contract has been executed, Section 103.09 of the *Standard Specifications* defines the provisions under which SCDOT can defer or cancel the Contract with respect to indictment or conviction on criminal charges.

103.10 MOBILIZATION

Mobilization is considered the preparatory work required for the Contractor to start the project. Section 103.10 of the *Standard Specifications* defines the work for mobilization.

103.11 MEASUREMENT AND PAYMENT (MOBILIZATION)

Section 103.11 of the *Standard Specifications* defines how mobilization (see Section 103.10) will be measured and paid. Unless otherwise specified, mobilization, which includes demobilization, will be a lump sum Contract pay item which will be measured and paid for in the first, second and last Monthly Payment Estimates. These partial payments will be as defined in Section 103.11 of the *Standard Specifications*. If the final payment for mobilization occurs on the last Monthly Payment Estimate of the project, do not approve the Estimate for payment until all work on the project has been completed and accepted.

103.12 PROJECT INITIATION

Upon receipt of a properly executed Contract from the successful bidder, Contract Administration will upload from BAMS the required data to initiate the project in SiteManager. Once the District Construction Engineer has assigned a Resident Construction Engineer to the project and authorized the Resident Construction Engineer in SiteManager, then the Resident Construction Engineer will be responsible for initiating the project in SiteManager and preparing and forwarding the Notice to Proceed to the Contractor. See Section 101.6 for additional information on administering contracts via SiteManager. Mobilization will be measured and paid for in accordance with Section 103.10 and 103.11.

Section 104
Scope of Work

As soon as practical after being assigned to the project, the Resident Construction Engineer should study the Contract Plans and Specifications in relation to existing field conditions and initiate any changes to the Contract deemed necessary to complete the project in accordance with best highway engineering practices and the intent of the design. In addition, once the work has begun, immediate action should be taken to facilitate Contract changes that may be required so that the Contractor's schedule of operations will not be impeded. Section 104 of the *Standard Specifications* governs the scope of work of the Contract and provides for its revision, if necessary. A revision to the scope of work will require the creation and proper execution of a Change Order using SiteManager (see Section 101.6.3).

104.1 INTENT OF CONTRACT

Section 104.01 of the *Standard Specifications* defines the intent of the Contract. In general, the intent of the Contract is to provide for the construction and completion of the scope of work described.

104.2 ALTERATION OF PLANS OR CHARACTER OF WORK

104.2.1 Overview

Section 104.02 of the *Standard Specifications* provides SCDOT with the right to increase or decrease quantities and to alter the work within the scope of the original Contract. In such situations, a Change Order will need to be created and properly executed using SiteManager, as discussed in Section 101.6.3. The *Standard Specifications* and the Contract Special Provisions will govern the limits on such revisions and the extent to which quantities and unit prices may be adjusted.

104.2.2 Deletion of Roads and Road Sections

Do not confuse the deletion of work items with the deletion of roads or road sections from the Contract. For example, an authorized deletion of a surface course pay item from a Contract for a particular road section does not imply an authorized deletion of the entire road section from the Contract. Similarly, an authorized deferment of work on a particular road does not imply an authorized deletion of the road from the Contract. The temporary deferment of work on roads or road sections requires authorization and is sometimes necessary due to factors such as right-of-way difficulties. Such deferment provides SCDOT time to resolve the difficulties so that the work can be resumed under the original Contract. However, when progress on the Contract has neared completion and it is unreasonable to expect the Contractor to proceed with the deferred work once the difficulties have been resolved, deletion of the road or road section may be warranted.

104.2.3 <u>Changes to Construction Quantities</u>

Overruns and underruns in pay item quantities require the creation and proper execution of a Change Order, as discussed in Section 101.6.3. During the life of the project, the Resident Construction Engineer should try to balance overruns and underruns in pay item quantities to maintain the total amount of the original Contract. The potential for an increase in the total Contract amount due to gross overruns in pay items should be closely monitored, especially for unclassified excavation and roadway leveling courses. If problems are suspected, immediately investigate the matter and contact the District Construction Engineer for any needed assistance.

If a construction change involves changing, adding or deleting quantities or pay items, a revised Summary of Estimated Quantities sheet must be provided with the changed plan sheet(s). Figure 104A presents an example note to be placed below the original quantities. The original quantities must not be changed. The note should include the date of the revision and the sheet number(s) of the revised sheet(s). The changes should be listed in the order shown in the example, as applicable. The quantities shown should include a (+) for additional or a (-) for subtracted quantities. Future revisions should be listed beneath the previous revision. Additional Summary of Estimated Quantities sheets may be added if necessary.

104.3 VALUE ENGINEERING

The provisions of Section 104.03 of the *Standard Specifications* encourages Contractors to submit Value Engineering Proposals. Upon receipt, the Resident Construction Engineer will contact the appropriate SCDOT personnel to discuss the original design intent and the potential merits and cost savings of accepting the proposal. Contact the District Construction Engineer for guidance in determining who should be involved in the review. If approved by the Department, the Value Engineering Proposal will require the creation and proper execution of a Change Order using SiteManager, as discussed in Section 101.6.3.

104.4 EXTENSION OF CONTRACT

104.4.1 <u>Overview</u>

Section 104.04 of the *Standard Specifications* defines the provisions within which SCDOT may offer Contractors additional work beyond the limits of original Contracts or extend Contracts to include additional roads. Although Contractors are required to accept quantity increases and decreases within the limits specified, as discussed in Section 104.2, Contractors are not obligated to accept Contract Extensions offered by the Department.

SUMMARY OF ESTIMATED QUANTITIES

Item No.	Pay Item	Quantity	Pay Unit
1031000	MOBILIZATION	1	LS
1050800	CONST. STAKES, LINES & GRADES	1	EA
1071000	TRAFFIC CONTROL	1	LS
1090200	AS-BUILT CONSTRUCTION PLANS	1	LS
2012000	CLEAR. & GRUB. WITHIN ROADWAY	1	LS
2013050	CLEARING & GRUBBING DITCHES	0.5	ACRE
2031000	UNCLASSIFIED EXCAVATION	4165	CY
2033000	BORROW EXCAVATION	7797	CY
2034000	MUCK EXCAVATION	3717	CY
3050108	GRADED AGGR. BASE COURSE – 8″ UNIF	10215	SY
3069900	MAINTENANCE STONE	50	TON
3103000	H/M ASPH. AGG. BASE CR. – TYPE 2	2746	TON
4010005	PRIME COAT	2759	GAL
4011004	LIQUID ASPHALT BINDER PG64-22	232	TON
4013990	MILL. EXISTING ASPHALT PAVEMENT – VARIABLE	2820	SY
4023000	H/M ASPHALT. CONCRETE BINDER CR. – TYPE 2	991	TON
	Revised Pay Items – DD/MM/YY – Affected Sheets 4, 6, 7		
	Pay Items Revised	**Adjustments to Quantities**	
2034000	MUCK EXCAVATION	-500	CY
3069900	MAINTENANCE STONE	+25	TON
	Pay Items Deleted		
4013990	MILL. EXIST. ASPH. PVMT. – VARIABLE	-2820	SY
	Pay Items Added		
4031100	H/M ASPH. CONC. SURF. CR. TYPE 1	+1013	TON

CHANGES TO CONSTRUCTION QUANTITIES
Figure 104A

104.4.2 Highway-Railroad Grade Crossings

Highway-railroad grade crossings, which may occur in roadway sections of Contract Extensions, must be brought to the attention of the Central Office so that the grade crossings can be properly coordinated with the Railroad Company.

104.4.3 Municipal-State Highway Projects

When a road or section of road is within the corporate limits of a municipality, it will be necessary to obtain a Municipal-State Highway Project Agreement (SCDOT Form 807). The execution of this Agreement is usually the responsibility of the Right-of-Way Section; however, some Contract Extensions may require the Resident Construction Engineer to become involved. In such cases, contact the District Engineering Administrator for assistance.

104.4.4 Authorization Process

Requests for Contract Extensions must be approved by the State Highway Engineer and can only be initiated after the right-of-way has been acquired, the plans have been completed, the proposed work has been programmed and the funding made available. The following procedures will be used to authorize all Contract Extensions:

1. Upon arrival of the request by the State Highway Engineer, the District Engineering Administrator will review projects in the county in which the proposed work is to be performed. If no similar projects are underway in the same county, similar projects in adjacent counties will be considered. The District Engineering Administrator will figure the total estimated cost for the extended work for each project being considered. The same unit prices as in the existing Contracts will be used to determine the cost. To make an accurate assessment, it may be necessary to make preliminary Contracts with Contractors having the existing Contracts and obtain quotes for items not included in each respective Contract. The District Engineering Administrator will establish a list of projects, prioritizing them in order, from the least to the highest cost to the Department.

2. The stipulations in Item #1 may be waived if, in the opinion of the District Engineering Administrator, it is in the best interest of SCDOT to extend the additional work to a particular Contract. Documentation supporting this position will be submitted along with the other information required by these procedures. If this option is used, Item #5 would be the next step. Also, only the applicable portions of Item #7 would be necessary.

3. After this determination has been made, the Contractors for the projects should be contacted in order of priority to determine their interest and willingness to accept the additional work. Results of the contacts should be documented. If contacts are made by telephone, the results of the contacts should be confirmed in writing to those Contractors expressing no interest in the additional work.

4. When reviewing Contracts to be extended, other factors, such as Contract status and completion dates, should be considered. If extenuating circumstances, such as those previously stated, prevent a Contract from being considered for extension, the District Engineering Administrator will document the reasons.

5. Once the Contract to be extended has been determined, the District Engineering Administrator will obtain a signed statement from the Contractor indicating their willingness to accept the extension. The Statement will also address the need for additional time or state that no additional time will be necessary. Consider the following:

    a. The amount of additional time will apply only to the additional work and will be commensurate with the amount and difficulty of the added work, thereby not affecting the original/revised completion date for previously authorized work in the Contract.

    b. Consideration may be given to allowing additional time for the entire Contract, including the additional work. However, the extension will not be issued to allow additional time to avoid liquidated damages for any original Contract work.

    c. If a Contractor is unwilling to accept the additional work with a reasonable time extension, as detailed in Item #5a and #5b, these facts should be documented, and the next Contractor in order of priority should be contacted.

6. If no Contractor is willing to accept the work in accordance with the above conditions, the State Highway Engineer will be advised, in writing, accordingly.

7. If a Contractor is found who is willing to accept the extended work as detailed above, the District Engineering Administrator will forward the recommendation for the extension to the State Highway Engineer. The recommendation should include the File Number to which the additional work is to be extended and should indicate if the Contract recommended for extension resulted in the least cost to the Department. If the Contract recommended for extension is not the Contract that would result in the least cost, the documentation supporting the recommendation will be forwarded to the State Highway Engineer with the letter of recommendation. The signed Statement from the Contractor, as required by Item #5, will also be transmitted along with the letter.

8. After all information necessary to authorize the extension has been received, including any Supplemental Agreements, a letter to the Contractor will be prepared for the State Highway Engineer's signature, authorizing the extension. Final authorization will be subject to the approval of the Executive Director. Verbal request for authorization will not be considered, and verbal authorization to proceed with work will not be issued until the Executive Director has approved the extension.

9. If the amount of the extension exceeds 50% of the total amount of the original Contract, or $100,000.00, whichever is the lesser amount, the State Highway Engineer will present the extension to the Commission and receive approval prior to any work being performed.

10. The District Engineering Administrator will be sent a copy of the Letter of Authorization, signed by the State Highway Engineer and approved by the Executive Director. This letter will serve as authority to proceed with the extended work.

104.4.5 Change Orders

Upon authorization of a Contract Extension by the State Highway Engineer, a Change Order for the additional work will need to be created and properly executed using SiteManager, as discussed in Section 101.6.3.

104.5 EXTRA WORK

Section 104.05 of the *Standard Specifications* requires the Contractor to perform unforeseen work for which there is no price scheduled in the Contract. Because this is considered Extra Work, the Resident Construction Engineer must use SiteManager to create and properly execute either a Change Order or a Force Account Work Order, as appropriate, before initiating the work (see Section 101.6.3). The Change Order will be used to establish the unit prices for the unforeseen work and to revise the allotted Contract time, if the addition of the unforeseen work will negatively impact the critical path of the project. On the other hand, if the item is lump sum and its scope has changed significantly from what was originally intended or a change to the Contract Specifications is required, the Change Order will be used to revise the amount of the original lump sum. A Force Account Work Order will be used to provide for unforeseen work when SCDOT and the Contractor cannot agree on unit prices for the additional items of work. See Section 109.4 for additional information on Extra Work and Force Account Work.

104.6 DETOURS AND HAUL ROADS

Section 104.06 of the *Standard Specifications* governs the provisions for establishing, constructing, using and maintaining detours and haul roads.

104.7 MAINTENANCE AND MAINTAINING TRAFFIC

104.7.1 Overview

Section 104.07 of the *Standard Specifications* governs the provisions for maintaining roadways open to traffic and for maintaining traffic through the work zone. It is the responsibility of the Resident Construction Engineer to ensure compliance with these provisions, paying particular attention to public convenience and safety. These provisions cover the maintenance of adjacent roadways and access drives until the facility has been completed. At the Preconstruction Conference, the Resident Construction Engineer should stress to the Contractor the importance of these provisions. Changes to the Traffic Control Plan and associated pay items in the Contract will require a Change Order, as discussed in Section 101.6.3. See Sections 601, 602 and 603 for additional information.

104.7.2 Maintenance of Secondary Highways

Neither the Contractor nor SCDOT will assume responsibility for maintenance of Secondary Highways added under SC Code Annotated Section 57-5-70 (1976) until the Contractor begins construction. The Contractor will be responsible for maintenance as soon as work is begun on a road regardless of the nature of the work being performed by the Contractor. The agency or governmental entity having jurisdiction over the road prior to its being placed in the State Highway Secondary System will be responsible for maintenance until the Contractor assumes the responsibility.

Maintenance by the Contractor will include the maintenance of bridges. If a bridge is damaged as a result of being overloaded by the Contractor's equipment, the Contractor will be responsible. The Contractor will not be responsible for the failure of a bridge through general public use and the use of equipment within the licensed capacity of the equipment.

If there are sections of a road on which the Contractor is requested to perform no work due to right-of-way difficulties of for other reasons, the Contractor will be expected to maintain these sections of road until such sections are deleted from the Contract. After deletion of these sections, the Department will maintain them until they are removed from the Construction Program.

In the event the Contractor, after beginning construction, fails to provide adequate maintenance on a road being used by traffic and does not correct unsatisfactory conditions immediately upon notice, necessary maintenance will be provided by the Department and the cost of such work will be charged to the Contractor.

104.7.3 Road and Bridge Damage By Contractor

The Resident Construction Engineer should be very watchful of any damage being done to a base, pavement or structure by loaded vehicles of the Contractor. Such damage will shorten the life of the roadway and will not be tolerated by SCDOT. Quite often an existing pavement is being retained on a project, and special care must be exercised not to let the Contractor damage such pavements.

In most instances, pipe lines are laid prior to the grading operation. The Contractor should be required to take every precaution against damaging pipe lines by knocking them out of line and grade by careless use of heavy equipment. After the grading operations have been completed, the Resident Construction Engineer should inspect all pipe lines and structures to determine if there has been any damage during the grading operations. Necessary corrections should be made by the Contractor prior to the placing of the base course.

Quite often the appearance of bridges, culverts, concrete curb and gutter and sidewalk are marred by lack of proper protection during the asphalt surfacing operations or the application of other asphalt material. When asphalt work is being performed adjacent to such structures, the work must be carried out in such fashion to prevent the asphalt material from marring their appearance. Any asphalt which is splattered on the structure must be removed.

The Contractor should be instructed to use care in rolling operations at the ends of structures so as not to damage flared curbs or ends of concrete decks. Occasionally during the pulling of ditches and the dressing of shoulders, freshly laid asphaltic surfacing is damaged by the Contractor's equipment. The Contractor should be required to use such equipment and methods as necessary to prevent such damage. In the event of damage to the surfacing, necessary repairs must be made.

104.8 REMOVAL AND DISPOSAL OF STRUCTURES AND OBSTRUCTIONS

104.8.1 General

Section 104.08 of the *Standard Specifications* governs the provisions for the work and the disposition of materials related to the removal of structures and obstructions.

104.8.2 Merchantable Timber

104.8.2.1 Contract Review

Prior to clearing and grubbing, the Resident Construction Engineer will review the Contract Plans and Specifications, Special Provisions and right-of-way agreements, including landowner agreements, to determine the disposition of any merchantable timber. Verify that the trees are clearly marked in the field as merchantable timber.

104.8.2.2 Property of Contractor

The timber will generally become the property of the Contractor and will be removed from SCDOT right-of-way. Do not allow the Contractor to stockpile the timber on private property unless the Contractor has a properly executed agreement with the landowner. Do not allow the Contractor to cut timber outside the construction lines except as specified or otherwise designated by the Resident Construction Engineer.

104.8.2.3 Property of Landowner/Grantor

When the Contract specifies that the timber will become the property of the landowner, contact the landowner before the timber is cut to determine the desired length of sections, stockpile location and time of pickup. Verify that the Contractor performs this activity as desired by the owner. There may be some locations on primary projects where the timber will become the property of the land grantor. Check the Special Provisions, and verify that the timber is cut and stockpiled for the land grantor. Merchantable timber on secondary road construction becomes the property of the grantor, unless specified otherwise.

104.8.2.4 Property of SCDOT

When the Contract specifies that the timber will become the property of the Department, verify that the timber is cut and stockpiled on the project right-of-way. The lengths of sections should be in the best interest of the Department with respect to transport and resale. Once a sufficient quantity of timber has been stockpiled, notify the District Construction Engineer in writing to discuss disposition and pickup. On most projects, the value of the timber is included in the appraisal of the property, and the owner is compensated for the timber within the right-of-way. Contact the South Carolina Forestry Commission, as needed, for information on tree types, sizes, cutting methods and merchantable lengths of timber.

104.9 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK

Section 104.09 of the *Standard Specifications* defines the contractual rights of excavated or dismantled materials and how they may be used on the project.

104.9.1 Legal Reference

The reuse or disposal of non-hazardous surplus materials generated from SCDOT projects is governed by the provisions of the Contract with respect to rights of ownership and the regulations promulgated by SCDHEC. Depending on the disposition of the material, other Federal, State and local environmental regulations may apply, as discussed further in Section 107.26.

104.9.2 Reuse of Excavated Material

104.9.2.1 Embankment and Shoulder Material

Where suitable material is encountered during excavation and near locations where embankment material is to be placed, the material will be salvaged and reused. The decision to salvage the material must be based on economics. Shoulder material is the most commonly salvaged material. The salvaging of this material is usually performed during the first stages of the grading operation with the material being stockpiled at selected locations within the right-of-way for future use. This material should not be stockpiled in excess of its need. If staged construction is specified, the needs of the remaining Contract also must be considered.

104.9.2.2 Embankment Topping

The Contract Specifications require the Contractor to preserve the best material for constructing the top portion of embankments. This material should not be excavated and stockpiled but should remain in its original position until the embankment is built up to the elevation where the best material can be excavated and placed on the fill. Use experience and available soil test reports in selecting the material to be preserved for topping embankments.

104.9.2.3 Stone, Gravel and Sand

If the material is suitable and its use will be in the best interest of the Department, the Resident Construction Engineer may elect to allow the Contractor to reuse stone, gravel and sand that is uncovered during project excavation. In such cases, measure and pay for both the excavation of the material and for the pay item on which the excavated material is used. However, if the excavated material was needed for fill but the Contractor elected to use the material elsewhere, the Contractor must replace the excavated material at their own expense. Note that the Contractor is not permitted to excavate material within the right-of-way from locations outside the grading limits, unless authorized by the Resident Construction Engineer.

104.9.3 Surplus Soil Material

104.9.3.1 General

Where surplus soil material is generated from cutting high shoulders, cleaning of ditches, reducing backslopes or other construction or maintenance activities, SCDOT will require the Contractor to dispose of the material in such a manner as to promote the best interest of the Department.

104.9.3.2 Reuse of Surplus Soil

Prior to earthwork operations, inspect the project to determine whether surplus soil material will be generated and if it can be used on the project. Contact the Resident Maintenance Engineer to determine if the material can be used on other SCDOT right-of-way. Surplus soil material can be effectively used as follows:

- topsoil;
- correcting low shoulders;
- widening shoulders;
- regrading eroded ditch lines;
- backfilling washes in foreslopes, backslopes and fills;
- widening fills and flattening slopes for safety;
- landscaping at interchanges and other areas with wide right-of-way; and
- stockpiling, if SCDOT storage is sufficient and haul distance is reasonable.

104.9.3.3 Disposal of Surplus Soil

Where surplus soil cannot be reused, the following applies to the disposal of the material on private property:

- surplus soil can be placed on private property only if SCDOT has determined that such placement is in the Department’s best interest;

- placement of surplus soil on private property must be approved by the District Engineering Administrator;

- placement of surplus soil on private property will be limited to the landowner whose property adjoins the roadway that is being reworked, and the location where the surplus soil is deposited must be within 300 feet of the roadway in accordance with SC Code Annotated Section 57-3-770; and

- an agreement with the landowner, SCDOT Form 200.04 – Agreement for Placing Debris on Private Property, must be properly executed before any surplus soil is placed on private property.

If any unusual request for surplus soil or other condition not covered in the above arises, contact the District Engineering Administrator for assistance in determining the proper disposition of the material.

104.10 FINAL CLEANING UP

Section 104.10 of the *Standard Specifications* governs the provisions for cleaning up after construction, which is required prior to acceptance and final payment.

Section 105
Control of Work

105.1 AUTHORITY OF THE ENGINEER

The Resident Construction Engineer will be the final SCDOT spokesperson to the Contractor Superintendent with respect to decisions regarding the quality and acceptability of the work, materials and rate of progress, all interpretations of the Contract Plans and Specifications and the acceptability of the progress toward completion of the Contract. Contact the District Construction Engineer for any needed assistance.

105.2 THE PLANS, WORKING DRAWINGS AND SHOP PLANS

Section 105.02 of the *Standard Specifications* governs the provisions for interpreting the Contract Plans, Working Drawings and Shop Plans. See Section 725 for additional information.

105.3 CONFORMITY WITH PLANS AND SPECIFICATIONS

Section 105.03 of the *Standard Specifications* governs the provisions of the Contract with respect to the Contractor's conformity with the Contract Plans and Specifications.

105.4 COORDINATION OF PLANS, SPECIFICATIONS, ETC.

Section 105.04 of the *Standard Specifications* defines how to interpret discrepancies in contractual documents. If the Resident Construction Engineer finds a discrepancy in the Contract documents before or during construction, immediately investigate the matter and initiate a Change Order, when appropriate, on behalf of the Department as discussed in Section 101.6.3.

105.5 COOPERATION BY CONTRACTORS

Section 105.05 of the *Standard Specifications* establishes the provisions for the expected cooperation by the Contractor. The primary interface will be between the Resident Construction Engineer and the Contractor Superintendent. Impartial enforcement of Contract requirements should be administered. SCDOT Inspectors must be thoroughly familiar with the Contract Plans and Specifications. Evidence of such knowledge will gain respect and cooperation.

105.6 COOPERATION WITH UTILITIES

105.6.1 Overview

Utility facilities that may be affected by SCDOT construction projects may be publicly or privately owned and any needed utility work, such as relocations or adjustments, will require the cooperation of the affected utility companies, the Contractor and the Department. When required, utility work will be coordinated and executed in accordance with the applicable sections of 23 CFR 645A & 645B and Chapter 5 of the *SCDOT Highway Design Manual*. SCDOT personnel should strive to minimize utility conflicts through all stages of project development and construction. Section 105.06 of the *Standard Specifications* governs the contractual responsibilities of the Contractor for cooperating with utility companies. Section 107.22 of the *Standard Specifications* governs the Contractor's responsibility for protecting utility property and services and for damage to utility facilities caused by the Contractor's operations.

105.6.2 Investigation of Prior Rights

Prior to advertising for bids, the Resident Construction Engineer will examine the project plans carefully to determine utility coordination requirements and then arrange a meeting with affected utility companies to locate existing utilities and schedule relocations and adjustments. If utility work is necessary, the Resident Construction Engineer will request from the utility company information on easements and other documentation necessary to determine whether SCDOT or the utility company has prior rights. If the utility company cannot establish prior rights or is located within SCDOT right-of-way by encroachment permit, utility work must be performed at the cost of the utility company and the utility company must prepare relocation plans and furnish SCDOT with a Letter of No Cost. If the utility company can establish prior rights and SCDOT is to participate in the cost of the utility work, the utility company will prepare and submit the necessary forms, drawings and information as discussed in Section 105.6.4. Copies of the project plans will be furnished to each affected utility company to assist in their drafting any needed plans for relocation or adjustments.

105.6.3 Notification of Utilities

A minimum of 10 days notification of a Preconstruction Conference will be given to utility companies. In addition to the standard information, this notification will include a copy of the proposed agenda for the conference and a request that the utility company be prepared to discuss all aspects of the relocation of its facilities including the submission of a progress or work schedule. The utility company will be requested to send someone to the Conference who is knowledgeable and who can speak with authority for the company. The company will be requested to furnish the name of a contact person or persons who will be available for the duration of the project for coordination with the Department and the Contractor. On projects with major utility involvement, a utility agreement, cost estimate and plans may be necessary prior to the Conference.

105.6.4 Utility Agreement, Cost Estimate and Plans

If the utility company has no prior rights, the company is required to prepare and submit plans for the utility work together with a Letter of No Cost. However, if the utility company has prior rights and requests reimbursement, the company will prepare and submit SCDOT Form 100.12 – Utility Agreement, together with a detailed cost estimate and plans for the utility work. Upon receipt, the Resident Construction Engineer will review the submittal for completeness and prepare and forward recommendations through the District Construction Engineer for review and approval by the Utilities Office. The Utilities Office will coordinate any needed review by the FHWA. Utility plans must include the following information:

- legend;
- location of facilities to be relocated or adjusted in relation to centerline stationing;
- utility facilities that are occupying public lands;
- vertical and horizontal clearances; and
- location, type, size and class of major items of material for:
    - existing facilities to be adjusted,
    - temporary facilities to be installed,
    - permanent facilities to be installed, and
    - facilities to be abandoned.

Cost estimates for utility work must include the following information:

- items of work to be performed;
- detailed costs for the utility work, including:
    - labor costs,
    - construction overhead charges,
    - costs for materials and supplies,
    - handling charges,
    - transportation and equipment charges,
    - right-of-way costs,
    - preliminary engineering costs, and
    - construction engineering costs.
- items of material representing major components;
- factors included in construction overhead charges;
- betterment and extended-service-life credits due, including calculations; and
- itemized salvage credit due.

105.6.5 Authorization to Proceed

The term “authorize utility companies to begin relocation work” means that, if possible, after consulting with the Resident Construction Engineer, the utility will begin relocating their facilities. If this is not feasible, the companies should begin procuring the necessary materials, etc., and be prepared to perform the work. For Federal-aid projects, the Utilities Office will authorize all utility companies to begin relocation work. For C Projects and Non-Federal-aid projects, the Utilities Office will authorize those companies with executed agreements to begin relocation work. The District Engineering Administrator will authorize companies with relocation sketches to begin relocation work.

105.6.6 Inspection of Utility Work

When SCDOT participates in the cost of utility work, the Resident Construction Engineer will be responsible for ensuring that the utility work is properly inspected and that field notes are adequately maintained. Periodic inspections should be performed to ensure that the utility work is being performed in accordance with utility plans. Document these inspection records as discussed in Section 105.6.7. When the work is performed by the utility company in which SCDOT does not participate, ensure that the Contractor maintains complete and accurate records of the utility work as it progresses and that the work is being performed in compliance with the utility plans. Although it is not necessary for SCDOT personnel to maintain detailed records of utility work in which SCDOT does not participate, SCDOT records should minimally indicate compliance and the approximate dates on which the utility work was performed. It is the responsibility of the Resident Construction Engineer, the District Utilities Coordinator and the District Construction Engineer to follow-up as often as necessary with utility companies to ensure that appropriate progress is being made. If assistance is needed in this area, after efforts by the Resident Construction Engineer and the District Construction Engineer have not produced results, then the Utilities Office must be notified with a request for assistance and the type of assistance needed.

105.6.7 Inspection Records

Records of utility work, including temporary work performed in which SCDOT participates, are to be maintained in the Daily Work Report and SCDOT Form 100.13 – Utility Field Daily Diary. A diary sheet is to be fully completed for each day the utility company works on the project. The first diary sheet should be labeled Report #1 and subsequent diary sheets should be numbered consecutively. A different diary is to be maintained for each utility agreement, even though the agreements may be for utility work on the same project. Major materials (e.g., poles, cross-arms, guy-wires, conductors, lengths and size of pipe) must be recorded on the diary sheets and labor records are to be fully completed for each day. The labor and material records must be compared against the final billing prior to payment. If material from the utility work is scrapped or junked, the material must be inspected and an entry in the Daily Work Report provided as to the disposition of the material. The Utility Field Diary must be forwarded to the Utilities Office with the final invoice for each utility agreement.

105.6.8 Utility Agreement Revisions

If changes are made after a utility agreement has been executed and the changes affect the utility agreement, notify the Utilities Office. If an urgent condition exists, verbal authorization may be granted upon approval by the Utilities Office, until the revised utility agreement can be processed and approved. Such practice will avoid delaying construction. Minor changes in construction or minor changes in cost need only be noted in the Daily Work Report.

105.6.9 As-Built Plans

The final location of all utilities within the project limits will be shown on the As-Built Plans.

105.6.10 Final Invoice

In accordance with requirements to close out utility agreements within 6 months of completing the utility work, once a utility company has completed its work under the terms of an agreement, the Resident Construction Engineer will request a final invoice from the company. The utility invoices will be reviewed and recommended for approval by the Resident Construction Engineer and District Engineering Administrator and then forwarded to the Utilities Office for processing.

105.7 COOPERATION BETWEEN CONTRACTORS

Section 105.07 of the *Standard Specifications* establishes the expected cooperation and assignment of prior rights to Contractors under separate Contract on the same highway facility.

105.8 CONSTRUCTION STAKES, LINES AND GRADES

105.8.1 Responsibility for Survey Work

Section 105.08 of the *Standard Specifications* governs the contractual requirements of construction stakes, lines and grades, including the division of responsibilities between SCDOT and the Contractor (i.e., partial SCDOT responsibility, 100% Contractor responsibility for roadway work, 100% Contractor responsibility for bridge structures). Check the Special Provisions of the Contract for additional information.

The most predominant case is that the Contractor performs 100% of the construction surveying and staking, which allows the Contractor full control over scheduling to prevent project delays. When the Contractor is fully responsible for surveying and staking, the Resident Construction Engineer will be responsible for ensuring compliance. See Figure 105A for guidelines on the minimum frequency of verifying Contractor surveying and staking.

BRIDGES			
Item	**Verification of**	**Shot Location**	**Frequency**
Footings	Elevation	Corners	Each Footing
Columns	Elevation	Top of Column	Each Column
Bent Caps	Elevation	Corners	Each Cap
Drilled Shafts	Elevation	Top of Shaft	Each Shaft
Piles	Elevation	Cut-off Elevation	One Pile per Bent
Bridge Beam Seats	Being Level	Corners and Mid-point	Each Seat
Armor Plates	Elevation	Crown and Face of Parapet	Each Plate
Bents	Distance Between	Bents	Each Span
ROADWAYS			
Item	**Verification of**	**Shot Location**	**Frequency**
Curb and Gutter	Line and Grade	Top of Curb	10% of hubs
Pipes / Culverts	Flow Line	Invert	Each Line of Pipe (excluding driveway pipe)
Catch Basins	Flow Line / Top of Box	Invert / Top of Box	10% of Boxes
Subgrade	Line, Grade and Cross-slope	Stagger Across Roadway (C/L, EOP, Lanes)	Every 500' on Station
Base	Line, Grade and Cross-slope	Stagger Across Roadway (C/L, EOP, Lanes)	Every 500' on Station
Surface Course	Line, Grade and Cross-slope	C/L, EOP. Lanes	Every 500' on Station
Retaining Walls	Line and Grade	Top of Wall	Every 100'
Barrier Walls	Line and Grade	Top of Wall	Every 250' on Station

Notes:

1. *Alignment and elevations should be checked more frequently at the beginning of the project to ensure that proper benchmarks, etc. are being used.*

2. *All survey checks should be kept in one central location.*

MINIMUM FREQUENCY OF VERIFYING SURVEY CONTROL
Figure 105A

When SCDOT is partially responsible for survey work, the work is usually for setting hubs, slope stakes, centerline stakes and grade stakes (i.e., blue tops) and it will be the responsibility of the Resident Construction Engineer to ensure that the Contractor is provided with sufficient control to the proper degree of accuracy to allow the Contractor to construct the work in accordance with the Contract Plans. Due to the frequently high rate of progress of the Contractor’s forces, especially during the early rough grading operations, detailed planning and cooperation with the Contractor is required. The Resident Construction Engineer should see that sufficient stakes are furnished to the Contractor. The Contractor’s preferences as to the location and manner of staking should be given consideration. Under no circumstances, except when the Resident Construction Engineer is not properly notified of the Contractor’s plan of work, will any delay in staking be permitted that may hinder the construction operations.

105.8.2 Protection of Stakes and Markers

It is the obligation of the Contractor to preserve and to protect all stakes and markers. When the Contractor neglects to take normal precautions and, due to the Contractor’s negligence, stakes are destroyed, the Contractor should be charged with the cost of resetting.

105.8.3 NPDES Lines and BCA Lines

The NPDES lines designated on the Contract Plans must be clearly delineated in the field. See Section 815.2.4 for additional information on NPDES areas. During construction of a new bridge, a large crane needs access to one of the four corners of the structure. An access road and staging area will be designated on the Contract Plans. Desirably, the area will be on project right-of-way; however, if unattainable, a landowner agreement will be required. The symbol delineating Bridge Construction Access (BCA) is shown in Figure 105B, which must be clearly delineated in the field.

– – – – – BCA – – – – – BCA – – – – – BCA – – – – –

SYMBOL FOR BCA LINES ON CONTRACT PLANS
Figure 105B

105.8.4 Survey Party Organization

The technical control of the party is usually under the direction of the Party Chief; however, the methods used and the work to be accomplished are the Resident Construction Engineer’s responsibility. To produce satisfactory quality and quantity of work, there must be close cooperation between all members of the party. It is essential that personnel understand what is expected of them. Some members of the party will at times be idle while other members of the party are preparing to perform an operation. All operations should be performed as concurrently as practical. For instance, when a surveyor has completed set-up, a sight should be ready for shooting. All needs of the work should be anticipated. Supplies and equipment that are required should be on hand when needed.

The number of personnel necessary in a survey party will depend on the type of work being performed. The taking of cross-sections or setting of finish grade stakes may require four or five people, while the final measurement of pipe lines may require only two or three. The Resident Construction Engineer should organize survey parties according to conditions, rather than maintaining a set number in a party regardless of the type of work to be performed.

The Party Chief should not tolerate inefficiency among any members of the survey party. The bad habits of one employee are quite often picked up by other members.

It is the responsibility of the Resident Construction Engineer and SCDOT Inspectors to instruct survey party personnel on the methods used by SCDOT and the duties to be performed. Each member of the party, showing promise of being able to advance within the Department, should be trained in as many duties as practical so that personal abilities will be an asset to the Department, as well as to the promising employee.

The Party Chief should have a thorough knowledge of surveying theory and practice as applied to highway construction. The survey party should maintain a book of surveying tables. The Resident Construction Engineer should maintain on hand a good surveying text for use as a reference.

105.8.5 Relations with the Public

Survey parties performing field work are more conspicuous to the passing public than other SCDOT personnel on the project. The appearance and conduct of all party members should always be beyond reproach.

105.8.6 Care of Equipment

Surveying instruments are precise and expensive pieces of equipment and are based on sophisticated electronic computer, GPS and laser technology. Total Station Instrumentation is typically used to set up control points because the system allows many points to be shot from one location, acquiring both planar and elevation data and directly interfacing with construction and CADD computer software. Such equipment should receive proper care and should be maintained in good adjustment at all times. Survey instrumentation should not be left unattended.

The care of equipment applies just as much to hand levels, range poles, level rods, bush hooks, axes and related equipment as it does to surveying instruments. The progress of the survey party will be much impeded if proper care and maintenance of equipment is not provided. The Party Chief should make frequent inspections, preferably weekly, of all surveying instruments and equipment maintained by the survey party.

All surveying instruments, including hand levels, should be checked at frequent intervals to ensure they are maintaining the required accuracy. A two peg check should occasionally be made of hand levels and engineer levels. Checking of engineer levels can be performed as follows. Hand levels can be checked in a similar manner, except the distances should be much closer:

- Level the instrument over a point B halfway between two points A and C, approximately 300 feet apart. Determine the difference in elevation between points A and C by subtracting the two rod readings. The true difference in elevation is thus obtained even though the axis of sight is not exactly horizontal since the distance to the two points is the same.

- Set the level very close to point A in line with A and C. Read the rod on points A and C and determine the difference in elevation between points A and C.

- If the line of sight is parallel to the axis of the level bubble, the two differences in elevation, as determined previously, will be the same. If not, the level should be adjusted to give the true difference in elevations as was determined when the instrument was sitting halfway between points A and C. While the level is still at the point near A, dumpy levels may be adjusted by moving the horizontal cross hairs up or down (while looking at point C) until the true difference in elevation between A and C is read.

The Party Chief should see that the survey party transportation vehicle is maintained in a clean and presentable condition, both inside and out. The vehicle should be periodically washed.

105.8.7 Survey Notes

All survey notes should be recorded neatly, clearly and legibly and in sufficient detail. A line should be drawn through errors and the corrections entered directly above. Notes are not to be copied. The first sheet of each set of notes should show the contents, the File Number, the road or route number and other desirable information that might be helpful for identification. Notes should show the date and the survey party personnel at the beginning of each day's notes. The duties of each employee of the survey party should also be indicated. Persons making computations and checking computations must always be identified by name.

105.8.8 Re-Establishing Centerline

105.8.8.1 Alignment Notes

In most instances field alignment notes can be prepared before beginning the centerline survey. The alignment notes should show the complete curve data for each curve and the curve deflections. The referencing of control points should be placed on the alignment notes during the staking operations. The Contract Plans should be carefully studied for any alignment changes to be made during construction. Equalities, whether caused by alignment changes during construction or whether indicated on the Contract Plans, should be noted in the alignment notes.

105.8.8.2 Staking

The centerline of construction should be reproduced from the Contract Plans and marked by stakes driven on the centerline with the station number facing the zero station of the survey. Along the traveled way, centerline stakes should be offset at right angles with the station and offset distance from the centerline marked on the side of the stake facing the centerline. Offset the stakes a uniform distance throughout, as practical. Offset stakes should not be placed where pedestrians might fall over them or in locations where they will obviously not remain in place for any length of time. Where the line follows on an existing pavement, nails and caps or other suitable markers should be driven on the centerline to denote the actual centerline points.

On work such as secondary road construction where the cuts and fills will not be of appreciable heights, hubs should be placed in front of the offset stakes for future use in conjunction with cut or fill stakes.

Tangent sections should typically be staked at 100-foot intervals and horizontal curves should be staked at 50-foot intervals.

105.8.8.3 Referencing Control Points

At the time the centerline is reproduced, or immediately thereafter, control points should be referenced so that the line can be readily and accurately re-established when required. In general, it is necessary to reference the beginning and end of curves, points on tangents at approximately 1000-foot intervals and points of tangent intersections, where practical. Reference points placed at points of minimum cut and fill are particularly desirable.

There are various methods of referencing control points and the selection of the proper method should be left to the judgment of the Party Chief. Reference points should be placed at locations where there is little probability of their being disturbed during the construction work and where it is practical to re-establish the centerline from the points with a minimum of delay.

The following methods of referencing points are most commonly used:

- Points set at right angles to the roadway tangent.
  - One point placed on each side of the centerline at recorded distances with one or more additional points for line and distance, or for line only and approximate distance.
  - Two points at recorded distance from the centerline on same side of road with one or more additional points for line and distance, or for line only and approximate distance.
- Points on angle with roadway tangent and stakes set as above.
- Intersection method where the angle of intersection between the lines from the reference hubs should be as near to 90° as practical.

The marking on guard stakes for reference hubs must include the station number of the referenced station and must also include the distance to the point referenced except when the hub is to be used for line only.

Locations and descriptions of reference points must be noted on the right-hand page of the alignment notes. It should be kept in mind at all times that the Party Chief running the centerline and referencing the points may not be the person re-running the alignment at a future date. The reference notes should be perfectly clear and adequate for any Party Chief, whether familiar with the project or not, to easily re-establish any portion of the alignment.

105.8.9 Profile Levels and Cross-Sectioning

When the computer is to be used for computation of earthwork quantities, it is preferred that all the original or all the final cross-sections be taken with either the engineer's level or the hand level, but not a combination of the two. A reading must be shown at the centerline on both original and final cross-sections. Should it be necessary to show more readings than allowed on one line, the reading may be continued on the next vacant line; however, a connecting directional arrow should be shown. On the station number side of the large cross-section level paper, only one number may be placed in any square and it should be placed in the proper relation as to decimal point. The entire station number must be shown. Notes do not have to be reduced. They can be either elevations or rod readings to be reduced from a profile elevation.

Profile levels and the taking of cross-sections are ordinarily performed simultaneously with the use of an engineer's level. This method is best used in flat and rolling terrain where it is possible to run a profile of the centerline and take cross-sections with the same instrument setup. It is frequently supplemented by the use of a hand level to extend the cross-section where it is not possible to see the level rod from the instrument setup point. When a cross-section is extended by the hand level, the rod reading should be computed and written in the notes just as if the rod had been read by the instrument personnel. A plus will have to be used in the notes when the ground level extends above the height of the instrument. A full description of each bench mark location must be written into the cross-section notes.

Where it is not feasible due to the rough terrain or trees to run profile levels and take cross-sections at the same time, the hand level method may be used to take the cross-sections after the profile has been run. This method is less accurate than the above method and should not be used except when necessary. The recordings in the cross-section notes should be plus or minus from the centerline elevation when this method is used.

Cross-section notes should normally indicate the horizontal distance from the centerline to the level rod to the nearest foot. Where the break to be shown is of a sharp nature, the distance should be recorded to the nearest 0.5 foot.

Profile levels should be run using the bench marks as shown on the Contract Plans. Shots on bench marks, turning points and permanent surfaces must be read to the nearest 0.01 foot. Ground shots should be read to the nearest 0.01 foot. During the running of the profile levels, consecutive benches must be tied together. This will reveal any error between bench marks. If the bench mark elevation obtained during profile leveling and that shown on the Contract Plans differ by more than 0.03 foot, the Party Chief should re-run a level line to pinpoint the error.

Temporary bench marks, placed during the running of the profile, are especially useful for future use on heavy grading projects and municipal projects where a large number of grade stakes will have to be set. Their location should be selected with care, taking into consideration the changes in the ground surface that will be made during construction. Locations opposite points of minimum cut and fill are particularly desirable.

During the running of the profile on secondary work where the cuts and fills will not be of appreciable heights, the offset hubs as placed during the staking operations should be read. The hubs should be read to the nearest 0.01 foot. Later these hub elevations can be used in computing the cut or fill at each station. A cut or fill stake is usually all that is necessary for grading purposes on this type of construction.

Original cross-sections should be taken at intervals not exceeding 100 feet for flat or gently rolling terrain and not exceeding 50 feet for hilly terrain. Before taking the original cross-sections, the Party Chief should determine at what stations final cross-sections will be necessary and the originals should be taken accordingly. It should be well understood that excavation of materials is a pay item and every effort should be made to ascertain that this item is accurately shown by first truly representing the terrain during cross-sectioning by selecting the proper cross-section interval.

Cross-sections are to be taken perpendicular to the centerline. In rough terrain or where the sections are to extend out to an appreciable length, the use of a transit is usually necessary to determine the perpendiculars.

It is best to take the original cross-sections to the right-of-way line and farther should the slope of the new construction extend beyond the right-of-way. In all cases, original cross-sections should be extended, if necessary, when slopes are to be flattened or where borrow is to be obtained.

The subgrade should be approved and should be within reasonable conformity with the typical sections before taking of final cross-sections. This should include the shape of the surface as well as the shoulder breaks and ditch lines.

Final cross-sections should be taken at all stations as taken in the original cross-sectioning plus any additional sections necessary to show correctly the excavation or embankment. The finals should extend to at least the earthwork construction line. In all instances where practical, the Party Chief should note on the final cross-section notes the station number where the cut and fill begins or ends.

On roads where the Contractor is to be paid quantity for unclassified excavation, a profile line of levels should be run on the centerline of the road after fine grading is complete so as to substantiate that the road is built to plan grade within the grade tolerance permitted.

105.8.10 Grade Computation

Prior to slope staking, it is best for the Party Chief to prepare grade notes. This is necessary to take into consideration the crown of the roadbed, superelevation due to horizontal curvature and transitions. Computations should be made for all stations that are to be slope staked.

The grade notes should include sufficient columns to show the elevation of the centerline, the distance from the centerline to the cut or fill break and the elevation of the break. Time will be saved when grade computations are performed in this manner while in the office.

Where cut and fill stakes are to be used in lieu of slope stakes, grade notes should also be made. They need not show all the information outlined above. The cuts and fills are usually computed directly on these notes using the hub elevations as determined while taking profile levels. The amount of superelevation should also be shown on the notes and should be placed on the cut and fill stakes. It is usually best to reference the cut or fill stakes to the centerline subgrade elevation as the superelevation is usually rotated around the centerline for secondary work.

105.8.11 Slope Stakes

Slope stakes should be set on projects as necessary for guidance and for adequate control of the work. The stakes should be placed at ample intervals, preferably at 50 feet in rough terrain. Prior to beginning of setting of slope stakes, the staking procedure should be discussed with the Contractor and their views should be considered.

The Party Chief or a designated employee should prepare staking notes before the field work begins. It is good practice to set slope stakes with cut or fill reference to the subgrade at the shoulder edge. The break point from the centerline for cut sections can be determined by extending the shoulder elevation over until it intersects with the cut slope.

Slope stakes are set at locations where the toes of fill slopes and the tops of cut slopes meet the original ground. In heavy work or hilly terrain, it is most important to set the stakes at high angles to the centerline on tangents, and on the radial lines on curves. The right angle prisms method or the transit should be used as necessary.

The use of an engineer’s level, level rod and tape is generally best suited for setting slope stakes where the ground is flat or rolling. It is often supplemented by use of a hand level to establish the slope stakes when it is not possible to set the stake from the instrument setup. Where the terrain is rough, the level instrument is often used by running in only one side of the roadway at the time. This necessitates two lines of levels being run but is considered most accurate.

Where the terrain is rough or where high accuracy is not required, the hand level, level rod and tape are commonly used in setting slope stakes. Using this method, it is necessary to run a centerline profile with an instrument to establish the centerline elevations and subsequent cut or fill. From the centerline date, it is then possible to set the slope stakes by use of the hand level.

The placement of slope stakes can be expedited by using two tapes with the zero ends of each tape tied together. The break-point distance is held on one tape at the centerline, thus putting the zero end of the other tape automatically over the break point, and the distance from the break point to the rod reads directly on the second tape.

While there are different methods used for marking slope stakes, a recognized and often used method is to place the station number on the side of the stake away from the roadway, and to show the following on the side facing the roadway:

- amount of the cut or fill to the shoulder subgrade or datum used in computing distances;
- distances from the stake to the centerline; and
- rate of the slope, such as 2:1.

At locations where it does not appear possible to preserve slope stakes or when desired by the Resident Construction Engineer, the stakes should be referenced back by placing a hub and stake a safe distance from the slope stake, usually 5 or 10 feet. It is preferred that the reference stakes be placed at a uniform distance behind the slope stakes so as to facilitate locating the reference stake and the re-establishing of the slope stakes. Indicate on the side of the stake away from the roadway, all of the information that is normally shown on the roadway face of the slope stake and on the roadway face of the reference stake, including:

- the letter “R;”
- amount of cut or fill from the elevation of the reference hub to the slope stake elevation;
- distance from the reference stake to the slope stake; and
- station number.

The slope stake notes should be maintained in a neat and orderly fashion until completion of the fine grading so that reference will be readily available when necessary. After the slope stakes have been placed, it is helpful to let an office employee check the slope stake notes for errors in calculations. This should be performed before grading operations begin.

105.8.12 Finishing Stakes (Blue Tops)

Finish grade stakes are generally required on most projects involving earthwork. When the rough grading or placement of the material to be fine graded has been completed to within reasonable elevation, blue-top stakes should be set at intervals of 50 feet or less. Blue-tops are placed at the required locations, and driven so that the top of the hub is at the elevation of the subgrade or at the elevation of the layer of material being graded. They should be placed to within 0.01 foot of the required elevation.

It is very useful to the Contractor and will expedite the setting of finish stakes, if the Contractor is provided with a line of cut or fill stakes after the rough grading has been performed. Using these stakes, the Contractor can fine grade the roadbed making the blue-top stakes to be within close conformity to the graded roadbed.

105.8.13 Material Pits

Material pits which must be cross-sectioned for pay quantities are usually cross-sectioned from an established base line. Both ends of the base line should extend well beyond any possible area of the Contractor's operations or disturbance. Alignment notes should be made during the staking of the pit with the bearings of the base line being recorded. Points should be referenced at each end of the base line with the referencing noted in the alignment notes.

The normal cross-section interval should not exceed 50 feet with closer intervals being used if necessary to show the earthwork volume correctly. Sections must be taken on a true perpendicular to the base line. The transit is normally used to establish the perpendicular lines. Reference is made to applicable portions of Section 105.8.8 for additional instructions.

If practical, bench mark levels should be run from the road to the material pit. Should this not be practical, an assumed elevation will be satisfactory. Assumed elevations should be so identified. Two or more bench marks should be placed at the pit site well out of the way of construction. The benches should be referenced to the base line with a full description of the location written into the cross-section notes.

105.8.14 Staking Pipe Culverts

The centerline of the pipe should be indicated by driving hubs on the centerline of the culvert at some convenient distance from the ends of the culvert far enough out so as not to be disturbed. The guard stake for the hub should show the following:

- size, length, and type and class of pipe;
- amount of cut or fill from the top of the hub to the flow line at the end of the pipe; and
- horizontal distance from the hub to the end of the pipe.

In addition to the above hubs and stakes, additional stakes should be furnished the Contractor where the pipe is of any appreciable length. The stakes should be offset from the centerline of the pipe and should show the amount of cut or fill to the flow line and the offset distance from the hub to the pipe centerline. When staking out for concrete pipe, the lengths should be staked in multiples of 4 feet.

At the time of staking the pipe, inlet and outlet ditches should be adequately staked to ensure proper drainage. Accurate excavation notes are to be kept on inlet and outlet channels so as to provide adequate data for determination of pay quantities. The excavation notes are to be transmitted to the Central Office with the As-Built Plans. The decision of the exact location and the elevation at which to place a pipe is in most cases a field decision. In a large drainage layout, the elevations and locations of control drainage structures should be determined prior to pipe staking in order that all areas will be drained properly.

105.8.15 Field Layout of Bridge Structures

105.8.15.1 Importance

The staking out of bridges should be a thorough operation so as to completely eliminate the possibility of mistakes due to layout. The layout should be completely checked, preferably by different personnel, so that the various parts of the bridge substructures will be built in the exact positions shown as indicated on the Contract Plans and also that the various parts of the bridge fabricated away from the bridge site will fit exactly and not require expensive alterations in the partially built bridge. If any alterations, such as removing and recasting concrete or shortening or lengthening of beams, are caused by inaccurate layout or level work done by Department personnel, the costs of making the alterations will have to be borne by the Department.

105.8.15.2 Accuracy

Neat and legible layout notes are to be kept of each bridge staked. Steel tapes only should be used. The tape should show no evidence of being spliced or repaired unless the length of the repaired tape is checked with a tape in good condition. The transit and level, if used, should also be in good operating condition and should have been checked recently as to its adjustment. Hub stakes should be at least 12 inches long, and longer if the ground is soft, so as to avoid likelihood of the tack point moving off position during construction. All measurements should be made with the tape level or corrections made if measurement is on a slope or an appreciable sag occurs in the tape. The pull on the tape should be uniform for each measurement, usually 15 pounds where long measurements are made. Horizontal measurements between tacks should be made with the aid of plumb bobs.

105.8.15.3 Procedure

The Contract Plans should be thoroughly studied. Distances between the piers or bents should be verified as being in agreement with the Contract Plans. The various distances between piers or bents should be added to see if the total agrees with the overall distance between the two ends of the bridge. In spite of careful checking, an occasional mistake will be found in the Contract Plans.

The road and bridge centerline should be obtained and points established near the bridge so that they may be used as control points. If the bridge is to span another highway or a railroad track, similar procedures should be followed on the highway or railroad. The intersection of the two lines should be established. Once established, the angle between the two intersecting lines should be measured. Should this angle vary more than a few minutes from the Contract Plans, the Bridge Construction Engineer should be contacted for technical advice.

When a bridge is to span a road or railroad, the intersection of the two lines, established as outlined previously, should be used as the control point for laying out the bridge. With the transit set up on the bridge centerline, the distances in each direction from the intersecting point along the centerline of the bridge to each of the centerlines of the two piers or bents nearest the intersection tack should be measured and a hub and tack placed. In like manner, the centerlines of the remaining piers or bents should be established by measuring from the intersecting point to the pier or bent where feasible. In measuring the horizontal distance at the end fill slope, drive hub stakes at suitable intervals up the slope on the bridge centerline and place a tack in each such stake. Measure horizontally the distance between tacked points using plumb bobs. Add up the distances thus obtained. A check on the above procedure may be obtained by first running levels on the stakes to determine the difference in elevation between the first and last stakes using a constant slope. The square of the horizontal distance is the square of the measurement on the slope less the square of the difference in elevation between the two stakes.

After setting the hubs and tack points on the centerline of the piers or bents, the transit should be set up on each point and the angle to the centerline of the pier turned. This angle will be 90° if the bridge is not skewed. If the bridge is skewed, the complement to the skew angle (i.e., the angle which added to the skew angle totals 90°) will generally be shown on the Contract Plans. The skew of a bridge or culvert is the angle the centerline of the pier or culvert is rotated from the usual right angle of a square structure. After the transit is turned to the angle on which the pier or bent centerline should lie, two offset hub stakes should be set on this centerline and well beyond the construction area of the pier or bent and tacks driven in them. Two similar offset hubs and tacks should also be placed on the centerline extension on the opposite side of the structure. These offset hubs should be set far enough away from the pier that they will not be disturbed by the construction. The inside offset hubs should also be set a measured distance from the bridge centerline tack a constant distance, if practical, so that the bridge centerline tack can be re-established by measuring the distances back to the centerline tack and obtaining alignment with a stringline between the inside offset hubs.

If conditions will not permit the offset hubs on one side of the bridge, four of such hubs on the other side should be set. Whenever the bent centerline is desired, it may be accurately re-established by setting the transit over one of the outside offset hubs and sighting on the tacks in the three remaining offset hubs. A good alignment of the three remaining hub tacks will check the correct pier or bent centerline.

The use of total station will allow a stakeout of the bridge based on station numbers for each bent or pier, as shown on the Contract Plans. Once the control points have been established (e.g., PC, PT, POT), these control points can be used for layout and spot-checking any and all layout dimensions.

Triangulation is not covered in this manual; however due to obstructions to line of site or to chaining, triangulation may be necessary. Should any assistance be necessary, the Bridge Construction Engineer should be contacted.

105.8.15.4 Checking the Layout

The following information is useful to check angles turned with a transit. The well known ratio of sides of a right triangle of 3:4:5 or multiples of 3:4:5 may be employed to check a 90° angle. If, say, 30 feet is measured on one leg of a triangle and 40 feet is measured on the other leg, then the hypotenuse, or distance between the two ends of the legs, should be 50 feet. Of course, these distances could be 18, 24 and 30 feet or 60, 80 and 100 feet, which distances are all multiples of the base triangle with sides of 3, 4 and 5.

To check an angle of less than 90° between the centerline of bridge and the centerline of pier which has been established with a transit, measure along each centerline the same distance, say 60 feet. The measured distance between the ends of the 60-foot distances should be twice 60 times the sine of half of the angle. To illustrate; if the skew angle is 20°, the angle between centerline of bridge and pier is 70°. If 60 feet is measured along the centerline of bridge and also the centerline of bent, the distance between the ends of the 60-foot distances should be twice 60 times the sine of 35° or (2) x (60) x (0.57358) = 68.83 feet.

Another advantage of a constant distance from the intersection of centerline of bridge and centerline of bent to the inside offset hub tack is that the overall distance between the ends of a short bridge or between several consecutive piers of a long bridge can be measured between the inside offset hub tacks. If the overall distance thus measured is the same as the staked-out distance along centerline of bridge, the staked-out distance and angles turned will be checked.

Bench marks should be established at suitable intervals at the bridge site. Levels between the nearest two or three bench marks shown on the Contract Plans should be run to see if the differences in elevation between the plan bench marks can be checked. If not, the levels should be extended to additional bench marks to find out which plan bench mark elevation is in error. In running levels, the level setups should always be chosen that result in practically the same distance from foresight to instrument as from backsight to instrument. This will give more accuracy to the work since most of the maladjustment in the instrument will be canceled out if equal distances are used as stated above. Care shall also be taken in not setting a bench mark on a location subject to settlement, such as a newly set telephone or power pole or on a new embankment. If a nail is used to set a bench mark, it should be large enough and driven deep enough that it will not change in elevation due to bending.

105.8.16 Miscellaneous Staking

Sufficient stakes should be provided for adequate control of all incidental construction. This is to include both line and grade stakes, where necessary. Stakes should be placed in such positions as not to be destroyed by the Contractor’s operation.

105.9 AUTHORITY AND DUTIES OF THE ENGINEER'S REPRESENTATIVE

The Resident Construction Engineer is the SCDOT representative in charge of the project and will communicate all final decisions to the Contractor Superintendent, as governed under the provisions of Section 105.09 of the *Standard Specifications*. Seek guidance, as needed, from the appropriate District personnel.

105.10 INSPECTION OF THE WORK

Under the provisions of Section 105.10 of the *Standard Specifications*, the inspection of all work and materials is the responsibility of SCDOT Inspectors, as assigned by the Resident Construction Engineer for the project. Seek guidance from the Resident Construction Engineer in questionable situations.

105.11 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK

Under the provisions of Section 105.11 of the *Standard Specifications*, the Resident Construction Engineer and SCDOT Inspectors are responsible for ensuring that any unacceptable work or materials is removed and replaced to meet the requirements of the Contract Plans and Specifications.

105.12 LOAD RESTRICTION

During the project, monitor the Contractor's operations to ensure that the weight of haul trucks and equipment on SCDOT roads and bridges do not exceed legal limits and, as needed, enforce the provisions of Section 105.12 of the *Standard Specifications*.

105.13 FAILURE TO MAINTAIN ROADWAY OR STRUCTURE

When the Contractor fails to maintain a roadway or structure as provided for in the Contract, enforce the provisions of Section 105.13 of the *Standard Specifications*.

105.14 TERMINATION OF CONTRACT

Section 105.14 of the *Standard Specifications* provides for the termination of the Contract.

105.15 ACCEPTANCE AND FINAL INSPECTION

Section 105.15 of the *Standard Specifications* governs the provisions of final inspection and acceptance of all pay items in the Contract. See Section 110 for additional information.

105.16 CLAIMS FOR ADJUSTMENT AND DISPUTES

105.16.1 Architect-Engineer (A-E) Liability Claims

Upon discovery of an apparent design deficiency that may increase the Contract cost, the Resident Construction Engineer will immediately notify the District Engineering Administrator of the details of the problem. The District Engineering Administrator will then contact the Director of Preconstruction for disposition.

105.16.2 Contractor Claims Policy and Procedure

A claim is a request from the Prime Contractor for additional time or money, but does not include a situation where the additional work is initiated by SCDOT and/or the price or additional time requested is agreed upon between SCDOT and the Prime Contractor. Check the Special Provisions of the Contract to determine if the governing claims procedures use the standing Dispute Review Board or the Ad Hoc Dispute Review Board. Follow the procedures in the

Contract Specifications to process a Notice of Claim when received by the Contractor. The Contractor must furnish written notice prior to beginning additional work. The Contractor must also provide written notice when requesting additional time or money. Use SCDOT Form 100.04 – Contractor Notice of Claim for the written notice.

105.16.3 Change Orders

If a Claim has been resolved, as discussed in Section 105.16 of the *Standard Specifications*, the Resident Construction Engineer will be responsible for initiating and processing a Change Order in SiteManager as discussed in Section 101.6.3.

105.17 GENERAL DESIGN FEATURES

Section 105.17 of the *Standard Specifications* provides for the general design features of the project.

Section 106
Control of Material

106.1 SOURCE OF SUPPLY AND QUALITY OF MATERIALS

Many materials typically used on SCDOT construction projects must be supplied from SCDOT-approved sources. The Approval Policies and Approval Sheets corresponding to SCDOT-approved material sources are maintained by the Research and Materials Engineer on the SCDOT Internet Web Site. Approval Sheets are frequently updated, so ensure that the most current set is being used. The SCDOT Inspector will be responsible for ensuring that such materials come from a supplier listed on the appropriate Approval Sheet. The Research and Materials Engineer also is responsible for the sampling, testing and approval of structural members and similar items produced off the project site. The SCDOT Inspector will be responsible for ensuring that such materials have been approved by the Research and Materials Engineer for use on the project and that the materials are shipped to the job site in an acceptable condition. All other materials incorporated in the work must be sampled and tested in accordance with established SCDOT policy and procedures and comply with the requirements of the Contract.

106.2 LOCAL MATERIAL SOURCES

Section 106.02 of the *Standard Specifications* governs the contractual provisions of the use of local material sources.

106.3 SAMPLES AND TESTS

106.3.1 <u>General</u>

Accurate and representative sampling of the work and materials cannot be overemphasized. An improperly taken sample may not be truly representative and, if testing is performed on a non-representative sample, the test results will be meaningless with respect to assessing quality and adherence to specified requirements. Section 106.03 of the *Standard Specifications* governs the contractual provisions with respect to the samples and tests used for control of materials. Section 106.3 of this *Manual* presents the SCDOT policy and procedures for field sampling and testing most materials used in highway and bridge construction. Inspection guidance for materials used in pay items is presented in the sections of this *Manual* that correspond to the *Standard Specifications* (e.g., Section 703 for reinforcing steel). The Resident Construction Engineer and SCDOT Inspectors must become familiar with this information and the SCDOT Sampling and Testing Procedures presented in Appendix C. Contact the Research and Materials Laboratory for any needed assistance.

106.3.2 Personnel Certification

SCDOT and Contractor personnel must be certified in their area of responsibility. The following certifications apply to SCDOT work:

- Nuclear Gauge Safety Certification,
- Earthwork and Nuclear Gauge Technician Program,
- Foundations Certification,
- Asphalt HMA Technician Certifications,
- Portland Cement Concrete Certification,
- Coarse Aggregate Technician Certifications, and
- Field Welder Certification.

With the exception of the Nuclear Gauge Safety Certification and the Field Welder Certification, these are five-year certifications. The Nuclear Gauge Safety Certification is a three-year certification due to Federal regulations. The Field Welder Certification is a two-year certification. It is the responsibility of the Resident Construction Engineer to ensure that each Inspector on the project is properly certified for the type of sampling and testing being performed. Refer to the Technician Certification policy on the SCDOT Internet Web Site for additional information.

106.3.3 Sample Identification Cards

Each sample obtained in the field must be properly identified and shipped using Sample Identification Cards. See Appendix B for completion instructions and examples of completed Sample Identification Cards.

106.3.4 Priority Testing of Samples

When test results are needed quickly to continue a construction activity, indicate RUSH in large print on the Sample Identification Card. If test results are needed by the Resident Engineer immediately upon completion of testing, indicate on the Sample Identification Card the contact phone number or email address. The Research and Materials Laboratory will process samples as they are received. Samples identified as RUSH will be given priority and delivered to the appropriate unit immediately after assignment of a Laboratory Identification Number. Samples received after 1:00 PM on Friday, with the exception of Portland cement concrete test specimens, will be processed the following business day. Exceptions will be accommodated on a case-by-case basis.

106.3.5 Shipping of Samples

Samples must be shipped to SCDOT laboratories using the quickest and most readily available means. Under normal circumstances, samples should remain in the possession of SCDOT personnel until delivered to the appropriate laboratory. If circumstances require that Contractor or other non-SCDOT personnel deliver the samples, the samples must be secured using an approved tamper-proof seal. Samples delivered by non-SCDOT personnel without this seal will not be accepted. Samples that are tested in the field, such as asphalt cores for density determination, will also be secured with a tamper-proof seal if they are to be delivered to a field laboratory by non-SCDOT personnel. Approved tamper-proof seals and instructions for their use are available from the Quality Assurance Section of the Research and Materials Laboratory.

106.3.6 Reporting of Test Results

Test results for samples submitted to the Research and Materials Laboratory will be posted electronically on the SCDOT Intranet Web Site via MatLab. The Research and Materials Laboratory will maintain hard copies of material Test Reports. The test results will be promptly posted to MatLab upon completion of testing. It is the responsibility of the Resident Engineer to obtain copies of Test Reports from MatLab, because hard copies will not be distributed. If a failing sample Test Report is posted to MatLab, a computer-generated email will be sent to the District Construction Engineer and the Resident Construction Engineer with notification of the failing Test Report as shown in Figure 106A. In certain instances, pre-approved materials and previously tested batches of material will be reported without being tested and referenced as such on the Test Report.

A report with a lab number of M45180 has been uploaded with a result of Fail. Go to http://iwww.dot.state.sc.us/matlab/filegrab.asp?result=M45180.pdf to view the report.

FAILING TEST REPORT EMAIL NOTIFICATION EXAMPLE
Figure 106A

106.3.7 Check Samples

In general, when a sample fails to meet specified requirements, a minimum of two check samples representing the material originally sampled must be obtained and submitted. Additional check samples will be taken as deemed necessary by the Resident Construction Engineer. Use engineering judgment. Complete and submit SCDOT Form 100.09 – Report of Disposition of Material Failing to Meet Specifications. Sample Identification Cards must show the Test Report number of the original report and be marked Check Sample. Consider the following:

1. PG Binder/Liquid Asphalts. Only one check sample is required for failing samples of PG binder and liquid asphalts.

2. Subbase/Base Materials. In securing check samples of subbase, base or similar materials, obtain one check sample approximately 50 feet behind the original point of sampling and another approximately 50 feet ahead.

3. Reinforcing Steel. Check samples of reinforcing steel are to be obtained from different bars of the same size, heat number and manufacturer, with neither check sample being taken from the original bar.

106.3.8 Quality Control Samples and Tests

Quality Control Samples and Tests are used to ascertain on a day-to-day basis whether the quality of the material being incorporated or proposed for incorporation in the work and the quality of the work performed are in compliance with the requirements of the Contract Specifications. They constitute the principal means of determining, prior to or at the time of performing the construction operation, whether the materials and workmanship are satisfactory or whether corrective action must be taken before proceeding with the work. They also serve as the principal basis for determining acceptability of the completed work. Quality Control Sampling and Testing must be performed in accordance with the schedule presented in Figure 106B and in accordance with the inspection guidelines presented in the corresponding sections of this *Manual*. Except as otherwise noted, a minimum of one sample of each material must be taken from each Contract. The initial sample should be taken prior to use, where practical. After the initial sample, the minimum frequency requirements presented in Figure 106B govern for the duration of the project. The frequency requirements are minimum criteria. Additional sampling and testing should be performed as needed to properly control the work. Samples that are not tested by the Resident Construction Engineer will be submitted to the Research and Materials Laboratory. Occasionally, there will be materials or items of work in the Contract for which sampling and testing instructions have not been issued. In such cases, the Resident Construction Engineer should contact the Research and Materials Laboratory for sampling and testing guidance.

106.3.9 Acceptance of Small Quantities

Required minimum Quality Control Sampling and Testing of certain materials may be waived by the Resident Construction Engineer when total project quantities are small and the material is supplied from a recognized source. The materials may be accepted on the basis of one of the following methods:

- acceptance on the basis of visual examination to verify that the general condition and quality of the material appears to be acceptable; or

- acceptance on the basis of a manufacturer's certification to verify that the material furnished conforms to the specified requirements for the material.

The acceptance of materials under either of the above methods will be documented by the Resident Construction Engineer on SCDOT Form 100.25 – Report of Acceptance of Small Quantity Materials. The types and maximum small quantities of materials per Contract that may be accepted by the Resident Construction Engineer are shown in Figure 106C.

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Admixtures, Concrete	—	—	Approval Sheet 5 and/or Approval Sheet 53	See Section 501 and Section 701.
Aggregates, Coarse Non-HMA	See SC-T-1, SC-T-3, and SC-T-4.	Each 500 tons.	Gradation and Approval Sheet 2	Submit one sample of each type, each Contract. See Section 501, Section 701, and Section 802.
Aggregates, Fine Non-HMA	10 pounds See SC-T-2, SC-T-3, and SC-T-4.	Each 500 tons.	Gradation and Approval Sheet 1	Submit one sample of each type, each Contract. See Section 501, Section 701, and Section 802.
Aggregates, Coarse HMA	—	—	Approval Sheet 2	See Section 401 and current HMA specifications.
Aggregates, Fine HMA	—	—	Approval Sheet 1	See Section 401 and current HMA specifications.
Asphalt, Liquid PG binder	1 quart	Each 10,000 tons of mix produced.	Approval Sheet 37	See Section 401.
Blocks, Concrete	5 blocks	Each source.	—	—
Bolts, High Strength	3 assemblies of bolt, nut and washer.	Each possible combination of bolt lot, nut lot and washer lot.	—	See Section 709.

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Brick	10 bricks each source.	Each 50,000 bricks.	—	—
Cable Strand	One (1) 40 inch and One (1) 12 inch	Each 5 reels per heat number.	—	Sample at prestress yard.
Castings, Catch Basins Drop Inlets	—	—	Dimension	Inspect all castings for workmanship. See Section 719. Manufacturer's Certification Required.
Cement Stabilized Earth Base	—	Each 1000 feet per 2 lanes.	Compaction	—
	—	Each 250 feet per 2 lanes.	Depth	—
Cement, Fly Ash	1 gallon	Each 50 tons	—	See Section 501 and Section 701. Mill Test Report Required.
Cement, Portland & Slag	1 gallon	Each 100 tons. On large paving and modified base projects, rate determined by the Research and Materials Engineer	—	See Section 701. Mill Test Report Required.
Cement, Masonry	—	—	—	Verify Type in Field. See Section 718.

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Concrete, Structural, Prestressed, Lean & Other	—	As needed to control consistency.	Slump	Test when consistency is questionable and when cylinders are made.
	—	As needed to control % entrained air.	Air Content	Test when air content is questionable and when cylinders are made.
Concrete, Structural	Three (3) 6-inch cylinders.	See Section 701.	Make specimens for compressive strength.	AASHTO T-23 (ASTM C 31)
Concrete, Prestressed	Six (6) 4-inch cylinders.	See Section 704.	Make specimens for compressive strength.	AASHTO T-23 (ASTM C 31)
Concrete, Lean	Four (4) 6-inch cylinders.	One (1) set each one-half day's production.	Make specimens for compressive strength.	Contact Laboratory.
Concrete Pavement	—	Four (4) each day's run and each time test specimens are made.	Slump	AASHTO T-19 (ASTM C143)
	—	Four (4) each day's run and each time test specimens are made.	Air content	AASHTO T-196 (ASTM C 231) or (ASTM C 173)
	Four (4) flexural beams	One (1) set each 1500 cubic yards, or part thereof. Minimum one (1) set per day.	Make specimens for flexural strength.	See SC-T-46.

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Coquina Shell Base	25 pounds	Each 1000 feet per 2 lanes, each layer	—	Submit to Laboratory. See Section 304.
	—	Each 250 feet per depth 2 lanes.	Depth	—
	—	Each 1000 feet per 2 lanes, each layer	Compaction	See Section 304.
Curing Compound, Spray-On/ Brush-On Concrete Coatings	—	No samples required.	Approval Sheet 7 or Approval Sheet 33	Not necessary to sample pre-approved material. See Section 702. Manufacturer's Certification Required.
Embankments	—	Each 2000 cubic yards, minimum 1 per lift.	Compaction	See Section 205.
Embankment Material	—	One (1) each day of work from each source used.	—	See Section 205.
Emulsions	0.5 gallon	Each 2500 gallon.	Approval Sheet 38	See Section 401. Manufacturer's Certification Required.
Fence, Barbed Wire	One (1) 3-foot length.	Each 16,000 feet, each source.	—	—
Fence, Chain Link	One (1) 2-foot length.	Each 50 rolls, each source	—	—
Fence, Woven Wire	One (1) 4-foot length.	Each 50 rolls, each source.	—	—

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Fence, Hardware	Three (3) each type.	Each 50 rolls, each source.	—	—
Fertilizer	—	—	—	See Section 810.
Guardrail, Beams, Steel Posts & Hardware	See Section 805.	See Section 805.	Visual defects and Approval Sheet 29.	See Section 805. Manufacturer's Certification Required.
Guardrail, Wood Posts & Blocks	—	—	Visual defects.	Must bear Inspection Agency's hammer mark. See Section 805.
Guardrail, Composite Blocks	—	—	Visual defects and Approval Sheet 49.	See Section 805.
Guardrail, Cable Barrier	—	—	Visual defects.	See Section 805. Manufacturer's Certification Required for Cable.
Handrailing, Steel Pipe	—	—	—	See Section 709. Manufacturer's Certification Required.
Handrailing, Aluminum	—	—	—	See Section 709. Manufacturer's Certification Required.
HMA Mixes	See SC-T-62.	See current HMA specifications.	See current HMA specifications.	See Section 401 and current HMA specifications.

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
HMA Mixes Sand-asphalt (roadmix)	See SC-T-62.	Each 750 feet per 2 lanes.	Asphalt Content and Stability	Submit each fifth sample. See Section 309.
	—	Each 250 feet Per 2 lanes.	Depth	See Section 309.
Joint Material, Structural and Pavement	See Section 702.	See Section 702.	—	See Section 702.
Lime, Agricultural and Hydrated	—	—	Approval Sheet 39 for hydrated lime.	See Section 401 and Section 810.
Graded Aggregate Base	SC-T-1	Each 1000 feet per 2 lanes, each layer	—	See Section 305.
	—	Each 250 feet per 2 lanes	Depth	—
	—	Each 1000 feet Per 2 lanes, each layer	Compaction	See Section 305.
Mineral Filler, HMA	1 quart	Each source Per project.	—	See Section 401.
Paint, Structural Steel	—	—	—	See Section 710. Manufacturer's Certification Required.
Piles, Steel	—	—	Visual Flaws	Mill Test Report required. See Section 711.

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Piles, Treated Timber	—	—	Visual Flaws	Must bear Inspection Agency's hammer mark. See Section 711.
Piles, Prestressed	—	—	Visual Flaws and SCDOT Stamp	See Section 711.
Pipe Culverts, Concrete	—	—	Visual Flaws	Must be pre-tested and stenciled. See Section 714.
Pipe Culverts, Corrugated Metal	—	—	Visual Flaws	Mill Test Report required. See Section 714.
Pipe Culverts, Corrugated Aluminum	—	—	Visual Flaws	Mill Test Report required. See Section 714.
Pipe Culverts, High Density Polyethylene Pipe	If ID $\leq$ 10 inches One (1) 3-foot piece. If ID > 10 inches One (1) 1-foot piece.	Each size, each shipment.	Visual Flaws and Manufacturer's Stamp	Manufacturer's Certification required. See Section 714.
Rip Rap	—	—	Visual Check for Size and Quality	Contact the R&M Engineer, as needed, for assistance. See Section 804.

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Sand Clay Base, Roadway	10 pounds	Each 1000 feet per 2 lanes, each layer.	—	See Section 303.
	—	Each 250 feet per 2 lanes.	Depth	—
	—	Each 1000 feet per 2 lanes, each layer.	Compaction	When minimum percent compaction is specified. See Section 303.
Seed	—	See Section 810.	—	See Section 810.
Steel, Structural	—	—	Visual Defects and Inspection Agency Marks	Mill Test Report required for components not pre-approved. See Section 709 and Section 711.
Steel, Reinforcing	40 inches (30 inches Charleston Lab.)	Each size, each shipment.	—	See Section 703.
Subbase, Cement-Modified	As required.	Once daily.	% Passing 2 inch and #4 sieves.	Contact Laboratory.
	Two (2) 4-inch diameter cores	Once daily.	—	Contact Laboratory.
	—	Each 1000 feet per 2 lanes, each layer.	Compaction	—
	—	Each 500 feet per 2 lanes.	Depth	—

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Subgrade, Untreated	—	Each 1000 feet per 2 lanes.	Compaction	See Section 208.
	10 pounds	Each 1000 feet per 2 lanes.	—	See Section 208.
Timber, Treated	—	—	Visual Defects	Must be pre-tested and bear Inspection Agency's hammer mark.
Timber, Untreated	—	—	Visual Flaws, Knots, etc.	Not pre-tested Or pre-approved.
Traffic Marking, Paint Waterborne or Solventborne	—	Paint is pre-tested by Research and Materials Laboratory.	Check batch numbers at job site and match certification documents.	Manufacturer Certification must include SCDOT laboratory test number indicating pre-testing. See Section 601 and Section 604.
Traffic Marking, Thermoplastic or Epoxy	—	No field samples required.	Check batch numbers at job site and match certification documents.	Accepted based on Manufacturer Certification. See Section 601 and Section 604.
Traffic Marking, Pavement Markers	20 markers per lot. Randomly selected.	See Section 601 and Section 605.	—	See Section 601 and Section 605 Manufacturer's Certification Required.
Traffic Marking, Reflective Beads Spray-on/ Drop-on	One (1) 50 or 55-pound bag when bagged. No sample in bulk pack.	One bag per each batch (44,000 pounds)	—	See Section 601.

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Underdrains & Sectional Drains, Corrugated Polyethylene	If ID $\leq$ 10 inches One (1) 3-foot piece. If ID > 10 inches One (1) 1-foot piece	Each size, each shipment.	—	See Section 802. Manufacturer's Certification Required.
Underdrains & Sectional Drains, Concrete Perforated.	2 joints	Each source.	—	See Section 802.
Underdrains & Sectional Drains, Corrugated Metal Perforated	—	—	—	Mill Test Report required. See Section 802.
Underdrains & Sectional Drains, Asphalt Fiber	One (1) 2-foot length and One(1) 1-foot length.	Each size, each shipment.	—	See Section 802. Manufacturer's Certification Required.
Underdrains & Sectional Drains, Corrugated Aluminum	—	—	—	Mill Test Report required. See Section 802.
Underdrains & Sectional Drains, Class PS 46 PVC	One (1) 3-foot piece.	Each size, each shipment.	—	See Section 802.
Water	1 gallon	Each source.	—	See Section 701.
Waterproofing, Asphalt or Tar	—	—	—	See Section 702.
Waterproofing, Fabric	—	—	—	See Section 702.

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL OR PRODUCT	MINIMUM SIZE OF EACH SAMPLE	MINIMUM FREQUENCY OF SAMPLING	RESIDENT CONSTRUCTION ENGINEER TO TEST FOR	REMARKS
Wire, Reinforcement	One (1) 40-inch length.	Each size, each shipment.	—	See Section 703.
Wire Mesh Reinforcement	One (1) 24 inch x 24 inch sample.	Each size, each shipment.	—	See Section 703.

QUALITY CONTROL SAMPLING AND TESTING
Figure 106B
(continued)

MATERIAL	MAXIMUM SMALL QUANTITY
Aggregates Other than in critical Portland Cement Concrete work or asphalt mixes.	500 tons each type
Portland Cement Concrete Including component materials for use in structural non-critical items such as sidewalks, curb and gutter, catch basins, signs, fence posts and guardrail anchoring.	50 cubic yards (See Section 701.3.2)
Fence Including barbed wire, woven wire, chain link fabric and hardware.	500 linear feet
Underdrains and Sectional Drain Pipe Concrete or clay only.	100 linear feet
PG Binder	2500 tons of HMA produced
Emulsions and Cut Back Asphalts	5000 gallons

MAXIMUM SMALL QUANTITIES FOR MATERIALS
Figure 106C

106.3.10 Maintaining Records of Sampling and Testing

At the beginning of each Contract, the Resident Construction Engineer should prepare a list of the number of tests that are required for each item of work or material, whichever is applicable. A similar list will be furnished to the Resident Construction Engineer by the Research and Materials Laboratory, but the Resident Construction Engineer should check this list for correctness. The Resident Construction Engineer should also maintain for each Contract a file of the test results obtained by SCDOT personnel with the test results for each material being filed together, as practical. Also, a record is to be maintained of samples that are sent to the Laboratory for testing. The record should show the date the sample is submitted to the Laboratory, the date the test results were received from the Laboratory, whether the sample failed or passed and any other information desired by the Resident Construction Engineer. Use SCDOT Form 100.11 – Materials Sampling and Testing Log to record this information. Materials that require manufacturer certification will be recorded on SCDOT Form 100.10 – Materials Certification Log. A copy of all certifications should be retained by the Resident Construction Engineer and a copy should be forwarded to the Research and Materials Engineer.

106.3.11 Independent Assurance (IA) Sampling and Testing

106.3.11.1 Purpose and Application

The Department's Independent Assurance (IA) Program serves as an independent evaluation of the sampling and testing procedures used for materials acceptance. IA test results are not used as a basis for material acceptance. The IA Program applies to all Federal-aid projects and may also be applied to any State-funded project selected by the Research and Materials Engineer. This Program requires a high degree of cooperation and coordination between the Resident Construction Engineer and Laboratory personnel.

106.3.11.2 Sampling Responsibilities

IA sampling will be performed by certified personnel from either the Research and Materials Laboratory or District Laboratory, or by certified project personnel in the presence of certified Laboratory personnel. All IA samples, except concrete cylinders and beams, must remain in the custody of the Laboratory personnel until testing can be performed. The Resident Construction Engineer will be responsible for notifying the Quality Assurance Manager of the Research and Materials Laboratory or the District Testing Engineer when IA samples and measurements are needed. Notification may be given by telephone, radio or e-mail.

Certified Laboratory personnel will perform IA testing. An IA test will not be performed with the same equipment used for the Quality Control test. Personnel may not perform both Quality Control and IA tests on the same material for any project.

106.3.11.3 Maintenance of Records

For each applicable Contract, the Resident Construction Engineer will maintain an IA Sampling and Testing File containing reports, measurements and other relevant information. The IA Sampling and Testing File must contain separate folders of chronologically ordered Test Reports of each material sampled.

106.3.11.4 Progress IA Samples and Tests

Progress IA Samples are samples taken at approximately the same location and time in the construction process as Quality Control Samples. This usually occurs when the materials are delivered and before they are incorporated in the work while construction work is in progress.

Progress IA Samples are taken and tested to provide an independent check on the reliability of the results obtained in Quality Control Sampling and Testing. It is therefore essential that the numerical results obtained from testing Progress IA Samples be promptly compared with those obtained from testing Quality Control Samples of the material. Comparisons will be made in accordance with the criteria presented in Figure 106D.

When the results from Quality Control Sampling and Testing are compared to the results from IA Sampling and Testing, the comparison will be made by either the Research and Materials Laboratory, District Laboratory or SCDOT project personnel. SCDOT prefers that the comparison be made by Research and Materials Laboratory or District Laboratory personnel associated with the IA Sampling and Testing Program. When the comparison is made by the Research and Materials Laboratory or District Laboratory, the Test Reports and comments regarding the results of the comparison will be promptly forwarded to the Resident Construction Engineer.

Do not use the results of testing Progress IA Samples for the basis of assessing acceptability, which is the purpose of Quality Control Sampling and Testing.

106.3.11.5 Final Samples and Tests

Final IA Samples are samples taken at random from completed construction work or completed portions thereof under the same requirements and procedures as for Progress IA Samples.

106.3.11.6 Comparing Quality Control with IA Test Results

Figure 106D presents the allowable deviation when comparing the results of Quality Control Sampling and Testing with the results of IA Sampling and Testing. If the results for a particular comparison vary in excess of the criteria presented in Figure 106D, additional samples will be taken to determine if the variation was caused by the sampling procedure, the testing method or faulty equipment. Corrective action needed to resolve the problem will be documented.

INDEPENDENT ASSURANCE SAMPLE	ALLOWABLE DEVIATION FROM QUALITY CONTROL SAMPLE TEST RESULT
General	
All test results in general, percent of numerical value, except as provided for below.	±10%
Asphalt Mix	
Gradation:	
1″	±7%
¾″	±7%
½″	±7%
$^{3}/_{8}$″	±6%
No. 4	±6%
No. 8	±5%
No. 30	±4%
No. 100	±3%
No. 200	±2%
Asphalt Binder Content	±0.6%
Percent Compaction (All Items)	
All items	±2%
Sieve Analysis (All Items)	
No. 4 sieve and larger.	±7%
Smaller than No. 4 sieve.	±3%

DEVIATION GUIDE FOR COMPARING QUALITY CONTROL TEST RESULTS TO INDEPENDENT ASSURANCE SAMPLE TEST RESULTS
Figure 106D

106.3.11.7 Sampling and Testing Schedule

Figure 106E presents the schedule of IA Sampling and Testing that will be used for all Federal-aid projects and on State-funded projects, as deemed necessary by the Research and Materials Engineer. The requirements for IA Sampling and Testing will be determined by the Quality Assurance Section of the Research and Materials Laboratory based on the criteria presented in Figure 106E and reported to the Resident Construction Engineer on SCDOT Form LAB-R-2 – Independent Assurance Sampling and Measurement Requirements. Figure 106E will be used as a guide, and additional sampling, testing and dimensional checks will be made as deemed necessary to control work and materials. Note that the frequency schedule shown in Figure 106E is based on a 20 foot to 24 foot width of pavement. The actual number of samples to be taken will be based on the quantities presented in the schedule, as adjusted for the actual width of pavement. The following exceptions apply:

1. Portland Cement/Reinforcing Steel. IA Sampling and Testing of Portland cement and reinforcing steel will be performed annually by the Research and Materials Laboratory. Therefore, no further IA Sampling and Testing is required for the project.

2. Asphalt Plant Mixes/Component Aggregates. Asphalt plant mixes and component aggregate in quantities less than 1000 tons are not subject to the IA Sampling and Testing Program.

3. Emulsions/Cutback Asphalts. An IA Sample of emulsions and cutback asphalts will be taken for each 100,000 gallons. Quantities less than 100,000 gallons and fractions beyond a given multiple of 100,000 gallons are not subject to the IA Sampling and Testing Program.

4. PG Binder. An IA Sample of PG Binder will be taken for each 50,000 tons of HMA mix produced. Quantities less than 50,000 tons of HMA mix produced and fractions beyond a given multiple of 50,000 tons of mix produced are not subject to the IA Sampling and Testing Program.

5. Small Quantities. The requirements of the IA Sampling and Testing Program are waived for materials, other than those listed above, where the quantity of the material is considered small, as discussed in Section 106.3.9.

6. Final Width Measurements. Final width measurements under the IA Sampling and Testing Program will be waived for projects where the traffic will remain open during construction and the safety of the IA Inspector would be placed in jeopardy.

MATERIAL OR PRODUCT	TYPE OF SAMPLE	SAMPLE AND/OR FREQUENCY	TEST FOR
Aggregate Coarse Surface Treatment	Progress	One (1) Each 10,000 tons	Gradation
Aggregate Fine Surface Treatment	Progress	One (1) Each 10,000 tons	Gradation
Aggregate Fine Asphalt Mixes	Progress	One (1) Each 15,000 tons	Gradation
Aggregate Coarse PCC	Progress	One (1) Each 3500 tons	Gradation
Aggregate Fine PCC	Progress	One (1) Each 3000 tons	Gradation
Aggregate Coarse PCC Pavement	Progress	One (1) Each 3 miles	Gradation
Aggregate Fine PCC Pavement	Progress	One (1) Each 3 miles	Gradation
Aggregate Stabilization of Subbase or Subgrade	Progress	One (1) Each 10,000 tons	Gradation
Asphalt Plant Mixes (See Note 1)	Progress	One (1) Each 15,000 tons	Gradation, Asphalt Content and Stability Test. (where applicable)
Asphalt Plant Mixes (See Note 1)	Progress	One (1) Each 3 miles	Density (where applicable).
Asphalt Plant Mixes	Final	One (1) Each mile	Width and Thickness (when bid on SY basis).
Asphalt Liquid PG Binder	Progress	One (1) Each 50,000 tons of mix produced.	Applicable Specifications
Asphalt Liquid Emulsions and Cutbacks	Progress	One (1) Each 100,000 gals.	Applicable Specifications (except for emulsion). Other Tests (as deemed necessary).

SCHEDULE OF INDEPENDENT ASSURANCE SAMPLING AND TESTING
Figure 106E

MATERIAL OR PRODUCT	TYPE OF SAMPLE	SAMPLE AND/OR FREQUENCY	TEST FOR
Cement Modified Subbase	Progress	One (1) Each 3 miles	Compaction
Cement Modified Subbase (See Note 1) (See Note 7)	Progress	One (1) Each 3 miles	Width and Thickness
Cement, Portland	Progress	One (1) Each source per year.	Specified Material Requirements.
Cement Stabilized Earth Base Course	Progress	One (1) Each 3 miles	Compaction
Cement Stabilized Earth Base Course	Final	One (1) Each 3 miles	Width and Thickness.
Concrete PCC Pavement (See Note 1)	Progress	One (1) Set of Three (3) Beams Each 3 miles	Beam Strength, % Air and Slump.
Concrete PCC Pavement (See Note 2)	Final	One (1) Each mile	Width and Thickness.
Concrete Structures (See Note 1) (See Note 3)	Progress	One (1) Set of cylinders Each 1000 cubic yards Each Contract	Compressive Strength, % Air and Slump.
Coquina Shell Base	Progress	One (1) Each 2 miles	Gradation, Liquid Limit and Plasticity Index. (Density, where applicable)
Coquina Shell Base	Final	One (1) Each 2 miles	Width and Thickness.
Embankment	Progress	One (1) Each 3 miles	Compaction

SCHEDULE OF INDEPENDENT ASSURANCE SAMPLING AND TESTING
Figure 106E
(Continued)

MATERIAL OR PRODUCT	TYPE OF SAMPLE	SAMPLE AND/OR FREQUENCY	TEST FOR
Graded Aggregate Base	Progress	One (1) Each 3 miles	Gradation and Compaction (where applicable).
Graded Aggregate Base (See Note 5)	Final	One (1) Each 3 miles	Width and Thickness
Sand Clay Base (See Note 4)	Final	One (1) Each 2 miles	Gradation, Liquid Limit, Plasticity Index and Density (where applicable).
Sand Clay Base	Final	One (1) Each 2 miles	Width and Thickness.
Reinforcing Steel	Progress	One (1) Each source per year.	Weight, Yield Point, Elongation and Tensile Strength.
Shoulders (See Note 1)	Progress	One (1) Each 3 miles of roadbed.	Applicable Testing
Shoulders (See Note 6)	Final	One (1) Each 3 miles of roadbed.	Width and Thickness.
Subgrade	Final	One (1) Each 5 miles	Compaction
Surface Treatment	Progress	(See Note 1)	(See Note 1)
Surface Treatment	Final	One (1) Each mile	Width and Visual Inspection of Workmanship.

SCHEDULE OF INDEPENDENT ASSURANCE SAMPLING AND TESTING
Figure 106E
(Continued)

Notes:

1. *Each material entering into this processed mixture is to be sampled and tested in accordance with the schedule for each material.*

2. *In lieu of making the beams, the Laboratory representative may observe the beam making. The beams will be so marked that the identification will match that shown on the Sample Identification Cards. The percent air and slump will also be determined and the results shown on the Sample Identification Card. The station number where the concrete under testing is placed will be recorded.*

3. *In lieu of making the cylinders, the Laboratory representative may observe the making. The cylinders will be so marked that the identification will match that shown on the Sample Identification Cards. The percent air and slump shall also be determined and the results shown on the Sample Identification Card. The location and part of the structure where the concrete under testing is placed will be recorded.*

4. *Final Independent Assurance Samples will be taken from the compacted base before priming. Where the shoulder material and the base material are alike, no width measurement will be necessary; however, this fact must be noted and reported for Independent Assurance documentation purposes.*

5. *Progress Independent Assurance Samples should be taken after the material is thoroughly mixed but before compaction. Final Independent Assurance Samples and depth measurements must be taken after final shaping and rolling.*

6. *Where paved shoulders are constructed with processed materials such as graded aggregate base, soil-cement, etc., Progress Independent Assurance Samples will be taken from each 5 miles of completed shoulder pavement, alternating from left shoulder to right shoulder on two-lane highways, and from inside shoulder to outside shoulder on divided-lane highways.*

7. *Mix uniformity will be observed after mixing and shaping and prior to compaction. The Laboratory representative will observe the rate of cement application and will make a spot check of the project records to compare the amount of cement to that being reported. A statement of the findings both as to uniformity of mixing and cement used will be included in the report for Independent Assurance documentation purposes.*

SCHEDULE OF INDEPENDENT ASSURANCE SAMPLING AND TESTING
Figure 106E
(Continued)

106.3.12 **Final Materials Certification**

SCDOT requires the preparation of a Materials Certification for each State and Federal-aid construction project upon completion of the work. The purpose of the Materials Certification is to document that the materials incorporated into the construction work and the construction operations controlled by sampling and testing are in reasonably close conformity with the Contract Plans and Specifications, and such results compare favorably with the results of Independent Assurance Sampling and Testing, if performed. Any exceptions, failures or discrepancies will be documented and explained in the Certification. The following establishes uniform procedures for the timely preparation and submission of Materials Certifications for all State-funded and Federal-aid construction projects.

The Research and Materials Engineer will prepare SCDOT Form LAB-29 – Minimum Sample Requirements for each SC File Number project and furnish it to the Resident Construction Engineer shortly after the project is awarded. Form LAB-29 will show the minimum number of samples necessary during construction and other required materials documentation.

The Resident Construction Engineer will be responsible for obtaining and submitting all required Quality Control Samples and Tests (see Section 106.3.8), manufacturer's certifications and Mill Test Reports as required by SCDOT policy and the governing provisions of the Contract Plans and Specifications. The following procedures will be used to prepare, review and approve the final materials certification:

- Upon completion of the project, the Resident Engineer will forward to the Research and Materials Engineer, through the District Engineering Administrator, SCDOT Form 100.02 – Preliminary Letter of Certification indicating that all required samples and tests have been performed, listing all material failures, deletions and variations from Contract Specifications and noting the actions taken to correct failing materials by referencing the applicable SCDOT Form 100.09 – Report of Disposition of Material Failing to Meet Specifications.

- The Research and Materials Engineer will review the preliminary Letter of Certification and all project test results that are not in compliance with the Contract Specifications. Special attention will be placed on reviewing actions taken at the project level to correct materials found to be out of compliance. Further action may be warranted.

- The Research and Materials Engineer will review the comparison of results from Independent Assurance Samples and Tests and Quality Control Samples and Tests to certify that the results compared favorably. Any deviations falling outside the acceptable ranges presented in Figure 106D will be noted along with the corrective action taken.

- The Research and Materials Engineer will prepare a Letter of Certification based on the above analyses stating that all materials were found to be in reasonably close conformity with the Contract Plans and Specifications, except for variations as noted.

106.3.13 <u>Central and District Laboratory Inspection Program</u>

106.3.13.1 Central Laboratory

The Research and Materials Laboratory regularly participates in on-site inspections and proficiency sample testing through the AASHTO Materials Reference Laboratory (AMRL) and the Cement and Concrete Reference Laboratory (CCRL) accreditation programs, which are sponsored by AASHTO and ASTM, respectively. Laboratory test equipment, standard test procedures and SCDOT Technician proficiency are reviewed for materials including soil, liquid asphalt, HMA and aggregates through the AMRL program and cement, concrete and steel through the CCRL program. Discrepancies found during inspections or proficiency sample testing will be resolved through a review of test procedures used, equipment checks and re-testing of materials.

106.3.13.2 District Laboratory

The Department has three satellite laboratories – District 3 in Greenville, District 5 in Florence and District 6 in Charleston. Each laboratory participates in proficiency sample testing of soils and HMA through the AMRL program. Research and Materials Laboratory Unit Supervisors complete annual inspections for compliance with AASHTO requirements for equipment and familiarity with procedures. The Quality System Manager of the Research and Materials Laboratory completes semi-annual inspections for documentation on equipment calibration and SCDOT Technician qualifications, training and competency.

106.4 INSPECTION OF ASPHALT MATERIALS

Section 106.04 of the *Standard Specifications* defines SCDOT policy for the inspection and use of liquid asphalt materials, including performance graded binders. The required samples and tests are discussed in Section 106.3. See Section 401.4 for additional information.

106.5 PLANT INSPECTION

106.5.1 <u>HMA Plants</u>

HMA plants mechanically blend aggregate and asphalt binder materials together to produce a hot, homogeneous paving mixture. The HMA Quality Manager, District Asphalt Manager and Research and Materials Laboratory are responsible for verifying plant conditions and operations (e.g., certification, scales and weights, materials, mix proportions, mix temperatures). For additional information on plant operations, refer to the *HMA Quality Control Technician's Manual*.

106.5.1.1 HMA Plant Certifications

The Research and Materials Laboratory will approve the laboratory and lime system of the HMA plant prior to use. Before production, verify that the laboratory and lime system have been properly certified. Check compliance as follows:

1. Scales and Weights. Plant scales used to weigh aggregate, binder materials and batches, including truck scales, must conform to the Contract Specifications. Check for proper certification. Note that the seal on the scale indicates only that it was accurate at the time it was certified. Periodically check for accuracy and the need for recalibration.

2. Temperature Sensing Devices. The temperature sensing device (e.g., pyrometer) at the discharge end of the aggregate dryer and all thermometers used at the plant should be checked and calibrated before the plant is approved. The pyrometer and thermometers should be recalibrated, as needed, during production.

106.5.1.2 HMA Plant Inspection – Materials

With respect to materials at the HMA plant, the District Asphalt Manager or SCDOT Plant Inspector, as assigned, will check to ensure that:

- there is an approved Job Mix Formula for the project;
- materials on the Job Mix Formula are being used in the mix;
- fine and coarse aggregates comply with Contract Specifications;
- aggregates in stockpiles and bins are not intermixing;
- aggregate stockpiles are constructed to avoid segregation and contamination;
- HMA mixture complies with the specified properties (e.g., gradation, binder content); and
- lime and RAP systems are calibrated by the Contractor and are feeding properly.

106.5.1.3 HMA Plant Inspection – Equipment

With respect to the equipment at the HMA plant, the District Asphalt Manager or SCDOT Plant Inspector, as assigned, will check to ensure that:

- the plant complies with the Contract Specifications (AASHTO M 156, etc.);
- equipment is in good mechanical condition;
- the hydrated lime system has been approved by the Research and Materials Laboratory;
- the baghouse is operating properly;
- fines are properly reintroduced into the mix;
- scales have been certified within the last 6 months;
- plant scale tickets are adequate and accurate;
- haul trucks and truck-bed covers are in compliance;
- an approved release agent is being used in truck beds;
- the field laboratory has been approved by Research and Materials Laboratory; and
- the loader operator is working the full face of aggregate stockpiles.

106.5.1.4 HMA Plant Inspection – Production

With respect to HMA production, the District Asphalt Manager or SCDOT Plant Inspector, as assigned, will check to ensure that:

- the Contractor's inspection, sampling and testing of mix production is adequate;
- the asphalt binder, aggregate and mix temperature are in compliance;
- the plant has been properly calibrated by the Contractor;
- cold-feed bins are feeding properly;
- the mix is uniformly coated with asphalt binder;
- segregated mix is not being introduced into truck beds;
- proper loading of trucks (i.e., front, back, middle) is being performed;
- hydrated lime is feeding and mixing properly;
- conveying devices are depositing mix into center of silo or batcher;
- no mix is stored overnight, unless approved in writing by the Asphalt Materials Engineer;
- a batcher is being used at top of the silo;
- the gates on batcher are closing properly; and
- the mix is not dribbled into truck beds to complete a load.

106.5.2 PCC Plants

See Section 701.2.5 for information on Portland cement concrete plants.

106.6 FIELD LABORATORY

The Contractor is responsible for ensuring that the HMA plant laboratory is provided in accordance with the Contract Specifications. The laboratory should be located so that production operations are readily visible. The laboratory should contain copies of all reference materials applicable to the project (e.g., Contract Plans, *Standard Specifications*, Supplemental Specifications, Special Provisions, sampling and testing procedures, Quality Control Plan, Job Mix Formula, SCDOT Construction Forms). See Section 401.2.5 for additional information on HMA plant laboratories. All equipment calibrations and verifications should be readily available and up to date.

106.7 STORAGE OF MATERIALS

Materials must be stored in such a manner as to prevent damage and defects. Non-compliance with the provisions of Section 106.07 of the *Standard Specifications* is grounds for rejection. Document all rejected materials on the appropriate SCDOT Construction Form.

106.8 HANDLING MATERIALS

Materials must be handled in such a manner as to prevent damage and defects. Non-compliance with the provisions of Section 106.08 of the *Standard Specifications* is grounds for rejection. Document all rejected materials on the appropriate SCDOT Construction Form.

106.9 UNACCEPTABLE MATERIAL

Section 106.09 of the *Standard Specifications* governs the contractual provisions for unacceptable materials. The Resident Construction Engineer is responsible for assessing the acceptability of all project materials based on the requirements of the Contract Specifications, including Special Provisions, before the material is incorporated in the work. Reject all unacceptable materials. Document all rejected materials on the appropriate SCDOT Construction Form. Contact the Research and Materials Engineer for any needed assistance.

106.10 MATERIAL GUARANTEE

Section 106.10 of the *Standard Specifications* governs the requirements of submitting a Material Guarantee at the completion of the project. If required by the Special Provisions of the Contract, the Contractor's Material Guarantee must be submitted with the final Materials Certification, as discussed in Section 106.3.12.

106.11 MATERIAL PIT ACQUISITION AND TESTING

106.11.1 Acquisition of Material Pits

Where materials are needed for the project but are unavailable on SCDOT right-of-way, in terms of either suitability or quantity, the acquisition of privately owned land may be necessary. This situation generally occurs when borrow or select materials and sand-clay are needed.

The permits needed for such land are the Contractor's responsibility. Unless the Special Provisions state otherwise, SCDOT will not furnish such material pits. The Contractor may forward material samples to the Research and Materials Laboratory or to an approved Independent Laboratory for testing prior to the material being used on the project. Test results of samples obtained from material pits will be provided to the Contractor for information only and for the Contractor's use in evaluating pits.

106.11.2 Reclamation of Material Pits

When a material pit has served its purpose, the Contractor is required to reclaim the land in accordance with the reclamation standards of the South Carolina Mining Act, enacted by the South Carolina General Assembly in 1973 and adopted by SCDOT (South Carolina Code Annotated Section 48-20-10 et. seq.). Review the Contract Special Provisions and pay particular attention to the requirements for side slopes, drainage, seeding and erosion control. The Resident Construction Engineer will make a final inspection of the reclaimed land, on behalf of the State Highway Engineer. Retain these records in the project file and make reference in the Daily Work Report.

Section 107
Legal Relations and Responsibility to Public

107.1 LAWS TO BE OBSERVED

107.1.1 General

Depending upon the nature and complexity of the construction project, the Contractor must comply with a wide range of Federal, State and local laws and regulations. These apply to the following broad areas:

- Occupational Safety;
- Health;
- Environmental (e.g., noise, air, water);
- Navigational; and
- Labor.

The Contractor is responsible for scrutinizing the Contract provisions and identifying all applicable laws and regulations for the specific project. The Resident Construction Engineer must ensure that the Contractor fulfills these legal obligations. The *Standard Specifications* and the *Construction Manual* address applicable legal requirements in various places throughout the two documents. For example, Section 107.26 discusses environmental laws that may apply to the project. Section 107.1.2 specifically discusses those labor regulations that apply to highway construction on Federal-aid projects.

107.1.2 Labor Regulations on Federal-Aid Projects

107.1.2.1 General

The Resident Construction Engineer must ensure that all provisions of the Special Provisions relating to the Federal Labor requirements and reports are properly implemented.

On each Contract in which there is Federal-aid participation, the Resident Construction Engineer should establish a check system as a means of assuring that all reports required of the Contractor and subcontractors are being submitted. The Contractor should be written and advised when reports are past due. The Resident Construction Engineer or a designated employee should review the reports submitted by the Contractor. Any reports that are improperly completed must be returned to the Contractor for correction.

Posting of wage rates at the job site by the Contractor is required on Federal-aid projects. The rates should be placed in a location so as to be readily available for viewing by interested employees or other persons.

The Resident Construction Engineer must investigate promptly any complaints of violation of minimum wage rate provisions referred to them by the employees of the Contractor or any subcontractor, by the Federal Highway Administration in its own behalf or in behalf of any other Federal agency, or complaints received from any other source. A report of each such investigation and the action taken must be furnished to the Office of Compliance.

107.1.2.2 Interviewing of Contractor's Personnel on All Federal-Aid Projects

Systematic spot interviews of Contractor's or subcontractor's personnel must be made weekly by the Resident Construction Engineer or their designated representative on all Federal-aid projects. The interview should generally include employees of different classifications. Each interview should reflect the name of the employee, class of craft or power-equipment operator, and the description of the work being performed.

Check with the foreman or superintendent after interviewing the Contractor's employees to ensure that the employee's name and any other pertinent factors are shown correctly. Any irregularities with the labor requirements found during these interviews must be immediately investigated.

Interviews must be reported on SCDOT Form 100.07 – Wage Regulation Report, and must be submitted directly to the Resident Construction Engineer at the end of each week. Copies of this report will be retained by the Resident Construction Engineer in their file. This form should be submitted even though there has been no work performed by the Contractor. A statement should be made on the form stating the reason why no interviews were made.

The Wage Regulation Report must also contain a list of the Contractors and of each subcontractor who worked on the project during the week. Copies of the Wage Regulation Report that are retained in the Resident Construction Engineer's file must be compared with the payroll transcripts for the same period.

SCDOT Form 100.20 – Equal Employment Opportunity Stage Type Inspection should be completed in accordance with the current procedures from the Compliance Office. This inspection should be performed once during the duration of the project.

107.1.2.3 Payroll Transcripts

Payroll transcripts received from the Contractor should be carefully studied. Each transcript should contain the name of each employee, their correct classification, rate of pay, daily and weekly number of hours worked, deductions made and actual wages paid. When an employee's name first appears on the payroll transcript, their address and social security number should be shown. The listing of the addresses of all employees on each transcript is not discouraged, however. Except in unusual cases, the employee's classification must conform with a classification which is set up in the Wage Regulation Schedule for the project. Unusual job classifications must be explained by the Contractor or the Resident Construction Engineer.

The transcripts must be legible, suitable for reproduction, and should be identified by the File number, the Federal-aid Project number and by the name of the Contractor or subcontractor.

Each payroll transcript must bear a certification by a proper official of the Contractor's organization affirming that the payroll is correct and complete, that the wage rates contained therein are not less than those determined by the Secretary of Labor, and that the classification set forth for each laborer or mechanic conforms with the work being performed.

Supervisory employees such as superintendents, foremen and timekeepers, who are employed at hourly rates, must be paid overtime for work in accordance with the provisions of the Wage-Hour Law. The wage rate inserted on transcripts for supervisory employees who are employed on a straight-time weekly basis should be the actual weekly rate of employment and not an hourly rate prorated on the basis of the number of hours worked.

Payroll transcripts are considered past due after a period of four weeks has elapsed following the close of the payroll period. Failure to submit payroll transcripts in this time frame will result in construction estimates being withheld.

All payroll transcripts must be compared with the Wage Rate Schedule shown in the Contract to ensure compliance with the minimum wage rates that have been set for each classification of labor.

Attempts must be made to correct variances between the information listed on the payroll transcripts and on the wage regulation reports. If the Resident Construction Engineer or the District Engineering Administrator is unable to make such a correction, a full report of the circumstances involved should be submitted to the Office of Compliance.

The Resident Construction Engineer is expected to observe the type of work being performed by the various classifications of labor to determine whether employees are properly classified. If, in the opinion of the Resident Construction Engineer, an employee's classification does not conform to the work being performed, the issue should be directed to the Contractor's attention.

When revised payroll transcripts are submitted, the notation "Revised" should be written on the transcripts. The reason for the revision should also be stated. The Resident Construction Engineer or a designated employee should initial the transcripts as an indication that they have been reviewed and are properly completed.

107.1.2.4 EEO and OJT Procedures

The Specific Equal Employment Opportunity (EEO) Responsibilities Provision will appear in all Federal-aid Contracts. SCDOT Form 100.18 – Annual EEO Reports – Contractors should be completed for work performed in the month of July. The Special Training Provision, which covers the On-the-Job Training (OJT) Program, will be included in most Federal-aid Contracts on which it is determined that such training can be supported. Thus, the Specific EEO Responsibilities Provision may be present with or without the Special Training Special Provision; but the Special Training Provision will never appear in a Contract that does not have the Specific EEO Responsibilities Provision. The Contractor is responsible for complying with these provisions and submitting SCDOT Form 100.22 – Monthly Training Status Report and SCDOT Form 100.23 – Trainee Termination Report. The Office of DBE Program Development will provide the Resident Construction Engineer with a copy of *EEO and OJT Procedures*, which is a detail checklist specifically developed to assist the Resident Construction Engineer in overseeing the activities of the Contractor regarding the EEO and OJT Provisions. These Provisions deserve no less emphasis than any other Contract provision.

107.1.2.5 DBE Quarterly Reports

Ensure that SCDOT Form 100.19 – DBE Quarterly Report is submitted within 15 days of the end of the quarter as specified in the Contract Supplemental Specifications titled “Disadvantaged Business Enterprises (DBE) – Federal Projects.” Contractors should be reminded that these reports must be submitted within this time frame or payments will be withheld until they are received. Also, the report must be submitted to the Director of Construction and must be an original copy with the signature of the subcontractor. If any revisions are necessary, the individual making the revision must initial the change. If no payments are made to a DBE subcontractor, a signature is not required.

107.2 PERMITS, LICENSES AND TAXES

Section 107.02 of the *Standard Specifications* governs the Contractor’s responsibilities with respect to permits, licenses and taxes.

107.3 PATENTED DEVICES, MATERIALS AND PROCESSES

Section 107.03 of the *Standard Specifications* governs the Contractor’s responsibilities with respect to using patented devices, materials and processes.

107.4 RESTORATION OF ROADWAY SURFACES OPENED BY PERMIT

Section 107.04 of the *Standard Specifications* governs the provisions for opening and restoring roadway surfaces on the project under SCDOT permit.

107.5 FEDERAL PARTICIPATION

107.5.1 <u>General</u>

The Federal Highway Administration (FHWA) administers the Federal-aid program that funds eligible highway improvements nationwide. FHWA’s basic responsibility is to ensure that the State DOTs comply with all applicable Federal laws, policies and procedures in their expenditure of Federal funds and to ensure that the State DOTs meet the applicable engineering, legal and administrative requirements for their Federally funded highway projects. FHWA maintains a Division Office within each State, and this is the primary point of contact for a State DOT.

SCDOT complies with all Federal laws, regulations and directives for the design, construction, operation and maintenance of all Federal-aid projects. FHWA may review or investigate any phase of the Federal-aid program on any Federal-aid project, especially those that contain unique features or those with unusual circumstances. Furthermore, this does not preclude SCDOT from requesting FHWA involvement in projects.

107.5.2 FHWA Role in Construction

Figure 107A summarizes FHWA's oversight role in construction. The following also applies:

1. Interstate System. All new construction and reconstruction projects on the Interstate system will be constructed with full FHWA oversight and approval as shown in Figure 107A. Upon agreement by the FHWA and the Department, large or complex rehabilitation projects may also be considered for full FHWA oversight.

2. NHS. For new construction and reconstruction projects on the non-Interstate, National Highway System (NHS), FHWA oversight and approval will be required where the total project costs exceed $50 million. For 3R projects and new construction and reconstruction projects less than $50 million, SCDOT will assume all responsibilities.

3. All Other Projects with Federal Funding Participation. SCDOT will assume all construction responsibilities. This precludes the need for any FHWA approval or concurrence, except those actions that require FHWA approval for Title VI compliance.

The level of FHWA involvement in a project will typically be determined during the preconstruction phase and transfer to construction.

Project Level Actions	**Highway System**		
	Interstate or NHS > $50 million	**NHS ≤ $50 million**	**Non-NHS**
Approvals of the Award of the Contract	x		
Disadvantaged Business Enterprise (DBE) Program	x	x	x
All Construction Engineering	x		
Davis-Bacon Act Regarding Wages	x	x	x
Approval of Extra Work, Time Extensions and Claims	x		
Approval of Minor Construction Supplemental Agreements and Contract Modifications	x		
Final Acceptance	x		

Note: X = FHWA Involvement Required

FHWA PROJECT OVERSIGHT FOR CONSTRUCTION
Figure 107A

107.5.3 FHWA Relationships

The relationship between FHWA and SCDOT does not directly involve the Contractor. FHWA representatives inspect the project to review the Department's construction procedures. The FHWA representative is reviewing the State's performance and not the Contractor's. FHWA has neither the responsibility nor authority to interact directly with the Contractor relative to ensuring compliance with the plans and specifications. All Department employees are urged to cooperate with the FHWA during all phases of the Contract. Construction personnel must be courteous to FHWA representatives whenever they conduct their reviews. FHWA personnel have been delegated to review construction activities relating to progress, quality, Contractor's payrolls, etc. They may also take field measurements, review test procedures and results, or investigate requested Contract changes. Comments made by the FHWA representatives should be noted in the Daily Work Report, and issues that require action by the Department should be referred to the Resident Construction Engineer.

107.6 SANITARY HEALTH AND SAFETY PROVISIONS

107.6.1 Contractor Responsibilities

The Contractor is responsible for complying with the regulations of the Occupational Safety and Health Administration (OSHA), SCDHEC and other applicable Federal, State and local agencies regulating the health and safety of construction personnel and the general public. The Contractor must comply with the OSHA Federal Construction Safety Standards. It is good practice for the Contractor to hold weekly meetings to discuss health and safety issues on the project. On bridge structure projects, a Crane Safety Plan will be required. Check the Special Provisions of the Contract.

107.6.2 SCDOT Responsibility and Authority

107.6.2.1 Safety Meetings

SCDOT will not permit any employee to work in or around unsanitary or unsafe conditions. It is important to remain alert during construction activities to avoid mishaps and injury. Because many hazards exist on construction projects, it is good practice for the Resident Construction Engineer to include safety as a topic of discussion during the weekly progress meetings.

107.6.2.2 Inspection Duties

All SCDOT personnel should continually monitor Contractor and subcontractor activities for non-compliance with respect to the health and safety provisions of the Contract, including the minimum safety requirements of the OSHA and SCDHEC. SCDOT personnel should instruct the Contractor to verify safety requirements if non-compliance is suspected.

107.6.2.3 Imminent Danger

If imminent danger is obvious or suspected, immediately issue a verbal stop-work order to suspend all work in the vicinity of the hazard. In this context, imminent danger is any condition on the project that could result in serious injury or death. Immediately contact the Resident Construction Engineer for any needed assistance.

107.6.3 Tall Timbered Regions

Clearing and grubbing operations, particularly in dense, tall timbered regions, can be very hazardous. The Contractor will generally use specialized methods and equipment to fell tall timber. All project personnel should be especially careful in the vicinity of clearing such areas. Immediately inform the Contractor if clearing tall timber endangers personnel, poses a potential hazard to the general public or damages existing facilities in or adjacent to the right-of-way.

107.6.4 Poisonous Plants

All project personnel should use caution when working in areas known to have poison oak and poison ivy. The oils from these common poisonous plants cause an irritable rash when contact is made with the skin. In addition, the smoke from burning these poisonous plants can cause an equally serious condition, both internal and external. Those individuals with severe allergic reactions to such exposure will require immediate medical attention.

107.6.5 HMA Activities

Construction personnel must be safety and health conscious and monitor HMA plant and paving operations. Consider the following:

1. Dust and Plant Emissions. Dust and plant emissions are particularly hazardous. It is not only a threat to the lungs and eyes, but it also may contribute to poor visibility, especially when trucks, front-end loaders and other equipment are working around stockpiles and cold bins. Reduced visibility in work traffic is a prime cause of accidents.

2. Noise. Noise is harmful to hearing and can distract workers' awareness of moving equipment and other dangers at the HMA plant and project site. As appropriate, wear hearing protection.

3. Stockpiles. HMA plant personnel should not work on stockpiles while the plant is in operation. No one should walk or stand on stockpiles or the bunkers over the feeder gate openings. It is possible in these areas to be pulled down into the material and buried without warning.

4. Moving Machinery. Moving belts that transport HMA materials should be a constant concern, as should belts to motors, sprockets and chain drives. All pulley, belt and chain drive mechanisms should be covered or otherwise protected. Loose clothing that can

get caught in machinery should never be worn at the HMA plant or near the paver. Similar safety precautions should also be observed in the laboratory.

5. Fire and Burn Hazards. Burning flames and high temperatures around ovens, dryers, silos, haul trucks and pavers are obvious hazards. Control valves that can be operated from a safe distance should be installed on all fuel lines. Flame safety devices also should be installed on all fuel lines. Smoking should not be permitted near binder or fuel storage tanks. Check frequently for leaks in oil heating lines, steam lines and the jacketing on binder distribution lines. Be sure safety valves are installed in all steam lines and that they are in working order. Make use of screens, barrier guards and shields for protection. Ensure that the HMA plant and project site are equipped to handle emergency fire and hazardous material spill situations. When handling heated asphalt material, use chemical goggles and a face shield. All shirt collars should be worn closed and cuffs buttoned at the wrist. Gloves with gauntlets that extend up the arm should be worn loosely so that they can be flipped off easily if covered with hot asphalt material. Pants without cuffs should extend over boot tops. Closely monitor the temperature of liquid asphalt binder and do not allow the temperature to approach the flash point of the material.

6. Screen Deck. Exercise extreme caution at the HMA plant when climbing around the screen deck, inspecting screens and hot bins and collecting hot bin samples. Use covered or protected ladders or stairways to access these parts of the plant. All stairs and platforms should be equipped with secure handrails.

7. Traffic. Truck traffic patterns at the HMA plant should be planned for both safety and convenience. Trucks entering the plant to pick up loads should not have to cross the path of trucks leaving the plant. Also trucks should not have to back up. At the project site, continually be alert to paver movement, haul truck traffic and vehicular traffic, where it is being maintained and operational during construction.

8. Site Maintenance. The HMA plant and project site should be kept free of loose wire, lines, pipes, hoses and obstacles. High voltage lines, field connections and wet ground surfaces are hazards that should be continually monitored. Immediately report for repair any loose fittings or connections, frayed insulation and improperly grounded equipment.

107.6.6 Safety Considerations for Burning Operations

Where permitted, the Contractor may elect to burn combustible waste materials on the project right-of-way. The Contractor is solely responsible for the safe control of such operations. Left unattended or performed improperly, open-air burning of combustible materials can quickly develop into wildfires outside the project right-of-way. Consider the following guidelines:

1. Legal Issues. Check to ensure that the Contractor’s burning operation is performed in accordance with the provisions of the Contract and the applicable laws, ordinances, regulations and provisions of SCDHEC. Ensure that the South Carolina Forestry Commission has been notified prior to the burning operation.

2. Preparation of Area. Inspect the burning operation to ensure the Contractor properly prepares and cleans the surrounding area of combustible debris.

3. Fire Fighting Equipment. Check to ensure the Contractor has fire fighting equipment readily available.

4. Watchmen. Verify that the Contractor provides watchmen to control the spread of fire.

5. Location. Visually inspect to ensure that the debris is being burned on right-of-way, unless a landowner agreement permits otherwise, and in a location that will prevent the spread of fire to adjacent forested areas.

6. Utilities. Do not allow the Contractor to burn materials anywhere near overhead utility lines. Also, give consideration to the type and depth of existing underground utility facilities (e.g., gas lines).

7. Pile Size. Where advisable for better burn control, inform the Contractor to use chippers to reduce the size of burn piles.

8. Unfavorable Conditions. In high winds or very dry conditions, halt burning operations in lieu of more favorable weather and ground moisture conditions. Verify that the Contractor douses smoldering embers to prevent rekindling by high winds.

See Section 107.7.2 for air quality considerations with respect to burning operations.

107.6.7 Reporting Injuries and Fatalities

The Contractor must notify OSHA of project injuries and fatalities using the following procedures from 29 CFR 1904.8 – Reporting of Fatality or Multiple Hospitalization Incidents (Item (c) relates to Resident Construction Engineers):

(a) Within 8 hours after the death of any employee from a work-related incident or the in-patient hospitalization of three or more employees as a result of a work-related incident, the employer of any employees so affected must verbally report the fatality/multiple hospitalization by telephone or in person to the Area Office of the Occupational Safety and Health Administration, Department of Labor, that is nearest to the site of the incident, or by using the Occupational Safety and Health Administration toll-free central telephone number 1-800-321-6742.

(b) This requirement applies to each such fatality or hospitalization of three or more employees which occurs within thirty (30) days of an incident.

(c) Exception: If the employer does not learn of a reportable incident at the time it occurs and the incident would otherwise be reportable under paragraphs (a) and (b) of this section, the employer will make the report within 8 hours of the time the incident is reported to any agent or employee of the employer.

(d) Each report required by this section must relate the following information: Establishment name, location of incident, time of the incident, number of fatalities or hospitalized employees, contact person, phone number, and a brief description of the incident.

107.7 AIR POLLUTION CONTROL

107.7.1 Air Quality

The Contractor will be responsible for complying with all Federal, State and local laws and regulations with respect to preventing pollution of the atmosphere from particulate and gaseous matter. Construction activities generate a number of products that can contribute to air pollution. These include emissions from plant and equipment operations, chemicals from bridge cleaning and plant operations and particulate matter (e.g., smoke from burning debris, dust from earthwork operations). During periods of limited dispersion, construction operations may be temporarily suspended if those operations are producing the specific air pollution elements of concern. Water may be used as a dust reducer, as directed by the Resident Construction Engineer, to prevent a public nuisance. Other options for controlling dust include dust suppressants (i.e., cement-based products that form a protective shell once sprayed) and, for open stockpiles, the use of barriers, screens and covers. In addition, it may be appropriate to restrict or suspend dust-producing operations during periods of dry and windy conditions.

107.7.2 Air Quality Considerations for Burning Operations

Non-merchantable trees, limbs, stumps and brush may be disposed of by burning, unless prohibited by ordinances or regulations. Sometimes, complete combustion of the larger pieces is not possible, and the remains are disposed of by other suitable means. During the burning operation, the Contractor must take all reasonable precautions to not endanger adjacent properties. When fire damages some portion of their property, owners tend to place the blame upon the Department, rather than the Contractor. The Contractor is responsible for all damages. Check to ensure that the Contractor burns the materials within the right-of-way limits under the constant care of competent watchmen and that the action does not jeopardize items to remain in place or the surrounding timber and grasslands of adjacent properties. Consider the following:

1. Legal Issues. Prior to burning, verify that the Contractor has obtained the required Burn Number from the South Carolina Forestry Commission. Monitor compliance and notify the Contractor of any obvious infractions of the regulations promulgated by SCDHEC.

2. Urban Areas. Local ordinances generally prohibit burning of combustible waste materials in urban areas. Unless the Resident Construction Engineer approves otherwise, do not allow the Contractor to burn materials in urban areas.

3. Fire and Smoke Hazards. The Resident Construction Engineer may prohibit the Contractor from burning materials in areas where it is apparent or obvious that fire and smoke will present a hazard to the health, safety, comfort and property of citizens in the vicinity of the project.

4. Incinerators. Incinerators, including air curtain burners, may be used provided that SCDHEC approves their use.

5. Damages. The Contractor is solely responsible for damages. Visually inspect any damage to trees, shrubs, fences or other objects to remain in place and make sure that

the Contractor adequately repairs or replaces the damaged items. Note damages and directives in the Daily Work Report.

6. Cleanup and Restoration. Check to make certain that the Contractor removes and disposes of burned materials and seeds the burned areas in an acceptable manner.

See Section 107.6.6 for safety considerations with respect to burning operations.

107.8 QUARANTINE REGULATIONS

The Contractor must comply with the quarantine regulations of the Clemson University Division of Regulatory and Public Service Programs and the US Department of Agriculture for noxious plant and insect pest control. Noxious plants and insects (e.g., witchweed, fire ants) are detrimental to the health and well being of other living organisms within South Carolina. Discuss and reiterate this policy at the Preconstruction Conference and prior to operations such as earthwork, seeding, sodding, planting and mulching. Project materials such as soil, mulch, seed, sod, plants and shrubs must be free of noxious plants and insects to minimize their propagation within the State. Where required, obtain and retain proper certification from the Contractor before the materials are used on the project. Soil moving equipment, in particular, is subject to these provisions and may need to be cleaned and inspected before they are moved into regulated areas. Because these provisions will vary from county to county, check the Special Provisions of the Contract for specific requirements.

107.9 PUBLIC CONVENIENCE AND SAFETY

Public and private roadways and intersections may be affected by the Contractor’s construction activities. The Contractor is responsible for maintaining these facilities in a safe and passable condition. It is critical that the Resident Construction Engineer and all Inspectors continually monitor operations for potential hazards to the public. Perform daily visual checks to ensure that the Contractor is adequately cleaning and sweeping mud, oil, debris and other objectionable materials from the traveled way. Do not allow the Contractor to place any equipment or materials that would become an obvious hazard to vehicular or pedestrian traffic. Notify the Contractor in writing of any obvious safety hazards to the public that require immediate correction. Note these activities in the Daily Work Report.

107.10 CONSTRUCTION OVER OR ADJACENT TO NAVIGABLE WATERS

Section 107.10 of the *Standard Specifications* governs the provisions for construction over or adjacent to navigable waters.

107.11 TRAFFIC CONTROL

Section 107.11 of the *Standard Specifications* governs the provisions for traffic control on the project. See Section 601, 602 and 603 for additional information.

107.12 PAYMENT FOR TRAFFIC CONTROL

Section 107.12 of the *Standard Specifications* governs the provisions for payment for traffic control used on the project. See Section 601, 602 and 603 for additional information.

107.13 CORRECTING LOW SHOULDER CONDITIONS

Section 107.13 of the *Standard Specifications* governs the provisions for correcting low shoulder and lane drop-offs during construction. See 601.3.12 for additional information.

107.14 RAILWAY-HIGHWAY PROVISIONS

107.14.1 General

For railroad-highway crossings, the Contractor's key point of contact will be the Road Master of the railroad company. If construction operations are performed adjacent to or within railroad right-of-way, the Contractor must notify the railroad company and comply with Contract provisions with respect to insurance requirements, grade crossing adjustments, mitigation, coordination of schedules, track clearances and use of railroad flaggers.

107.14.2 Railroad-Highway Crossing Improvements

107.14.2.1 General

When construction plans are available, the Railroad company is advised of its responsibility to improve the railroad-highway grade crossing, which includes the installing or rearranging of crossbuck signs. The Utilities Office gives the notification to the Railroad company. The initial request for a Railroad company to improve a grade crossing is usually made as soon as construction plans are available for the road on which the crossing occurs. When it appears likely that delays will be encountered in the construction of a highway section adjacent to grade crossings, the Resident Construction Engineer should take prompt action to address this issue to the attention of the Utilities Office.

Upon receipt of the construction plans by the Resident Construction Engineer, the plans should be reviewed to ensure that they contain all information as outlined in Section 107.14.2.2. If sufficient information is not given on the plans, the Resident Construction Engineer should furnish this information to the Utilities Office because this information is usually necessary when advising the Railroad companies of the crossings to be improved.

Unless stated or shown otherwise in the plans, the finished grade of the roadway must fit the existing railroad rail elevations. Care must be exercised in fitting the roadway grades to the rails because, otherwise, a rough riding crossing will result. On resurfacing contracts, the added surfacing will usually be feather-edged at the crossing.

The Resident Construction Engineer should cooperate with the local Railroad company officials as practical to hasten the grade crossing improvement. This should be done by personally contacting the local Railroad officials.

107.14.2.2 Information to be furnished on Location Surveys

Resident Construction Engineers are often requested to make location surveys, and these surveys frequently cross railroad tracks. When the survey crosses a railroad, the following should be provided in the survey notes:

- the survey station and elevation of rails on mainline tracks, side tracks, storage tracks, and pass tracks;
- the angle of intersection between the survey line and the centerline of the railroad;
- the alignment of the tracks (on tangent or degree of curvature);
- right-of-way lines must be ascertained and indicated;
- distances to and identification numbers of nearest railroad milepost. For spur lines, where there are no railroad mileposts, switch points must be referenced to mainline mileposts. When ascertainable, the National Grade Crossing Inventory Number should be indicated for existing crossings;
- survey station at which the highway centerline and railroad intersect;
- name of Railroad;
- identification of line (e.g., Columbia-Rock Hill mainline tracks);
- survey station number and the elevation of lowest wire on all utility wire lines that cross the survey line near the railroad;
- the relocation of the proposed railroad-highway grade crossing must be referenced to the existing grade crossing by showing the distance between crossings, the distance being measured along the centerline of the track. The inventory number for the existing crossing should be given; and
- where proposed grade crossing relocations are within reasonable distances of existing grade crossing locations, the survey notes should accurately show the location of the old highway roadbed.

107.14.2.3 Pipeline Construction on Railroad Property

Frequently, the plans call for pipelines to be placed under a railroad or upon the Railroad company's right-of-way. When the Resident Construction Engineer receives the construction plans, they should be examined to determine if pipelines will be installed at such locations. If pipes will be placed within the Railroad's right-of-way, the Resident Construction Engineer should examine the project correspondence file to determine if the Railroad company has been advised of this proposed pipeline construction. If no such notice is found in the file, the Utilities Office should be advised so that the Railroad company can be notified. Often, extra-strength pipe and other installation requirements are made by the Railroad company.

107.14.2.4 Railroad Crossing Signs

1. Railroad Advance Warning Signs. As stipulated for in the *MUTCD*, the Department must install and maintain railroad advance warning signs at railroad grade crossings. This applies to roads under construction and those under maintenance. The Resident Construction Engineer shall advise the proper highway official of any roads where it is necessary to install the above signs. The Contractor should not be permitted to damage or destroy the signs while performing its work. Should it be necessary to move the signs during construction, the Contractor shall relocate them to a suitable place.

2. Railroad Crossbuck Signs. Under Section 56-5-100 of the 1976 Code of Laws of South Carolina, Railroad companies are required to place and maintain at grade crossings standard crossbuck signs in accordance with the requirements of the *MUTCD*. Reference must be made to Section 107.14.2.1 for instructions regarding the notifying of the Railroad companies of their responsibility to install or relocate crossbuck signs.

107.14.2.5 Flashing Lights and Barrier Gates

Flashing lights and barrier gate installations or modifications are made by Railroad personnel under agreement with the Department. The cost of the installation or modification is usually shared by the Department and the Railroad company, except for new crossings.

When an agreement between the Department and the Railroad has been reached and the plans for the installation prepared, the Resident Construction Engineer will receive copies of the plans for conflicts that may occur with utilities such as overhead wires in the case of barrier gates.

The completion of plans and agreements for the installation of flashing lights and barrier gates is often delayed. It is, therefore, important that any rearrangement of utilities be done so that the utilities will not be placed in the way of future railroad grade crossing installations. Flashing light signals with short-arm gates are required on Federal-aid projects at railroad grade crossings with (a) multiple mainline tracks, (b) multiple track crossings with or without main tracks on which more that one train may occupy the crossings at the time, or (c) single or multiple track crossings when train operating speeds are 70 miles per hour or greater and sight distances are restricted.

107.14.2.6 Railroad Flashing Light Signal Installation

The following procedures are established for the processing of railroad flashing light signal installations:

1. The Railroad will notify the District Engineering Administrator of the date it intends to commence work and the Resident Construction Engineer (or other designee of the DEA) will monitor the signal installation.

2. Upon completion, the District Engineering Administrator will furnish SCDOT Form 100.24 – Final Inspection Acceptance Report Railroad Grade Crossing Signal Project to the State Highway Engineer indicating the following:

- Date work was started and completed.

- All work has been completed in accordance with agreement and plans.

- All signs and pavement markings are in compliance with the authorization sketch and MUTCD.

- Any situations that occurred during construction that could lead to a project cost overrun or underrun.

- Status of any force account work by the Department that may be charged to the project.

- To their knowledge, there are no other charges to be made against this file except railroad invoices and, once they have been paid, this file can be closed.

107.15 USE OF EXPLOSIVES

The Contractor may need to use explosives during construction of the project. Prior to blasting, the Contractor must obtain approval from the Resident Construction Engineer. Transport, storage, handling and detonation of explosives pose extremely hazardous conditions to workers and the public. Where blasting is performed, adequate protection and coordination must be provided, including cordoning areas, establishing clear areas from roads and structures, coordinating utilities and railroads and erecting warning signs to prohibit radio and cell phone transmissions. Such operations must be conducted under the careful, competent supervision of licensed personnel. The Contractor will be responsible for any injury and property damage claims. Inform the Contractor of any obvious safety violations. Where blasting in or near a stream, verify that the South Carolina Department of Natural Resources has been notified prior to the blasting operation, as provided for in the Contract Specifications. Ensure that the SCDOT Information Office has been properly notified prior to any blasting. The Contractor must submit SCDOT Form 200.06 – Blasting Notice.

107.16 PRESERVATION & RESTORATION OF PROPERTY, TREES, ETC.

107.16.1 <u>Typical Uses of Off Right-of-Way Property</u>

The need for access to privately owned or publicly held land off SCDOT right-of-way will be assessed on a project-by-project basis. This assessment will generally occur during project development, such as during the Constructability Review. Such land will typically be adjacent to the project and may be used for:

- NPDES and BCA areas,
- additional points of access to the project,
- waste and debris disposal sites,
- equipment staging areas,

- material storage and stockpile areas, and
- construction offices.

See Section 106.11 for information on the acquisition and reclamation of land needed for material pits.

107.16.2 Landowner Agreements

The provisions of the Contract specify that the Contractor will not enter property off SCDOT right-of-way without the consent of the landowner. Permission will be obtained through a written agreement between the landowner and the Contractor, which must be executed on SCDOT Form 200.04 – Agreement for Placing Debris on Private Property. SCDOT is generally not a legal party to this agreement. The agreement provides written consent from the owner to the Contractor to use the land for an intended purpose. The agreement will explicitly define the limits of access, acceptable and unacceptable uses and restoration requirements, including evidence that the landowner is satisfied with restoration and cleanup. The Resident Construction Engineer will obtain from the Contractor copies of all such agreements. The Resident Construction Engineer and all Inspectors should review these agreements to understand the Contractor's limits of operations.

107.16.3 SCDOT Responsibility

It is important to note that adhering to the requirements of landowner agreements is the Contractor's responsibility, not the Department's. However, SCDOT construction personnel, in good faith to owners of adjacent property, should notify the Contractor immediately of any known infractions or damage. This will enhance the Department's relationship with the public, which will benefit future SCDOT projects. Once the project has started, monitor construction activity to ensure that the Contractor operates within the limits of landowner agreements. Once the land has served its intended purpose, verify that the Contractor has reclaimed the land as defined in the agreement and that the Contractor has obtained the owner's signatory release. Reference these activities in the Daily Work Report, noting any directives and progress with respect to reclamation and any needed repairs.

107.16.4 Preservation of Property

The Contractor is responsible for preserving all items and areas within the right-of-way that are marked for protection. The Contractor is also responsible for preserving public and private properties along, adjacent, above and below SCDOT right-of-way. These provisions apply to trees, forests, crops, survey monumentation, environmentally sensitive areas, above and below ground utilities, railroads and highway infrastructure. The Contractor will determine the method in which property is to be protected. Do not direct the Contractor on how to accomplish this task, unless specifically covered in the Contract, and as long as the method is reasonable and consistent with good construction practice.

107.16.5 Restoration of Damaged Property

The Contractor is responsible for property damage that may occur within or outside SCDOT right-of-way due to the Contractor's or subcontractor's operations. If damage is found, notify the Contractor immediately and note the details of such directives in the Daily Work Report.

107.17 FOREST PROTECTION

The Contractor will be responsible for protecting forested land in and adjacent to the project and for preserving trees that are designated to remain in place. This includes compliance with all Federal and State laws and any landowner agreements with respect to cutting of timber, refuse disposal, burning operations and the location and reclamation of areas used for construction purposes. Pay particular attention to any unauthorized debris burning operation or cutting of timber outside the right-of-way. In addition, trees are generally designated for protection for environmental and aesthetic purposes. Consider the following:

1. Marking of Trees. The Resident Construction Engineer is responsible for designating the trees and shrubs that are to be preserved. This should be performed by flagging or other means. Clearly indicate to the Contractor the trees or areas of trees to be preserved. Verify that marks on protected trees are at a location and height clearly visible to equipment operators.

2. Drip Line. The drip line is a circle around the tree trunk directly under the outermost edge of the canopy.

3. Clearing Limits. Where clearing occurs near protected trees, the clearing must not encroach the area around the tree bounded by the drip line. Verify that trees and areas marked for protection are not disturbed during the work.

4. Equipment Operation. Equipment must not encroach the drip line or otherwise cause damage to the trunk or canopy of a protected tree. Operators must never use protected trees to clean equipment (e.g., bucket slamming).

5. Fencing. As needed, fencing may be placed along the drip line to protect tree roots, trunks and canopies.

6. Trenching. Where trenches are constructed, they should be located as far away from protected trees as practical. Trenches must never encroach the drip line.

7. Injury. Check to ensure that any damage to protected trees is repaired as soon as practical. Diagnosis and repair should be prescribed by a forester or tree specialist.

107.18 RESPONSIBILITY FOR CLAIMS, ETC.

Section 107.18 of the *Standard Specifications* governs the contractual responsibilities for claims due to injury and damage that may occur during the project.

107.19 THIRD PARTY LIABILITY

Section 107.19 of the *Standard Specifications* governs the contractual provisions for third party liability.

107.20 OPENING OF SECTION OF HIGHWAY TO TRAFFIC

Section 107.20 of the *Standard Specifications* defines the provisions for opening of a section of highway to traffic.

107.21 CONTRACTOR'S RESPONSIBILITY FOR THE WORK

Section 107.21 of the *Standard Specifications* defines the Contractor's responsibility for the work as defined by the Contract.

107.22 CONTRACTOR'S RESPONSIBILITY FOR UTILITIES

To minimize project delays and mishaps, utility adjustments and relocations should be carefully reviewed and clearly understood by all affected parties. Ensure that representatives of all affected utility and railroad companies are invited to the Preconstruction Conference. Verify that all underground utilities have been clearly marked. Visually check for and report in the Daily Work Report any evidence of damage to utility and railroad facilities.

107.23 FURNISHING RIGHT-OF-WAY

107.23.1 General

For each Contract the Right-of-Way Special Provisions will be posted on the Intranet website. Before work begins on the project, the Resident Construction Engineer should carefully study the list so that any of the Special Provisions agreed upon by the property owner and the Department will be implemented. If the work to implement a right-of-way Special Provision will be performed by the Contractor and is not included in the Contract, it will be necessary to negotiate a supplemental agreement. Any right-of-way Special Provision not implemented during the Contract should be brought to the attention of the Maintenance Department prior to or at the time of acceptance so that the Maintenance Department can perform any work necessary to fulfill the agreement.

Occasionally, the Special Provisions will stipulate that the property owner be paid for certain work to be performed. After such work has been done, the Resident Construction Engineer should initiate payment for this work.

107.23.2 Encroachment

The Resident Construction Engineer should be familiar with the right-of-way limits. It is the Resident Construction Engineer's responsibility to ensure that there are no right-of-way encroachments during construction. After the project is accepted for maintenance, this responsibility then transfers to the Resident Maintenance Engineer.

107.24 PERSONAL LIABILITY OF PUBLIC OFFICIALS

Section 107.24 of the *Standard Specifications* governs the personal liability of public officials.

107.25 NO WAIVER OF LEGAL RIGHTS

Section 107.25 of the *Standard Specifications* governs the contractual provisions once the work under Contract has been inspected and accepted by the Department.

107.26 ENVIRONMENTAL PROTECTION AND WATER POLLUTION CONTROL

The Resident Construction Engineer will be responsible for ensuring that the Contractor complies with the provisions of all Federal, State and local environmental laws and permits throughout the life of the project. This Section provides a brief discussion to assist in fulfilling this task.

107.26.1 Impact Assessment, Coordination and Permits

During project development on Federal-aid projects, the Environmental Section will prepare an environmental evaluation of project impacts. The impacts typically having the greatest impact on construction include the requirements for environmental and navigational permits, wetlands mitigation, archaeological and historical sites, hazardous waste disposal and assessment and recovery of underground storage tanks.

The Environmental Section is responsible for securing all environmental and navigational permits for highway and bridge projects during Preconstruction. The Contract Special Provisions will document permit requirements that impact construction. The following identifies permits that may be applicable to a particular project:

1. US Army Corps of Engineers. The provisions of Section 404 Permits will govern projects that require fill in tidal or freshwater wetlands and mechanized clearing in wetlands.

2. US Coast Guard. Section 9 Permits will govern the construction of bridge crossings over navigable waterways.

3. Federal Aviation Administration. FAA Permits will govern projects, including equipment, encroaching navigable airspace.

4. State Budget and Control Board. These are administered by the Water Resources Commission for navigable waters of the State, exclusive of Critical Areas in coastal areas.

5. South Carolina Coastal Council. Regulations of the South Carolina Coastal Council will govern the construction of bridges and wetland fill in Critical Areas (e.g., tidal waters) and freshwater wetland fill in the Coastal Zone, which includes the counties of Jasper, Beaufort, Colleton, Charleston, Dorchester, Berkeley, Georgetown and Horry.

6. SCDHEC. The Water Quality Certificate issued by SCDHEC will be required for projects having other related permits, except a USACE Nationwide Permit. The Department also issues NPDES Permits; see Section 107.26.2. Compliance with the provisions of the Water Quality Certificate (e.g., erosion and sediment control, waste management and disposal, wetland encroachment) must be closely monitored. The regulations of SCDHEC will also apply to air quality; testing, removal, transport and disposal of hazardous materials and underground storage tanks; licensing use, transport and storage of radioactive materials; and responses to environmental emergencies.

7. Federal Energy Regulatory Commission. FERC regulations will apply to construction activity in lakes under the Commission's jurisdiction.

8. County Agencies. Some counties may require a wetland permit.

107.26.2 NPDES Construction Permit (Section 402)

107.26.2.1 General

Much attention has been directed to controlling erosion and sedimentation. Numerous Federal and State regulations have been promulgated governing the disturbance of land, including the National Pollutant Discharge Elimination System (NPDES) Construction Permit (Section 402), which addresses stormwater discharge from construction sites. SCDHEC administers the NPDES Program in South Carolina on behalf of the US Environmental Protection Agency. SCDOT has a General Permit with SCDHEC for NPDES applications. See Section 815 for detailed information on the NPDES Permit.

107.26.2.2 Chipping for Erosion Control

The Special Provisions of the Contract may specify that material generated during clearing and grubbing be chipped or ground to use the material as mulch in erosion control applications. In such cases, the Contractor will reduce the material to chips and then place the chips, as a substitute for straw mulch, in areas where erosion control is required. Inspect the Contractor's operations to make certain chipping operations conform to the governing Contract provisions and that the use of the chips complies with the Erosion and Sediment Control Plan (see Section 815). As approved in areas designated by the Resident Construction Engineer, the Contractor also may dispose of chips between the construction lines and the right-of-way lines.

107.26.3 US Army Corps of Engineers Permit (Section 404)

The Resident Construction Engineer must monitor the Contractor's compliance with the provisions of the Section 404 Permit and any Mitigation Plan included in the Contract. The

Special Provision will set forth the conditions that must be met by the Contractor. A continued violation of any of these conditions will be cause for the US Army Corps of Engineers to:

- halt work on the project,
- suspend or revoke the Permit, or
- take other action as appropriate.

If the Contract makes no reference to US Army Corps of Engineers permits and the Contractor intends to perform any dredging or discharge of fill material into freshwater or tidal wetlands, advise the Contractor not to proceed without the appropriate permit. Contact the Resident Construction Engineer, who will contact the Environmental Section.

107.26.4 Wetlands and Animal Habitats

Protected wetland areas and habitats of threatened and endangered species will be designated in the permit application package. During project development, the Environmental Section will evaluate the project, which may include examination of National Wetland Inventory Maps and field investigations, to assess the impact on wetland areas and the need for any Federal, State and local permits. Where impacts can be avoided, the Contract Plans and Specifications will designate areas for protection and specify activities required to preserve these areas. Where impacts are unavoidable, the Environmental Section will obtain the necessary permits. The Contract Plans and Specifications will incorporate governing Special Provisions related to permits, plans for mitigation (e.g., removal of abandoned fill sections from wetlands, lowering high ground to wetland elevation, restoring and enhancing degraded wetland areas), and profiles and cross-sections of impacted wetland areas. Ensure that protected wetland areas and animal habitats within the limits of construction are clearly staked or otherwise delineated. Make absolutely certain that all Contractor personnel have been informed of the sensitivity of these areas and the importance of their preservation. As needed, contact the Environmental Section for assistance.

107.26.5 Spill Prevention and Containment

Where chemicals and hazardous substances will be used on the project, best management practices typically will be specified in the Stormwater Pollution Prevention Plan to ensure safe storage, contain spillage and mitigate pollution. Consider the following guidelines:

1. Storage Area. Unless otherwise specified, the storage area should be:

    - located at least 50 feet from any receiving body of water;
    - surrounded by a berm to contain at least 1.5 times the total stored volume;
    - lined with an impermeable liner and covered; and
    - designated with signs indicating material type and cleanup procedures.

2. Storage Containers. Verify that all containers are appropriately labeled, tightly sealed and free of leaks.

3. Cleanup Material. Ensure that the proper absorbent cleanup material is readily available on the project to clean up any spills that may occur.

4. Spills. If a leak is evident or a spill occurs, notify the Contractor and verify that it is mitigated as soon as practical by authorized personnel (e.g., absorbent material).

5. Disposal. Ensure that unused or contaminated material is disposed of in accordance with Federal, State and local laws. If applicable, retain receipts of disposal in the project records.

See Section 107.27 for a detailed discussion on hazardous substances.

107.26.6 Disposal of Non-Hazardous Waste

107.26.6.1 Legal Considerations

The Contractor is responsible for complying with all applicable Federal and State laws and safety regulations and any applicable local ordinances with respect to waste disposal and burning of debris, as governed by the provisions of the Contract. The Contractor must dispose of non-hazardous materials consistent with SCDOT policy and the regulations promulgated by SCDHEC and the South Carolina Forestry Commission. The Contractor is responsible for obtaining all necessary permits and, where applicable, landowner agreements. Check the Special Provisions of the Contract for additional disposal requirements.

107.26.6.2 Burying on Right-of-Way

In general, do not allow the Contractor to bury combustible materials within the right-of-way, unless such disposal areas are clearly marked on the Contract Plans or otherwise approved by the Resident Construction Engineer. Under no circumstances allow the Contractor to bury timber or other combustible materials in embankment areas. If burying combustible clearing debris on the right-of-way is permitted, constantly monitor the Contractor's operation for unacceptable practices and examine embankment areas (e.g., ravine bottoms) to ensure that they are kept clean and ready to receive embankment material. The Resident Construction Engineer may allow the Contractor to dispose on the right-of-way non-combustible construction and demolition waste materials such as concrete, crushed stone, bricks and blocks. Where permitted, check to make sure that the Contractor covers such waste materials with a minimum of 2 feet of soil and that the area is well drained and seeded. Contact the Resident Construction Engineer for the disposal of such waste materials in embankment areas.

107.26.6.3 Disposal off Right-of-Way

It is often necessary for the Contractor to dispose of construction and demolition waste off the right-of-way. Waste from construction and demolition operations includes, but is not limited to, clearing and grubbing waste, refuse, pavement materials, wood, plaster, metals, asphaltic substances, bricks, blocks, concrete, crushed stone and masonry materials. Construction and demolition waste does not include asbestos and other hazardous materials (e.g., lead-based paint, chemicals, fuel oil). See Section 107.27. Consider the following:

1. Land Disposal Permit. SCDHEC controls the disposal of construction and demolition waste material outside the right-of-way. The Contractor may dispose of construction and demolition waste provided that the waste is taken to a SCDHEC approved commercial landfill or the Contractor and owner of the disposal site applies for and obtains a SCDHEC Land Disposal Permit.

2. Landowner Agreement. The Contractor is required to make all necessary arrangements with SCDHEC and the property owner and furnish the Department with a written release covering the disposal of the material. The release will be obtained on SCDOT Form 200.04 – Agreement for Placing Debris on Private Property. This release from the property owner does not relieve the Contractor of the requirement to deposit the material off the right-of-way where it will not be visible from a public road. The Contractor also must have a written agreement with the owner of the proposed disposal site. Before the Contractor disposes of materials outside the right-of-way, check to ensure that the Contractor has a written agreement with the property owner and any required permits.

3. Temporary On-Site Storage and Containment. A suitable and properly prepared on-site location should be used to temporarily store waste and debris until it can be hauled to the disposal site. Factors that should be considered include location, number of containers, lids, coverings, drainage, etc. If the Contractor uses a site on private property, written permission from the landowner, in the form of a properly executed landowner agreement, is required.

4. Director Approval. The Director of Construction must approve the use of a proposed disposal site adjacent to the right-of-way. Although the property owner may grant permission for waste disposal, SCDOT may disapprove the site because it could become a potential roadside nuisance, natural drainage obstruction or maintenance problem (e.g., debris sliding into the right-of-way).

107.26.7 Archeological and Historical Sites

107.26.7.1 Legal Reference

Section 106 of the National Historic Preservation Act of 1966, as amended, is intended to protect, rehabilitate, restore and reuse sites, buildings, structures and objects significant in American history, architecture, archeology, culture and engineering. The Special Provisions of the Contract will document the requirements for avoiding or mitigating the adverse impacts on these sites or properties. These contractual provisions are especially important during earthwork operations such as clearing and grubbing, building demolition, roadway excavation, borrow excavation and embankment construction. In particular, note that Section 106 of the Act is applicable to borrow sites on Federal-aid projects.

107.26.7.2 Assessment and Field Investigation

To comply with Federal and State statutes pertaining to archaeological, historical and paleontological resources, the SCDOT Archaeologist will review all proposed Federal-aid projects during the environmental planning process of project development. The sites that are found to be eligible for, potentially eligible for or already listed on the National Register of Historic Places may have been intentionally avoided during design or designated for protection in the Contract Plans and Specifications. Avoidance of these sites may be part of agreements with the State Historic Preservation Officer and/or the Advisory Council for Historic Preservation. Protected sites should be clearly marked before construction begins. Contractors will avoid disturbances to these sites.

107.26.7.3 Late Discovery

Contractor personnel must continually watch for the presence of potential prehistoric or historic remains such as arrowheads, pottery, ceramics, flakes, bones, graves, gravestones or brick concentrations. If found, the Contractor is responsible for immediately notifying the Resident Construction Engineer and halting all work in the vicinity of the site until the SCDOT Archaeologist or the State Highway Engineer directs otherwise. This applies to all areas of ground disturbance, including road construction, borrow pits, and staging areas. Extra work associated with late discoveries will be paid as follows:

1. SCDOT Right-of-Way. With the exception of commercial operations, SCDOT-furnished sites (e.g., project right-of-way, SCDOT-furnished borrow pits, disposal sites, staging areas, haul roads, field offices) will be evaluated and cleared of potential issues by the SCDOT Archaeologist prior to letting. If the discovery occurs on such sites, compensation (i.e., time and money) will be paid the Contractor in accordance with Section 104.4 and Section 108.6. In such situations, maintain accurate records of work and delays in the Daily Work Report.

2. Contractor-Furnished Borrow Pits. If the discovery occurs in a Contractor-furnished borrow pit, no additional compensation (i.e., time or money) will be provided the Contractor for project delays or extra work. Emphasize this provision, which is especially important on Federal-aid projects, because the Contractor may want to retain professional services to clear the site of issues before opening the borrow pit.

107.26.8 Construction Noise

The primary legal references for noise impacts resulting from highway activities are the Federal Noise Control Act of 1972, 23 USC 109(i) and 23 CFR 772 “Procedures for Abatement of Highway Traffic Noise and Construction Noise.” Noise is any sound that has the potential to annoy or disturb humans or cause an adverse psychological or physiological effect on humans. The noise levels generated during highway construction vary depending on the type of equipment and the nature of the work being performed. Noise impacts can be severe, especially during nighttime activities and, in many cases, simple noise mitigation strategies may not suffice. Excessive construction noise may result from the following activities:

- equipment,
- blasting operations,
- pile driving,
- jackhammers, and
- plant operations.

During the project development phase, Preconstruction will have performed the following assessment with respect to construction noise:

- Identify land uses or activities that may be affected by noise from construction, especially sensitive receptors (e.g., schools, hospitals, neighborhoods, churches).

- Determine appropriate noise criteria limits for the identified receptors. These may be dictated by local regulations or ordinances.

- Document any measures required during construction to minimize or eliminate adverse construction noise impacts to the surrounding area.

The Special Provisions will document any restrictions or noise abatement measures required of the Contractor. For example, the Contractor may be required to provide sound-deadening devices, shields or physical barriers (e.g., plywood sheets, lead-vinyl curtains) or to provide noise abatement measures to restrict the transmission of noise in the immediate vicinity of schools, hospitals, rest homes, churches, libraries, museums, parks and other noise-sensitive sites specified in the Contract. These measures may include limiting working hours to minimize noises during school hours, for example, or may specify certain times for blasting. Other common-sense measures to reduce construction noise include ensuring that equipment is well maintained (e.g., mufflers), operating equipment at lower power or increasing the spacing of equipment.

107.26.9 <u>Project Conformance Review</u>

Consider the following guidelines when assessing compliance of the project with respect to water quality management:

1. <u>Erosion and Sediment Control</u>. Erosion, sedimentation and stormwater run-off control will be assessed based on the guidelines presented in Section 815.

2. <u>Fording of Streams</u>. Frequent fording of live streams will not be permitted. Check to ensure that the Contractor provides temporary bridges where required. Operation of mechanized equipment, except equipment that is normally used in the construction of structures or channel changes, is not permitted in live streams. This will require written authorization from the Resident Construction Engineer.

3. <u>Waste Disposal Areas</u>. Verify that waste disposal areas are located and constructed in a manner that will keep sediment and foreign substances from entering streams or other adjacent bodies of water.

4. <u>Man-Made Pollutants</u>. Check the project for pollutants (e.g., fuels, lubricants, bitumens, raw sewage) that may be discharged into adjacent waterways or man-made channels leading to these waterways. This provision also applies to the wash water from concrete mixing operations. This is absolutely unacceptable. Notify the Superintendent of any such occurrence and require immediate correction.

5. Work in Waterways. Where work is permitted in waterways, verify that all falsework, piling, debris and other unacceptable materials are cleared as soon as practicable after construction.

6. Non-Compliance. Pay particular attention to any contamination or sedimentation of adjacent streams, watercourses, lakes, ponds or adjacent properties and to any on-site or off-site damage resulting from stormwater runoff. Immediately notify the Contractor in writing of any non-compliance and enforce the provisions of the Contract with respect to repairs and rework.

107.27 HAZARDOUS AND/OR TOXIC WASTE

107.27.1 Contractor Compliance

The Contractor is responsible for complying with all Federal and State regulations and permit requirements for hazardous material abatement and worker protection, including:

- removal and containment,
- sampling and testing,
- handling and on-site storage,
- transport and disposal, and
- medical surveillance tests.

The Contractor also is responsible for immediately notifying the Resident Construction Engineer and the appropriate State and Federal agencies of any release of hazardous materials into the environment and any exposure incidents involving construction personnel and the public. SCDOT will withhold payment to the Contractor associated with any fines issued by State and Federal agencies for non-compliance.

107.27.2 Types of Hazardous Materials

Many different types of materials have been tested and classified as hazardous. The following are hazardous materials that are commonly used, produced or encountered during construction:

- asbestos;
- lead-based paints;
- radioactive materials (e.g., nuclear density gauges);
- pesticides and petroleum products (e.g., fuel, oil);
- paints, solvents, enamels and epoxies;
- lead acid and heavy metals;
- above-ground storage containers and barrels; and
- underground storage tanks.

Materials that have been classified as hazardous are those that have been tested and found to have adverse health and environmental impacts at specific concentrations. Improper handling and disposal of such materials can expose workers to health hazards and contaminate surface water, groundwater and soil.

107.27.3 Assessment and Field Investigation

During project development, the Environmental Section, in cooperation with other SCDOT personnel, may review project right-of-way, perform field investigations and inspect structures, buildings and underground facilities, as appropriate, to determine if hazardous materials will be used, generated or encountered during construction. This preliminary investigation is routine, but critical, on projects that may require:

- on-site storage of hazardous materials needed to perform the work;
- demolition of building facilities;
- demolition, dismantling or repainting of structures; and
- removal and disposal of storage tanks, contents and contaminated soils.

For projects requiring abatement or mitigation of hazardous materials to protect workers and the environment in accordance with State and Federal regulations, the Contract Plans and Special Provisions will include detailed plans, directives and operational procedures that the Contractor must comply with during construction. Consider the following:

1. Building Demolition. Unless otherwise specified in the Contract, the Contractor will be responsible for having a licensed environmental firm inspect any buildings to be razed on the project for the presence of asbestos. A copy of the Inspection Report will be submitted to the Resident Construction Engineer.

2. Demolition or Renovation of Structures. If the project involves the demolition or renovation of an existing structure, SCDOT will inspect the structure for the presence of asbestos and lead-based paint. The Special Provisions of the Contract will include the results of the inspection. Copies of the report will be made available through the District Engineering Administrator's Office and the Bridge Construction Office.

3. Underground Storage Tanks. SCDOT will assess the disposition of underground storage tanks located on the project. Separate pay items will be developed and included in the Contract for:

    - removal and disposal of tank contents;

    - removal and disposal of low-level and high-level contaminated soil located around the underground storage tank, as classified by SCDHEC; and

    - removal and disposal of the underground storage tank, all piping associated with the connection to the underground storage tank system and the dispenser island.

    The Contract Plans and Special Provisions will delineate the station number and offset (i.e., left or right of centerline) and a detailed description of the work to be performed.

107.27.4 Permits and Submittals

Prior to beginning any operation involving hazardous materials, the Contractor will submit the following to the Resident Construction Engineer:

- evidence that the Contractor, or subcontractor, performing the work has been properly certified for the work;
- demolition, dismantling, removal or renovation plan (e.g., surface preparation, containment, ventilation), stamped by a Professional Engineer registered in the State of South Carolina, as appropriate;
- on-site storage, containment, enclosure and security plan, including emergency response and spill mitigation;
- transportation and disposal plan, including certificates and licenses required by the governing State and Federal agencies;
- worker protection program, including required training certificates for each employee on the project and the results of base-line medical surveillance tests, as appropriate;
- all permits required by SCDHEC and the South Carolina Occupational Safety and Health Administration; and
- EPA Identification Number, including contact information for the disposal facility and the transporter.

The Resident Construction Engineer will obtain the EPA Identification Number from the Environmental Section. Furnish the EPA Identification Number to the Contractor, because it must be placed on all project correspondence, shipping invoices, disposal affidavits and forms related to the work involving the hazardous materials. For work on existing structures, the Resident Construction Engineer and Contractor will jointly complete SCDOT Form 200.05 – Notification of Demolition required by SCDHEC. The Notice of Demolition will be signed by SCDOT and the Contractor. Verify that the Contractor has forwarded this Form to SCDHEC.

107.27.5 Field Marking of Site

Ensure that all buildings containing asbestos, structures containing asbestos or lead-based paint, underground storage tanks, hazardous material storage areas and other hazardous waste sites on the project have been cordoned off, marked and signed as specified in the Contract.

107.27.6 Emergency Response Contact Sheet

Prior to starting removal operations, the Resident Construction Engineer will prepare an Emergency Response Contact Sheet of contact names and telephone numbers to use in the event of a hazardous material/hazardous waste situation. It is recommended that the chart be a one-page flow chart illustrating the priority of calling both SCDOT personnel and non-SCDOT agencies. Place the chart in an obvious location within the Resident Construction Engineer's office. In a catastrophic situation where an extremely hazardous or life-threatening substance is encountered, immediately notify 911 Emergency Response, the South Carolina highway patrol, local fire department and the SCDHEC Emergency Response Team.

107.27.7 Removal Operation

Where buildings, structures and underground storage tanks are either demolished, dismantled, removed or renovated, check to ensure that the removal and handling method, containment and ventilation system and the method used to protect the environment, workers and public comply with specified requirements. Continually monitor the operation for obvious signs of non-compliance and notify the Contractor, in writing, of any needed corrections. Maintain accurate records of infractions and any directives to the Contractor in the Daily Work Report and appropriate SCDOT Construction Forms.

107.27.8 On-Site Containment and Storage

The waste generated by the removal operation must be held in containers (e.g., drums, roll-off boxes, gondolas) and kept covered at all times, except during the actual addition or removal of the material. Verify that waste, having been classified as hazardous, is stored and labeled as required by the South Carolina Hazardous Waste Management Regulations. The containers must be stored on-site in a locked fenced area and labeled as a hazardous waste storage area. Verify that the on-site storage area is secure, not subject to accidental spills or vandalism and not located near traffic, water courses or drainage facilities.

107.27.9 Transport and Disposal

Observe the transport and disposal operation for compliance. Transport vehicles must be signed as a carrier of hazardous material of the type being carried. This is a Federal requirement. Ensure that the hazardous waste generated by the removal operation is shipped by a licensed transporter to an approved disposal facility, as determined by SCDHEC. The Contractor is responsible for informing the facility to dispose of the waste as a hazardous material.

107.27.10 Late Discovery

107.27.10.1 General

Where a suspected hazardous waste or material is discovered during construction, pay particular attention to the encounter and treat each situation uniquely. Use common sense, remain calm and stay alert. Use the guidelines in the following Sections to mitigate and contain the situation and obtain needed assistance.

107.27.10.2 Potential Discovery Situations

Upon discovery of a potential hazardous substance, do not open any closed container or otherwise attempt to identify the substance. Halt work in the immediate vicinity of the site and immediately notify the proper authorities, which will depend on the nature and severity of the situation. Consider the following:

1. Excavation. Hazardous substances could be encountered during excavation. Treat all underground storage tanks, buried containers and suspect soil and groundwater as potential hazards. Obnoxious fumes, unusual odors, discolored soils, water surface sheen and visible fumes and smoke are key indicators of a hazardous substance.

2. Illegal Dumping. Be aware that hazardous materials could be illegally dumped within the right-of-way during off-shift hours. Use common sense and collaborative judgment to assess the nature of the encounter.

3. Construction Mishaps. Construction personnel and equipment operations could inadvertently rupture a natural gas or petroleum pipeline or cause a large fuel or chemical spill. Treat such incidents as a hazardous-material situation.

107.27.10.3 Halt Work in the Vicinity of the Site

Upon discovery of a suspect substance, immediately notify the Resident Construction Engineer. All construction personnel must treat such conditions with extraordinary caution. A written directive to stop work in the vicinity of the suspect substance will be issued to the Contractor. This action is necessary to avoid health risks to all personnel at the site and the general public. Health and safety take precedence over construction costs and delays. Individuals who have come into direct contact with suspect substances (e.g., skin contact, inhalation) or exhibit adverse reactions should receive immediate attention by authorized medical personnel. People who have been exposed to suspect substances also should be monitored for adverse, delayed reactions based on the recommendations of authorized medical personnel.

107.27.10.4 Secure the Area

After work has been stopped, the area surrounding the suspect substance must be secured to prevent inadvertent or unauthorized access by personnel or the general public. Treatments generally consist of cordoning the area, installing temporary fencing and/or rerouting traffic patterns. Specific actions will depend on the scale, severity and nature of each situation. In addition, each situation will require appropriate administration of the Contract. After the area has been properly secured, the Resident Construction Engineer should consider practical alternatives for the Contractor to continue work on the project. If unavailable, document work delays in the Daily Work Report, because Contractor negotiations will be necessary.

107.27.10.5 Notify Personnel of the Incident

Use the Emergency Response Contact Sheet posted in the Resident Construction Engineer's office to initiate contacts of the incident. A coordinated effort is necessary to properly address each hazardous material/hazardous waste situation. To provide continuity within the project, the Resident Construction Engineer always should be kept informed. Maintain complete and accurate records in the Daily Work Report (e.g., contacts made, recommendations, decisions, planned and completed activities, schedules). Key contacts are as follows:

1. Resident Construction Engineer. After the Resident Construction Engineer has been notified, the Resident Construction Engineer will contact the District Construction Engineer and the District Engineering Administrator. The District Construction Engineer will provide initial guidance regarding the handling of suspect hazardous materials. Do not permit suspect soils that have been excavated to be rehandled unless otherwise recommended by the District Construction Engineer.

2. District Construction Engineer. The District Construction Engineer will contact the Research and Materials Engineer and the Environmental Section for additional guidance regarding the handling of suspect hazardous materials. This guidance should immediately be passed on to the Resident Construction Engineer. As needed, the District Construction Engineer then will notify the:

   - Director of Construction,
   - Road Construction Engineer,
   - Bridge Construction Engineer,
   - Resident Maintenance Engineer,
   - Federal Highway Administration (if project is under Federal Oversight), and
   - SCDHEC.

3. Director of Construction. The Director of Construction will contact the Environmental Section and the Right-of-Way Section to assess the need for immediate public relations; to investigate encroachment on private property, source of origination and ownership; and to assess the need for an emergency procurement of a qualified hazardous material Contractor.

4. Right-of-Way Section. The Right-of-Way Section will coordinate with the Environmental Section to determine if it is necessary to contact the South Carolina Office of the Attorney General with regard to liability, cost recovery and documentation issues.

107.27.10.6 Considerations of Avoidance Alternatives

Alternatives to completely or partially avoid the hazardous materials are preferred. The Resident Construction Engineer, District Construction Engineer, Road Construction Engineer, Bridge Construction Engineer and Director of Construction will initially assess the feasibility of complete avoidance. As needed, SCDOT personnel from Preconstruction will assess the feasibility of design revisions, partial deletions of work and construction alternatives. SCDOT will also consider the feasibility of terminating the Contract based on the scope of the situation, the costs of other alternatives, the magnitude of claim settlements and the project's significance to public safety and other planned improvements. If complete avoidance is not feasible, alternatives for partial avoidance will be considered to minimize health risks. If complete avoidance is selected, the Resident Construction Engineer will issue the Contractor a written directive addressing changes to the project and revisions to the Contract. As needed, forward one copy of the written directive to the following:

- District Construction Engineer,
- Contract Administration,
- Bridge Construction Engineer,
- Road Construction Engineer,
- Director of Construction,
- Right-of-Way Section, and
- Environmental Section.

Cost and delay issues will probably necessitate Contractor negotiations and may require a Change Order. Therefore, maintain complete and accurate records in the Daily Work Report. As needed, request a revised progress schedule from the Contractor to address the changes to the project.

107.27.10.7 Documentation and Payment Considerations

Where the removal and disposal of known hazardous materials on the project have been scheduled, measure, document and pay for the work based on the pay items provided for in the Special Provisions of the Contract. Where late discovery of hazardous substances occurs, the work for investigating, testing, removing and disposing of the hazardous material will be measured and paid for as extra work or force account work (see Section 104.5 and Section 109.4), unless a specialty firm is contracted to perform the work under separate Contract. Therefore, maintain complete and accurate records in the Daily Work Report and supplemental SCDOT Construction Forms through the course of processing a hazardous material or hazardous waste discovery. Written notes, reports, detailed cost records, photographs and videos all should be considered. Such records will assist SCDOT in cost recovery and possible litigation.

Section 108
Prosecution and Progress

108.1 SUBLETTING OF CONTRACT

Section 108.01 of the *Standard Specifications* governs the provisions for subletting the Contract. A subcontractor is a person or firm who performs under Contract with the Prime Contractor the work on a Contract item or items or portion of an item for the Contractor. The Resident Construction Engineer should not allow any subcontractor to perform work on a project unless written approval from the Director of Construction has been given. Subcontractors will comply with all Contract requirements and will only work on such Contract items that have been sublet to them.

108.2 PRECONSTRUCTION CONFERENCE AND PARTNERING

108.2.1 <u>Preconstruction Conference</u>

108.2.1.1 Purpose of the Conference

In accordance with the Section 108.02 of the *Standard Specifications*, a Preconstruction Conference will be held prior to starting each SCDOT construction project. The purpose of the Preconstruction Conference is to ensure that a working understanding is established among all parties involved in the project, thus enhancing coordination and reducing miscommunication and delays. Discussion topics will be determined on a project-to-project basis, but may include:

- intent of the Contract and its provisions;
- authority of SCDOT administrative and inspection personnel;
- responsibilities of Contractor and subcontractor personnel;
- partnering relationship and requirements, whether formal or informal;
- value engineering proposals, when appropriate;
- Contract Plans, including alterations, schedules and phasing of work;
- right-of-way agreements, outstanding or otherwise;
- landowner agreements affecting construction;
- utilities and railroads, including coordination, abandonment, relocation and adjustment;
- health and safety requirements of construction personnel and the public;
- maintenance and protection of traffic during construction;
- environmental protection and water pollution control;
- compliance with environmental, navigational and other permits (e.g., NPDES);
- non-hazardous and hazardous waste handling and disposal;
- procedures for mishaps and discovery during construction (e.g., skeletal remains, UST);
- unusual conditions and areas requiring special attention;
- allowable time extensions and payment for extra work;
- change orders, extensions and responsibilities for delay and damages;
- subletting and claim processing procedures;

- subletting criteria and responsibilities;
- special requirements of Federal-aid projects;
- repercussions for contractual non-compliance;
- criteria for halting work, withholding or deducting payment;
- material requirements, including approved sources and pit acquisition and reclamation;
- specialized equipment requirements;
- proposed construction methods;
- requirements for project acceptance and closure; and
- other issues to better progress and efficiency.

Pay items in the Contract may be discussed so that all affected parties will understand the schedule, materials, construction methods, sampling and testing responsibilities, acceptance criteria and method of measurement and payment. Stress to the Contractor the importance of compliance with all requirements of permits contained in the Contract (e.g., NPDES).

108.2.1.2 Attendees of the Preconstruction Conference

Attendees of the Preconstruction Conference may include:

- Superintendent and any other Contractor representatives deemed necessary;
- representatives of all subcontractors employed on the project;
- material suppliers, as appropriate;
- Resident Construction Engineer;
- Inspectors assigned to the project;
- District Construction Engineer;
- District Engineering Administrator;
- Road or Bridge Construction Engineer, as appropriate;
- Director of Construction;
- representatives of all affected utility and railroad companies;
- local county and municipal government officials, as appropriate;
- FHWA representatives, on Federal-aid projects; and
- representatives of other affected Federal, State, local or private concerns.

Pay particular attention to affected utility and railroad companies. Relocation and adjustments can greatly delay the project if not carefully scheduled and executed. See Section 105.6, Section 107.14 and the Special Provisions for additional information.

108.2.1.3 Meeting Coordination and Scheduling

The Resident Construction Engineer will schedule and facilitate the meeting. The meeting will be held after the Notice of Award but prior to the Notice to Proceed. Telephone and electronic mail service may be used to coordinate schedules; however, once a mutually agreeable date and location have been established, prepare and forward a formal invitation, including agenda, to each desired attendee.

108.2.1.4 Minutes of Meeting

The Resident Construction Engineer will forward the minutes of the meeting to each attendee and invitee and retain a copy of the minutes and attendance log in the project files. Ensure that a copy is forwarded to each Inspector assigned to the project.

SCDOT Form 100.01 – RCE Checklist should be completed after the Pre-Construction Conference.

108.2.2 Partnering

108.2.2.1 Overview

Project-level partnering will be utilized on all State highway construction contracts as of June 2003. Known as the South Carolina Partnering Program (SCPP), this initiative has been jointly embraced and supported by both the Department and other members of the highway construction industry in our State.

Partnering is a proven project management technique that has saved millions of dollars and countless amounts of time on projects across the United States. It is a tool that owners, engineers and Contractors have used for many years in both the public and private sectors to successfully deliver projects of all types and sizes.

The SCPP sets the stage for SCDOT and the State highway industry to be more successful in the delivery of their highway construction projects to the people of South Carolina. As a result, SCDOT can better manage its overall project costs, contractors are more profitable, projects are built to higher quality levels, and work is completed faster. The overall impact to the program is significant, if all of the steps and elements of the SCPP are implemented faithfully by individuals at all levels in all organizations.

108.2.2.2 South Carolina Partnering Program Oversight

Oversight and management of the SCPP will be accomplished using the organizational structure of SCDOT. Duties and responsibilities will be as follows:

1. Executive Director/State Highway Engineer. Provide overall vision, leadership and support for the development, implementation and continued use of the partnering process on SCDOT highway construction projects.

2. Director of Construction. Responsible for Statewide support and implementation of partnering on all construction projects. Establishes and provides the list of facilitators to be used on the projects. Monitors and reviews the progress of partnering implementation throughout the State. Reviews project evaluations and identifies trends and issues that need to be addressed to improve the overall implementation of partnering. Provides initial training and any needed follow-up training in the principles of partnering.

3. District Engineering Administrator. Responsible for the proper and effective implementation of partnering on all highway construction projects in their District. Offers proper support to the Resident Construction Engineers so that partnering implementation is not encumbered either by policy or due to resource allocation. The District Engineering Administrator will attend approximately 50% of the partnering workshops. Attendance in some cases may be delegated to a representative designated by the District Engineering Administrator.

4. Resident Construction Engineer. Responsible for the implementation of partnering on each of their projects. Works with the Contractor's Project Manager to select the facilitator, scheduling and participating in the Initial and Follow-Up Workshops, utilization of the Team Evaluation Process and all other activities associated with the implementation of partnering on their projects. The Resident Construction Engineer is also responsible for any additional training required to assist SCDOT Inspectors and SCDOT Technicians on understanding and implementing the partnering process.

The process of partnering consists of a number of elements that work together to successfully impact overall performance on a highway construction Contract. These elements are:

- Leadership and Management,
- Partner all Projects,
- Partnering costs,
- Facilitation,
- Initial Workshop,
- Follow-up Workshop,
- Team Charter,
- Issue Escalation Process, and
- Team Evaluation Process.

Each of these elements will be described in detail in the following sections.

108.2.2.3 Leadership and Management

Leadership is a major element of every successful partnering program. There are several layers of leadership and management that will be required to yield an effective partnering program. Further details are provided in the sections that follow.

108.2.2.3.1 Executive Director/State Highway Engineer

The Executive Director / State Highway Engineer is the first management level. There is a clear message to the agency that partnering is the new paradigm for doing business and that it is the preferred means for administering construction projects throughout the State. A strong and unequivocal message is essential for everyone to accept partnering and its implementation.

108.2.2.3.2 Director of Construction

The second management level in partnering is the Director of Construction. The Director of Construction is the key person designated within SCDOT who will be the leader of the partnering effort on a day-to-day basis, who speaks with the authority of the Executive Director on all matters relating to the implementation of this effort and who has the resources necessary to handle the administrative elements for the partnering effort. The Director of Construction not only has oversight for the SCPP activity within SCDOT but also functions as the direct liaison with the construction industry on all matters pertaining to partnering. The staff of the Construction Office will assist the Director of Construction in the administration of the partnering program.

108.2.2.3.3 District Engineering Administrator

The final level of leadership or management critical to the implementation of the SCPP is the District Engineering Administrator. This individual has responsibility for the day-to-day administration of the specific construction projects and the personnel who will provide the site inspection and interface with the Contractor. It is imperative they support, advance and otherwise set the tone in their Districts for the work that will be necessary to establish partnering on their projects.

108.2.2.4 Partner All Projects

The partnering process requires a different mindset for all project participants. Traditional approaches by Contractors and owners in their relationships must be set aside in exchange for the higher and more appropriate objectives of the partnering relationship. The Contractor transitions from an approach that focuses on meeting minimum Contract requirements to a higher quality and more profitable operation. The owner moves from a catch-and-punish approach in Contract administration to a collaborative relationship that results in better projects delivered faster than before.

This difference in approach is tangible. Experience across the country has shown that it is impractical for Contractors and owners who work together regularly to only partner some of their projects and not others. Therefore, it is the intent of SCDOT and the Carolinas AGC that every project built in South Carolina be partnered using the formal process outlined in the SCPP.

108.2.2.5 Partnering Costs

There are nominal expenses associated with the partnering process. The Initial Workshop costs include salaries and benefits for all of the participants, the cost of the facility, any meals and breaks, the outside facilitator and other incidental expenses. However, these expenses turn out to be modest when compared to the money saved on each partnered project.

The expenses for a typical Initial Workshop will be borne collectively by the participants. Each organization will bear the expense of having its staff present and any associated travel costs.

The owner and the Contractor will split facility costs, meals, breaks and audio-visual expenses. In addition, the cost of the facilitator and their travel expenses will be borne equally by the Contractor and the owner.

The Contractor will pay for the non-labor related expenses and the costs relating to the facilitator used in the partnering program. A Change Order to the Contract will be initiated to cover reimbursement for one half of the direct expenses associated with the partnering process. See Section 101.6.3 for additional information on processing Change Orders in SiteManager.

108.2.2.6 Facilitation

One of the factors that contributes to the success of a partnering process is the use of facilitators to assist the team through the Initial Workshop and also the Follow-Up Workshop if necessary. In general, facilitators will be independent of the Contractor or the State and selected from the pool of outside facilitators already under contract with SCDOT. While the expense of a facilitator may seem unnecessary to some, it is nominal compared to the cost of not resolving problems during the course of a project.

Project facilitators will develop an agenda with the Resident Construction Engineer and the Contractor's Project Manager for the specific project for which they will provide services. This agenda for the Initial Workshop will follow the basic format established for the SCPP but may be modified based on the unique issues relevant to the project and also the style and approach of the facilitator. Once selected, the Resident Construction Engineer and the Contractor's Project Manager will agree upon a date for the Initial Workshop with the facilitator.

Facilitators will be compensated at their established rate plus any additional expenses they may incur in support of the partnering workshop. If the project is of a long enough duration or of a high level of complexity, there may be a Follow-Up Partnering Workshop. In this case, it would be desirable to have the same facilitator provide services for that session as used for the Initial Workshop.

108.2.2.7 Initial Workshop

The Initial Workshop is the part of the process that most individuals associate with partnering. Unfortunately, on many projects, this is where the process begins and ends. In doing so, many project teams deny themselves of the many other benefits of partnering that are derived from using all of the tools available. It is the intent of the SCPP that the Initial Workshop be just the beginning of the partnering process on State highway projects.

The Initial Workshop is held before any construction begins on the project. It typically involves from 20-35 key members of the project team representing the Contractor, SCDOT, design engineer and any other key stakeholder or contributor who can impact the successful completion of the project. It is the responsibility of the Resident Construction Engineer and the Contractor's Project Manager to set a date for the Initial Workshop and make all necessary physical arrangements for a productive session.

The Resident Construction Engineer and Contractor's Project Manager are also responsible for identifying the individuals who should attend from their respective organizations as well as other potential participants. They will issue invitations as appropriate.

A partnering facilitator will be selected from the pre-qualified list and a pre-workshop conference call will occur between the Resident Construction Engineer, Contractor's Project Manager and the facilitator to review project issues and any other elements of the project that must be addressed during the Initial Workshop. The Initial Workshop has five objectives, as follows:

- Establish team relationships.
- Develop the listing of common goals for the project and capture these in writing in the form of a Team Charter.
- Develop an Issue Escalation Process to provide project team members a tool to resolve problems quickly and equitably.
- Develop a Team Evaluation process to assess team performance and make appropriate adjustments during the life of the project.
- Identify project issues that need immediate resolution.

The one-day Initial Workshop may be modified as necessary to complete the needed activities for launching the partnering process on a given project. On simple projects the Initial Workshop may be shortened to less than a day or combined with other projects. The partnering session will be coordinated with the traditional Preconstruction Conference held on SCDOT construction projects.

In other cases, such as very large projects or those that are extremely complex, it may be advisable to extend the Initial Workshop to one and a half or two days. The process and approach are flexible enough to accommodate any type of project condition that will present itself. On these types of projects the Resident Construction Engineer will work with the Contractor's Project Manager and the facilitator to create an agenda that meets the goals and objectives of this meeting.

A well-executed Initial Workshop will create the environment for partnering to succeed on any project. Careful planning, attendance of essential project personnel and professional facilitation will help to ensure this success.

108.2.2.8 Follow-Up Workshop

On longer or complex projects it will be advantageous to have one or more Follow-Up Workshops. These workshops differ from the Initial Workshops in that all of the partnering elements are already in place (i.e., Team Charter, Issue Escalation Process). The Follow-Up Workshop has four objectives, as follows:

1. Reaffirm the Original Project Goals Contained in the Team Charter. Are they still valid? Is everyone still committed to the goals? Do any of them need to be modified for whatever reason?

2. Evaluate Team Performance. Are the partnering tools being used? Is the Issue Escalation Process working? What can be done to improve team performance?

3. Issue Resolution. Are there outstanding issues that need to be resolved? Are there issues on the horizon that need to be addressed at this time so they do not become problems in the future?

4. Identify Project Completion Priorities. What are the critical elements left to complete on the project? How can the respective team members work together to address these priorities?

The agenda for a typical Follow-Up Workshop will be developed by the facilitator in consultation with the Resident Construction Engineer and the Contractor's Project Manager. It is advisable to use the same partnering facilitator for both the Initial Workshop and the Follow-Up Workshop. This will allow the team the opportunity to leverage their past relationship with the facilitator and the facilitator's knowledge of the project and team members for a more effective session. Attendance should include the same individuals who participated in the Initial Workshop or their replacements and any new stakeholders or team members who are critical to the success of the project. Follow-Up Workshops should be held on projects based upon the following criteria:

- Projects exceeding one year in duration – at least one Follow-Up Workshop at the mid-point of the project or before the second construction season begins.

- Projects exceeding $20 million – at least one Follow-Up Workshop at the mid-point of the project.

- Projects exceeding $50 million – Follow-Up Workshops held quarterly.

These criteria can be modified or adjusted based on specific project needs. Experience has shown there are too few Follow-Up Workshops being held on partnered projects. When in doubt, the team should invest the time, even if it is for just a half a day. Follow-Up Workshops are critical to the success of large or complex partnered projects and must be held.

108.2.2.9 Team Charter

One of the products of the Initial Workshop will be the development of the Project Partnering Charter or Team Charter. This will be an important document for the project team since it will list the collective objectives that will define success for the particular project. The Team Charter is developed through a variety of means used by the facilitator depending on the project and the experience of the team participants. For those with a great deal of partnering experience, the process is much simplified and the charter is developed more quickly. The Team Charter will contain goals and objectives that will assist the team in defining the ultimate success of the project. In addition, it will also provide them a tool to make project evaluations throughout the life of the project. Measuring team performance against these goals during the project helps to keep the team on track and leads to greater success in the partnering process. The Team

Charter consists of three basic parts: preamble, goals and objectives, and project commitment. Each of these is described in the following sections.

108.2.2.9.1 Preamble

The preamble is the introductory paragraph for the Team Charter and provides basic information on what the project is, who the team members are and introduces the goals and objectives that will follow. It need not be long; perhaps 3-5 sentences, but is important in framing the rest of the document.

108.2.2.9.2 Goals and Objectives

The second part of the Team Charter is the goals and objectives. As part of the Initial Workshop there will be time dedicated to developing the goals and objectives of the project team. These goals and objectives are not intended to replace the Contract documents but rather will enhance the team member's understanding of the issues they must collaborate on. For example, partnering is not a replacement for the quality control specifications contained in the Contract Specifications for a project. In fact, projects where there is a high level of commitment to the partnering process have fewer quality control problems or issues and ultimately result in a better product overall.

Sincerely committed team members will see the Team Charter as a document that speaks to a higher level of performance than is perhaps required of the Contract documents. Not higher in the sense of more stringent specifications but rather higher in that individuals and companies have made personal commitments to one another to do their very best to help each party achieve their respective goals and objectives. True partnering creates a synergy that does not exist on other projects and results in greater profitability for the Contractors and better projects for the owners.

These goals and objectives often include such items as safety, finishing the project in a specific amount of time, budget goals and quality goals often relating to not having any rework. In addition to these, there will be others that will be unique to the specific project but that will be important to this team in defining their collective success. Care must be taken so that all the Team Charters not be the same or become a fill-in-the-blank type of document. Rather, they must be developed by the team and result in a feeling of ownership on the part of all participants.

Once the project goals and objectives are developed, they should be reduced to simple statements generally one sentence in length. Where possible, they should reflect a measurable goal or objective to facilitate ease in assessing progress throughout the life of the project. For example, a project completion goal should be defined in terms of "completed in 180 working days," or "completed by November 1, 2004," or "two months ahead of schedule." In some cases it will not be possible to add this element of measurement to a goal or objective. Nevertheless, the goal should still be included in the Team Charter with an understanding on the part of the team as to how this particular goal will be evaluated over time.

108.2.2.9.3 Project Commitment

The last part of the Team Charter is the project commitment. It comes at the end of the charter and reflects the overall commitment of the team members to one another and the project. The project commitment statement need not be long, two to three sentences at the most, but helps to finalize the document and give the team an opportunity to summarize their collective commitment to the project and one another. Team Charters should be no more than a page long. It is often appropriate to put company and agency logos on the charter document. Many teams cho0se to print the charter on high-quality paper that adds a special touch to the overall document.

At the end of the Initial Workshop, it is customary that the team members all sign the Team Charter. Generally, the senior individual from the Contractor and owner's teams sign first and then all other participants are invited to do so also. While not a Contract document, there is something powerful about having individuals sign a Team Charter and make these personal commitments relating to their performance and the goals and objectives of the team. Copies of the Team Charter should be framed and posted in conspicuous places at the owner's and Contractor's project offices. A team picture often accompanies the charter wherever it is displayed.

Occasionally, there will be someone who doesn't want to sign the charter. Their hesitancy is often the result of their fear of foregoing some power or regulatory role. In fact, the Team Charter does neither but is a reflection of individual and collective commitment to acting in good faith, dealing honestly and fairly with one another and assisting each party in achieving their goals and objectives for the project. No one should be forced to sign. Even their presence at the Initial Workshop will derive benefits to the team in the long run.

108.2.2.10 Issue Escalation Process

Another product of the Initial Workshop is an Issue Escalation Process. One of the challenges of every construction project is getting problems resolved quickly before they become costly for the Contractor or the owner. Problems are going to occur and issues will arise on every project. It would be unrealistic to expect a problem-free project. The real measure of success on a partnered project is not how many issues arise but rather how the team handles the issues when they do develop. Partnering gives the project team the tools to resolve problems quickly and cost effectively for all team members.

The Issue Escalation Process must be developed as part of the Initial Workshop. It should define how the team will address issues that arise during the course of the project. There are four critical elements to any Issue Escalation Process:

- An understanding of the different levels of authority/management of the organizations involved in the project.
- A clear reflection of the authority that resides with each level.
- The time element that specifies how long a particular level of the escalation process has to resolve the problem before it is automatically elevated to the next level.

- While not a formal part of the Issue Escalation Process, it is often helpful to have examples of the types of issues that will be resolved at what level agreed upon at the Initial Workshop.

Each of these four elements are described in further detail in the following sections.

108.2.2.10.1 Understanding Levels of Authority / Management

One of the problems with resolving issues on a construction project is a lack of understanding on who the players are and how they fit into the other party's chain of command and authority structure. At the Initial Workshop, the project participants define what those relationships are and gain an understanding on how those relationships will work to resolve issues that arise. The facilitator will assist the team members in accurately describing their organizations and how they function in solving issues on their projects.

It is usually helpful in developing the Issue Escalation Process to document the levels of management. This will help the partnering participants in understanding who will work with whom, to whom the issues go on the project and who they go to once the issue leaves the project.

Sometimes partnering teams will find that one party or the other has a relatively flat management structure with few layers between the project field supervisor and the top manager. This is most often the case with small Contractors who have a limited management structure. Care must be taken to align management levels properly so that issues can receive a fresh set of eyes as they are escalated to successive levels in management. The facilitator will assist the team in this process.

108.2.2.10.2 Definition of Authority

The second important element of the Issue Escalation Process is the definition of authority that resides at each level. One of the most common complaints from owners and Contractors alike is that their counterparts do not have any authority or are limited by their management in the kinds of decisions they can make.

A properly developed Issue Escalation Process defines the authority that each individual has and all project participants have a clear understanding of who can make what decisions. For example, a Resident Construction Engineer for the owner may have $25,000.00 in Contract Change Order authority, whereas a Project Manager may have more or less than that. Knowing the authority levels of the individuals involved will help the team understand where the decision will be made on the issue and will make the overall process more efficient. The most effective Issue Escalation Processes have these authorities levels defined and well understood.

108.2.2.10.3 Definition of Time

The third element of an effective Issue Escalation Process is a definition of time. Time is the enemy of all parties when it comes to resolving issues on the project. Even good decisions, if not made in a timely manner, can have detrimental impacts on overall project success. Thus, the Issue Escalation Process must include a time element to ensure timely resolution of problems.

Many partnering teams actually assign timeframes to their Issue Escalation Process. These timeframes are generally longer for the first levels of escalation with shorter and shorter periods allocated the higher the issues go in the process. The theory is that, if an issue must be escalated through several layers of management then timely resolution is becoming even more critical as the project work moves ahead. No specified timeframes should be forced upon the partnering team. Rather, timeframes should be developed in cooperation between the owner and the Contractor in a way that makes sense for the given project.

108.2.2.10.4 Definition of Specific Issues

The final element of the Issue Escalation Process is the definition of specific types of issues that may need to be resolved and at what level. Basically, it is helpful to many project teams to select hypothetical issues that can then be applied to the Issue Escalation Process so that all participants can see how the process works. Sometimes the Issues Escalation Process seems a bit abstract to new participants, and a few examples of issues have proven valuable in communicating how the process works. This may or may not be reflected in the final version of the Issue Escalation Process depending on the preferences of the team members.

108.2.2.11 Team Evaluation Process

One of the essential elements of the partnering process is the Team Evaluation process. This is a tool that allows a project team to examine how they are performing, assess their progress towards the goals included in the Team Charter, elevate project issues that need to be resolved and identify areas where their relationship may need to improve to assure project success. The Team Evaluation is often overlooked on many partnering projects with a consequential diminishment in the returns gained from the partnering process. In the SCPP, a Team Evaluation process will be required for each partnered project. The process will be developed during the Initial Workshop and will be administered by the Resident Construction Engineer and the Contractor's Project Manager. The evaluation process will have the following attributes:

- Evaluation criteria will come from the goals and objectives in the Team Charter.
- The process will occur monthly.
- The Resident Construction Engineer and the Contractor's Project Manager will jointly review the results of the Team Evaluation and address any issues that come to the forefront out of that process.

- The results of all Team Evaluations will be reviewed by the District Engineering Administrator on a monthly basis.
- The results of all Team Evaluations will be reviewed by the Director of Construction at least quarterly.
- Team Evaluations will be developed by the project team using a format required by the Director of Construction.

It will be the responsibility of the Resident Construction Engineer and the Contractor's Project Manager to administer the functions of the Team Evaluation process. The District Engineering Administrator and the Director of Construction will have general oversight responsibility for the evaluation process and will offer assistance and counsel as necessary to the project team.

108.3 PROSECUTION OF THE WORK

The Resident Construction Engineer will be responsible for processing and forwarding the Notice to Proceed to the Contractor. The Contractor is not permitted to begin work on the project before receiving the Notice to Proceed and must complete the project by Contract completion, as adjusted by any approved Contract time extensions.

108.4 LIMITATION OF OPERATION

Section 108.04 of the *Standard Specifications* governs the Contractor's limitation of operations.

108.5 CHARACTER OF WORKERS, METHODS AND EQUIPMENT

Section 108.05 of the *Standard Specifications* governs the provisions of the Contractor's workers, methods and equipment. The Resident Construction Engineer is responsible for ensuring that the Contractor's personnel are properly trained and certified, as required by current SCDOT policy. SCDOT field personnel generally cannot require the Contractor to use specific construction methods or equipment, unless expressly stated in the Contract. Inspect construction equipment in terms of its ability to produce specified results in a continuous operation, with final approval from the Resident Construction Engineer. Consider the following:

1. <u>Type</u>. Verify that the Contractor has provided the type of equipment required for the project (e.g., mixing plants, haul trucks, pavers, rollers, graders, spray tankers, hand tools). If asked by the Contractor, the Resident Construction Engineer may suggest equipment that has been used successfully on similar projects.
2. <u>Capacity and Number</u>. Verify that the equipment provided on the project is sufficient, in terms of capacity and number, to prosecute the work in a continuous and timely manner.
3. <u>Condition</u>. Check to ensure that the Contractor maintains equipment in good working condition and has sufficient spare parts and backup equipment on-hand to minimize unnecessary delays due to mechanical breakdown.

4. Calibration. For construction equipment that requires calibration before use, ensure that the equipment is properly set to meet specified results and perform periodic inspections, as needed, to determine if recalibration is necessary.

5. Operators. Although the equipment may be acceptable, the use of inexperienced operators can often lead to unacceptable results. Where suspected, discuss this situation with the Resident Construction Engineer and, as needed, direct the Contractor Superintendent to provide an experienced operator.

Resident Construction Engineers and SCDOT Inspectors must never operate or adjust Contractor equipment. However, it is good practice to understand the operation of equipment to ensure it is being properly used. Ensure that obvious deficiencies are corrected before the operation begins. This will avoid delays and ensure that quality work is obtained.

108.6 DETERMINATION AND EXTENSION OF CONTRACT TIME

Calendar days, not working days, are used to administer Contract time for all SCDOT construction projects. Contract time will automatically be monitored in SiteManager based on progress entries and approval of Daily Work Reports, as discussed in Section 101.6. Consider the following:

1. Notice to Proceed. The Contract may provide that Contract time will be based on the date specified in the Notice to Proceed plus a specified number of calendar days, which will establish the Contract completion date.

2. Notice of Award. The Contract may provide that Contract time will be based on the date of the Notice of Award plus a specified number of calendar days, which will establish the Contract completion date.

3. Floating Start. The Contract may provide for a floating start period (e.g., year) from which a specified number of days will be added to the end of the period to establish the Contract completion date.

Section 108.06 of the *Standard Specifications* governs the provisions for assessing the acceptability of honoring a Contractor’s request for extending Contract time beyond the Contract completion date. Approval of such requests is generally limited to circumstances beyond the Contractor’s control. Otherwise, the schedule of liquidated damages will apply (see Section 108.9). Liquidated damages and Contract time extensions will require the initiation and proper execution of a Change Order, as discussed in Section 101.6.3. See Sections 104.2 and 104.4 for additional information.

108.7 TEMPORARY SUSPENSION OF WORK

If the Resident Construction Engineer provides written authorization of the suspension of a work item on the critical path for the convenience of the State, such time will not be counted against the allotted calendar days established in the Contract. In such cases, the Contract completion date must be extended an amount equal to the suspension period. The extension of time will require the initiation and proper execution of a Change Order, as discussed in Section 101.6.3.

108.8 FAILURE OF CONTRACTOR TO MAINTAIN SATISFACTORY PROGRESS

If the Contractor is found to be delinquent toward completing the project by the established Contract completion date, the Resident Construction Engineer will notify the Director of Construction who will be responsible for preparing and processing a Notice of Delinquency, which must be sent to the Contractor via certified mail, as provided for in Section 108.08 of the *Standard Specifications*.

108.9 FAILURE TO COMPLETE THE WORK ON TIME

Section 108.09 of the *Standard Specifications* provides the schedule of liquidated damages that will apply if the Contractor fails to complete the work by the specified completion date.

108.10 DEFAULT AND TERMINATION OF CONTRACT

If the Contractor is found to be in default of the Contract, the Resident Construction Engineer will notify the Director of Construction who will be responsible for preparing and processing a Notice of Default, which should be sent to the Contractor via certified mail, as provided for in Section 108.10 of the *Standard Specifications*.

Section 109
Measurement and Payment

109.1 MEASUREMENT OF QUANTITIES

Section 109.01 of the *Standard Specifications* governs the contractual provisions for measuring pay item quantities during the prosecution of the work. Figure 109A presents the rounding criteria that should be used to round pay item quantities entered in the Daily Work Report.

109.2 SCOPE OF PAYMENT

Section 109.02 of the *Standard Specifications* governs the contractual provisions for the scope of payment of each pay item, as defined in the provisions of the Contract under Basis of Payment. Pay particular attention to the type and rounding of measurements that must be documented in the Daily Work Report for each pay item. SiteManager will keep a running track of all quantities expended and remaining within the scope established in the Contract for each pay item.

109.3 COMPENSATION FOR ALTERED QUANTITIES

Compensation for altered quantities is governed under the provisions of Section 109.03 of the *Standard Specifications*, which will require the initiation and proper execution of a Change Order, as discussed in Section 104.2 and Section 101.6.3.

109.4 EXTRA AND FORCE ACCOUNT WORK

Desirably, extra work should be performed under a properly executed Change Order, rather than a Force Account Work Order. However, when the extent of the work cannot be defined, or when the actual cost cannot be estimated with reasonable accuracy, or a mutual agreement with the Contractor cannot be reached, then it will be necessary to perform the work under a Force Account Work Order, as governed under Section 109.04 of the *Standard Specifications*. When the Resident Construction Engineer directs the Contractor to proceed with disputed work, the provisions of a Force Account Work Order will apply. The Contractor may submit SCDOT Form 100.04 – Contractor Notice of Claim for the disputed work. When a Force Account Work Order is justified, the Resident Construction Engineer will be responsible for properly executing a Change Order, as discussed in Section 101.6.3, prior to beginning the Force Account Work. This Change Order will be used by SiteManager to monitor the labor, equipment and material used for the Force Account Work. An accurate record must be entered in the Daily Work Report of the number of hours each piece of equipment is actually in use on the Force Account Work. Also, the names, rates of pay, job classifications and number of hours worked for each laborer and foreman actually engaged in the Force Account Work must be entered on a daily basis.

PAY ITEM	ROUNDING CRITERIA	
Mobilization	LS	1
Value Engineering	LS	1
Construction Stakes, Lines and Grades	EACH	1
Traffic Control	LS	1
Clearing and Grubbing within Roadway	LS	1
Clearing and Grubbing Ditches	ACRE	0.1
Removal of Structures and Obstructions	LS	1
Removal & Disposal Items (pavement)	SY	0.1
Removal & Disposal Items (structures)	EACH	1
Excavation (unclassified)	CY	1
Excavation (classified)	CY	0.1
Geotextile	SY	0.1
Structure Excavation	CY	0.1
Cofferdam (all types)	EACH	1
Temporary Sheet Piling	LF	0.1
Permanent Sheet Piling	SY	0.1
Embankment In-Place	CY	0.1
Overhaul	CYHM	1
Flowable Fill	CY	0.1
Aggregate	TON	0.01
Aggregate Base	SY	0.1
Asphalt Plant Mix	TON	0.001
Asphalt Cement (liquid)	TON	0.001
Asphalt Surfacing	SY	0.1
Seal Joints	LF	0.1
Pavement Markings	LF	1
Pavement Markers	EACH	1
Impact Attenuators	EACH	1
Construction Signs	SF	1
Concrete (Structural)	CY	0.1
Reinforcing Steel	POUND	1
Prestressed Concrete Beam	LF	0.1
Bridge Parapet	LF	0.1
Handrail (all types)	LF	0.1
Handrail (all types)	LS	1
Structural Steel	POUND	1
Structural Steel	LS	1

PAY ITEM QUANTITY ROUNDING CRITERIA
Figure 109A

PAY ITEM	ROUNDING CRITERIA	
Piling (steel or concrete)	LF	0.01
Piling (timber)	LF	0.1
Drilled shaft Excavation	LF	0.01
Drilled shaft casing	LF	0.1
Mechanically Stabilized Earth Retaining Wall	SF	0.1
Pipe (all)	LF	1
Masonry (all)	CY	0.01
Catch Basin	EACH	1
Drop Inlet	EACH	1
Manhole	EACH	1
Precast Concrete Riser	LF	0.1
Curb and Curb and Gutter	LF	0.1
Concrete (pavements, driveways and sidewalks)	SY	0.01
Aggregate underdrain	CY	0.1
Riprap	TON	0.01
Riprap	CY	0.1
Riprap (Grouted)	SY	0.1
Slope Protection	SY	0.1
Steel Beam Guardrail	LF	0.1
Fencing	LF	1
Seeding	MSY	0.001
Lime	TON	0.01
Fertilizer	TON	0.01
Nitrogen (actual)	POUND	1
Topsoil	CY	0.1
Sodding	SY	1
Right-of-Way Markers	EA	1
Waterproofing	SY	0.1
Erosion Control Blanket	SY	0.1
Silt Fence	LF	1
Turbidity Barrier	LF	1
Silt Basins	CY	0.1
Sediment Dams	CY	0.1
Slope Drains	LF	1
Ditch Checks	EACH	1
Detention Pond	CY	0.1
Timber (untreated)	LF	0.1

PAY ITEM QUANTITY ROUNDING CRITERIA
Figure 109A
(Continued)

109.5 ELIMINATED ITEMS

Compensation for eliminated items is governed under the provisions of Section 109.05 of the *Standard Specifications*, which will require the initiation and proper execution of a Change Order, as discussed in Section 104.2 and Section 101.6.3.

109.6 PARTIAL PAYMENTS

Partial payments are governed by the provisions of Section 109.06 of the *Standard Specifications*. The following procedures apply:

- The SCDOT Inspector will enter pay item quantities in SiteManager's Daily Work Report (see Section 101.6.1).
- The Resident Construction Engineer will review and authorize pay items described in the Daily Work Reports (see 101.6.2) and, on the estimate day for the District defined in Section 109.06 of the *Standard Specifications*, will generate the Monthly Payment Estimate (see 101.6.4). Once generated, the Resident Construction Engineer will print one copy of the Monthly Payment Estimate for the Contractor to sign and return. The Resident Construction Engineer then will notify the District Construction Engineer that the Monthly Payment Estimate is ready for approval.
- The District Construction Engineer will review and approve the Monthly Payment Estimate in SiteManager.
- Upon receipt of the Contractor's signed copy, the Resident Construction Engineer will sign the copy and fax it to the Director of Accounting, send a copy to Contract Administration for payment to the Contractor and keep the original on file.

If retainage is authorized, it will be established in SiteManager as directed by the Director of Construction and will be automatically processed by SiteManager. Federal-aid participation, if applicable, will be established and automatically processed in a similar manner.

109.7 PAYMENT FOR MATERIAL-ON-HAND

Section 109.07 of the *Standard Specifications* governs compensation for material-on-hand, which will require the initiation and proper execution of a Change Order, as discussed in Section 104.2 and Section 101.6.3. Alterations in the Contract Plans and Specifications may result in leaving the Contractor, either on hand or in transit, with materials that were ordered prior to being notified of such changes. The Department may take over the surplus material and pay the Contractor the actual cost of the material, including transportation. The provisions of the Contract should be studied carefully to determine when it is necessary to pay for such material. If SCDOT is obligated to pay for materials left on hand, ensure that the cost of the material is transferred from the project account to the proper maintenance account or other account on which the material will be used. Note in the Daily Work Report the payment due the Contractor, the reason why it was necessary to pay for the material and that the internal SCDOT cost accounting transaction has been submitted. The Resident Construction Engineer should retain a copy of the Contractor's invoice prices. See Section 101.6.6 for additional information.

109.8 ACCEPTANCE AND FINAL PAYMENT

Upon completion and final inspection and acceptance of the work, as governed under the provisions of Section 105.15 of the *Standard Specifications*, the Resident Construction Engineer will close out the project, as discussed in Section 110, and prepare the Final Estimate of each pay item using SiteManager (see Section 109.6). SiteManager will automatically process any needed adjustments to Final Estimates. The Resident Construction Engineer will be responsible for obtaining all documentation the Contractor is obligated to provide under Section 109.08 of the *Standard Specifications*. This documentation should be attached to the Final Estimates when submitted for payment to the Contractor.

Section 110
Project Closure

110.1 FINAL INSPECTION AND ACCEPTANCE

110.1.1 General

Final inspection of the project will be made to ascertain if the work complies with all requirements of the *Standard Specifications*, Special Provisions, Contract Plans, supplemental agreements and/or Letters of Authorization. Figure 110A presents a project closure checklist that will be used to close SCDOT construction projects.

110.1.2 Federal-Aid Projects

Upon completion of all bid items of work and upon notification by the Resident Construction Engineer that a project, or section of project, is ready for a final inspection, the Resident Construction Engineer will arrange a suitable date for the final inspection. A representative of the FHWA will be invited to attend, if applicable. The Resident Construction Engineer should ensure that the date selected is suitable to the Contractor so that the Contractor may have a representative present. The final inspection party will inspect the completed work and determine if it has been satisfactorily completed in accordance with the Contract. If the work is not acceptable at the time of such inspection, the Contractor will be advised as to the corrective work to be performed. During the final inspection, the Resident Construction Engineer should keep notes on the corrective action needed to assure that such work will be rectified.

110.1.3 State-Funded Projects

The same procedure as outlined in Section 110.1.2 will be followed, except FHWA will not be involved, in the final inspection of major type road projects and for all bridges constructed by Contract. For C Projects, the District Engineering Administrator will normally make the final inspection.

110.1.4 Recommending Acceptance

If upon completion of the final inspection the completed work is found acceptable, the Resident Construction Engineer will recommend acceptance of the project by the use of SCDOT Form 100.03 – Report Recommending Roads for State Maintenance, which will be submitted through the District Office for District Engineering Administrator review and concurrence. The District Office will, in turn, forward the report to the Director of Construction. When the final inspection is made and there are certain deficiencies (not Contract bid items) identified, the Contractor will correct such deficiencies promptly. The Resident Construction Engineer will recommend acceptance after such corrections have been accomplished.

Project Closeout Checklist

SC File No.______________________________ Proj. No.________________________________

Route:__________________________________ Contractor:______________________________

The following items must be addressed prior to a project being closed out:

- ❑ All major items of work have been completed.
- ❑ Final inspection has been performed and punch list has been compiled.
- ❑ Permanent construction signs have been removed from project after major items of work have been completed.
- ❑ DWR's have been stopped when the charging of time stops.
- ❑ Additional DWR's have been completed for additional work performed by Contractor (e.g., corrective work, correcting punch list items).
- ❑ The Request for SCDOT Form 100.21 – DBE Summary Report has been submitted to the Office of Contract Audit Services after all major items of work have been completed (Note: For Federal-aid projects only).
- ❑ The final DBE Certification Letter has been received from the Office of Compliance.
- ❑ The Memo to Pay has been received from the DBE Office of Program Development for projects with trainees only.
- ❑ SCDOT Form 100.02 – Preliminary Letter of Certification has been submitted to the Research and Materials Laboratory after all major items of work have been completed.
- ❑ Final Material Certification Letter has been received from the Research and Materials Engineer.
- ❑ SCDOT Form 100.17 – Notice of Termination has been submitted after permanent seeding requirements have been met.
- ❑ All Utility Agreements have been closed out.
- ❑ All claims have been settled.
- ❑ All borrow pits are in compliance with the South Carolina Mining Act.
- ❑ SCDOT Form 100.03 – Report Recommending Roads for State Maintenance has been submitted, with exceptions, after final inspection.
- ❑ The final SCDOT Form 100.03 – Report Recommending Roads for State Maintenance has been submitted, without exceptions.
- ❑ Final Plans have been submitted after all major items of work have been completed.
- ❑ A copy of the As-Built Plans has been delivered to the local Resident Maintenance Engineer.
- ❑ Final Estimate has been submitted to the Contracts Engineer after the final SCDOT Form 100.03 – Report Recommending Roads for State Maintenance has been submitted and approved.
- ❑ Project Closeout Letter has been received from the Director of Construction.

All project records will be kept on hand according to the SCDOT Retention Schedule.

____
Resident Construction Engineer

PROJECT CLOSEOUT CHECKLIST
Figure 110A

Where it is considered not feasible due to weather or similar conditions to perform the corrections promptly, the Resident Construction Engineer should recommend acceptance of the project with exceptions. The exceptions should be listed on SCDOT Form 100.03 – Report Recommending Roads for State Maintenance.

110.1.5 Acceptance

The Contractor will be notified by letter from the State Highway Engineer of both partial and final acceptances of a project. A partial acceptance may relieve the Contractor of further maintenance of a portion of a project with or without exceptions. A final acceptance may relieve the Contractor of any further maintenance on the entire project without any exceptions, or it may relieve the Contractor of further maintenance with the understanding that final payment will not be made until certain exceptions are completed. Upon completion of these exceptions, a final letter of acceptance will be written to the Contractor acknowledging the fact so that the records regarding the acceptance of the project will be clear and complete.

110.2 AS-BUILT PLANS AND FINAL PROJECT RECORDS

The purpose of As-Built Plans and final project records is to document a permanent record of the actual work performed, the actual materials used and how the project was actually constructed in the field. Such information is a matter of public record and subject to review for compliance with the original Contract documents.

Throughout the project, the Resident Construction Engineer and SCDOT Inspectors assigned to the project will maintain an accurate and detailed record of all work performed and all materials used by the Contractor on the project, as adjusted by authorized deviations from the Contract Plans and Specifications (e.g., unit prices, quantities, costs, overruns, underruns, extensions, deletions). Starting the day of the Notice to Proceed and continuing through the completion of the Contract, this data will be continually collected by:

- entering field notes, computations and other project data in Daily Work Reports, Change Orders and similar data-entry features of SiteManager, including references to supporting electronic and hard-copy documents that contain information that cannot be entered into SiteManager;

- completing and filing the appropriate electronic and/or hard-copy SCDOT Construction Forms to collect supporting information that cannot be entered into SiteManager;

- retaining supporting documents provided by the Contractor, as needed, for each Contract pay item (e.g., invoices, automatic printout tickets); and

- preparing As-Built Plans by “red-lining” the CADD files of the original Contract Plans, documenting the lines, grades, dimensions and features that reflect how the project was actually constructed in the field.

The Resident Construction Engineer is responsible for ensuring that the above project records are documented accurately and in a timely manner and for archiving supporting electronic and hard-copy documents throughout the project until the SCDOT Retention Schedule allows them to be destroyed. It is important that project records be entered, prepared, checked, reviewed, approved and filed as the work progresses.

At the completion of the project, SiteManager files will be archived by the Construction Applications Manager. SCDOT Construction Forms and other supporting hard-copy information will be either retained by the Resident Construction Engineer as specified in the SCDOT Retention Schedule or submitted with the As-Built Plans, as appropriate. The As-Built Plans will be assembled in accordance with the index on the Cover Sheet FP-201. The Cover Sheet will be completed with the required information reflecting the as-constructed status of the project. The As-Built Plans will be submitted to the Final Plans Section of the Central Office.

DIVISION 200
Earthwork

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

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Section 200
General Guidelines

200.1 PRECONSTRUCTION CONSIDERATIONS

The activities performed at the start of a highway construction project are routine, but critical, because they literally will establish the facility's location in the field and provide for the overall foundation and drainage infrastructure on which the highway will be placed. Mistakes made during this phase of the project can be costly, if not immediately discovered and corrected. Some key activities that will be performed include:

- staking ROW, construction, NPDES and BCA (Bridge Construction Access) lines;
- establishing the facility's alignment, grade and cross-section;
- marking items to remain in place and areas that must not be disturbed;
- installing temporary and permanent erosion and sediment control features;
- clearing and grubbing objectionable and unsuitable materials;
- removing structures and obstructions;
- establishing sources of suitable soil material and excavating borrow pits;
- excavating for the roadbed, drainage and other structures;
- installing subsurface and surface drainage features;
- constructing roadway embankments;
- constructing the facility's subgrade, shoulders and slopes;
- handling and disposing of waste materials (i.e., hazardous and non-hazardous); and
- reclaiming affected public and private properties.

These start-up activities require close inspection and coordination with SCDOT and Contractor personnel, as well as with other affected parties such as utilities, railroads and owners of private properties. Prior to construction and in accordance with the applicable provisions of the Contract, the Contractor is responsible for meeting all permit requirements of Federal, State and local agencies and any permissions required, in the form of written agreements, from affected public and private property owners. Permit requirements, legal issues and regulations should be thoroughly addressed during the Constructability Review and Preconstruction Conference.

At the Preconstruction Conference, the Contractor is required to submit a SCDOT Form 100.15 – Stormwater and Pollution Prevention Plan for Highway Construction. This plan will include detailed half-size plans that define the Best Management Practices (BMPs) required for water quality control by type and project survey station. BMPs are schedules of activities, prohibitions and practices that are employed to control erosion and sediment and to minimize pollution of stormwater run-off and receiving waters both during and after construction.

To ensure good performance and longevity of the pavement structure, continuous and thorough inspection of these initial activities cannot be overemphasized. Pavement structure failures can generally be traced to an improperly constructed embankment, subgrade, subbase, base course or drainage feature. Good field inspection will detect deficiencies early in the project, facilitating immediate corrective action and minimizing future pavement failures. Division 200 provides the

Resident Construction Engineer and SCDOT Inspectors with guidance that should be used in conjunction with sound engineering judgment and field experience to execute these initial construction activities and inspect the construction of earthwork pay items.

200.2 SOIL CONSIDERATIONS

200.2.1 General

Soil is generally considered unconsolidated earthen material that can be excavated. The soils encountered during earthwork will include the insoluble products from either organic decomposition or rock weathering, or some combination of the two. Soils that are highly organic are generally referred to as muck and are not suitable for highway construction. Soils that are the result of rock weathering will generally be suitable for construction, but suitability will depend on the intended construction application.

200.2.2 Unsuitable Soils (Muck)

Organic soil, commonly referred to as muck, is formed when vegetation is deposited in marshy or swampy areas. If the vegetation has rotted or decomposed, the soil will usually be black in color, although some organic silt may range in color from light to dark gray. Organic soil may contain hydrogen sulfide gas, which when wet or heated, will emit an odor similar to rotten eggs.

Muck material will usually be encountered in low-elevation areas where the water table is near or above the surface of the natural ground. Muck that is found in marshy areas of the Coastal Region of South Carolina is usually black and may contain fine sand, which causes it to have a gritty feel. Muck that is found in the swampy areas of other regions of South Carolina will contain very little or no sand, which will have a spongy feel when wet. Muck material has poor engineering qualities and is unsuitable for highway construction. Where muck material is known to exist on the project or where it is encountered during construction, its removal and replacement with suitable soil material is generally required. Where muck must be removed, ensure that it is removed for its full depth, as shown on Standard Drawing 203-1.

200.2.3 Suitable Soils

Most earthwork for highway construction will involve soil material that is composed of the insoluble products of rock weathering. This type of soil usually contains many different types and sizes of granular particles. Generally, the particles will be either bulky or flaky. Bulky particles may be angular, subangular, rounded or subrounded, and flaky particles will be scale-like and extremely thin. Soils that are composed of bulky particles (i.e., sands and gravels) are capable of supporting heavy, static loads but may be easily displaced by vibration. Soils that contain a large percent of flaky particles (i.e. clay and silt) tend to deform easily under static loads but are not greatly affected by vibration. Clay will usually have a greasy or slippery feel when squeezed between the fingertips. Soil materials that are composed of the insoluble products of rock weathering are generally suitable for highway construction, but suitability will depend on the soil's engineering characteristics and intended construction application.

200.2.4 Soil Classification

To assess the suitability of a soil material for an intended engineering application, soil must be sampled, tested and classified. Such procedures are necessary to determine the engineering characteristics of a particular soil, including:

- estimating the extent to which the soil will shrink or swell,
- understanding the soil's subsurface drainage characteristics,
- determining the extent to which the soil can be compacted, and
- assessing suitability of the soil as a fill material.

A mechanical analysis of the soil will be necessary to determine the various sizes of particles (i.e., grains) that are present in the soil. This procedure generally requires separating the clay particles from a soil sample and then shaking the remaining particles through a nest of calibrated sieves. The portion of the sample retained on each sieve represents the relative quantity of each size of particle in the soil.

Soil consistency represents the condition of a soil and its degree of firmness. As a soil changes consistency, its engineering properties also change. The Atterberg Limits (i.e., liquid limit and plastic limit) are a measure of soil consistency.

Upon determination of the sizes of particles in the soil and the soil's Atterberg Limits, the soil may be classified for highway construction purposes. Refer to AASHTO M 145 – Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

200.2.5 Moisture Content and Compaction of Soils

Compaction is the action of packing the soil particles together by rolling, ramming or vibrating the material, which decreases the volume of air voids and increases the density of the soil (i.e., weight per unit volume). It is usually expressed as the percent ratio of the soil's in-place density to a standard maximum dry density (i.e., laboratory or one-point proctor). During compaction, the soil must contain a certain quantity of uniformly distributed moisture (i.e., optimum moisture content). Optimum moisture content is the percent of moisture in the soil at which its maximum density can be obtained with a given compactive effort. Optimum moisture content and standard maximum dry density generally will be determined in the field by the One-Point Proctor Method (SC-T-29). Control of compactive effort and moisture content during compaction cannot be overemphasized. The strength of the soil material increases in direct proportion to how much it is compacted. This is especially important for embankment construction.

200.2.6 Embankment Soil Material

An embankment is frequently constructed along a highway to carry traffic over a valley or low lying area and must be capable of supporting the load of the pavement structure and traffic as well as the weight of the embankment itself. The ability of the embankment to adequately support this combined load will depend on:

- strength of the soil material under the embankment,
- engineering characteristics of the embankment material,
- proper construction of benches and transitions,
- proper placement of the embankment material in lifts,
- control of moisture content near optimum during compaction, and
- compaction of each lift of embankment material to target density.

If unsuitable soils or improper construction techniques are used, uneven settlement of the embankment could occur due to consolidation of the soil material. This can be a serious and very expensive problem to correct, which can be effectively minimized through diligent and thorough inspection of methods and materials. Prior to construction, an investigation typically will be performed to assess the suitability of the underlying soil and to evaluate the engineering characteristics of locally available embankment material. To provide a sound embankment structure, the material then must be properly placed, maintained near optimum moisture content and thoroughly and uniformly compacted to target density. See Section 205 and Section 206 for additional information on embankment construction inspection.

200.2.7 Subgrade Soil Material

The subgrade is the foundation of the pavement structure. It is the top 18 inches of the roadbed, unless otherwise defined. Its function is to support, without excessive deflection, the pavement structure (i.e., subbase, base course, surface course) and the vehicular loads applied to it. In some cases, the engineering characteristics of the existing subgrade soil will be capable of supporting these loads. In other cases, however, the heavy loads of project vehicular traffic may require the construction of a special subgrade layer, requiring unsuitable material to be either removed and replaced with suitable material or modified to improve its load bearing capacity. In general, the requirements for subgrade material are identical to those for embankment material (i.e., strength, freedom from shrink and swell, sufficiently rigid to minimize excessive deflection under live loads). In some cases, the subgrade can be very close to the natural ground surface and may be subject to volumetric change due to changes in moisture. Table 1 of AASHTO M 145 – Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes can be used as a general guide for predicting subgrade performance. See Section 208 for additional information on subgrade construction inspection.

200.3 DRAINAGE CONSIDERATIONS

200.3.1 General

One of the most important factors to consider in highway design and construction is the control of surface and subsurface water. Water is arguably the most detrimental natural factor to a highway structure and can come from groundwater, seeps, springs, rain and streams. Unless the flow of water is properly intercepted and moved away from the highway, structural failures will be imminent. Surface and subsurface water are typically controlled through a combination of ditches, pipe and box culverts, aggregate and pipe underdrains and slope drains.

200.3.2 Ditches

Ditches are open channels that are constructed for the primary purpose of collecting and channeling surface water away from the roadway. Where designated, they must be constructed in accordance with the construction details shown on the Contract Plans. It is impractical for the design engineer to address all drainage situations on the project. Therefore, the Roadway Inspector should become familiar with the drainage requirements of the project and ensure that the flow of water is properly controlled during construction. See Section 203 for additional information on ditch construction.

200.3.3 Pipe and Box Culverts

Culverts are constructed of prefabricated lengths of round, oval, arch or box sections of material that are joined together at the proper line and grade to form a tunnel or closed channel. In general, culverts serve the same purpose as ditches, except that a culvert also may be used to channel water under the roadway and carry the overlying load of the highway structure and vehicular traffic. Materials used for pipe culverts vary depending on their application and include reinforced concrete, clay, metal structural plate and polyethylene. Some metallic pipe culverts will require an asphalt coating for durability. See Section 714 for additional information on the construction and inspection of pipe culverts. Box culverts serve a similar function as pipe culverts but are primarily constructed of reinforced concrete sections. See Sections 714 – 722 for addition information on the construction and inspection of box culverts.

200.3.4 Aggregate and Pipe Underdrains

Underdrains generally serve the same function as other drainage structures, except that they act as collectors of subsurface drainage that channel water out and away from the roadbed. Where a high-water table, seep or spring exists or is encountered during construction, underdrains must be properly installed to control the flow of this subsurface water. The Resident Construction Engineer and Roadway Inspector must continually monitor earthwork operations for evidence of subsurface water and ensure that underdrains are properly installed at these locations; otherwise a failure of the pavement structure can be expected. Aggregate or pipe underdrains are generally used for this purpose. Aggregate underdrains consist of entrenched crushed stone constructed on line and grade to allow subsurface water to be intercepted, collected and channeled out from under the roadway through the aggregate material. See Section 801 for additional information on the construction and inspection of aggregate underdrains. Pipe underdrains consist of sections of perforated pipe that are connected and embedded in entrenched aggregate material on line and grade to allow subsurface water to be intercepted, collected and channeled by the pipe out from under the roadway. See Section 802 for additional information on the construction and inspection of pipe underdrains.

200.3.5 Slope Drains

Slope drains are generally constructed along shoulders, slopes and at other locations designated by the Resident Construction Engineer to control surface water flow and prevent erosion. Slope drain pipe may consist of HDPE plastic, corrugated metal, asphalt-fiber or concrete material. See Section 803 for additional information on the construction and inspection of slope drains.

Section 201
Clearing and Grubbing

201.1 DESCRIPTION OF WORK

One of the first items of work on a highway construction project is to clear and grub the areas designated in the Plans. Clearing and grubbing is generally performed within the areas bounded by the construction lines, NPDES lines, BCA lines, ditch and channel areas, designated easement areas and areas within the right-of-way lines that are not designated for protection. Check the Contract Plans, Specifications and Special Provisions. The Contractor will selectively remove and dispose of all vegetation, debris and obstructions that are not designated in the Contract to remain in place (e.g., vegetative undergrowth, trees, stumps, debris, buildings, foundations, abandoned utilities, drainage structures). All protected natural vegetation, rock formations, survey monumentation, historical markers and other objects designated to remain in-place must be marked in the field for preservation and protected from injury and defacement during the operation.

201.2 PRECONSTRUCTION CONSIDERATIONS

201.2.1 Contract Document Review

Review the Contract Plans and Specifications, including Right-of-Way Special Provisions, with the Contractor. Pay particular attention to the Special Provisions related to the protection of the environment, workers and the public.

201.2.2 Permits and Agreements

Verify that the Contractor complies with all applicable Federal, State and local permits, especially those required by SCDHEC. Ensure that any required landowner agreements are properly executed and in-hand prior to the start of work.

201.2.3 Surveying and Staking

Verify that the NPDES lines, BCA lines and right-of-way lines have been staked and that the construction lines have been established by slope stakes. Survey stakes and monumentation must be protected until the Resident Construction Engineer directs otherwise.

201.2.4 Marking of Protected Items and Areas

Check that items and areas that require protection are clearly marked and communicated to the Contractor (e.g., trees, shrubs, plants, utilities, historical sites, wetlands).

201.2.5 Disposition of Items

Review with the Contractor the items and facilities that need to be demolished, removed, relocated or salvaged (e.g., fences, guardrail, utilities, buildings, underground storage tanks, merchantable timber). Pay particular attention to the Special Provisions with respect to ownership of salvageable materials and to the requirements for protecting workers and the environment from hazardous materials.

201.2.6 Removal and Disposal Documentation

Obtain the Contractor's documentation showing that all requirements have been met with respect to removing and transporting construction and hazardous waste to a licensed disposal facility. Retain copies of the manifests and disposal receipts in the project files.

201.3 INSPECTION DURING CONSTRUCTION

201.3.1 Items to Remove

Unless otherwise specified or directed to be protected, relocated or salvaged, the items to be removed and disposed of during clearing and grubbing include:

- trees, stumps, shrubs, logs and roots;
- dead trees, tree tops and limbs in and over the right-of-way;
- trash, rubbish and debris;
- building framework and foundations;
- fences, posts, signs and other structures;
- utility connections not in service;
- underground storage tanks; and
- other objects, as deemed necessary.

Pay particular attention to the demolition, dismantling and removal of buildings, structures and underground storage tanks to ensure compliance with the Special Provisions and the requirements of SCDHEC.

201.3.2 Erosion and Sediment Control

Verify that the Contractor is limiting the erodible area and has in place the proper erosion and sediment control measures. Pay particular attention to the Contractor's type and scheduling of installing erosion control measures. They should be of the type specified and installed prior to each soil disturbing operation. Notify the Resident Construction Engineer immediately if additional measures are needed. Perform inspections of the controls, as required by the NPDES permit, to ensure proper operation and adequate maintenance. Verify that temporary seeding is placed on areas that will remain inactive for longer than 21 days. See Section 815 for additional information on erosion and sediment control.

201.3.3 Merchantable Timber and Salvageable Materials

Verify that trees of value to be removed are being sawed into merchantable lengths and stacked within the right-of-way, or as otherwise designated by landowner agreement. Ensure that the Contractor does not cut, damage or destroy any timber outside the construction lines, except as designated by the Resident Construction Engineer. Verify that salvageable materials are properly removed and stored without damage.

201.3.4 Clearing and Grubbing within Right-of-Way

Check that the Contractor is clearing and grubbing the full width of the right-of-way, including all NPDES areas, BCA areas and all necessary cut and fill slopes that extend beyond the right-of-way line. Verify that tree tops, damaged trees and other debris within the right-of-way are being cleared. Make certain the Contractor does not cut, damage or destroy timber outside the right-of-way lines, unless otherwise directed.

201.3.5 Clearing and Grubbing within Roadway

Check that the Contractor is clearing and grubbing the full width of the construction limits as shown on the plans. Verify that tree tops, damaged trees and other debris are being removed. To reduce maintenance problems, trees with limbs hanging over the roadway must be trimmed to an 18-foot clear height. Measure this for compliance as the work progresses. In addition, dead or damaged trees adjacent to or overhanging the right-of-way that may become a maintenance problem should also be removed. Check with the Resident Construction Engineer prior to encroaching onto adjacent property. Ensure that any additional widths designated on the Contract Plans are being cleared. Check the depth of grubbing for compliance.

201.3.6 Clearing and Grubbing at Intersections and Interchanges

Check that the Contractor clears and grubs the full width of the right-of-way provided at intersections and interchanges, including sight triangles. Sight triangles at road intersections will be designated on the Contract Plans. Pay particular attention to the staking of the sight triangle in relation to the construction lines and the edge of traveled way, as shown on the Contract Plans. The entire sight triangle must be cleared; however, check with the Resident Construction Engineer to see if there are any trees or shrubs that warrant transplanting rather than clearing.

201.3.7 Clearing and Grubbing at Bridge Sites

Verify that bridge sites are cleared and grubbed past the outer edges for the full width of right-of-way and beyond the beginning and end of the bridge, including the BCA area, unless otherwise directed. The area within the BCA (i.e., Bridge Construction Access) lines will be cleared and grubbed during construction, and a silt fence will be installed along the outer most limits of the BCA lines. A minimum of 20 feet is required between the toe of fill and BCA line.

201.3.8 Clearing and Grubbing Excavation Areas

Verify that all excavated areas are completely grubbed of all vegetation.

201.3.9 Clearing and Grubbing Embankment Areas

201.3.9.1 Embankment Fills

Pay particular attention to locations where embankments will be constructed. All vegetation must be grubbed in these areas. Check the depth of grubbing for compliance as it relates to the height of fill on the cross-sections. Stumps must be completely removed in areas where fills will be less than 5 feet high; otherwise stumps can extend no more than 8 inches above the groundline or low water level, as measured from the base of the stump. Verify that stump holes are backfilled with suitable material and thoroughly compacted.

201.3.9.2 Flattening Fill Slopes

Where suitable surplus soil material is available and the adjacent landowner approves the work via SCDOT Form 200.04 – Agreement for Placing Debris on Private Property or SCDOT Form 100.14 – Slope Permission, as appropriate, the area beyond the toe of fill may be extended to flatten the slope and enhance roadside safety. The Resident Construction Engineer must authorize this work, and may need approval from the District Construction Engineer before proceeding, which will be determined on a case-by-case basis. Where this work is approved, the extended area must be cleared and grubbed.

201.3.10 Waste Disposal Methods

Check compliance of all disposal methods used within the right-of-way (e.g., burning). Verify that the proper disposal sites have been secured for the type of waste generated (e.g., construction waste, hazardous waste). Disposal sites are regulated by SCDHEC. Retain copies of manifests and disposal receipts in the project files.

201.4 POST-CONSTRUCTION CONSIDERATIONS

Do not allow grading work to begin on a section of the project until the full extent of clearing and grubbing has been completed and approved, as directed by the Resident Construction Engineer. Inspect the cleared and grubbed areas well in advance of the grading operation to minimize interference with the Contractor's grading forces. Clearing and grubbing should be inspected and approved as the work progresses, rather than waiting until the clearing and grubbing personnel have moved off the project. The Contractor may elect, however, to wait until the grading force has arrived to remove such debris as weeds, leaves and other light vegetation. Ensure that the Contractor has preserved all items designated to remain. Any damage found will be assessed and withheld from payment to the Contractor.

201.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

201.5.1 Clearing and Grubbing Roadway and Right-of-Way (Lump Sum Basis)

Document acceptability in the Daily Work Report of the areas cleared and grubbed within the roadway and right-of-way. Once completed and approved, these pay items will be paid for on a lump sum basis, adjusted as provided for in the Contract for changes to project length. Such length adjustments will be made by applying a unit price per length, as determined from the original project length and the lump sum bid amount. Note in the Daily Work Report, for later assessment, any fines from other agencies and damage to protected items and areas, salvageable materials, merchantable timber and utilities. Keep accurate notes of the work in progress. SiteManager will maintain a record of the quantities paid and pending, and payment may be initiated once the Resident Construction Engineer approves the Daily Work Report and processes the Monthly Pay Estimate.

201.5.2 Clearing and Grubbing Other Areas (Unit Area Basis)

Measure and document in the Daily Work Report the actual surface area (i.e., width x length), based on field stakes, for the following approved cleared and grubbed areas:

- NPDES and BCA areas;
- channel changes within the right-of-way, not shown on the Contract Plans;
- borrow areas within the right-of-way, not shown on the Contract Plans;
- channel changes outside the right-of-way;
- ditches outside the right-of-way;
- areas for flattening slopes beyond the typical sections; and
- areas where work is extended (e.g., frontage road) without increasing project length.

Payment for these areas will be made based on the Contract unit price for ditches, or as otherwise directed. Keep accurate notes of the work in progress. SiteManager will maintain a record of quantities paid and pending, and payment may be initiated once the Resident Construction Engineer approves the Daily Work Report and processes the Monthly Pay Estimate.

Section 202
Removal of Structures and Obstructions

202.1 DESCRIPTION OF WORK

The Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring that the Contractor removes and disposes of structures and obstructions as designated and in accordance with the Contract Plans and Specifications, including salvaging materials and backfilling holes where appropriate. See Section 104.8 for additional information on the removal and disposal of structures and obstructions and Section 808 for information on relocating structures and other items on the project.

202.2 PRECONSTRUCTION CONSIDERATIONS

202.2.1 Project Assessment

Prior to construction, the following will be obtained for each item within the right-of-way:

- type of object (e.g., building, drain field, septic tank, underground fuel tank, utility);
- location of the object (i.e., distance left or right of centerline);
- description of object (e.g., dimensions, hazards, utility connections, active status);
- disposition of the object (i.e., move, reset, demolish);
- description of the work to be performed (e.g., salvage, dispose); and
- owner name and contact information.

On projects other than "C" projects, the District Engineering Administrator will obtain this information within 4 weeks of receiving preliminary right-of-way plans from the Road Design Section. Once obtained, the District Engineering Administrator will forward the information to the Road Engineer-Design, who, in turn, will forward a copy with the right-of-way plans to the Right-of-Way Section. For "C" projects, this information will be obtained during the Design Field Review. Check the right-of-way Special Provisions of the Contract for this type of information.

202.2.2 Contract Document Review

Review with the Contractor the items and facilities that need to be demolished, removed, relocated or salvaged (e.g., utilities, buildings, structures, underground storage tanks). Pay particular attention to the Special Provisions with respect to ownership of salvageable materials and to the requirements for protecting workers and the environment from hazardous materials.

202.2.3 Building Structures

Verify that the Contractor has performed the required Asbestos Investigation and has obtained the proper permits from SCDHEC. The Resident Construction Engineer will be responsible for signing SCDOT Form 200.05 – Notification of Demolition on behalf of SCDOT prior to its submittal to SCDHEC.

202.2.4 Bridge Structures

For projects requiring the removal of a bridge structure, the Resident Construction Engineer will notify the Geotechnical Materials Engineer at the Research and Materials Lab that an Asbestos Investigation is needed for the bridge structure if not included in the contract. The Asbestos Investigation Report will be forwarded to the Resident Construction Engineer. At least 10 working days prior to the start of demolition, the Resident Construction Engineer will prepare and submit SCDOT Form 200.05 – Notification of Demolition to SCDHEC. The Resident Construction Engineer and the Contractor must sign the form. A copy of the Asbestos Investigation Report must accompany the submittal.

202.2.5 Underground Storage Tanks

Ensure that any removal and disposal of underground storage tanks is in accordance with the Contract Plans and Specifications, including Special Provisions, and the requirements of SCDHEC regulations.

202.2.6 Landowner Agreements

Verify that the Contractor has obtained all required landowner agreements with respect to encroachment, use and disposal of construction debris off right-of-way. Check to ensure that property owner release has been obtained.

202.2.7 Contractor Certification of Permits

Obtain the Contractor's documentation showing that all permit requirements have been met with respect to removing hazardous waste and transporting construction waste and hazardous waste to a licensed disposal facility. Retain copies of the documentation, manifests and disposal receipts in the project files.

202.3 INSPECTION DURING CONSTRUCTION

202.3.1 Building and Structures

Buildings, foundations, fences, structures and other obstructions within the right-of-way and outside the right-of-way, as designated, will be razed and disposed of properly. Consider the following:

1. Utilities. Ensure that utility connections (e.g., sewer, gas, water, power) have been shut off and capped. Utility materials must be carefully stored and protected.

2. Foundations. Outside the construction lines, check that foundations are removed to the specified depth below the natural ground level. Inside the construction lines, check that foundations are removed to the specified depth below the subgrade elevation.

3. Basements. Verify that basement floors are broken up to promote drainage. Basement cavities must be backfilled with suitable material and compacted, as specified.

4. Pavement/Curb and Gutters. Check that pavement and curb and gutter to remain is left in good condition.

202.3.2 Bridges and Culverts

All designated items and those found that will interfere with the new structure must be completely removed (e.g., culverts, arches, pipe, tile). Note that pavements, sidewalks and curbs that are removed may be suitable for use in embankment construction. Check with the Resident Construction Engineer. Consider the following guidelines during the removal of bridges and culverts:

1. Hazardous Materials. Check compliance with removal and disposal of items containing lead-based paint and other hazardous materials.

2. Traffic Control. Verify that arrangements to accommodate traffic have been made and that the Contractor is in conformance with the approved Traffic Control Plan and the requirements of the *MUTCD* (see Section 601). Verify that traffic control is in place before drainage structures used by traffic are removed.

3. Blasting. Blasting must be approved by the Resident Construction Engineer. Verify that the Contractor has coordinated with the South Carolina Department of Natural Resources District Fisheries Biologist and the District Law Enforcement Captain before blasting in any waterway.

4. Depth of Removal. Verify that structures have been removed down to the natural stream bottom and that structures outside the stream have been removed to 1 foot below the natural ground.

5. Shoring. Ensure that all excavation work adjacent to culverts and bridges and its approaches have been adequately shored.

6. Salvageable Materials. All designated pipe and tile drains must be removed in a careful manner and neatly stored on-site, unless they are to be relaid as part of the Contract. If required, steel and wood bridges must be carefully dismantled without damage. The Resident Construction Engineer will designate the on-site storage location. Check salvageable materials for damage during removal, handling and storage.

202.4 POST-CONSTRUCTION CONSIDERATIONS

The removal of all buildings, structures and underground facilities must be completed and approved by the Resident Construction Engineer prior to initiating further work on the project section. Ensure that inspections are completed in a timely manner so as not to hold up the Contractor's operations. Pay particular attention to the disposal of the construction debris and any hazardous materials generated from the operation. Construction debris must be disposed of outside the limits of view of the traveled way and, if off-site, in accordance with landowner agreements. Note any damages to salvageable materials that are the property of the Department. Assessments will be made and deducted from payment to the Contractor for any such damage.

202.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

202.5.1 General

Document in the Daily Work Report, for later assessment, any fines issued to the Contractor by other agencies. If the Contract does not specify pay items for removal of structures and obstructions or the removal is not measured and paid for as other items of work, the work will performed as discussed in Section 104.8 and Section 201.

202.5.2 Buildings and Other Facilities (Lump Sum Basis)

After removal and disposal, document acceptability in the Daily Work Report of each building, utility, underground storage tank, etc. itemized in the Contract. Once completed and approved, pay for each of these items on their respective lump sum in the Contract. Also, document in the Daily Work Report the volumetric quantity of approved and accepted backfill required to fill cavities generated from the removal of these facilities. Pay for this backfill based on the Contract price per unit volume for unclassified or borrow excavation, as deemed appropriate. Do not measure for separate payment any such facility that is not itemized in the Contract, because removal and disposal of such items will be incorporated elsewhere.

202.5.3 Bridge Structures (Lump Sum Basis)

After removal and disposal, document acceptability in the Daily Work Report of each bridge structure itemized in the Contract. Once completed and approved, pay for each bridge structure based on the lump sum in the Contract.

202.5.4 Reclamation of Existing Roadways

202.5.4.1 Non-Itemized Pavement or Curb Removal (Unit Volume Basis)

Where existing pavement or curb has been removed but not itemized in the Contract, document acceptability in the Daily Work Report and measure and pay for the work as unclassified excavation. See Section 203 for additional information.

202.5.4.2 Pavement (Unit Area Basis)

Document in the Daily Work Report the accepted area of existing pavement removed and disposed. The quantity will be determined by actual surface area (i.e., length x width) made in the field prior to removal. Pay for this work based on the Contract unit price per area. Note that areas extending beyond the construction lines will be identified on the Contract Plans and must be included for payment.

202.5.4.3 Removal of Asphalt Pavement < 2 inches

Document in the Daily Work Report the accepted area of existing pavement (i.e., < 2 inches in thickness) removed and disposed. Pay for this work as unclassified excavation.

202.5.4.4 Removal of Asphalt Pavement ≥ 2 inches

Where existing asphalt pavement has been removed (i.e., ≥ 2 inches), document acceptability in the Daily Work Report. The quantity will be determined by actual horizontal area (i.e., length x width) made in the field prior to removal. Pay for this work based on the Contract unit price per area. Note that areas extending beyond the construction lines will be identified on the Contract Plans and must be included for payment.

202.5.4.5 Curb (Unit Length Basis)

Document in the Daily Work Report the accepted length of existing curb removed and disposed. The quantity will be determined by actual linear measurements made in the field prior to removal. Pay for this work based on the Contract unit price per length.

202.5.4.6 Earth Roadway (Unit Area Basis)

Where it is necessary to reclaim an existing earth roadway, the area outside the construction lines will be scarified, graded to drain and seeded as shown by crosshatching on the Contract Plans. Document in the Daily Work Report the accepted area of existing earth roadway reclaimed. The quantity will be determined by actual surface area (i.e., length x width) made in the field prior to removal. Pay for this work based on the Contract unit price per area. Note that areas extending beyond the construction lines will be identified on the Contract Plans and must be included for payment.

202.5.5 Culverts

Where existing culverts are removed, document acceptability and quantities in the Daily Work Report and measure and pay for the work as provided for in the Contract Specifications and Special Provisions.

Section 203
Roadway and Drainage Excavation

203.1 DESCRIPTION OF WORK

The Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance of roadway and drainage excavation. In general, the Contractor will be required to excavate and dispose of unsuitable material; stockpile and reuse suitable materials; and obtain, haul, place and compact material within the right-of-way for embankment, subgrade, shoulder, slope and intersection construction. All clearing and grubbing for a given section must be completed and approved by the Resident Construction Engineer prior to initiating grading operations in that area. The SCDOT Inspector assigned to the grading work must be thoroughly familiar with the method of staking, soil test reports, typical sections, planned drainage facilities and the material sources that will be used on the project. As the excavation work progresses, the SCDOT Inspector must make sure that the Contractor is constructing each section in accordance with the Contract Plans, paying particular attention to the construction of slopes.

203.2 PRECONSTRUCTION CONSIDERATIONS

203.2.1 Contract Document Review

Review with the Contractor the Contract Plans and Specifications for the roadway and drainage excavation to be performed. Pay attention to the Special Provisions with respect to material reuse and disposal, material testing, acquisition and reclamation, landowner agreements, protection of workers and the environment, and erosion and sediment control.

203.2.2 Permits and Agreements

Verify that all applicable Federal, State and local permits (e.g., SCDHEC) have been obtained. Ensure that any required landowner agreements are properly executed and in-hand prior to the work.

203.2.3 Surveying and Staking

Verify that the NPDES lines, BCA lines and right-of-way lines have been staked and that the construction lines have been established by slope stakes. Survey stakes and monumentation must be protected until the Resident Construction Engineer directs otherwise. Check slope stakes for compliance with the typical sections and verify that lines and grades are as shown on the Contract Plans, or as otherwise directed by the Resident Construction Engineer. Ensure that all necessary cross-sections have been taken prior to the Contractor beginning work. The digital terrain method is acceptable for borrow pit cross-sectioning, and the grid method will be used to measure bridge and other similar excavation.

203.2.4 Material Pits and Haul Roads

Borrow pits will generally be provided by the Contractor. Ensure that the Contractor has obtained the permits and agreements required by SCDHEC, NPDES and landowners. Verify with the Contractor the exact location and limits of the pit that will be used for the Contract. This is especially important if the pit will be used for other contracts during the project. Check the Contract Plans for any haul roads required for hauling borrow material. Ensure that the Contractor restores all pits and haul roads to a condition satisfactory to property owners, as required by the South Carolina Mining Act.

203.2.5 Sampling and Testing Considerations

203.2.5.1 Borrow Pits

The sampling and testing of borrow pit material is generally the responsibility of the Contractor. Check the Special Provisions of the Contract. Any additional sampling and testing desired by the Resident Construction Engineer will be performed only for the purpose of assessing suitability of the material with respect to the requirements of the Contract Specifications. These samples and tests must be performed well in advance of the grading operation. SCDOT does not approve borrow pits.

203.2.5.2 Excavation Areas

If an area of questionable material is encountered, it may be necessary for the Resident Construction Engineer to request additional borings for the purpose of verifying shrink/swell and suitability. This will be determined on a case-by-case basis. The Resident Construction Engineer should contact the Research and Materials Laboratory to arrange the use of any needed boring equipment. See Section 106 for additional information on control of materials.

203.2.6 Material and Equipment Considerations

Where geotextile fabric will be used on the project, verify that the material meets the Contract specifications for its intended use. Obtain the manufacturer's certification from the Contractor and submit it to the Research and Materials Laboratory prior to use. See Section 300.2.5 for additional information. Check the condition of the equipment to be used on the project.

203.2.7 Resetting of Items

Verify that any items required to be reset (e.g., mailboxes, guide signs, traffic control signs, traffic warning signs, guardrail) have been properly reset without damage. The Contractor is responsible for executing SCDOT Form 800.01 – Agreement for Moving Items Release. The Resident Construction Engineer must sign this form.

203.3 INSPECTION DURING CONSTRUCTION

203.3.1 Erosion and Sediment Control

Verify that the Contractor is limiting the erodible area and has in place the proper erosion and sediment control checks to protect adjacent rivers, streams, wetlands and impoundments. Pay particular attention to the Contractor's type and scheduling of installing these checks. They should be of the type specified and installed prior to each soil disturbing operation. Notify the Resident Construction Engineer immediately if additional measures are needed. Perform inspections of the controls, as required by the NPDES permit, to ensure proper operation and adequate maintenance. Verify that erodible areas have been sloped and seeded and that temporary seeding is placed on areas that will remain inactive for longer than 21 days. See Section 815 for additional information on erosion and sediment control.

203.3.2 Removal of Unsuitable Material (Muck Excavation)

203.3.2.1 General

Unsuitable material is organic muck or soft, pumping, extremely wet material. See Section 200.2 for information on soils. During the work, continually monitor the site for areas that are unstable for foundation, subgrade or other roadway purposes. Ensure that the Contractor removes and disposes of unsuitable material to the cross-section shown on the typical sections and backfills the excavation with suitable material.

203.3.2.2 Excavation Near Watercourses

Verify that all roots, stumps, rock and other unsuitable materials along the sides and bottom of watercourses are cut to conform to the slope, grade and shape of the typical sections. Check that material is not deposited within 3 feet of watercourse edges. Verify that suitable material excavated from ditches and channels is placed in the embankment or along the banks.

203.3.2.3 Subgrade and Underdrains

As the excavation work nears the subgrade elevation, observe the cut for any unusual displacement of the ground by earthmoving equipment. Abnormal displacement may occur because of subsurface moisture or because of the instability of the material. Should either condition exist, the cause should be determined and corrected, if necessary, by placement of interception ditches and underdrains, removal of the unstable material or other appropriate means. Consult the Resident Construction Engineer and, as needed, the District Construction Engineer, for advice when unsuitable material is encountered, causing the need for underdrains. Use sound engineering judgment in determining mitigation plans. Additional boring and soil testing may be necessary. See Section 200.3.4 for additional information on underdrains and Section 208 for additional information on subgrade. The District Construction Engineer must approve the subgrade prior to further work.

203.3.3 Reuse of Suitable Material

Ensure that any stripped material that is determined by the Resident Construction Engineer to be beneficial to the establishment of permanent vegetation on the project is salvaged and stockpiled for later use on the project. Check the Contract Plans for designated areas of surplus and waste materials.

203.3.4 Ditches and Channels

Satisfactory drainage is often difficult to obtain, especially in areas with flat terrain. Ditches should drain away from the roadway. Cut ditches should be flared out away from the roadbed at the end of cuts and extended on the natural ground to a point where water will not be discharged along the junction of the fill slope and the natural ground. After ditches are constructed, their performance should be observed to determine if destructive erosion is taking place. On primary and Interstate projects, a bid item will usually be provided for the paving of ditches that may otherwise erode excessively. When such an item is provided, the Resident Construction Engineer should determine locations where placement of ditch paving will be performed. The Contractor should be advised of these locations well in advance of the completion of the project. For ditches and channels, the Resident Construction Engineer must approve any deviation from the Contract Plans.

203.3.5 Borrow Excavation

It is often necessary to borrow material to balance earthwork, because the shrink/swell factor does not agree with the design factor. Borrow material may be obtained by widening cuts, flattening cut slopes, lowering grades or by obtaining borrow pits. Grade adjustments on primary roads and Interstate projects and those greater than 0.3 feet on secondary roads should be avoided and require approval by the District Construction Engineer.

203.3.6 Rock Excavation

Where rock is encountered in the subgrade, verify that the rock is excavated to a depth of 6 inches below subgrade for the entire width of the roadbed, unless a cement-modified subgrade is specified in the Contract Plans. Where the plans specify a cement-modified subgrade and rock is encountered in the subgrade, ensure that the rock is excavated to a depth of 12 inches below the subgrade for the width specified in the Contract Plans, or as otherwise directed by the Resident Construction Engineer. Ensure that the resulting excavated areas are backfilled with suitable material. Verify that final breakage of rock excavation conforms to the slope required by the Contract Plans. Check with the Resident Construction Engineer prior to any pre-splitting blasting operation. Ensure that the pre-split face does not deviate more than 6 inches from the front line of the drill holes nor more than 12 inches from the back line. Watch for pre-split holes that did not detonate. See Section 107.15 for information on the use of explosives.

203.3.7 Embankment Construction

As practicable, ensure that the Contractor salvages the best excavation material for use in constructing the top portion of embankments. Verify that any material excavated beyond the slope stakes is used in the formation of the embankments, as applicable. Check that ditches and gutters discharging from cuts to embankment areas are constructed to avoid erosion of the embankment. Verify that final slopes are left reasonably smooth and uniform. Unless otherwise permitted, ensure that no rock projects more than 1 foot beyond established slopes.

203.3.8 Select and Surplus Material

Check that the Contractor strips and stockpiles select material for shoulders. Ensure that surplus or waste material is used to flatten embankment slopes, where practicable.

203.4 POST-CONSTRUCTION CONSIDERATIONS

Roadway and drainage excavation must be completed and approved by the Resident Construction Engineer prior to initiating further work on the project section. Ensure that inspections are completed in a timely manner so as not to hold up the Contractor's operations.

203.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

See Section 203 of the *Standard Specifications* for the method of measurement and basis of payment for roadway and drainage excavation. Use the Daily Work Report and appropriate SCDOT Construction Forms to document field notes, measurements and the day-to-day project activities for assessing acceptability and measuring work and materials for payment.

Section 204
Structure Excavation

204.1 DESCRIPTION OF WORK

Structure excavation consists of the removal and disposal of all materials necessary for the construction of foundations and substructures for bridges, box culverts and other structures. When specified, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with the Contract Plans and Specifications.

204.2 PRECONSTRUCTION CONSIDERATIONS

Review the Contract Plans and Specifications, including applicable Supplemental Specifications and Special Provisions, to understand the requirements and limitations for structure excavation. Pay particular attention to the criteria specified for assessing acceptability and for measuring the work for payment.

204.3 INSPECTION DURING CONSTRUCTION

204.3.1 Bridge Excavation

Excavation for bridges will be classified as either dry, wet, wet and dry, or rock. Excavation for other structures will be unclassified. The Contract Specifications will define the classifications for bridge excavation. In some cases, the Resident Construction Engineer may experience some difficulty in determining the portion of excavation that is to be classified as rock excavation. Boulders must be larger than 0.5 cubic yards to be classified as rock excavation. The rock must be of such hardness that blasting is required in most instances of removal. Material which may be commonly called rock but that can be broken up with a pneumatic jack hammer, chisel or spade point cannot be classified as rock excavation, because it does not meet the specified requirements for rock excavation. The classification between wet excavation and dry excavation will be specified in the Contract Plans and Specifications, unless a price is obtained for the combination of wet and dry excavation, in which case there will be no distinction made between wet excavation and dry excavation. Only when a price for rock excavation is itemized in the Contract Plans and Specifications will any rock excavation be paid for.

204.3.2 Cofferdams

Where cofferdams must be constructed, verify that the design calculation and Shop Plans (see Section 725) have been submitted for review prior to construction. Also, ensure that the cofferdam is kept free of water by pumping during construction.

204.3.3 Foundation Seals

For foundation seals, check the elevation of the foundation seal to ensure that it is within conformance of the grade specified on the Contract Plans. Also, check the placement of concrete for conformance with specified requirements.

204.4 POST-CONSTRUCTION CONSIDERATIONS

Verify that crosshole sonic logging is performed on drilled shafts, as required (see Section 712). All work related to structural excavation must receive final approval from the Resident Construction Engineer prior to any other work proceeding at the site. The Bridge Construction Engineer must approve any work that deviates from the Contract Plans.

204.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Document in the Daily Work Report the quantity of excavation to be paid for that was actually removed within the limits defined in the Contract Plans and Specifications. Prior to excavation, the Resident Construction Engineer will determine the elevation of the ground or stream bed at a sufficient number of points. These original elevations should be made to the nearest 0.1 foot.

1. Bridge Excavation. A grid system can be used to measure excavation for most bridge footings. This simplifies computations. Once the transverse centerline of the foundation has been staked, the corners of the excavation, as defined by the limits for payment, should be determined and elevations taken at each corner and at the center of each side. Elevations should also be taken at the intersection of lines joining the opposite side mid-points. This will form the grid system. Additional points along the sides may be necessary if the foundation is large or if the top of the ground is rough. The average ground line can then be determined by multiplying the elevation of each point by the number of rectangles of the grid that make contact with the point and dividing the sum by four times the number of rectangles in the grid. If the Contract specified a unit price for rock excavation and the unit price is substantially higher than that for unclassified excavation, the average elevation of the top surface of the material that qualifies as rock must be determined in a similar manner. Final elevations of the bottom of the excavation should be taken at the same points and the average elevation similarly determined. The volume can then be computed by multiplying the difference between the average elevations by the area of the excavation authorized for payment.

2. Culvert Excavation. The Contract will define the method to be used in measuring excavation for culverts. Cross-sections should be taken perpendicular to the centerline of the culvert at sufficient intervals, and the volume computed by average-end-area method. The digital terrain method of using total stations may also be used.

Payment will be made at the Contract unit price for the volume of the various classifications of excavation involved, except that wet excavation and rock excavation for bridges, whose final footing elevations are more than 5 feet below plan elevation for the bottom of the footing, will be paid for at an increase in price as specified in the Contract.

Section 205
Embankment Construction

205.1 DESCRIPTION OF WORK

Embankment construction is one of the most important phases of highway construction, and if acceptable results are to be obtained, diligent inspection must be provided. The importance of diligently inspecting the acceptability of this work and maintaining accurate notes in the Daily Work Report cannot be overemphasized. Mistakes occurring during this phase of construction can be costly, especially if they are covered over by a subsequent operation such as paving. The Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring that the Contractor constructs embankments as specified in the Contract. Embankment construction generally consists of forming embankments to the lines, grades and cross-sections in the Contract Plans, including preparing areas on which they will be placed, placing and compacting approved material where unsuitable material has been removed, and placing and compacting material in holes, pits and other depressions within the roadway area.

205.2 PRECONSTRUCTION CONSIDERATIONS

205.2.1 Contract Document Review

Review the Contract Plans and Specifications, including applicable Supplemental Specifications and Special Provisions, to understand the requirements and limitations for embankment construction. Pay particular attention to erosion and sediment control, work and material acceptance criteria and the documentation and measurements required for payment.

205.2.2 Sampling and Testing Considerations

The actual dry density will be determined using SC-T-30, SC-T-31, SC-T-32 or SC-T-33, as appropriate. The maximum dry density and the optimum moisture content will be determined using either the One-Point Proctor Method (SC-T-29) or the field method of determining moisture-density relationship (SC-T-25). The frequency of density testing must be performed in accordance with the minimum criteria presented in Section 106, but should be increased, as needed, to closely monitor compaction, such as in areas where fills are short, existing embankments are widened and when changes are noted in soil conditions (e.g., color, texture). Either SC-T-29 or SC-T-25 should be performed each time a change in soil condition is noted. Even if the soil remains fairly uniform, it will still be necessary to conduct a minimum of two tests each day using either SC-T-25 or SC-T-29, preferably one in the morning and one in the afternoon. Use previous experience and sound engineering judgment to assess the need for additional testing. In addition, if the Special Provisions require the material to be a certain AASHTO or ASTM classification, a minimum of one sample will be required from each source used that day. See Appendix C for SCDOT Sampling and Testing Procedures.

Submit embankment material samples to the Research and Materials Laboratory for testing. Include on the Sample Identification Card (see Appendix B) the survey station number, distance from centerline and approximate depth below the finished grade. If the Test Report from the Research and Materials Laboratory indicates the sample failed and a check sample is requested, obtain and forward to the Research and Materials Laboratory two check samples representing the failing material. Check samples are discussed in Section 106.

Maintain a full record of density tests and test results in the project files. The Resident Construction Engineer should retain SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge or SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge – Direct Read Gauge; however, SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge) must be sent to the Research and Materials Laboratory on a weekly basis. Report the location of each density test, including survey station number, distance from centerline and depth below the finished grade.

205.3 INSPECTION DURING CONSTRUCTION

205.3.1 Embankment Foundation

Inspection of an embankment foundation is essential and involves an appraisal of existing conditions. Ensure compliance of the clearing and grubbing work. Examine the foundation for soft or saturated material and evidence of seeps or springs. Watch for spongy material. Ensure that soil of questionable bearing is removed, replaced and satisfactorily drained. Contact the Resident Construction Engineer for any needed assistance. Pay particular attention to obtaining the best possible interlock between existing sloped ground and new embankment material. On hillsides, benching will be required to prevent slides and ensure a positive interlock between the embankment and its foundation.

205.3.2 Formation and Compaction

The ability of an embankment to support itself, the pavement structure and traffic loading depends greatly on how well each lift is placed and compacted and how well the embankment is drained. If improperly compacted or if it becomes saturated, the embankment will fail. Ensure that the required drainage for the embankment is properly installed. As the embankment is being constructed, check the drainage structures for any failures that may have occurred and, if found, halt embankment construction in the area until the condition has been corrected. Verify that each lift is placed in successive, horizontal and uniform compacted layers. Verify that the thickness of each lift complies with the *Standard Specifications*. Lifts that are placed too thick, too dry or too wet may not achieve target density when compacted. In addition, by controlling lift thickness, hauling equipment will make more passes over the embankment area, thus resulting in additional compactive effort. Verify that each lift is compacted to a minimum 95% of maximum density. The Contractor is responsible for obtaining the required density by any means desired. Where a swampy area is encountered and it is not necessary to remove the soft material, it may be necessary to place a foundation lift greater than 8 inches thick. This prevents the underlying material from being pumped up into the embankment. For the top portion of the embankment, only the best available embankment material should be used. This policy should be strictly enforced. By doing so, the supporting ability of the embankment will be greatly improved. See Section 205.2.2 for information on compaction sampling and testing.

205.3.3 Embankment Over and Around Structures

Where embankment material is placed over or around structures (e.g., box culverts, retaining walls), verify that the concrete has cured for at least 14 days prior to any backfilling or that the concrete has achieved desired strength. Ensure that embankment material is placed and compacted in equal lifts on both sides of concrete structures to avoid unbalanced earth pressures. If embankment material has been brought up more than one-half of the height of a box culvert, check that the remainder of the material is placed the same day to provide the minimum cover. Ensure that drains connecting weepholes have been installed, as specified.

205.4 POST-CONSTRUCTION CONSIDERATIONS

No pavement structure will be placed until the underlying embankment work has been tested and approved by the District Construction Engineer.

205.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The Resident Construction Engineer will retain the original and final roadway cross-sections. Although embankment will be measured separately for payment, the cross-sections will be necessary to compute embankment volume and any overhaul quantities.

Section 206
Embankment In-Place

206.1 DESCRIPTION OF WORK

The Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring the Contractor performs this work in accordance with the Contract Plans and Specifications. The work for embankment in-place generally consists of the construction of embankment by dredging and pumping acceptable material from rivers, canals or other areas or by excavating, loading and hauling acceptable material from pits and depositing the material at locations shown on the Contract Plans.

206.2 PRECONSTRUCTION CONSIDERATIONS

Prior to starting the work for embankment in-place, review the Contract Plans and Specifications, including applicable Supplemental Specifications and Special Provisions. Pay particular attention to the requirements for:

- dredging and environmental permits,
- environmental protection and water pollution control,
- erosion and sediment control,
- limits on the surface area of exposed erodible material,
- borrow pits and haul roads,
- landowner agreements and releases,
- disposal of stripped material from pits, and
- material and equipment.

206.3 INSPECTION DURING CONSTRUCTION

206.3.1 Hydraulic Construction

Check hydraulic construction for conformance with the requirements of the Contract Plans and Specifications. Pay particular attention to the requirements for:

- distance between the pit and the right-of-way line,
- pit approval and reclamation,
- distance material can be excavated or dredged within the toe of the embankment,
- prevention of muck from being trapped within the fill section,
- obtaining original and final cross-sections,
- embankment slopes,
- removal of timber and filling of holes in the embankment,
- prevention of damage to adjacent property, and
- use of excess material to raise the embankment.

206.3.2 Construction Using Hauled-in Material

Check that construction using hauled-in material complies with the requirements of the Contract Plans and Specifications. Pay particular attention to the requirements for:

- embankment elevation with respect to the action of ground water,
- compaction of layers of not less than 95% of maximum density,
- stability of material subject to ground water,
- removal of unstable material,
- obtaining original and final cross-sections, and
- use of glass aggregate material.

206.4 POST-CONSTRUCTION CONSIDERATIONS

No pavement structure will be placed until the underlying embankment work has been tested and approved by the District Construction Engineer.

206.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure and pay for embankment in-place by volume completed and accepted. Calculate the volume using cross-sectioning, the average end area method or digital terrain method, as applicable. Do not pay separately for embankment material used to replace material excavated beyond the lines and grades shown on the Contract Plans, and do not pay for overhaul. Document field notes and measurements in the Daily Work Report and applicable SCDOT Construction Forms.

Section 207
Overhaul

Overhaul is the hauling of excavated material beyond the free-haul limit from the source of excavation to the embankment or point of disposal. Overhaul is not typical for SCDOT projects. Check the Special Provisions.

The balance points shown on the Contract Plans represent the most economical haul, computed from theoretical shrink/swell factors. As practical, the Contractor should follow the haul as designated in the Contract Plans. The balance points on the Contract Plans may or may not be the balance points representing actual haul on the project.

When actual balances differ from the balance points on the Contract Plans by an appreciable amount, note the actual balance points observed. If excavated material is obtained from borrow or material pits, note the source and the roadway locations on which the material was used. This is especially important when multiple pits are used on a single project. Also note the distance over the shortest practicable route from the material pit to the project.

If final pay quantities deviate significantly from Plan quantities, a mass-haul diagram will be developed. The Resident Construction Engineer will make this determination and retain these records in the project files. The balance points on the mass-haul diagram will be those observed in the field, taking into consideration any cross-haul performed. In preparing the mass-haul diagram, the rising line will indicate an excess of excavation over embankment and a declining line will indicate a surplus of embankment over excavation after the shrinkage factor has been applied.

Section 208
Subgrade

208.1 DESCRIPTION OF WORK

The subgrade is the top 18” of the roadbed upon which the base structure and shoulders will be constructed. The Resident Construction Engineer and SCDOT Inspectors will be responsible for inspecting the subgrade with respect to materials, grade, width, thickness, cross slope, density and drainage. It is good construction practice to continually monitor the subgrade for excessively wet areas, high or low spots, ruts, muck and loose or segregated materials. Require that such unsuitable soil material be removed and replaced with acceptable material and properly compacted. Underdrains or rework (e.g., additional grading and compaction) may be required. The subgrade must be approved by the District Construction Engineer prior to constructing the base structure (e.g., subbase, base courses).

208.2 PRECONSTRUCTION CONSIDERATIONS

208.2.1 Contract Document Review

Prior to subgrade construction, review the Contract Plans and Specifications for any special requirements. Pay particular attention to the requirements for erosion and sediment control. All earthwork within the project section must be substantially completed and drainage structures must be completed and backfilled prior to work on the subgrade.

208.2.2 Sampling and Testing Considerations

It is the Contractor’s responsibility to obtain the required subgrade density by any means desired. The material’s actual dry density will be determined using SC-T-30, SC-T-31, SC-T-32 or SC-T-33, as appropriate. The maximum dry density and the optimum moisture content will be determined using either the One-Point Proctor Method (SC-T-29) or the field method of determining moisture-density relationship (SC-T-25). The frequency of density testing must be performed in accordance with the minimum criteria presented in Section 106, but should be increased, as needed, to closely monitor compaction, such as in areas where changes are noted in soil conditions (e.g., color, texture). This is especially important as the material is placed and compacted near subgrade elevation. Either SC-T-29 or SC-T-25 should be performed each time a change in soil condition is noted. Even if the soil remains fairly uniform during placement and compaction, it will still be necessary to obtain samples every 1000 feet to the depth indicated in the Special Provisions. Use previous experience and sound engineering judgment to assess the need for additional testing. In addition, if the Special Provisions require the top portion of the subgrade material to be a certain AASHTO or ASTM classification, subgrade samples will be obtained in both fill and cut sections. See Appendix C for SCDOT Sampling and Testing Procedures.

Submit subgrade material samples to the Research and Materials Laboratory for testing. It is critical to submit these samples promptly during the work so that poor subgrade material can be removed and replaced during the grading operation. Sometimes poor material is obvious, but other times it is not. Include on the Sample Identification Card (see Appendix B) the survey station number, distance from centerline and whether the sample is from a cut or fill section. Specifically note if the sample was obtained at subgrade elevation. If the Test Report from the Research and Materials Laboratory indicates that the sample failed and a check sample is requested, obtain and forward to the Research and Materials Laboratory the required check samples representing the failing material. Check samples are discussed in Section 106. In general, Test Reports on samples from cut sections are to assist the Resident Construction Engineer in assessing the suitability of the material.

Maintain a full record of density tests and test results in the project files. The Resident Construction Engineer should retain SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge or SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge – Direct Read Gauge; however, SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge) must be sent to the Research and Materials Laboratory on a weekly basis. Report the location of each density test, including the survey station number, distance from centerline and whether the sample is from a cut or fill section. Specifically note if the sample was obtained at subgrade elevation.

208.3 INSPECTION DURING CONSTRUCTION

Every effort should be made to provide a firm, uniform subgrade that will minimize differential settlement. Such settlement will eventually develop under the wheel paths of vehicular traffic. Soft, unstable material must be removed and replaced with suitable material. Such material will cause irregularities to be reflected in the final surface course. The subgrade on top of an embankment must be constructed of the best economically available material. Inform the Contractor of the material that is best suited for this purpose and ensure that it is properly placed and compacted. Continually check compliance of the cross-section of the subgrade using a hand level, engineer's level, or by other suitable means. The Contractor should not be permitted to place the base structure on a subgrade until its density, cross-section and grade have been approved by District Construction Engineer.

Compaction enhances subgrade bearing capacity and performance by reducing shrinkage, swelling and permeability. Verify that the subgrade is compacted to a minimum 95% of maximum density. The Contractor is responsible for obtaining this density by any means desired. Pneumatic-tire rollers are often used for this purpose. Density testing should be performed as discussed in Section 208.2.2. It is critical to perform density testing just prior to placing the base structure, because the subgrade will lose its compaction if exposed for any length of time to weather.

208.4 POST-CONSTRUCTION CONSIDERATIONS

Verify that the subgrade is finished to a smooth and compacted condition with a surface that is free from ruts and depressions and of the proper grade and cross-section. The District Construction Engineer must approve the subgrade prior to further work.

208.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Work and materials for subgrade will not be measured and paid for separately. Do not pay the Contractor any additional compensation for filling holes, ruts or depressions that develop in the subgrade or for bringing the surface to line and grade. Document all field notes in the Daily Work Report and appropriate SCDOT Construction Forms.

Section 209
Shoulders and Slopes

209.1 DESCRIPTION OF WORK

The Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring that shoulders and slopes are constructed in accordance with the requirements of the Contract Plans and Specifications. The work generally involves excavating, hauling, placing, compacting and maintaining approved select material. Where the shoulders are not constructed to the required cross-section, require the Contractor to correct any portions that are not within reasonable conformity with the Contract Plans.

209.2 PRECONSTRUCTION CONSIDERATIONS

Prior to construction of shoulders and slopes, pay particular attention to the requirements for:

- environmental permits and water pollution control;
- erosion and sediment control;
- limits on the surface area of exposed erodible material;
- material pits and haul roads and their reclamation;
- landowner agreements and releases;
- disposal of stripped material from pits;
- material and equipment;
- salvage and reuse of material (e.g., stockpiles, select excavation material); and
- original and final cross-sectioning.

209.3 INSPECTION DURING CONSTRUCTION

Verify that the select material for construction of shoulders and slopes is capable of growing grass. Know the requirements for sequencing the shaping, trimming and compaction operations and the timing, placement and compaction of the material with respect to the type of roadway being constructed. All construction should be performed in a manner that will promote drainage without erosion. Verify the proper densification of the material.

209.4 POST-CONSTRUCTION CONSIDERATIONS

All work related to shoulders and slopes must receive final approval from the Resident Construction Engineer prior to any other work proceeding at the site. Verify that the Contractor properly maintains shoulders and slopes during subsequent operations.

209.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The select material that will be placed on shoulders and slopes will be measured and paid for on a unit volume basis, as specified in the Contract. If no separate pay item is specified in the Contract, the material will be paid for as unclassified excavation. Discuss with the Resident Construction Engineer the method that should be use to obtain the volumetric measurements (e.g., cross-sectioning, load counts). Document measurements and field notes in the Daily Work Report and appropriate SCDOT Construction Forms.

Section 210
Flowable Fill

210.1 DESCRIPTION OF WORK

Flowable fill is a controlled low-strength material that can be placed in a self-leveling consistency or in a less flowable state to reduce the fluid pressure exerted by the material. Where flowable fill is used, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with respect to application, materials, proportioning, handling, maintenance and protection of the work.

210.2 PRECONSTRUCTION CONSIDERATIONS

Verify that the type of mix to be used (e.g., Mix 1 (less flowable), Mix 2 (very flowable)) is appropriate for the project application. The foaming agent used must be supplied from a manufacturer listed on SCDOT Approval Sheet 31. Check compliance of the equipment used to produce, transport and place the flowable fill.

210.3 INSPECTION DURING CONSTRUCTION

Ensure that the Contractor is taking precautions to prevent pipes from floating out of position due to the buoyancy of the flowable fill mix. The buoyancy is greater with the more flowable mixtures. Check cover for compliance. The minimum cover of flowable fill over pipes, utilities, etc., is 6 inches. Ensure that bleed water is being adequately drained. Ensure that backfilling of pipes is being distributed evenly to equalize the pressure on both sides of the pipe and to prevent movement. If it is necessary to resume traffic before the flowable fill has hardened sufficiently, verify that the Contractor has provided steel plates to bridge over the patched areas.

210.4 POST-CONSTRUCTION CONSIDERATIONS

Assessing the acceptability of the work and materials and final approval of the work is the responsibility of the Resident Construction Engineer.

210.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure and pay for flowable fill based on the volume delivered to the job site, incorporated into the work and accepted by the Resident Construction Engineer. Note that where Mix 2 (very flowable) has been used, the volumetric difference due to the additional water will be neglected. Document measurements and field notes in the Daily Work Report and appropriate SCDOT Construction Forms.

DIVISION 300
Bases and Subbases

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

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Section 300
General Guidelines

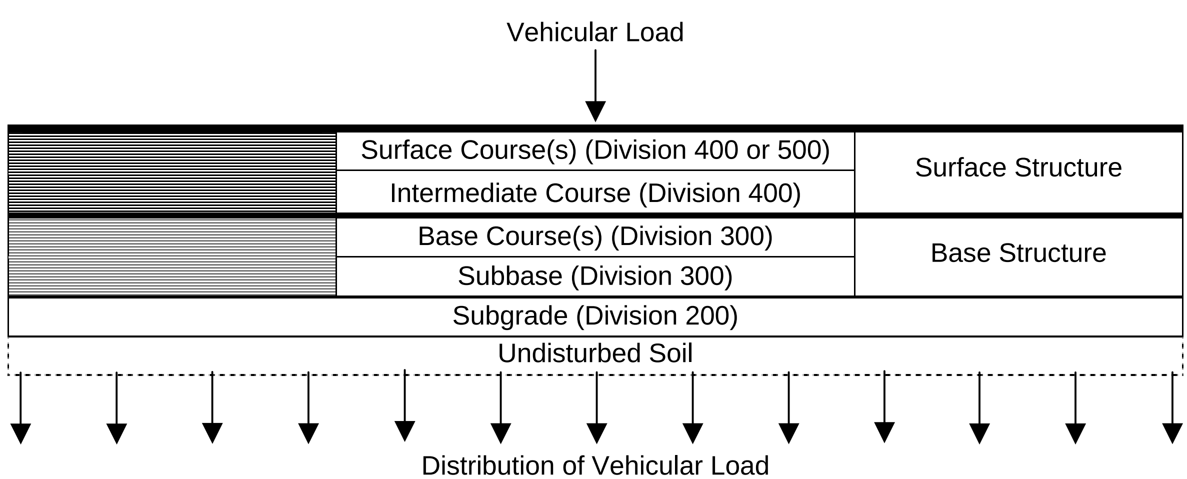
300.1 INTRODUCTION

To ensure good performance and longevity of a pavement structure, continuous and thorough inspection during the early stages of highway construction is critical. Pavement structure failures can often be traced to an improperly constructed subgrade, subbase, base course or drainage feature. Good field inspection will detect deficiencies early in the project, facilitating immediate corrective action and minimizing future pavement failures. Division 300 provides the SCDOT Inspector and Resident Construction Engineer with guidance that should be used in conjunction with sound engineering judgment and field experience to inspect the construction of highway pavement subbase and base courses.

300.2 PAVEMENT CONSTRUCTION: OVERVIEW

300.2.1 Pavement Structure

In general, a pavement structure is designed to carry the repetitive loads of projected vehicular traffic, taking into consideration the type of facility required, the number and type of vehicles that are expected to use the facility during its design life, the quality of materials available on the project and other design factors. The pavement structure itself consists of several layers of various material types and thicknesses, which are placed and compacted sequentially from the ground up. Each layer is designed to distribute the load it supports to the layer immediately below it, thus allowing the vehicular load directly supported by the surface courses to be uniformly distributed throughout the pavement structure to the subgrade foundation. This concept is illustrated in Figure 300A.



TYPICAL PAVEMENT STRUCTURE
Figure 300A

300.2.2 Subgrade Foundation

Earthwork must be completed and approved before initiating work on the subbase or any base course, including clearing and grubbing, roadway and drainage excavation, and embankment and subgrade construction (see Division 200). The subgrade is the foundation of the entire pavement structure; therefore, its construction must be closely inspected as discussed in Section 208. Once the subgrade has been approved by the District Construction Engineer, continue to monitor the subgrade for excessively wet areas, soft spots, ruts and grade deficiencies. Require the Contractor to correct such deficiencies in accordance with the provisions of the Contract before they are covered by a subsequent subbase or base course. Additional drainage, grading and compaction rework may be required to bring the subgrade into compliance. As needed, seek assistance from the Resident Construction Engineer.

300.2.3 Base Structure

The base structure within the pavement structure includes base courses and may include a subbase course, as well. The primary functions of the subbase and base courses are to:

- provide uniform structural support of the pavement;
- prevent volume changes in the subgrade (i.e., shrink, swell);
- minimize damage due to pavement pumping; and
- distribute traffic loads to the subgrade.

300.2.3.1 Subbase

The construction of a subbase is sometimes necessary to provide additional support for the pavement structure. The need for a subbase will be determined during the design phase and is based on criteria such as projected vehicular traffic and the strength characteristics of the underlying subgrade material. If warranted, the subbase will be defined in the Contract Plans and Specifications. In general, the subbase may be either a special treatment of the upper layer of the subgrade (see Section 301) or a layer of inexpensive, locally available aggregate material (see Section 302). Because a base course will overlay the subbase, closely monitor construction for compliance and obtain final approval of the subbase from the Resident Construction Engineer before initiating work on the base course.

300.2.3.2 Base Course

The base course is a structural layer that directly supports the surface structure, as shown in Figure 300A. As such, the base course must be constructed of suitable, durable material to withstand the relatively higher stresses imposed upon it. The Contract Plans and Specifications will designate, as determined during design, the number and type of base courses required and whether the base will be laid over a subbase or directly on top of the subgrade. The major Sections in this Division discuss the types of base courses that are typically used by SCDOT. Closely monitor construction for compliance and obtain final approval of each base course from the Resident Construction Engineer prior to initiating work on an overlying layer. The surface structure will be placed over the base structure.

300.2.4 Surface Structure

The surface structure, consisting of intermediate and surface courses as shown in Figure 300A, is the uppermost layer within the pavement structure. Because the surface structure directly bears the load of vehicular traffic, it must be constructed of the highest quality materials. The type of surface structure required for the project will be determined during the design phase and will be defined in the Contract Plans and Specifications. Closely monitor surface structure construction for compliance with respect to material quality, placement, consolidation, compaction, grade, cross slope, thickness and smoothness criteria. See Division 400 and Division 500, respectively, for additional information on the types of intermediate and surface courses that are typically constructed.

300.2.5 Geosynthetic Material Considerations

Geosynthetic materials (e.g., geotextiles, geocells, geogrids, geomembranes, geocomposites) are commonly used for various applications in highway construction. Section 815 discusses applications related to erosion and sediment control. Where geotextile fabric is used to separate layers within the pavement structure (e.g., subgrade, subbase, base course), the fabric allows the water to pass through the pavement structure without clogging. The water will be intercepted and carried away from the roadway by the underlying drainage structure. Such geosynthetic materials must be approved prior to installation. Obtain from the Contractor and submit to the Research and Materials Laboratory for approval the manufacturer’s certification document for the geosynthetic material, which should include the manufacturer’s name, fabric type or trade name, the project, the intended application on the project and the required test results (e.g., Minimum Average Roll Value). Verify that the material delivered to the project is labeled with the manufacturer’s name, fabric type or trade name, Lot Number and the quantity of shipment. Retain these labels in the project file, referencing the information on SCDOT Form 100.10 – Materials Certification Log. See the *SCDOT Guide Instruction Manual for Inspectors of Earthwork and Base Course Construction* for additional information.

300.3 SUMMARY OF INSPECTION DUTIES

Pavement construction is a sequenced operation. Construction of the base course cannot begin until the subgrade and subbase, if specified, have been completed and approved. Similarly, construction of the surface course cannot begin until the base course has been completed and approved. Roadway longevity, in general, depends greatly on the quality of the work and materials that are incorporated into each of these pavement courses. Inspection must therefore be deliberate and thorough as each course is constructed, demonstrating acceptability prior to initiating construction of an overlying course. It is very difficult to assess, and possibly correct, a suspected deficiency in an underlying layer once covered by a subsequent layer. In addition, once the facility is opened to traffic, a deficiency in only one course, having gone undetected, can cause premature pavement failure. Consider the following guidelines during the early stages of pavement construction:

- Review project documentation and become familiar with the requirements of the Contract, including plans, cross-sections, *Standard Drawings*, *Standard Specifications*, Supplemental Specifications and Special Provisions. Remember that the Contract Plans, Special Provisions and Supplemental Specifications take precedence over the *Standard Specifications*. See Section 105.04 of the *Standard Specifications* for information on the order of precedence of Contract documents.

- Review the meeting minutes from the Preconstruction Conference and understand any special requirements of the project. Know the conditions that exist within the limits of construction, paying particular attention to erosion and sediment control and to any areas where it may be difficult for construction equipment to access the project.

- Know the material requirements of the project and ensure that materials obtained from sources outside the right-of-way are obtained from approved sources. Verify that construction equipment and base plants have been properly calibrated.

- Become familiar with the sampling and testing procedures required for the project. Pay particular attention to the type and frequency of the Quality Control Samples and Tests and the Independent Assurance Samples and Tests required for component materials and Contract pay items.

- Verify that sufficient drainage has been provided and that the drainage features, such as underdrains, have been properly installed. Ensure that the Contractor corrects any soft spots or otherwise unstable areas before placing embankment, subgrade, subbase or base course materials. Obtain final approval of the subgrade from the District Construction Engineer.

- During placement of material requiring moisture conditioning, monitor the differences in moisture content, density, color and texture to ensure it is being maintained at or near optimum, as established by the Research and Materials Laboratory. A change in these properties is a good indicator that the material being hauled to the project has changed.

- Prior to initiating work on a subsequent course, ensure that each layer of material is compacted to target density and that the course complies with the thickness and smoothness criteria specified in the Contract. Check line, grade and cross-section to ensure that the requirements of the project have been met.

Section 301
Cement Modified Subbase

301.1 DESCRIPTION OF WORK

Where the underlying subgrade material is determined to be of poor quality and more suitable soil or aggregate materials are either unavailable or uneconomical, the Contract will typically require that the subgrade be improved with cement in accordance with Section 301 of the *Standard Specifications*. The SCDOT Inspector will be responsible for verifying that the Contractor treats the existing subgrade as specified and where designated in the Contract Plans and Specifications. In general, the Contractor will be required to:

- pulverize the existing subgrade soil to a specified depth;
- apply Portland cement and water at a specified rate;
- thoroughly and uniformly mix the pulverized soil, cement and water materials;
- compact the resultant mixture to a target density;
- shape the compacted surface to the designated grade and cross slope;
- apply an asphalt curing material at a specified rate; and
- maintain the subbase surface in an acceptable condition during the operation.

For the reconstruction of an existing roadway, the Contract may specify the construction of a cement modified recycled base. The construction of a cement modified recycled base is similar to that of a cement modified subbase; however, the Portland cement will be mixed with the scarified and pulverized material of the existing pavement. When specified, the exceptions to Section 301 will be specified in the Special Provisions. Pay particular attention to the Contractor's sequence of operations, application rate of materials, depth and uniformity of mixing, moisture content during compaction, density obtained, curing period and the resultant thickness and smoothness of the completed subbase. Loose, segregated or rutted areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to placement of any subsequent base course, obtain final approval of the subbase from the Resident Construction Engineer and verify compliance for all test results.

301.2 PRECONSTRUCTION CONSIDERATIONS

301.2.1 <u>Contract Document Review</u>

Review the Contract Plans and Specifications and the publication *Guide Instruction Manual for Inspectors of Earthwork and Base Course Construction*. Pay particular attention to the requirements of Supplemental Specifications and Special Provisions that take precedence over *Standard Specifications*. Specifically note the required cross-section (e.g., width, depth, cross slope). Become familiar with the required materials, equipment and construction methods, sequence of operations, sampling and testing procedures and acceptance criteria. Know the measurements required for payment, applicable payment adjustments and the SCDOT Construction Forms that will be needed to document the prosecution and progress of the work.

301.2.2 Coordination of Project Personnel

Review the meeting minutes of the Preconstruction Conference. Meet with the Resident Construction Engineer and the Contractor Superintendent to ensure a complete and thorough understanding of inspection duties and to effectively communicate Contract requirements and any special directives to the Contractor.

301.2.3 Material Considerations

301.2.3.1 Subgrade Material

Additional sampling and testing of subgrade material is generally unnecessary at the time the subbase is to be constructed. See Section 301.2.6 for additional information.

301.2.3.2 Portland Cement and Water

Verify that Portland cement and water to be incorporated in the work conform to specified requirements and that quantities on the project are sufficient to ensure a continuous operation. Ensure that the Portland cement is supplied from a manufacturer listed on SCDOT Approval Sheet 6. Application rates will be established by the Research and Materials Laboratory.

301.2.3.3 Asphalt Prime Coat

Verify that the asphalt material to be used as the asphalt prime coat is supplied from a manufacturer listed on SCDOT Approval Sheet 38 and is of the type specified for the project. Several different types are generally acceptable; however, the Contract may specify the use of a particular type. If material type is optional, only one material type is to be used for curing; watch for evidence of cross-contamination with other asphalt materials used on the project. In addition, verify that the material is maintained in sufficient quantity to treat the surface area finished during the day’s operation. Prolonged exposure of the finished subbase surface without being properly treated with an asphalt prime coat should generally be avoided.

301.2.4 Weather Considerations

Pay particular attention to the weather forecast before work on the cement modified subbase begins or resumes. Check the temperature forecast for acceptability. Do not allow work to be performed on an excessively wet or frozen subgrade.

301.2.5 Sampling and Testing Considerations

Accurate and representative sampling of work and materials cannot be overemphasized. An improperly taken sample may not be truly representative; and if testing is performed on such a non-representative sample, the test results will be meaningless with respect to assessing quality and adherence to specified requirements. SCDOT and Contractor personnel who are responsible for sampling and testing must be certified by the Department. It is the responsibility of the Resident Construction Engineer to ensure that each Inspector is properly certified for the type of sampling and testing to be performed. Review and understand the applicable criteria for the Quality Control Samples and Tests and the Independent Assurance Samples and Tests that are documented in Section 106. Review and understand the procedures, equipment, safety precautions and acceptance criteria for the applicable sampling and testing procedures that are documented in Appendix C. See Appendix B for information on sample identification cards.

301.2.6 Subgrade Inspection and Approval

The SCDOT Inspector is responsible for inspecting the subgrade with respect to materials, grade, width, thickness, cross slope, density and drainage, as discussed in Section 208. Prior to initiating work on the subbase, the subgrade must be approved by the District Construction Engineer. Therefore, at the time the subbase is to be constructed, additional sampling and testing of the subgrade material is generally unnecessary. However, it is good construction practice to continually monitor the subgrade for evidence of unacceptability (e.g., excessively wet areas, high or low spots, ruts, muck, loose or segregated material). Require that unsuitable soil material be removed and replaced with acceptable material. Underdrains or rework (e.g., additional grading and compaction) may also be required before proceeding with subbase construction. As needed, seek guidance from the Resident Construction Engineer.

301.3 INSPECTION DURING CONSTRUCTION

301.3.1 Scarification Operation

Check the depth of scarification of the subgrade for compliance. Verify that the Contractor is not blading into the subgrade too deeply. Perform the required sieve analyses to verify that the gradation of the pulverized material (i.e., soil, existing pavement material) is within acceptable limits.

301.3.2 Application of Portland Cement

301.3.2.1 Moisture Content and Rate of Application

The application rate of cement and the initial optimum moisture content of the soil-cement mixture will be established by the Research and Materials Engineer based on a representative sample of the subgrade material to be treated. The application rate of cement is typically specified as pounds per square yard and the optimum moisture content is typically specified as percent moisture in the soil-cement mixture. The optimum moisture content should be tested using SC-T-29 twice per day or if material changes. Excessively dry conditions may warrant the application of additional water. Sudden downpours and rainy conditions may require the Contractor to halt work. Contact the Research and Materials Engineer for any needed assistance. See Section 301.3.4.1 for additional information on moisture content.

301.3.2.2 Spreading of Cement

Prior to the spreading of cement, verify that the Contractor has properly calibrated the spreader and closely monitor the rate of application to ensure that the cement is being spread uniformly across the entire width of the subgrade at a rate within ±5% of the pounds per square yard specified by the Research and Materials Engineer. Require the Contractor to recalibrate the spreader if necessary. The spreading operation must be continuous. Do not allow the Contractor to apply more cement along the length of the subgrade than can be completely processed in a single day's operation. The mixing operation, in particular the application of water, must commence within three hours of the application of cement. Check the application rate using SC-T-141 (see Appendix C).

301.3.3 Mixing Operation

301.3.3.1 Traveling Mixing Plant

To thoroughly blend the cement and subgrade soil materials, the Contractor will be required to use either a single-pass or a multiple-pass traveling mixing plant, as specified.

301.3.3.2 Dry Mixing

Dry mixing is used to pulverize and combine the air-dry soil and cement materials sufficiently to prevent cement balls from forming when water is added. Verify that dry mixing is maintained at the proper depth. Mixing deeper than that specified will dilute the mixture and possibly reduce the strength of the subbase. Watch for unpulverized lumps and require pre-wetting if evident.

301.3.3.3 Application of Water

Verify that the spray bar evenly distributes the water across the full width of the subgrade. Check the moisture content for acceptability and, if needed, require the rate of application to be adjusted. See Section 301.3.4.1 for additional information on moisture content.

301.3.3.4 Wet Mixing

After water has been introduced, the mixing of the moist soil and cement materials will continue until a uniform mixture has been obtained. At least twice daily, verify that 100% of the pulverized soil-cement mixture will pass a 2-inch sieve and at least 65% will pass a No. 4 sieve. The traveling plant should leave the treated subgrade in a loose condition ready for immediate compaction. Compaction must commence within 30 minutes of wet mixing.

301.3.3.5 Core Molding

Prior to compaction, core molding of the soil-cement mixture is required. Ensure that one set of two cores is molded each work day. Each core will be molded at 100% maximum dry density, according to the Standard Proctor Test, using the following procedures:

1. Preparation. Use a 4-inch split mold, available from the Research and Materials Laboratory, to mold the core. To prevent the core from sticking, spray the inside of the mold with a light coat of lubricant or use a large rubber membrane. Sieve a representative sample of the soil-cement mixture through a No. 4 sieve.

2. Core Molding. Mold each core in three equal layers at 25 blows per layer. Scarify the top of each layer approximately 0.125 inches deep to permit bonding of layers. Carefully remove the core from the mold.

3. Shipping and Handling. Immediately wrap each core in waterproof material (e.g., plastic food wrap) to prevent drying and then again in wet burlap to cushion and minimize overheating. Do not leave the cores in direct sunlight or in a parked vehicle where the temperature can exceed 70°F. Avoid rough handling. See Appendix B for information on processing Sample Identification Cards. Ideally, cores are to be cured for 7 days at 70°F and 100% relative humidity; therefore, it is necessary to ship the cores as soon as practical, preferably within 48 hours, to the Research and Materials Laboratory.

301.3.4 Compaction Operation

301.3.4.1 Moisture Content

The Research and Materials Laboratory will establish the initial moisture content for the soil-cement mixture. Prior to compaction, check to ensure that the moisture content is not more than two percentage points above but not less than that established as optimum. For example, if the optimum moisture content is 17%, an acceptable range for the moisture content during compaction will be between 17% and 19%, inclusive.

301.3.4.2 Density Testing

Compaction rolling must be completed within two hours of initial rolling. Check to ensure that the soil-cement mixture is uniformly compacted to not less than 95% of the maximum density. Use AASHTO T 134, SC-T-25 or SC-T-29, as appropriate, to determine the maximum density of the mixture (see Appendix C). Require the Contractor to adjust the compaction operation, as needed, to obtain the required density. The minimum requirement for density testing is one test each 1000 feet, per 2 lanes (on 4-lane sections, a test is required every 500 feet, etc.). Additional testing should be conducted, as needed, to ensure that proper compaction is being attained. See Section 106 for additional information on Quality Control Samples and Tests and Independent Assurance Samples and Tests. Contact the Resident Construction Engineer for any needed assistance.

301.3.5 Finishing Operation

Once the soil-cement mixture has been compacted to target density, the finishing operation will begin, which includes reshaping, light scarifying and finishing rolling, as needed, to bring the surface into compliance with the lines, grades and typical sections of the Contract Plans. Check compliance of the finished surface using a 10-foot straight edge, hand level, engineer's level, total station or other suitable means. Acceptable tolerance for surface smoothness is ±0.375 inches along the subbase in the direction parallel to the centerline and ±0.5 inches across the subbase in the direction of the cross-section. Require the Contractor to correct high and low spots, as specified. Pay particular attention to evidence of severe rutting, equipment imprints and loose material, and notify the Resident Construction Engineer, as needed, to assess corrective measures.

301.3.6 <u>Curing Operation</u>

Immediately after the finishing operation, ensure that the Contractor cures the finished surface with an asphalt curing membrane, as specified. Pay particular attention to the type of asphalt material used and the rate of application. Too much asphalt material can actually create a slip plane in the pavement structure. The asphalt material should completely seal the subbase surface and fill all voids. Watch for damage to the membrane caused by traffic and require the Contractor to sand, dust or repair the membrane, as appropriate. The membrane must be allowed to set for a minimum of three days before a subsequent base course is applied.

301.4 POST-CONSTRUCTION CONSIDERATIONS

301.4.1 <u>Construction Joints</u>

At the end of each work day, ensure that the Contractor forms longitudinal and transverse construction joints, as specified, to properly key in the next day's work.

301.4.2 <u>Checking Subbase Thickness</u>

Test holes will be used to measure subbase thicknesses at various locations. These measurements will be used to calculate an average job thickness to assess compliance of the completed cement modified subbase. Phenolphthalein solution, available from the Research and Materials Laboratory, must be used in making these measurements. Dig a test hole at least 2 inches deeper than the specified depth of the cement modified subbase. Beginning at the bottom of the test hole, make a vertical groove in the side of the hole with a screwdriver or other suitable instrument. When the groove is moistened from bottom to top with an eye dropper of phenolphthalein solution on the groove side of the test hole, the solution turns red when it reacts with cement, which will clearly identify the thickness of the cement modified layer. Measure subbase thickness at staggered intervals not to exceed 500 feet in length per 2-lane width (250 feet for 4 lanes, etc.). See Section 106 for additional information on Quality Control Samples and Tests and Independent Assurance Samples and Tests. When computing the average job thickness, individual measurements exceeding the specified thickness by more than 1 inch will be considered the specified thickness plus 1 inch. For example, if the specified thickness is 6 inches and the measured thickness at one location is 7.5 inches, use 7 inches when computing the average thickness. Ensure that the Contractor corrects thickness deficiencies greater than 1 inch, which will require full-depth replacement. Document this information on SCDOT Form 300.01 – Depth Check Records. Ensure that the test holes are backfilled with suitable material and thoroughly compacted using a hand tamp.

301.4.3 Traffic and Maintenance Considerations

Do not allow local or construction traffic on the completed subbase until the specified curing period has elapsed. Unless required for a subsequent construction operation, it is generally good practice for construction equipment to avoid traveling on the subbase by using areas such as shoulders to travel along the project. The Contractor is responsible for maintaining the integrity of the completed subbase. Watch for marring and defects to the surface and require the Contractor to correct such damage in accordance with Contract provisions.

301.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure and document in the Daily Work Report the surface area (i.e., width x length) of the completed and approved subbase. Payment will be made based on the Contract unit price; however, payment adjustment applies if the average thickness of the subbase is found to be more than 0.5 inch less than the thickness specified in the Contract. For example, if the Contract specifies a 6-inch cement modified subbase and the average thickness was determined to be less than 5.5 inches, ensure that payment is adjusted as specified. Ensure that ineligible quantities, such as those for corrective work, are not included for payment. Pay particular attention, however, to the provisions for rework due to rainy conditions. Obtain from the Contractor automatic printout tickets for Portland cement, which will be retained by the Resident Construction Engineer, and document in the Daily Work Report the weight of cement incorporated in the work. Portland cement will be paid for separately based on this weight, subject to the limits specified for the application rate.

Section 302
Soil-Aggregate Subbase

302.1 DESCRIPTION OF WORK

Where the underlying subgrade material is determined to be of poor quality and suitable aggregate material is economically available, the Contract may require the subgrade to be improved with a soil-aggregate subbase in accordance with Section 302 of the *Standard Specifications*. In general, the work for a soil-aggregate subbase consists of placing a layer of specified aggregate material on an approved subgrade or subbase. The aggregate material then will be mixed with the underlying material, to a specified depth, and thoroughly and uniformly compacted to a target density. To achieve the target density during compaction, the moisture content must be maintained at or near optimum for the mixture, as established by the Research and Materials Engineer.

The SCDOT Inspector will be responsible for verifying that the Contractor treats the subgrade as specified and where designated in the Contract Plans and Specifications. Pay particular attention to the Contractor's sequence of operations, application rate of material, depth and uniformity of mixing, moisture content during compaction and the density obtained. Loose, segregated or rutted areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to placement of any subsequent base course, obtain final approval of the subbase from the Resident Construction Engineer.

302.2 PRECONSTRUCTION CONSIDERATIONS

302.2.1 <u>Contract Document Review</u>

See Section 301.2.1 for guidance on reviewing Contract documents.

302.2.2 <u>Coordination of Project Personnel</u>

See Section 301.2.2 for guidance on coordinating project personnel.

302.2.3 <u>Materials Considerations</u>

The aggregate material for soil-aggregate subbase can be either crushed stone or gravel and must be sampled and tested prior to mixing with the approved subgrade or subbase material. Verify that aggregate materials are supplied from sources listed on SCDOT Approval Sheet 1 or Approval Sheet 2. Check gradation for compliance.

302.2.4 Weather Considerations

Pay particular attention to the weather forecast before work on the soil-aggregate subbase begins or resumes. Do not allow work to be performed on an excessively wet or frozen subgrade.

302.2.5 Sampling and Testing Considerations

See Section 301.2.5 for information on sampling and testing component materials and Contract pay items.

302.2.6 Subgrade Inspection and Approval

See Section 301.2.6 for information on subgrade inspection and approval.

302.3 INSPECTION DURING CONSTRUCTION

302.3.1 Application of Aggregate Material

The application rate of aggregate and the optimum moisture content of the soil-aggregate mixture will be established by the Research and Materials Engineer and denoted in the Contract Plans. The application rate is typically specified as the weight of aggregate per unit area and the optimum moisture content is typically specified as the percent moisture in the mixture. Excessively dry conditions may warrant the application of additional water. Sudden downpours and rainy conditions may require the Contractor to halt work. Contact the Research and Materials Engineer for any needed assistance.

Using the appropriate SCDOT Sampling and Testing Procedure (see Appendix C), check the application rate regularly to ensure compliance (i.e., weight of aggregate from automatic printout tickets divided by the area upon which the aggregate was spread). At the end of each workday, check and record in the Daily Work Report the weight of aggregate incorporated in the work, the area of subbase completed and approved and the actual application rate of aggregate. Remember that it is the Contractor's responsibility to achieve the specified rate of spread. The SCDOT Inspector is responsible for confirming the Contractor's work but should not take on the Contractor's duties.

302.3.2 Mixing Operation

After the aggregate has been spread, water will be sprayed over the materials and a thin layer of subgrade or subbase material will be mixed with the aggregate material. Water is added, as needed, to raise the moisture content of the mixture to the established optimum prior to compaction. Because it is very difficult to proportion the materials properly, only the most skilled motor-grader operator should be used for this work. A typical proportion is approximately 0.25 inch of subgrade or subbase material for each 100 pounds per square yard of aggregate material. Verify the grading depth and do not allow too much subgrade or subbase material to be incorporated into the mixture.

302.3.3 Compaction Operation

The compaction operation should immediately follow behind the mixing operation. Check to ensure that the soil-aggregate mixture is uniformly compacted to at least 95% of maximum dry density. Require the Contractor to adjust the compaction operation, as needed, to obtain the target density. Section 106 defines the type and frequency of Quality Control Samples and Tests and Independent Assurance Samples and Tests. The compacted subbase should be a uniform, dense surface that is free of loose material and rocky in appearance with all stone being thoroughly keyed. As needed, contact the Resident Construction Engineer for assistance.

302.3.4 Finishing Operation

Once the soil-aggregate mixture has been compacted to target density, the finishing operation will begin, which includes shaping and finishing rolling, as needed, to bring the surface into compliance with the lines, grades and typical sections of the Contract Plans. Check compliance of the finished surface using a hand level, engineer's level, total station or other suitable means. Pay particular attention to evidence of severe rutting, equipment imprints and loose or segregated material, and notify the Resident Construction Engineer, as needed, to assess corrective measures.

302.3.5 Application of Asphalt Prime Coat

If the Contract specifies that an asphalt prime coat be applied to the surface of the soil-aggregate subbase, verify that the material is of the proper type, comes from a source listed on Approval Sheet 38 and is applied to the surface immediately behind the finishing operation at the specified application rate. Although the asphalt prime coat should completely seal the subbase surface and fill all voids, do not allow more asphalt prime coat to be applied than specified. Watch for overspray and damage to the finished asphalt prime coat caused by traffic and require the Contractor to repair the defective areas.

302.4 POST-CONSTRUCTION CONSIDERATIONS

The Contractor is responsible for maintaining the integrity of the completed and approved subbase surface. Unless required for a subsequent construction operation, it is generally good practice for construction equipment to avoid traveling on the subbase by using areas such as shoulders to travel along the project. Watch for defects in the subbase surface and require the Contractor to correct such damage in accordance with the provisions of the Contract.

302.5 DOCUMENTATION FOR PAYMENT

Aggregate for this work will be weighed on certified platform scales as defined in the provisions of the Contract. See Section 109 for additional information on measuring material quantities. If at any time the weight of a load is suspect, witness the Contractor reweighing the suspect load on certified platform scales. Obtain from the Contractor the automatic printout tickets showing the weight of each load of aggregate incorporated in the completed and accepted soil-aggregate subbase. The Resident Construction Engineer will retain these tickets. Record the day's total in the Daily Work Report. Payment will be made based on this weight and the Contract unit price. Ensure that ineligible quantities, such as those for corrective work or in excess of those specified or otherwise approved, are not included for payment.

Section 303
Sand-Clay Base Course

303.1 DESCRIPTION OF WORK

The SCDOT Inspector will be responsible for verifying that the Contractor obtains materials and constructs the sand-clay base course in accordance with Section 303 of the *Standard Specifications* and any applicable Special Provisions. The work for a sand-clay base course consists of placing one or more lifts of naturally or artificially proportioned sand-clay material on an approved subgrade or subbase. The number of lifts will depend on the overall compacted thickness of the base course. Each lift of material then will be mixed and thoroughly and uniformly compacted to a target density. To achieve the target density during compaction, the moisture content must be maintained at or near optimum. Pay particular attention to the placement of material lifts, uniformity of mixing, moisture content during compaction, density obtained, application of asphalt prime coat and the resultant thickness and smoothness of the completed base course. Loose or rutted areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to placement of the asphalt prime coat or any subsequent course, obtain final approval of the base course from the Resident Construction Engineer, with concurrence from the District Construction Engineer.

303.2 PRECONSTRUCTION CONSIDERATIONS

303.2.1 Contract Document Review

See Section 301.2.1 for guidance on reviewing Contract documents.

303.2.2 Coordination of Project Personnel

See Section 301.2.2 for guidance on coordinating project personnel.

303.2.3 Material Considerations

303.2.3.1 Sand-Clay Material

Unless specified otherwise, the Contractor is responsible for securing the source of sand-clay material (e.g., pits, fields), including all permits, right-of-way, access, haul roads, erosion control and property restoration. Verify that the Contractor meets these Contract provisions. A local source of naturally proportioned base material may be available. If such a source is unavailable, the Contractor will be responsible for securing sources of materials that can be artificially proportioned for use as the base material. Samples should be obtained in accordance with SC-T-21 (see Appendix C). The Research and Materials Laboratory will test samples to verify that the material meets specified requirements (e.g., gradation, liquid limit, plastic limit). Test results for pit samples will be provided for information only. No sand-clay base material will be accepted based on the test results of pit samples.

303.2.3.2 Asphalt Prime Coat

Verify that the asphalt material to be used for the asphalt prime coat is supplied from a source listed on Approval Sheet 38. Several different types are generally acceptable; however, the Contract may specify the use of a particular type. If material type is optional, only one material type is to be used for the asphalt prime coat; watch for evidence of cross-contamination with other asphalt materials used on the project. In addition, verify that the material is maintained in sufficient quantity to prime the base course in a continuous operation.

303.2.4 Weather Considerations

Pay attention to the weather forecast before work on the base course begins or resumes. Do not allow work to be performed on an excessively wet or frozen subgrade or subbase. In general, base course material that is not promptly compacted will act as a blotter when it rains, saturating the subgrade and becoming plastic under compaction. This will require the subgrade to be repaired at Contractor expense, as specified. Closely monitor the rain forecast and the timing of the compaction operation.

303.2.5 Sampling and Testing Considerations

See Section 301.2.5 for information on sampling and testing component materials and Contract pay items.

303.2.6 Subgrade / Subbase Inspection and Approval

The SCDOT Inspector is responsible for inspecting the subgrade and subbase with respect to materials, grade, width, thickness, cross slope, density and drainage, as discussed respectively in Section 208, Section 301 and Section 302. Shoulder work should be constructed, inspected and approved as discussed in Section 209. To facilitate construction operations, this work should be completed and approved at least 500 feet ahead of the base course work. Prior to initiating work on the base course, the subgrade and subbase must be approved by the District Construction Engineer. Therefore, at the time the base course is to be constructed, additional sampling and testing of subgrade or subbase material is generally unnecessary. However, it is good construction practice to continually monitor the subgrade or subbase for evidence of unacceptability (e.g., excessively wet areas, high or low spots, ruts, muck, loose or segregated material). Require that unsuitable materials be removed and replaced with acceptable materials. Underdrains or rework (e.g., additional grading and compaction) may also be required before proceeding with base course construction. As needed, seek guidance from the Resident Construction Engineer.

303.3 INSPECTION DURING CONSTRUCTION

303.3.1 Hauling and Placement Operation

Prior to placement, check the moisture content of the subgrade or subbase. Wetting may be necessary to recondition the surface if it has become too dry. At the material pit, the Contractor is required to blade off and dispose of all deleterious materials from the surface prior to excavating the sand-clay material. During placement and mixing, however, it is good practice to continually monitor the operation for objectionable materials, including oversized stones, roots, sod and weeds. Require the Contractor to remove such objectionable materials. If found in excessive amounts, require removal and replacement of the base material. To minimize hauling over the work under construction, placement will typically begin at the station farthest from the pit. In general, hauling over the base should be avoided unless it is being constructed in lifts. Ensure that lifts are not placed too thick (i.e., 8-inch compacted thickness maximum). Verify that the Contractor evenly and uniformly spreads the base material over the approved and properly maintained subgrade or subbase. If naturally proportioned sand-clay material is not being used, pay particular attention to the acceptability of the windrow operation and the artificial proportioning of the materials. Such an operation will require the Contractor to control the proportioning of the materials during the mixing operation.

303.3.2 <u>Spreading Operation</u>

303.3.2.1 Mixing and Shaping

During mixing, do not allow equipment operators to mix the top surface of the subgrade or subbase with the sand-clay material. As the sand-clay material is being placed, verify that the Contractor immediately spreads and mixes the material until the base exhibits a homogeneous appearance throughout its width and depth. Verify that the Contractor adds water, as needed, to maintain the moisture content of the base material near optimum. To facilitate bonding of multiple lifts, ensure that the Contractor mixes the newly placed material with the top surface of the previous lift, as specified. Check the cross-section and grade to ensure conformance with the Contract Plans. As needed, require reshaping and removal and replacement of any unsuitable material encountered.

303.3.2.2 Sampling and Testing

Sampling and testing of each lift of sand-clay base course material is required after mixing and will be performed in accordance with the criteria for Quality Control Samples and Tests and Independent Assurance Samples and Tests discussed in Section 106. See Section 301.2.5 for additional information on sampling and testing. Sample the sand-clay base material immediately after the mixing operation. If the sand-clay base course is to lie unsurfaced for a prolonged period of time, such as over the winter, delay the sampling. Sample the sand-clay base course every 1000 feet per two lanes. Take the sample through the full lift depth at the following locations:

- at or near the centerline,
- approximately 2 feet from the right edge, and
- approximately 2 feet from the left edge.

Immediately ship the samples to the Research and Materials Laboratory for testing (e.g., gradation, liquid limit, plastic limit). If the Laboratory reports that a sample has failed and requests that a check sample be taken, obtain and ship two check samples representing the material that failed in accordance with the requirements for check samples documented in Section 106. Do not permit additional material to be placed over the lift until the sand-clay material samples have been tested and reported to be in compliance.

303.3.3 Compaction Operation

303.3.3.1 General

The compaction operation (i.e., blading and rolling) should follow immediately behind the mixing and shaping operation. Its purpose is to compress the soil particles into a dense mass by expelling air and reducing voids. Unless otherwise specified, the Contractor may choose the type of equipment to perform this operation; however, the use of pneumatic-tired rollers is fairly common and economical, because the tire pressure and/or weight of these rollers can be increased to generate high contact pressures. Rollers will generally work along the centerline and move toward the edge of the course. The compacted surface should be smooth and even textured. Watch for roller marks, knots and depressions and require the Contractor to adjust the roller pattern, as needed. For secondary roads where a sand-clay base course may be used in conjunction with an asphalt waterproofing or wearing surface, very little strength will be derived from the asphalt surface course. Thus, the strength of the overall pavement structure relies heavily on the strength of the sand-clay base course. Because density is a direct correlation to the resultant strength of the base course, it is paramount that each lift of the sand-clay material be thoroughly and uniformly compacted to target density.

303.3.3.2 Moisture Content

The optimum moisture content for the sand-clay material will be established using SC-T-25 or SC-T-29 (see Appendix C). Prior to compaction, check to ensure that the moisture content of the material is at or near optimum. The compaction operation is facilitated if the required water is added during the mixing and shaping operation.

303.3.3.3 Lift Thickness

Pay particular attention to the total compacted thickness of the sand-clay base course denoted on the Contract Plans. If greater than 8 inches, the Contractor will be required to construct the base course in multiple lifts of equal thickness, with each lift being compacted to 100% of maximum density before additional material is placed for a subsequent lift.

303.3.3.4 Density Testing

Density testing of each compacted lift of sand-clay base course material is required and will be performed in accordance with the criteria for Quality Control Samples and Tests and Independent Assurance Samples and Tests discussed in Section 106. See Section 301.2.5 for additional information on sampling and testing. Check to ensure that each lift of sand-clay base course is uniformly compacted to 100% of the maximum density. The actual dry density is to be determined in accordance with SC-T-30, SC-T-31, SC-T-32 or SC-T-33, as appropriate. The maximum dry density and optimum moisture content of the sand-clay base material will be determined by either the One-Point Proctor Method (SC-T-29) or by the field method of determining moisture-density relations of soils (SC-T-25). Do not permit an additional lift of sand-clay material to be placed until the required density of the underlying lift has been attained. See Appendix C for the sampling and testing procedures. If test results fail, require the Contractor to adjust the compaction operation or moisture content, as needed, to obtain the target density. The Resident Construction Engineer should retain SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge or SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge – Direct Read Gauge; however, SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge) must be sent to the Research and Materials Laboratory on a weekly basis. Reference additional testing for areas that fail and note the corrective actions to be taken.

303.3.4 Finishing Operation

Once the final lift of sand-clay base material has been compacted to target density, the finishing operation will begin, which includes reshaping and finishing rolling, as needed, to bring the surface into compliance with the lines, grades and typical sections of the Contract Plans. Check compliance of the finished surface using a hand level, engineer's level, total station or other suitable means. Be diligent in securing compliance of the surface. Require the Contractor to correct any areas that are not within reasonable conformity to the specified roadway section. Watch for severe rutting, equipment imprints, roller marks and loose or segregated material, and notify the Resident Construction Engineer, as needed, to assess corrective measures.

303.3.5 Checking Base Course Thickness

Immediately after the finishing operation but prior to the application of the asphalt prime coat, test holes will be used to measure base course thicknesses at various locations. These measurements will be used to calculate an average job thickness to assess compliance of the completed sand-clay base course. Measure base course thickness at staggered intervals not to exceed 250 feet in length per 2-lane width (125 feet for 4 lanes, etc.). See Section 106 for additional information on Quality Control Samples and Tests and Independent Assurance Samples and Tests. When computing the average job thickness, individual measurements exceeding the specified thickness by more than 0.5 inches will be considered the specified thickness plus 0.5 inches. For example, if the specified thickness is 6 inches and the measured thickness at one location is 7 inches, use 6.5 inches when computing the average thickness. Ensure that the Contractor corrects thickness deficiencies greater than 0.5 inches, as specified. Record the thickness measurements on SCDOT Form 300.01 – Depth Check Records. Ensure that the test holes are backfilled with suitable material and compacted using a hand tamp.

303.3.6 Application of Asphalt Prime Coat

The application of an asphalt prime coat will be required when a hot-mix asphalt or asphalt surface treatment will overlay the sand-clay base course. Do not allow the application of asphalt prime coat to begin until all other requirements have been met with respect to the construction of the sand-clay base course and final approval has been obtained from the Resident Construction Engineer, with concurrence of the District Construction Engineer. Pay particular attention to the type of asphalt material used. Check that the application rate is within specified limits. Too much asphalt material can actually create a slip plane in the pavement structure. The asphalt material should completely penetrate the base surface and fill all voids. Watch for damage to the asphalt prime coat caused by traffic and require the Contractor to sand, dust or repair the asphalt prime coat, as appropriate. Pay particular attention to overspray and potential damage to adjacent property, and notify the Resident Construction Engineer for any needed assistance. See Section 401.4 for additional information on the application of asphalt prime coats.

303.4 POST-CONSTRUCTION CONSIDERATIONS

The Contractor is responsible for maintaining the integrity of the sand-clay base course during construction. During subsequent operations, watch for damage and defects caused by traffic and erosion and require the Contractor to repair the surface of the base in accordance with the provisions of the Contract.

303.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure and document in the Daily Work Report the surface area (i.e., width x length) of the completed and approved sand-clay base course. Payment will be made based on the Contract unit price; however, payment adjustment applies if the average thickness of the base course is found to be more than 0.25 inch less than the thickness specified in the Contract. For example, if the Contract specifies a 6-inch sand-clay base course and the average thickness was determined to be 5.5 inches, ensure that payment is adjusted as specified. Ensure that ineligible quantities, such as those for corrective work, are not included for payment. Obtain from the Contractor all invoices for the asphalt prime coat material, which will be retained by the Resident Construction Engineer, and document in the Daily Work Report the volume of asphalt material used for asphalt prime coat. Prime coat will be paid for separately based on this volume.

Section 304
Coquina Shell Base Course

304.1 DESCRIPTION OF WORK

The material required for coquina shell base course is readily available in natural deposits in the Pee Dee coastal area. As such, this type of base course is typically specified as an alternative to graded aggregate base course (see Section 305) for secondary roads in SCDOT District No. 5 counties, which include Florence, Marlboro, Dillon, Darlington, Marion, Horry, Williamsburg and Georgetown. Note that earthwork quantities will be specified for graded aggregate base course and the elected use of coquina as an alternative will be 1.5 times the thickness of the graded aggregate base course. However, the lift thickness limitations as described in Section 304.3.3.3 still apply. Therefore, the use of coquina as an alternative to graded aggregate base course will require adjustment to the grade of the subgrade to allow for the additional thickness, and quantities for unclassified excavation and borrow excavation.

When specified, the SCDOT Inspector will be responsible for verifying that the Contractor obtains materials and constructs the coquina shell base course in accordance with Section 304 of the *Standard Specifications* and any applicable Special Provisions. In general, the work for coquina shell base course consists of placing one or more lifts of specified coquina shell material on an approved subgrade or subbase. The number of lifts will depend on the overall compacted thickness of the base course. Each lift of material then will be mixed, shaped and thoroughly and uniformly compacted to a target density. To achieve the target density during compaction, the moisture content must be maintained at or near optimum for the mixture, as established by the Research and Materials Engineer. Pay attention to the Contractor's sequence of operations, placement of material lifts, uniformity of mixing, moisture content during compaction, density obtained, application of asphalt prime coat and the resultant thickness and smoothness of the completed base course. Loose, segregated or rutted areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to application of asphalt prime coat and placement of any subsequent course, obtain final approval of the base course from the Resident Construction Engineer, with concurrence from the District Construction Engineer.

304.2 PRECONSTRUCTION CONSIDERATIONS

304.2.1 <u>Contract Document Review</u>

See Section 301.2.1 for guidance on reviewing Contract documents.

304.2.2 <u>Coordination of Project Personnel</u>

See Section 301.2.2 for guidance on coordinating project personnel.

304.2.3 Material Considerations

304.2.3.1 Coquina Shell Material

Coquina shell base material is a mixture of aggregated shells, shell fragments and varying amounts of sand and clay materials that are obtained from naturally existing deposits. Verify that the material is supplied from a source listed on SCDOT Approval Sheet 4. If a new quarry is opened for a project, the Research and Materials Laboratory must be notified so that samples can be taken to assess the quality of the material and mining operations before use. Verify that the gradation requirements of the material are being met.

304.2.3.2 Asphalt Prime Coat

See Section 303.2.3.2 for information on asphalt material used for asphalt prime coat.

304.2.4 Weather Considerations

See Section 303.2.4 for information on weather considerations.

304.2.5 Sampling and Testing Considerations

See Section 301.2.5 for information on sampling and testing component materials and Contract pay items.

304.2.6 Subgrade / Subbase Inspection and Approval

See Section 303.2.6 for information on subgrade and subbase inspection and approval.

304.3 INSPECTION DURING CONSTRUCTION

304.3.1 Hauling and Placement Operation

Prior to placement, check the moisture content of the subgrade or subbase. Wetting may be necessary to recondition the surface if it has become too dry. At the material pit, the Contractor is required to blade off and dispose of all deleterious materials from the surface prior to excavating the material. During placement and mixing, however, it is good practice to continually monitor the operation for objectionable materials, including oversized stones, roots, sod and weeds. Require the Contractor to remove such objectionable materials. If found in excessive amounts, require removal and replacement of the base material. To minimize hauling over the work under construction, placement will typically begin at the station farthest from the pit. In general, hauling over the base should be avoided unless it is being constructed in lifts. Ensure that lifts are not placed too thick (i.e., 8-inch compacted thickness maximum). Verify that the base material is evenly and uniformly spread over the subgrade or subbase. Pay particular attention to segregated areas during placement and spreading, and require the Contractor to correct such areas in accordance with the provisions of the Contract.

304.3.2 <u>Spreading Operation</u>

304.3.2.1 Mixing and Shaping

During mixing, do not allow equipment operators to mix the top surface of the subgrade or subbase with the coquina shell material. As the coquina shell material is being placed, verify that the Contractor immediately spreads and mixes the material until the base exhibits a homogeneous appearance throughout its width and depth. Verify that the Contractor adds water, as needed, to maintain the moisture content of the base material near optimum, as established by the Research and Materials Engineer. Check the cross-section and grade to ensure conformance with the Contract Plans. As needed, require reshaping and removal and replacement of any unsuitable material encountered.

304.3.2.2 Sampling and Testing

Sampling and testing of each lift of coquina shell base course material is required after placement and mixing but before compaction. The sampling and testing will be performed in accordance with the criteria for Quality Control Samples and Tests and Independent Assurance Samples and Tests discussed in Section 106. See Section 301.2.5 for additional information on sampling and testing. Sample the coquina shell base material immediately after the mixing operation but before compaction. If the coquina shell base course is to lie unsurfaced for a prolonged period of time, such as over the winter, delay the sampling. Sample the coquina shell base course every 1000 feet per two lanes. Take the sample through the full lift depth at the following locations:

- at or near the centerline,
- approximately 2 feet from the right edge, and
- approximately 2 feet from the left edge.

The size of the sample will be in accordance with SC-T-1 (See Appendix C). Immediately ship the samples to the Research and Materials Laboratory for testing. If the Laboratory reports that a sample has failed and requests that a check sample be taken, obtain and ship two check samples representing the material that failed in accordance with the requirements for check samples documented in Section 106. Do not permit additional material to be placed over the lift until the coquina shell base course material samples have been tested and reported to be in compliance.

304.3.3 <u>Compaction Operation</u>

304.3.3.1 General

The compaction operation (i.e., blading and rolling) should follow immediately behind the mixing and shaping operation. Its purpose is to compress the shell particles into a dense mass by expelling air and reducing voids. Unless otherwise specified, the Contractor may choose the type of equipment to perform this operation; however, the use of pneumatic-tired rollers is required for final rolling. Rolling will generally start at the edge and proceed toward the center, except on superelevated curves where rolling proceeds from the lower to the upper side. The compacted surface should be smooth and even textured. Watch for roller marks, knots and depressions and require the Contractor to adjust the roller pattern, as needed. Because density is a direct correlation to the resultant strength of the base course, it is paramount that each lift of material be thoroughly and uniformly compacted to target density.

304.3.3.2 Moisture Content

The optimum moisture content for the coquina shell material will be established by the Research and Materials Engineer. Prior to compaction, check to ensure that the moisture content of the material is at or near optimum. The compaction operation is facilitated if the required water is added during the mixing and shaping operation.

304.3.3.3 Lift Thickness

Pay particular attention to the total compacted thickness of the coquina shell base course denoted on the Contract Plans. If greater than 8 inches, the Contractor will be required to construct the base course in multiple lifts, with each lift being compacted to 100% of maximum density before additional material is placed for a subsequent lift.

304.3.3.4 Density Testing

Density testing of each compacted lift of coquina shell base course material is required and will be performed in accordance with the criteria for Quality Control Samples and Tests and Independent Assurance Samples and Tests discussed in Section 106. See Section 301.2.5 for additional information on sampling and testing. Check to ensure that each lift of coquina shell base course is uniformly compacted to 100% of the maximum density. Field density tests are to be determined in accordance with SC-T-30, SC-T-31, SC-T-32 and SC-T-33, as appropriate. The theoretical maximum dry density will be determined by the Research and Materials Engineer, based on representative 200-pound samples submitted from the field. Submit these samples as soon as practical. Do not permit an additional lift of coquina shell material to be placed until the required density of the underlying lift has been attained. See Appendix C for the sampling and testing procedures. If test results fail, require the Contractor to adjust the compaction operation or moisture content, as needed, to obtain the target density. The Resident Construction Engineer should retain SCDOT Form 300.02 – Density Test Report (Nuclear Gauge) or SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) – Direct Read Gauge; however, SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge) must be sent to the Research and Materials Laboratory on a weekly basis. Reference additional testing for areas that fail and note the corrective actions to be taken.

304.3.4 <u>Finishing Operation</u>

Once the final lift of coquina shell base course material has been compacted to target density, the finishing operation will begin, which includes reshaping and finishing rolling, as needed, to bring the surface into compliance with the lines, grades and typical sections of the Contract

Plans. Check compliance of the finished surface using a hand level, engineer's level, total station or other suitable means. Be diligent in securing compliance of the surface. Require the Contractor to correct any areas that are not within reasonable conformity to the specified roadway section. Watch for severe rutting, equipment imprints, roller marks and loose or segregated material, and notify the Resident Construction Engineer, as needed, to assess corrective measures.

304.3.5 <u>Checking Base Course Thickness</u>

Immediately after the finishing operation but prior to the application of the asphalt prime coat, test holes will be used to measure base course thicknesses at various locations. These measurements will be used to calculate an average job thickness to assess compliance of the completed coquina shell base course. Measure base course thickness at staggered intervals not to exceed 250 feet in length per 2-lane width (125 feet for 4 lanes, etc.). See Section 106 for additional information on Quality Control Samples and Tests and Independent Assurance Samples and Tests. When computing the average job thickness, individual measurements exceeding the specified thickness by more than 0.5 inch will be considered the specified thickness plus 0.5 inch. For example, if the specified thickness is 6 inches and the measured thickness at one location is 7 inches, use 6.5 inches when computing the average thickness. Ensure that the Contractor corrects thickness deficiencies greater than 0.5 inch, as specified. Record the thickness measurements in SCDOT Form 300.01 – Depth Check Records. Ensure that the test holes are backfilled with suitable material and thoroughly compacted using a hand tamp.

304.3.6 <u>Application of Asphalt Prime Coat</u>

The application of an asphalt prime coat will be required when a hot-mix asphalt or asphalt surface treatment will overlay the coquina shell base course. Do not allow the application of asphalt prime coat to begin until all other requirements have been met with respect to the construction of the coquina shell base course and final approval has been obtained from the Resident Construction Engineer, with concurrence of the District Construction Engineer. Pay particular attention to the type of asphalt material used. Check that the application rate is within specified limits. Too much asphalt material can actually create a slip plane in the pavement structure. The asphalt material should completely penetrate the base surface and fill all voids. Watch for damage to the asphalt prime coat caused by traffic and require the Contractor to sand, dust or repair the asphalt prime coat, as appropriate. Pay particular attention to overspray and potential damage to adjacent property, and notify the Resident Construction Engineer for any needed assistance. See Section 401.4 for additional information on the application of asphalt prime coats.

304.4 POST-CONSTRUCTION CONSIDERATIONS

The Contractor is responsible for maintaining the integrity of the coquina shell base course during construction. During subsequent operations, watch for damage and defects caused by traffic and erosion and require the Contractor to repair the surface of the base in accordance with the provisions of the Contract.

304.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure and document in the Daily Work Report the surface area (i.e., width x length) of the completed and approved coquina shell base course. Payment will be made based on the Contract unit price; however, payment adjustment applies if the average thickness of the base course is found to be more than 0.25 inch less than the thickness specified in the Contract. For example, if the Contract specifies a 6-inch coquina shell base course and the average thickness was determined to be 5.5 inches, ensure that payment is adjusted as specified. Ensure that ineligible quantities, such as those for corrective work, are not included for payment. Obtain from the Contractor all invoices for the asphalt prime coat material, which will be retained by the Resident Construction Engineer, and document in the Daily Work Report the volume of asphalt material used for asphalt prime coat. Prime coat will be paid for separately based on this volume.

Section 305
Graded Aggregate Base Course

305.1 DESCRIPTION OF WORK

There are three types of graded aggregate base courses available to the Contractor under the provisions of Section 305 of the *Standard Specifications*:

- macadam base course,
- marine limestone base course, and
- recycled Portland cement concrete base course.

When the Contractor elects or is required to construct a graded aggregate base course the Contractor must elect to use only one of these alternatives for the project. The SCDOT Inspector will be responsible for verifying that the Contractor obtains materials and constructs the graded aggregate base course in accordance with Section 305 of the *Standard Specifications* and any applicable Special Provisions.

The composite aggregate material for this type of base course consists of both coarse and fine aggregate materials, which are proportioned so that the fines will fill voids and bind the coarse aggregate together once the composite mixture is placed and compacted. The type of coarse and fine aggregates required and the gradation of the composite mixture will depend on the alternative selected by the Contractor. Component aggregate materials must come from an SCDOT-approved source and the composite mixture must meet specified gradation requirements, after the material has been hauled and placed on the project.

The work for graded aggregate base course consists of placing one or more lifts of specified composite aggregate material on an approved subgrade or subbase. The number of lifts depends on the overall thickness of the compacted base course. Each lift of material then will be mixed, shaped and thoroughly and uniformly compacted to a target density. To achieve the target density during compaction, the moisture content should be maintained at or near optimum for the mixture, as established by the Research and Materials Engineer. Pay attention to the Contractor's sequence of operations, placement of material lifts, uniformity of mixing, moisture content during compaction, density obtained, application of asphalt prime coat and the resultant thickness and smoothness of the completed base course. Because this type of base course relies heavily on the gradation of the aggregate materials, extreme care should be taken to prevent segregation. Loose or rutted areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to placement of any subsequent course, obtain final approval of the base course from the Resident Construction Engineer, with concurrence from the District Construction Engineer prior to the application of asphalt prime coat.

305.2 PRECONSTRUCTION CONSIDERATIONS

305.2.1 Contract Document Review

See Section 301.2.1 for guidance on reviewing Contract documents.

305.2.2 Coordination of Project Personnel

See Section 301.2.2 for guidance on coordinating project personnel.

305.2.3 Material Considerations

305.2.3.1 Graded Aggregate Material

The composite mixture for graded aggregate base course consists of both coarse and fine aggregate materials, which are proportioned so that the fines will fill voids and bind the coarse aggregate together once the composite mixture is placed and compacted. The type of coarse and fine aggregates required and the gradation of the composite mixture will depend on the alternative selected by the Contractor. The following describes the composite mixtures for the alternative types available under the provisions of Section 305:

1. Macadam. The composite mixture for macadam base consists of crusher-run stone, gravel or slag, excluding marine limestone, and requires very little, if any, additional fines to be added, because the fine screenings produced by the crushing operation will be included in the mixture.

2. Marine Limestone. The aggregate material required for marine limestone base course is generally found in the coastal plains of South Carolina and consists of any limestone aggregate not meeting the classification of dolomitic limestone. Marine limestone aggregate and recrystallized limestone aggregate are considered marine limestone aggregate. The composite mixture will consist of the marine limestone aggregate and the fine material screenings produced by the mining or crushing operation.

3. Recycled Portland Cement Concrete. The composite mixture for recycled Portland cement concrete base course is comprised of crushed, graded, recycled Portland cement concrete, excluding crushed concrete block or pipe, and the natural sand or crushed fines that are typically added to meet gradation requirements.

The composite mixture to be incorporated in the work must come from an SCDOT-approved source (e.g., quarry, production plant) and meet specified gradation requirements, after the material has been hauled and placed on the project. The Research and Materials Laboratory, not the SCDOT Inspector, is responsible for compliance sampling and testing for source approval (e.g., Los Angeles Abrasion Test (AASHTO T 96)). If a new facility is opened for a project, the District Engineering Administrator is responsible for notifying the Research and Materials Laboratory so that samples can be taken to assess compliance before use. Verify that the gradation of the composite mixture complies to specified requirements with no evidence of segregation.

305.2.3.2 Asphalt Prime Coat

See Section 303.2.3.2 for information on asphalt material used for asphalt prime coat.

305.2.4 Weather Considerations

See Section 303.2.4 for information on weather considerations.

305.2.5 Sampling and Testing Considerations

See Section 301.2.5 for information on sampling and testing component materials and Contract pay items.

305.2.6 Subgrade/Subbase Inspection and Approval

See Section 303.2.6 for information on subgrade and subbase inspection and approval.

305.3 INSPECTION DURING CONSTRUCTION

305.3.1 Hauling and Placement Operation

Prior to placement, check the moisture content of the subgrade or subbase. Wetting may be necessary to recondition the surface if it has become too dry. At the material source, the Contractor is required to remove all objectionable matter from the aggregate materials (e.g., roots, sod, weeds, balls of clay, wire, asphalt, insulation, wood, brick, plastic). This is especially important because the material will be produced at quarries and recycled material production plants. During placement and mixing, however, it is good practice to continually monitor the operation for objectionable materials and oversized stones. Require the Contractor to remove such objectionable materials. If found in excessive amounts, require removal and replacement of the base material. To minimize hauling over the work under construction, placement will typically begin at the station farthest from the material source. In general, hauling over the base should be avoided unless it is being constructed in lifts. Ensure that lifts are not placed too thick (i.e., 8-inch compacted thickness maximum). Verify that the Contractor evenly and uniformly spreads the base material over the approved and properly maintained subgrade or subbase. Pay particular attention to segregated areas during placement and spreading, and require the Contractor to correct such areas in accordance with the provisions of the Contract.

305.3.2 Spreading Operation

305.3.2.1 Mixing and Shaping

It is preferable that the composite mixture that is hauled from stationary plants meet specified gradation requirements before it is placed on the project; however, the Contract provisions allow for the fine aggregate component to be hauled separately and mixed in the correct proportion with the coarse aggregate component on the subgrade or subbase. If mixing will occur on the project, do not allow equipment operators to mix the top surface of the subgrade or subbase with the graded aggregate material. As the graded aggregate material is being placed, verify that the Contractor immediately spreads and mixes the material until the base exhibits a homogeneous appearance throughout its width and depth. A uniform thickness for each lift should be attained. Verify that the Contractor adds water, as needed, to maintain the moisture content of the base material near optimum, as established by the Research and Materials Engineer. Only the most experienced motor grader operators should shape the base. Check the cross-section and grade to ensure conformance with the Contract Plans. As needed, require reshaping and removal and replacement of any unsuitable material encountered.

305.3.2.2 Checking Rate of Application

Where the Contract specifies that payment will be based on unit weight, an application rate for the graded aggregate material will be designated on the Contract Plans. Using the appropriate SCDOT Sampling and Testing Procedure (see Appendix C), check the application rate regularly to ensure compliance (i.e., weight of graded aggregate material from automatic printout tickets divided by the area upon which the material was spread). At the end of each workday, check and record in the Daily Work Report the weight of graded aggregate material incorporated in the work, the area of base course completed and approved and the actual application rate of aggregate. Remember that it is the Contractor's responsibility to establish the rate of spread. The SCDOT Inspector is responsible for confirming the Contractor's work but should not take on the Contractor's duties.

305.3.2.3 Sampling and Testing

Sampling and testing of each lift of graded aggregate material is required after placement and mixing but before compaction. The sampling and testing will be performed in accordance with the criteria for Quality Control Samples and Tests and Independent Assurance Samples and Tests discussed in Section 106. See Section 301.2.5 for additional information. Where the Contractor elects to incorporate the fine aggregate component on the project, obtain and ship to the Research and Materials Laboratory one sample for each 1000 tons of the fine aggregate material to be incorporated in the work. Do not permit the fine aggregate material to be incorporated in the work until the Laboratory reports that the material has been found to be in compliance. Sample each lift of graded aggregate material before compaction. If the graded aggregate base course is to lie unsurfaced for a prolonged period of time, such as over the winter, delay the sampling. Sample the graded aggregate base course every 1000 feet per 2 lanes. Take the sample through the full lift depth at the following locations:

- at or near the centerline,
- approximately 2 feet from the right edge, and
- approximately 2 feet from the left edge.

The size of the sample will be in accordance with SC-T-1 (See Appendix C). Immediately ship the samples to the Research and Materials Laboratory for testing (e.g., gradation). If the Laboratory reports that a sample has failed and requests that a check sample be taken, obtain and ship two check samples representing the material that failed in accordance with the requirements for check samples documented in Section 106. Do not permit additional material to be placed over the lift until the samples of the graded aggregate material have been tested and reported by the Laboratory to be in compliance.

305.3.3 <u>Compaction Operation</u>

305.3.3.1 General

The compaction operation (i.e., blading and rolling) should follow immediately behind the mixing and shaping operation. Its purpose is to compress the coarse and fine aggregate particles together into a dense mass by expelling air and reducing voids. Rolling will generally start at the edge and proceed toward the center, except on superelevated curves where rolling proceeds from the lower to the upper side. To facilitate minor corrective work, the Contractor should continually check lift thickness, grade and cross-section in a loose or lightly compacted condition. Once the graded aggregate base course has hardened, it is very difficult to correct surface deficiencies without completely ripping up the top layer of the compacted base. It is therefore extremely important that motor grader operators work in tandem with roller operators to maintain lift thickness and shape during compaction. The edge will generally be the most difficult to maintain and is subject to segregation. Rolling should generally extend 2 feet over the edge onto the shoulder. A drag broom is often pulled over the surface to deposit the excess fines into the surface voids. The compacted surface should be smooth and even textured. Watch for roller marks, knots and depressions and require the Contractor to adjust the roller pattern, as needed. Because density has a direct correlation to the resultant strength of the base course, it is critical that each lift be thoroughly and uniformly compacted to target density.

305.3.3.2 Moisture Content

One of the most important factors to consider is the amount of moisture in the graded aggregate material at the time it is compacted. Uniform distribution of water throughout the base material will result in the highest relative compaction with the least amount of compactive effort, assuming that the proper quantity of water is applied. The Research and Materials Engineer will establish the optimum moisture content for the graded aggregate base course material. Prior to compaction, check to ensure that the moisture content of the material is at or near optimum. The compaction operation is facilitated if the required water is added during the mixing and shaping operation.

305.3.3.3 Lift Thickness

Pay particular attention to the total compacted thickness of the graded aggregate base course that is denoted on the Contract Plans. If greater than 8 inches, the Contractor will be required to construct the base course in multiple lifts, with each lift being compacted to 100% of maximum density before additional material is placed for a subsequent lift.

305.3.3.4 Density Testing

During compaction, a hand shovel can be used to quickly assess the relative density of areas along the base course. The centerline will generally reach target density before the edges. With the shovel in vertical position, tap the handle end hard against the surface. If the surface is well compacted, a characteristic ring will be produced; otherwise, only a dull thud will be heard.

Density testing of each compacted lift of graded aggregate base course material is required and will be performed in accordance with the criteria for Quality Control Samples and Tests and Independent Assurance Samples and Tests discussed in Section 106. See Section 301.2.5 for additional information on sampling and testing. Check to ensure that each lift of graded aggregate base course material is uniformly compacted to 100% of the maximum density. Field density tests are to be determined in accordance with SC-T-30, SC-T-31, SC-T-32 or SC-T-33, as appropriate (see Appendix C). The theoretical maximum dry density will be determined by the Research and Materials Engineer, based on representative 200-pound samples submitted from the field. Submit these samples as soon as practical. Do not permit an additional lift of graded aggregate base course material to be placed until the required density of the underlying lift has been attained. If test results fail, require the Contractor to adjust the compaction operation or moisture content, as needed, to obtain the target density. The Resident Construction Engineer should retain SCDOT Form 300.02 – Density Test Report (Nuclear Gauge) or SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) – Direct Read Gauge; however, SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge) must be sent to the Research and Materials Laboratory on a weekly basis. Reference additional testing for areas that fail and note the corrective actions to be taken.

305.3.4 <u>Checking Surface Smoothness</u>

Once the final lift of graded aggregate base course has been compacted to target density, check compliance of the finished surface using a 10-foot straight edge, hand level, engineer's level, total station or other suitable means. Acceptable tolerance for surface smoothness is ±0.375 inch along the base in the direction parallel to the centerline and ±0.5 inch across the base in the direction of the cross-section. Be diligent in securing compliance of the surface. Require the Contractor to correct any areas that are not within reasonable conformity to the specified roadway section. Watch for severe rutting, equipment imprints, roller marks and loose or segregated material, and notify the Resident Construction Engineer, as needed, to assess corrective measures.

305.3.5 <u>Checking Base Course Thickness</u>

Immediately after compaction but prior to the application of the asphalt prime coat, test holes will be used to measure the thickness of the graded aggregate base course at various locations. Measure the base course thickness at staggered intervals not to exceed 250 feet in length per 2-lane width (125 feet for 4 lanes, etc.). See Section 106 for additional information on Quality Control Samples and Tests and Independent Assurance Samples and Tests. Verify that the Contractor corrects thickness deficiencies greater than 0.5 inches, as specified. Ensure that the test holes are backfilled with suitable material and thoroughly compacted using a hand tamp. If the Contract specifies that the graded aggregate base course will be paid for based on unit area, these measurements will be used to calculate an average job thickness to assess compliance of the completed graded aggregate base course. When computing the average job thickness, individual measurements that exceed the specified thickness by more than 0.5 inch will be considered the specified thickness plus 0.5 inch. For example, if the specified thickness is 6 inches and the measured thickness at one location is 7 inches, use 6.5 inches when computing the average thickness. Record the thickness measurements on SCDOT Form 300.01 – Depth Check Records.

305.3.6 Application of Asphalt Prime Coat

The application of an asphalt prime coat will be required when a hot-mix asphalt or asphalt surface treatment will overlay the graded aggregate base course. Do not allow the application of asphalt prime coat to begin until all other requirements have been met with respect to the construction of the graded aggregate base course and final approval has been obtained from the Resident Construction Engineer, with concurrence of the District Construction Engineer. A light brooming of the surface will be required prior to application. Pay particular attention to the type of asphalt material used. Check that the application rate is within the specified range of acceptability. Note that application rate for asphalt prime coat differs based on the type of graded aggregate base. Too much asphalt material can actually create a slip plane in the pavement structure. The asphalt material should completely penetrate the base surface and fill all voids. Watch for damage to the asphalt prime coat caused by traffic and require the Contractor to sand, dust or repair the asphalt prime coat, as appropriate. Pay particular attention to overspray and potential damage to adjacent property, and notify the Resident Construction Engineer for any needed assistance. See Section 401.4 for additional information on the application of asphalt prime coats.

305.4 POST-CONSTRUCTION CONSIDERATIONS

The Contractor is responsible for maintaining the integrity of the graded aggregate base course during construction. During subsequent operations, watch for surface damage and defects and require the Contractor to repair the surface in accordance with the provisions of the Contract.

305.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

305.5.1 Graded Aggregate Base Course (Unit Area Basis)

Where graded aggregate base course is to be paid for based on unit area, measure and document in the Daily Work Report the surface area (i.e., width x length) of the completed and approved graded aggregate base course. Payment will be made based on the Contract unit price; however, payment adjustment applies if the average thickness of the base course is found to be more than 0.25 inch less than the thickness specified in the Contract. For example, if the Contract specifies a 6-inch graded aggregate base course and the average thickness was determined to be 5.5 inches, ensure that payment is adjusted as specified. Ensure that ineligible quantities, such as those for corrective work, are not included for payment.

305.5.2 Graded Aggregate Base Course (Unit Weight Basis)

Where graded aggregate base course is to be paid for based on unit weight, the aggregate material must be weighed on certified platform scales as defined in the provisions of the Contract. See Section 109 for additional information on measuring material quantities. If at any time the weight of a load is suspect, witness the Contractor reweighing the suspect load on certified platform scales. Obtain from the Contractor the automatic printout tickets showing the weight of each load of aggregate incorporated in the completed and accepted graded aggregate base course. The Resident Construction Engineer will retain these tickets. Record the day's total in the Daily Work Report. Payment will be made based on this weight and the Contract unit price. Ensure that ineligible quantities, such as those for corrective work or in excess of those specified or otherwise approved, are not included for payment.

305.5.3 Asphalt Material for Prime Coat

Obtain from the Contractor all invoices for the asphalt prime coat material, which will be retained by the Resident Construction Engineer, and document in the Daily Work Report the volume of asphalt material used for asphalt prime coat. Prime coat will be paid for separately based on this volume.

Section 306
Reserved

Section 307
Cement Stabilized Earth Base Course

307.1 DESCRIPTION OF WORK

Cement stabilized earth base course consists of a combination of local soil and Portland cement, uniformly mixed with water at optimum moisture content and compacted to the required density. Materials will be mixed either by a stationary pugmill or by road mixing. To determine percent cement and moisture, representative samples of the soil for this type of base course should be sent as soon as practical to the Research and Materials Laboratory. The SCDOT Inspector will be responsible for verifying that the Contractor treats the roadbed subgrade in accordance with Section 307 of the *Standard Specifications* and any applicable Special Provisions. Pay particular attention to the Contractor's sequence of operations, application rate of materials, depth and uniformity of mixing, moisture content during compaction, density obtained, curing period and the resultant thickness and smoothness of the completed base course. Loose, segregated or rutted areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to placement of any subsequent course, obtain final approval of the base course from the Resident Construction Engineer.

307.2 PRECONSTRUCTION CONSIDERATIONS

307.2.1 <u>Contract Document Review</u>

See Section 301.2.1 for guidance on reviewing Contract documents.

307.2.2 <u>Coordination of Project Personnel</u>

See Section 301.2.2 for guidance on coordinating project personnel.

307.2.3 <u>Material Considerations</u>

307.2.3.1 Soil Material

The soil material used in the construction of cement stabilized earth base course will be either the in-situ soil material of the roadbed, excavated sand-clay material or a combination of these materials. Work cannot begin until an analysis of the soil to determine the application rate of cement and the optimum moisture content for the soil-cement mixture has been conducted. Obtain and submit a sample to the Research and Materials Laboratory and verify that soil gradation is established and maintained in compliance.

307.2.3.2 Portland Cement and Water

See Section 301.2.3.2 for guidance on inspecting Portland cement and water.

307.2.3.3 Asphalt Prime Coat

See Section 301.2.3.3 for guidance on inspecting the asphalt material used for curing.

307.2.4 Weather Considerations

See Section 301.2.4 and Section 303.2.4 for information on weather considerations.

307.2.5 Sampling and Testing Considerations

See Section 301.2.5 for information on sampling and testing component materials and Contract pay items.

307.2.6 Subgrade Inspection and Approval

If the Contractor uses the stationary plant method, the subgrade must be constructed and approved in accordance with the provisions of Section 208 of the *Standard Specifications*. If the road mixing method is used, the roadbed subgrade will be processed into a soil-cement layer similar to that for a cement modified subbase (see Section 301.2.6).

307.3 INSPECTION DURING CONSTRUCTION

307.3.1 Method and Timing of Operations

Mixing of the soil, cement and water materials will be by the stationary plant method unless road mixing is specified or otherwise approved. Pay particular attention to specified limitations on elapsed time and the time of starting various construction operations, especially with respect to introducing water to cement, mixing and compaction.

307.3.2 Stationary Plant Mixing Operations

307.3.2.1 Soil-Cement Mixture Production

Where the stationary mixing method is used, excavated sand-clay material (see Section 303.2.3.1) will be mixed by a pugmill in correct proportion with Portland cement and water. The percent cement and moisture will be established by the Research and Materials Engineer based on a representative sample of the soil material. Percent cement will be based on dry unit weight of soil and must be maintained within ±5% of the established percent during mixing. The optimum moisture content will typically be specified as percent moisture in the mixture.

307.3.2.2 Hauling and Placement

The soil-cement mixture will be hauled to the project in trucks, covered by tarps while transported. Prior to placement, check the moisture content of the subgrade. Wetting may be necessary to recondition the subgrade surface if it has become too dry. The soil-cement mixture should be homogeneous in appearance. During placement, monitor the mixture for objectionable materials, including oversized stones. Require the Contractor to remove such objectionable materials. If found in excessive amounts, require removal and replacement of the base material. To minimize hauling over the work under construction, placement will typically begin at the station farthest from the plant. In general, hauling over the base should be avoided unless constructed in lifts. Verify that the soil-cement mixture is placed and shaped in uniform lift thickness to the required grade and cross-section before compaction. Do not allow dumping of the mixture in piles or windrows.

307.3.3 Road Mixing Operations

307.3.3.1 Scarification and Pulverization Operation

Check the depth of scarification of the roadbed subgrade for compliance. Verify that the Contractor is not blading into the subgrade too deep. Perform the required sieve analyses to verify that the gradation of the pulverized material is within acceptable limits, and verify that the loosened soil is shaped to the required grade and cross-section before the spreading of cement.

307.3.3.2 Spreading of Cement

The application rate of cement and the optimum moisture content of the soil-cement mixture will be established by the Research and Materials Engineer based on a representative sample of the soil material (i.e., roadbed subgrade and/or sand-clay material). The application rate will typically be specified as weight of cement per unit area of spread. The optimum moisture content will typically be specified as percent moisture in the soil-cement mixture. Prior to spreading cement, verify that the Contractor has properly calibrated the spreader and closely monitor the rate of application to ensure that the cement is being spread uniformly across the entire width of the subgrade at a rate within ±5% of the rate per square yard established by the Research and Materials Engineer. Require the Contractor to recalibrate the spreader if necessary. Use SC-T-141 (see Appendix C) to check the application rate. The spreading operation must be continuous. Do not allow the Contractor to apply more cement along the length of the subgrade than can be completely processed in a single day’s operation.

307.3.3.3 Mixing and Shaping Operation

Once the cement has been spread, dry mixing will be performed to pulverize and combine the air-dry soil and cement materials sufficiently to prevent cement balls from forming when water is added. Verify that dry mixing is maintained at the proper depth. Mixing deeper than that specified will dilute the mixture and possibly reduce the strength of the base course. Watch for unpulverized lumps and require pre-wetting if evident. Once the cement has been spread, do not allow construction equipment other than that required for mixing and shaping (i.e., road mixing machine, disc harrows, road graders) to traverse the material. As moisture is added, verify that the spray bar evenly distributes the water across the full width of the material. Do not allow water to accumulate on the surface. Water should be evenly distributed throughout the mass. Check the moisture content for acceptability and, if needed, require the rate of application to be adjusted. Pay particular attention to the moisture content along the edges. Ensure that the Contractor mixes the soil and cement materials to a homogeneous mass for the full required depth. Do not allow the moist mixing operation to carve too deeply into the underlying roadbed subgrade. Check gradation of the moist soil-cement mixture for compliance. Monitor the operation for evidence of objectionable materials, including oversized stones, roots, sod and weeds and require removal or rework, as needed. Mixing should continue uninterrupted to leave the base in a loose and moist condition ready for immediate compaction. Compaction must commence within 30 minutes of moist mixing. If core molding is required, see Section 301.3.3.5 for guidance.

307.3.4 <u>Compaction Operation</u>

307.3.4.1 Moisture Content

The Research and Materials Engineer will establish the optimum moisture content for the soil-cement mixture. Prior to compaction, check to ensure that the moisture content is not more than two percentage points above nor less than that established as optimum. For example, if the optimum moisture content is 17%, an acceptable range for the moisture content during compaction will be between 17% and 19%, inclusive.

307.3.4.2 Density Testing

The compaction operation should immediately begin after shaping the loose soil-cement mixture. Compaction rolling must be completed within two hours of initial rolling. Check to ensure that the soil-cement mixture is uniformly compacted to not less than 95% of the maximum density. Use AASHTO T 134, SC-T-25 or SC-T-29, as appropriate, to determine the maximum density of the mixture (see Appendix C). Require the Contractor to adjust the compaction operation, as needed, to obtain the required density. The minimum requirement for density testing is one test each 1000 feet, per 2 lanes, each layer (on 4-lane sections, a test is required every 500 feet, each layer, etc.). Additional testing should be conducted, as needed, to ensure that proper compaction is being attained. See Section 106 for additional information on Quality Control Samples and Tests and Independent Assurance Samples and Tests. Contact the Resident Construction Engineer for any needed assistance. For density testing, the Resident Construction Engineer should retain SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge or SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge – Direct Read Gauge; however, SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge) must be sent to the Research and Materials Laboratory on a weekly basis.

307.3.5 <u>Finishing Operation</u>

Once the soil-cement mixture has been compacted to target density, the finishing operation will begin, which includes reshaping, light scarifying and finishing rolling, as needed, to bring the surface into compliance with the lines, grades and typical sections of the Contract Plans. Check compliance of the finished surface using a 10-foot straight edge, hand level, engineer's level, total station or other suitable means. Acceptable tolerance for surface smoothness is ±0.375

inches along the base course in the direction parallel to the centerline and ±0.5 inches across the base course in the direction of the cross-section. Require the Contractor to correct high and low spots, as specified. Pay particular attention to evidence of severe rutting, equipment imprints and loose material, and notify the Resident Construction Engineer, as needed, to assess corrective measures.

307.3.6 Curing Operation

Immediately after the finishing operation, ensure that the Contractor cures the finished surface with an asphalt curing membrane, as specified. Prior to applying the asphalt material, ensure that the surface is broomed and maintained in a moist condition. Pay particular attention to the specified elapsed time after finishing, the type of asphalt material used and the rate of application. Too much asphalt material can actually create a slip plane in the pavement structure. The asphalt material should completely seal the surface and fill all voids. Watch for damage to the membrane cased by traffic and require the Contractor to sand, dust or repair the membrane, as appropriate. The finished surface should generally be treated as soon as practical; however, surface treatment can be delayed until the following morning if weather conditions allow. The membrane should generally be allowed to set for 7 days prior to the application of a subsequent course.

307.4 POST-CONSTRUCTION CONSIDERATIONS

307.4.1 Construction Joints

See Section 301.4.1 for guidance on inspecting construction joints.

307.4.2 Checking Base Course Thickness

Test holes will be used to measure base course thicknesses at various locations. These measurements will be used to calculate an average job thickness to assess compliance of the completed cement stabilized earth base course. Phenolphthalein solution, available from the Research and Materials Laboratory, is useful in making these measurements. Dig a test hole at least 2 inches deeper than the specified depth of the cement stabilized earth base course. Beginning at the bottom of the test hole, make a vertical groove in the side of the hole with a screwdriver or other suitable instrument. When the groove is moistened from bottom to top with an eye dropper of phenolphthalein solution on the groove side of the test hole, the solution turns red when it reacts with cement, which will clearly identify the thickness of the cement modified layer. Measure base course thickness at staggered intervals not to exceed 250 feet in length per 2-lane width (125 feet for 4 lanes, etc.). See Section 106 for additional information on Quality Control Samples and Tests and Independent Assurance Samples and Tests. When computing the average job thickness, individual measurements exceeding the specified thickness by more than 0.5 inch will be considered the specified thickness plus 0.5 inch. For example, if the specified thickness is 6 inches and the measured thickness at one location is 7 inches, use 6.5 inches when computing the average thickness. Ensure that the Contractor corrects thickness deficiencies greater than 0.5 inch, which will require full-depth replacement.

Document this information in the Daily Work Report, and ensure that test holes are backfilled with suitable material and thoroughly tamped.

307.4.3 Traffic and Maintenance Considerations

Do not allow local traffic or construction equipment on the completed base course until the specified curing period has elapsed. Unless required for a subsequent construction operation, it is generally good practice for construction equipment to avoid traveling on the base course by using areas such as shoulders to travel along the project. Where crossings are approved, ensure that the Contractor covers the base course with at least 8 inches of earth to protect the finished surface. Once cured, light construction traffic will be permitted within 1000 feet ahead of the paving operation. The Contractor is responsible for maintaining the integrity of the completed base course. Watch for marring and defects to the surface and require the Contractor to correct such damage in accordance with the provisions of the Contract.

307.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure and document in the Daily Work Report the surface area (i.e., width x length) of the completed and approved cement stabilized earth base course. Payment will be made based on the Contract unit price; however, payment adjustment applies if the average thickness of the base course is found to be more than 0.25 inch less than the thickness specified in the Contract. For example, if the Contract specifies a 8-inch cement stabilized earth base course and the average thickness was determined to be 7.5 inches, ensure that payment is adjusted as specified. Ensure that ineligible quantities, such as those for corrective work, are not included for payment. Pay particular attention, however, to the provisions for reconstructive work due to rainy conditions. Measure and document in the Daily Work Report the volume, dimensions and calculations for any approved unclassified excavation of unsuitable or unstable material. Use the average end area method based on cross-sectional area and length measurements made in the field. Obtain from the Contractor automatic printout tickets for Portland cement, which will be retained by the Resident Construction Engineer, and document in the Daily Work Report the weight of cement incorporated in the work. Portland cement will be paid for separately based on this weight, subject to the limits specified for the application rate.

Section 308
Cement Stabilized Aggregate Base Course

308.1 DESCRIPTION OF WORK

Cement stabilized aggregate base course consists of a combination of either macadam or marine limestone aggregate material and Portland cement, uniformly mixed with water at optimum moisture content and placed and compacted to the required density on the subgrade. Materials typically will be mixed either in stationary pugmill or by road mixing. To determine percent cement and moisture, representative samples of the aggregate material for this type of base course should be sent as soon as practical to the Research and Materials Laboratory. The SCDOT Inspector will be responsible for verifying that the Contractor treats the roadbed subgrade in accordance with Section 308 of the *Standard Specifications* and any applicable Special Provisions. Pay particular attention to the Contractor's sequence of operations, application rate of materials, depth and uniformity of mixing, moisture content during compaction, density obtained, curing period and the resultant thickness and smoothness of the completed base course. Loose, segregated or rutted areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to placement of any subsequent course, obtain final approval of the base course from the Resident Construction Engineer.

308.2 PRECONSTRUCTION CONSIDERATIONS

308.2.1 Contract Document Review

See Section 301.2.1 for guidance on reviewing Contract documents.

308.2.2 Coordination of Project Personnel

See Section 301.2.2 for guidance on coordinating project personnel.

308.2.3 Material Considerations

308.2.3.1 Graded Aggregate Material

The aggregate material for cement stabilized aggregate base course will be either macadam or marine limestone as discussed in Section 305.2.3.1.

308.2.3.2 Portland Cement and Water

See Section 301.2.3.2 for guidance on inspecting Portland cement and water.

308.2.3.3 Asphalt Prime Coat

See Section 301.2.3.3 for guidance on inspecting the asphalt material used for curing.

308.2.4 Weather Considerations

See Section 301.2.4 and Section 303.2.4 for information on weather considerations.

308.2.5 Sampling and Testing Considerations

See Section 301.2.5 for information on sampling and testing component materials and Contract pay items.

308.2.6 Subgrade/Subbase Inspection and Approval

See Section 303.2.6 for information on subgrade and subbase inspection and approval.

308.3 INSPECTION DURING CONSTRUCTION

308.3.1 Method and Timing of Operations

Aggregate, cement and water materials will generally be mixed in a stationary pugmill. Pay particular attention to specified limitations on elapsed and starting time of various construction operations, especially with respect to introducing water to cement, mixing and compaction.

308.3.2 Aggregate-Cement Mixture Production

Aggregate and cement materials must be supplied from a source listed on SCDOT Approval Sheet 1, Approval Sheet 2 and Approval Sheet 6, as appropriate and will mixed by a stationary pugmill in correct proportion with Portland cement and water. The percent cement and moisture will be established by the Research and Materials Engineer based on a representative sample of the material. Percent cement will be based on dry unit weight of soil and must be maintained within ±5% of the established percent during mixing. The optimum moisture content will typically be specified as percent moisture in the mixture.

308.3.3 Hauling and Placement

The aggregate-cement mixture will be hauled to the project in trucks, covered by tarps while transported. Prior to placement, check the moisture content of the subgrade. Wetting may be necessary to recondition the subgrade surface if it has become too dry. The aggregate-cement mixture should be homogeneous in appearance. During placement, monitor the mixture for objectionable materials, including oversized stones. Require the Contractor to remove such objectionable materials. If found in excessive amounts, require removal and replacement of the base material. To minimize hauling over the work under construction, placement will typically begin at the station farthest from the plant. In general, hauling over the base should be avoided unless constructed in lifts. Verify that the aggregate-cement mixture is placed and shaped in uniform lift thickness to the required grade and cross-section before compaction. Do not allow dumping of the mixture in piles or windrows. Compaction must commence within 3 hours of mixing. If core molding is required, see Section 301.3.3.5 for guidance.

308.3.4 Compaction Operation

308.3.4.1 General

The compaction operation (i.e., blading and rolling) should follow immediately behind the placement and shaping operation. Its purpose is to compress the aggregate particles together into a dense mass by expelling air and reducing voids. Rolling will generally start at the edge and proceed toward the center, except on superelevated curves where rolling proceeds from the lower to the upper side. To facilitate minor corrective work, the Contractor should continually check lift thickness, grade and cross-section in a loose or lightly compacted condition. Once the cement stabilized aggregate base course has hardened, it is very difficult to correct surface deficiencies without completely ripping up the top layer of the compacted base. It is therefore extremely important that motor grader operators work in tandem with roller operators to maintain lift thickness and shape during compaction. The edge will generally be the most difficult to maintain and is subject to segregation. Rolling should generally extend 2 feet over the edge onto the shoulder. A drag broom is often pulled over the surface to deposit the excess fines into the surface voids. The compacted surface should be smooth and even textured. Watch for roller marks, knots and depressions and require the Contractor to adjust the roller pattern, as needed. Because density is a direct correlation to the resultant strength of the base course, it is paramount that each lift be thoroughly and uniformly compacted to target density.

308.3.4.2 Moisture Content

The Research and Materials Engineer will establish the optimum moisture content for the aggregate-cement mixture. Prior to compaction, check to ensure that the moisture content is not more than two percentage points above nor less than that established as optimum. For example, if the optimum moisture content is 17%, an acceptable range for the moisture content during compaction will be between 17% and 19%, inclusive.

308.3.4.3 Density Testing

During compaction, a hand shovel can be used to quickly assess the relative density of areas along the base course. The centerline will generally reach target density before the edges. With the shovel in vertical position, tap the handle end hard against the surface. If the surface is well compacted, a characteristic ring will be produced; otherwise, only a dull thud will be heard. Density testing of each compacted lift of cement stabilized aggregate base course material is required and will be performed in accordance with the criteria for Quality Control Samples and Tests and Independent Assurance Samples and Tests discussed in Section 106. See Section 301.2.5 for additional information on sampling and testing. Check to ensure that each lift of cement stabilized aggregate base course material is uniformly compacted to at least 98% of the maximum density. Field density tests are to be determined in accordance with SC-T-30, SC-T-31, SC-T-32 or SC-T-33, as appropriate (see Appendix C). The theoretical maximum dry density will be determined by the Research and Materials Laboratory, based on representative 200-pound samples submitted from the field. Submit these samples as soon as practical. Do not permit an additional lift of cement stabilized aggregate base course material to be placed until the required density of the underlying lift has been attained. If test results fail, require the Contractor to adjust the compaction operation or moisture content, as needed, to obtain the target density. The Resident Construction Engineer should retain SCDOT Form 300.02 – Density Test Report (Nuclear Gauge) or SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) – Direct Read Gauge; however, SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge) must be sent to the Research and Materials Laboratory on a weekly basis. Reference additional testing for areas that fail and note the corrective actions to be taken.

308.3.5 <u>Checking Surface Smoothness</u>

Once the final lift of cement stabilized aggregate base course has been compacted to target density, check compliance of the finished surface using a 10-foot straight edge, hand level, engineer's level, total station or other suitable means. Acceptable tolerance for surface smoothness is ±0.375 inches along the base in the direction parallel to the centerline and ±0.5 inches across the base in the direction of the cross-section. Be diligent in securing compliance of the surface. Require the Contractor to correct any areas that are not within reasonable conformity to the specified roadway section. Watch for severe rutting, equipment imprints, roller marks and loose or segregated material, and notify the Resident Construction Engineer, as needed, to assess corrective measures.

308.3.6 <u>Curing Operation</u>

Immediately after compaction, ensure that the Contractor cures the finished surface with an asphalt curing membrane, as specified. Prior to applying the asphalt material, ensure that the surface is broomed and maintained in a moist condition. Pay particular attention to the specified elapsed time after finishing, the type of asphalt material used and the rate of application. Too much asphalt material can actually create a slip plane in the pavement structure. The asphalt material should completely seal the surface and fill all voids. Watch for damage to the membrane cased by traffic and require the Contractor to sand, dust or repair the membrane, as appropriate. The finished surface should generally be treated as soon as practical; however, surface treatment can be delayed until the following morning if weather conditions allow. The membrane should generally be allowed to set for 7 days prior to the application of a subsequent course.

308.4 POST-CONSTRUCTION CONSIDERATIONS

308.4.1 <u>Construction Joints</u>

See Section 301.4.1 for guidance on inspecting construction joints.

308.4.2 Checking Base Course Thickness

Test holes will be used to measure base course thicknesses at various locations. These measurements will be used to calculate an average job thickness to assess compliance of the completed cement stabilized aggregate base course. Measure base course thickness at staggered intervals not to exceed 250 feet in length per 2-lane width (125 feet for 4 lanes, etc.). See Section 106 for additional information on Quality Control Samples and Tests and Independent Assurance Samples and Tests. When computing the average job thickness, individual measurements exceeding the specified thickness by more than 0.5 inches will be considered the specified thickness plus 0.5 inch. For example, if the specified thickness is 8 inches and the measured thickness at one location is 9 inches, use 8.5 inches when computing the average thickness. Ensure that the Contractor corrects thickness deficiencies greater than 0.5 inches, which will require full-depth replacement. Document this information on SCDOT Form 300.01 – Depth Check Records, and ensure that test holes are backfilled with suitable material and thoroughly tamped.

308.4.3 Traffic and Maintenance Considerations

Do not allow local traffic or construction equipment on the completed base course until the specified curing period has elapsed. Unless required for a subsequent construction operation, it is generally good practice for construction equipment to avoid traveling on the base course by using areas such as shoulders to travel along the project. Where crossings are approved, ensure that the Contractor covers the base course with at least 3 inches of screenings or sand to protect the finished surface. Once cured, light construction traffic will be permitted within 1000 feet ahead of the paving operation. The Contractor is responsible for maintaining the integrity of the completed base course. Watch for marring and defects to the surface and require the Contractor to correct such damage in accordance with the provisions of the Contract.

308.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure and document in the Daily Work Report the surface area (i.e., width x length) of the completed and approved cement stabilized aggregate base course. Payment will be made based on the Contract unit price; however, payment adjustment applies if the average thickness of the base course is found to be more than 0.25 inches less than the thickness specified in the Contract. For example, if the Contract specifies an 8-inch cement stabilized aggregate base course and the average thickness was determined to be 7.5 inches, ensure that payment is adjusted as specified. Ensure that ineligible quantities, such as those for corrective work, are not included for payment. Pay particular attention, however, to the provisions for reconstructive work due to rainy conditions. Obtain from the Contractor automatic printout tickets for Portland cement, which will be retained by the Resident Construction Engineer, and document in the Daily Work Report the weight of cement incorporated in the work. Portland cement will be paid for separately based on this weight, subject to the limits specified for the application rate.

Section 309
Hot-Mix Sand Asphalt Base Course

309.1 DESCRIPTION OF WORK

Hot-mix sand asphalt base course work consists of fine aggregate material and a performance graded asphalt binder, properly proportioned and mixed in an approved hot-mix asphalt plant, and placed and compacted on an approved subgrade or subbase. Materials are typically mixed in a hot-mix asphalt batch or drum mix plant. To assess gradation and determine percent asphalt binder required, a representative sample of the fine aggregate material must be sent as soon as practical to the Research and Materials Laboratory. The Research and Materials Laboratory and District Asphalt Manager are responsible for the inspection and approval of hot-mix asphalt plant operations. The SCDOT Inspector will be responsible for verifying that the Contractor constructs the hot-mix sand asphalt base course in accordance with Section 309 of the *Standard Specifications* and any applicable Special Provisions. Pay particular attention to the Contractor's sequence of operations, method of hauling and placement, appearance and temperature of the mix, depth and uniformity of lifts, compaction method, density of mat, thickness of the base course and the application of asphalt tack coat. Substandard thickness and segregated areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to placement of any subsequent course, obtain final approval of the base course from the Resident Construction Engineer.

309.2 PRECONSTRUCTION CONSIDERATIONS

309.2.1 Contract Document Review

See Section 301.2.1 for guidance on reviewing Contract documents. The SCDOT Inspector should also review hot-mix asphalt plant, hauling, placement and compaction operations as discussed in Section 401 and, as needed, reference the following publications:

- *SCDOT Asphalt Inspector's Guide Manual*,
- *SCDOT Asphalt Roadway Technician (ART) Course*,
- *AASHTO Hot-Mix Asphalt Paving Handbook*, and
- *AASHTO Segregation Causes and Cures for Hot-Mix Asphalt*.

309.2.2 Coordination of Project Personnel

When preparing for hot-mix asphalt construction, hold a conference to discuss project issues, including reasons for rejecting loads of mix, with SCDOT and Contractor personnel in charge of hot-mix asphalt production and operations at the project site. This may include the Asphalt Materials Engineer, District Asphalt Manager, Resident Construction Engineer, SCDOT Inspector and the Contractor's Plant and Roadway Superintendents. See Section 301.2.2 for additional guidance on coordinating project personnel.

309.2.3 Material Considerations

309.2.3.1 Performance Graded Asphalt Binder

Performance graded asphalt binders are used by the Department for all of its hot-mix asphalt mixtures. The performance grade (PG) designates a numeric syntax for various types of asphalt binders that are used for various applications. See Section 401 for additional information on performance grades and inspection of asphalt binders. Check to ensure that the asphalt binder used for the hot-mix sand asphalt base course is of the proper type and is supplied from a source listed on SCDOT Approval Sheet 37.

309.2.3.2 Aggregate Materials

The gradation and proportion of coarse and fine aggregate materials in hot-mix asphalt mixtures vary based on the design and intended application of the mixture. Many different types of designs are used. The provisions of Section 309 stipulate the requirements for hot-mix sand asphalt base course. The aggregate for this type of base course consists of local sand or local sand containing other approved materials. Check to ensure that the aggregate material is supplied from a source listed on SCDOT Approval Sheet 1 and Approval Sheet 2. Samples of the aggregate must be submitted to the Research and Materials Laboratory as soon as practical to determine compliance (SC-T-5, SC-T-34) and the percent of asphalt binder required for the base course. See Appendix C for SCDOT Sampling and Testing Procedures.

309.2.3.3 Hot-Mix Asphalt Mixture

The Contract will specify the type of hot-mix sand asphalt base course to be constructed. The Contractor will establish the percent of asphalt binder for the mixture based on laboratory test results. The Asphalt Materials Engineer will verify and approve the Contractor’s mix design. Note that a Job Mix Formula is not required and the specified percent asphalt range is not a tolerance limit. Percent binder will be controlled as established in *Control and Acceptance of Hot Mix Asphalt Mixtures*. The Contractor’s Plant Superintendent will be responsible for mix production, and the District Asphalt Manager will be responsible for verifying compliance of plant operations and the mixture. The Contract Special Provision will define the responsibilities of each party. Verify that the hydrated lime anti-stripping agent is supplied from a source listed on SCDOT Approval Sheet 39.

309.2.4 Weather Considerations

Weather plays an important role and is a very controlling factor in the production and compaction of hot-mix asphalt courses. See the provisions of Section 401.17 of the *Standard Specifications* and Section 303.2.4 for additional information.

309.2.5 Sampling and Testing Considerations

In general, quality control is the responsibility of the Contractor and quality assurance is the responsibility of SCDOT. The required sampling and testing procedures and acceptance criteria are complex and should be thoroughly reviewed and understood by all parties prior to initiating the construction of a hot-mix asphalt course (e.g., Quality Control, Quality Acceptance, Independent Assurance). The sampling and testing procedures and acceptance criteria, including payment adjustments, and the responsibilities of the Asphalt Materials Engineer, District Asphalt Manager, Resident Construction Engineer, SCDOT Inspector and the Contractor's Asphalt Technicians are well defined in Section 401 of the *Standard Specifications* and the Contract Special Provisions. See Section 301.2.5 for additional information.

309.2.6 Subgrade/Subbase Inspection and Approval

See Section 303.2.6 for information on subgrade and subbase inspection and approval.

309.3 INSPECTION DURING CONSTRUCTION

309.3.1 General

Section 401 provides an extensive discussion on hot-mix asphalt plant operations and pavement construction inspection, which also applies to hot-mix sand asphalt base course. In addition, pay particular attention to the following:

1. Hauling. Verify that the beds of trucks are properly coated with a release agent and that the mixture is adequately protected by a tarp. See SCDOT Approval Sheet 17.

2. Mix Inspection. Check the temperature of the loads of mix to ensure that they are between 250°F and 325°F when they arrive at the job site. Visually inspect the loads for conformance. Blue smoke is an indication that the mix is too hot. Crusting of the mix is an indication that it is too cold. A flat, shiny load sitting in the truck is an indication of too much asphalt binder. Watch for segregation. Reject unacceptable loads.

3. Placement. Check the rate of spread for conformance. Lifts should not exceed 4 inches of compacted thickness. Watch for segregation, especially along the edges and at joints. Verify that joints in the lifts overlap a minimum of 6 inches.

4. Compaction. Pay attention to the temperature of the mixture at the time of compaction rolling to ensure that optimum density is being obtained. Some mixtures exhibit problems if compacted during the tender zone. Note that sand-asphalt bases may be extremely tender and may require the material to cool down to allow the roller to compact the mixture without any significant horizontal or vertical displacement. Verify that density sampling and testing is being performed as specified in the provisions of the Contract. Pay attention to the quality acceptance and density criteria (see Sections 401.30 and 401.31 of the *Standard Specifications*).

5. Finishing. Do not allow rolling equipment to park on the surface of a freshly compacted mat. Check the surface smoothness, grade and cross-section for compliance using a 10-foot straightedge, engineer's level, total station or other suitable means.

309.3.2 Application of Asphalt Tack Coat

The application of an asphalt tack coat will be required between each lift of hot-mix sand asphalt base course. Do not allow the operation to begin until all other requirements have been met for the construction of the lift and final approval has been obtained from the Resident Construction Engineer. Drying and light brooming of the surface may be required when necessary prior to application. Pay particular attention to the type of asphalt material used. Optional types may be specified in the Contract. Only one type should be used, and it should not be mixed with other asphalt materials used on the project. Check the application rate for compliance. Too much asphalt material can create a slip plane in the pavement structure and too little will inhibit bonding between layers. The asphalt material should completely penetrate the lift and fill all voids. Watch for damage to the surface of the asphalt tack coat. Pay particular attention to overspray and potential damage to adjacent property, and notify the Resident Construction Engineer for any needed assistance. See Section 401 for additional information on the application of asphalt tack coat.

309.4 POST-CONSTRUCTION CONSIDERATIONS

309.4.1 Construction Joints

The construction of transverse and longitudinal joints in hot-mix asphalt mats must be constructed with exactness and inspected with diligence to ensure acceptability and quality of the final product, primarily due to the difficult nature of working with the hot-mix asphalt material. Improper construction causes segregation, mat separation and surface defects. Pay particular attention to the respective location of joints in lifts and courses. See Section 401 and Section 301.4.1 for additional guidance on inspecting joints.

309.4.2 Checking Base Course Thickness

When base course thickness is specified, core samples will be obtained to evaluate compliance.

309.4.3 Traffic and Maintenance Considerations

Do not allow local traffic or construction equipment on the completed base course until the specified curing period has elapsed. Unless required for a subsequent construction operation, it is generally good practice for construction equipment to avoid traveling on the base course by using areas such as shoulders to travel along the project. Where crossings are approved, ensure that the Contractor adequately protects the finished surface of the base course. Once cured, light construction traffic will be permitted ahead of the paving operation, as approved by the Resident Construction Engineer. The Contractor is responsible for maintaining the integrity of the completed base course. Watch for marring and other surface defects and require the Contractor to correct such damage in accordance with the Contract provisions.

309.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

309.5.1 Hot-Mix Sand Asphalt Base Course

The base course material must be weighed on certified platform scales as defined in the provisions of the Contract. See Section 109 for additional information on measuring material quantities. If at any time the weight of a load is suspect, witness the Contractor reweighing the suspect load on certified platform scales. Obtain from the Contractor the automatic printout tickets showing the weight of each load of base course material incorporated in the completed and accepted hot-mix sand asphalt base course. These tickets will be retained by the Resident Construction Engineer. Record the day's total in the Daily Work Report. Payment will be made based on this weight and the Contract unit price. Ensure that ineligible quantities, such as those for corrective work or in excess of those specified or otherwise approved, are not included for payment. SCDOT Form 400.04 – Daily Report of Asphalt Road Inspection should be completed.

309.5.2 Performance Graded Asphalt Binder

Document in the Daily Work Report the authorized weight of the asphalt binder incorporated in the completed and approved base course. The asphalt binder will be paid for separately based on this weight. Obtain from the Contractor automatic printout tickets for the asphalt binder, which will be retained by the Resident Construction Engineer. The Resident Construction Engineer will be provided with field laboratory extraction tests to check quantity. Be sure to include quantity adjustments for authorized increases or decreases to asphalt binder or required based on field laboratory extraction tests. Do not include quantities for unauthorized excess or waste. SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection must be completed.

309.5.3 Asphalt Material for Tack Coat

For the purpose of demonstrating compliance, document in the Daily Work Report the volumetric quantity, distribution area (i.e., length x width), application rate and type of asphalt material used for asphalt tack coat; however, asphalt tack coat will not be paid for separately. Document the rate on SCDOT Form 400.04 – Daily Report of Asphalt Road Inspection.

Section 310
Hot-Mix Asphalt Aggregate Base Course

310.1 DESCRIPTION OF WORK

Hot-mix asphalt aggregate base course work consists of coarse and fine aggregate material and a performance graded asphalt binder, properly proportioned and mixed in an approved hot-mix asphalt plant, and placed and compacted on an approved subgrade or subbase. The Research and Materials Laboratory and District Asphalt Manager are responsible for inspection and approval of hot-mix asphalt plant operations. The SCDOT Inspector will be responsible for verifying that the Contractor constructs the hot-mix asphalt aggregate base course in accordance with Section 310 of the *Standard Specifications* and any applicable Special Provisions. Pay particular attention to the Contractor's sequence of operations, method of hauling and placement, appearance and temperature of the mix, depth and uniformity of lifts, compaction method, density of mat, thickness of the base course and the application of tack. Substandard thickness and segregated areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to placement of any subsequent course, obtain final approval of the base course from the Resident Construction Engineer.

310.2 PRECONSTRUCTION CONSIDERATIONS

310.2.1 <u>Contract Document Review</u>

See Section 309.2.1 for guidance on reviewing Contract documents.

310.2.2 <u>Coordination of Project Personnel</u>

See Section 309.2.2 for guidance on coordinating project personnel.

310.2.3 <u>Material Considerations</u>

310.2.3.1 Performance Graded Asphalt Binder

See Section 309.2.3.1 for information on inspecting performance graded asphalt binders.

310.2.3.2 Aggregate Materials

Verify that the type and gradation of aggregate materials conform to the requirements specified in the provisions of Section 310 of the *Standard Specifications*. See Section 309.2.3.2 for additional information.

310.2.3.3 Hot-Mix Asphalt Mixture

The Contract will specify the type of hot-mix asphalt aggregate base course to be constructed. The Contractor will establish the percent of asphalt binder for the mixture based on laboratory test results. The Asphalt Materials Engineer will verify and approve the Contractor's mix design. A Job Mix Formula is not required for Asphalt Aggregate Base Course; however, the asphalt binder content for this HMA mixture will be verified and a Mix Design Form generated. The percent asphalt will be maintained within the specified range and tolerance in Section 310 of the *Standard Specifications*. See Section 309.2.3.3 for additional information.

310.2.4 Weather Considerations

Weather plays an important role and is a very controlling factor in the production and compaction of hot-mix asphalt mixtures. See the provisions of Section 401.17 of the *Standard Specifications* and Section 303.2.4 for additional information.

310.2.5 Sampling and Testing Considerations

See Section 309.2.5 for information on sampling and testing.

310.2.6 Subgrade / Subbase Inspection and Approval

See Section 303.2.6 for information on subgrade and subbase inspection and approval.

310.3 INSPECTION DURING CONSTRUCTION

Section 401 provides an extensive discussion on hot-mix asphalt plant operations and pavement construction, which applies to the construction of hot-mix asphalt aggregate base course. In addition, pay particular attention to the following:

1. Hauling. Verify that the beds of trucks are properly coated with a release agent and that the mixture is adequately protected by a tarp. Release agents must be supplied from a source listed on SCDOT Approval Sheet 17.

2. Mix Inspection. Check the temperature of the loads of mix to ensure that they are between 250°F and 325°F when they arrive at the job site. Visually inspect the loads for conformance. Blue smoke is an indication that the mix is too hot. Crusting of the mix is an indication that it is too cold. A flat, shiny load sitting in the truck is an indication of too much asphalt binder. Watch for segregation. Reject unacceptable loads.

3. Placement. Check the rate of spread for conformance and verify that the course is the proper thickness prior to compaction. Watch for segregation, especially along the edges, at joints and on the end of each load.

4. Compaction. Steel wheel tandem rollers weighing 8 to 10 tons are generally required. Initial rolling should begin when the mat has cooled sufficiently to support the weight of the rollers. Perform the required density testing.

5. Finishing. Do not allow rolling equipment to park on the surface of a freshly compacted mat. Check the surface smoothness, grade and cross-section for compliance using a 10-foot straightedge, engineer's level, total station or other suitable means.

310.4 POST-CONSTRUCTION CONSIDERATIONS

The guidance for post-construction inspection discussed in Section 309.4 applies to hot-mix asphalt aggregate base course work.

310.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

310.5.1 Hot-mix Asphalt Aggregate Base Course

Hot-mix asphalt aggregate base course material must be weighed on certified platform scales as defined in the provisions of the Contract. See Section 109 for additional information on measuring material quantities. If at any time the weight of a load is suspect, witness the Contractor reweighing the suspect load on certified platform scales. Obtain from the Contractor the automatic printout tickets showing the weight of each load of hot-mix asphalt aggregate material incorporated in the completed and accepted hot-mix asphalt aggregate base course. The Resident Construction Engineer will retain these tickets. Record the day's total in the Daily Work Report. Payment will be made based on this weight, the Contract unit price, and any price adjustments described in the contract. Ensure that ineligible quantities, such as those for corrective work or in excess of those specified or otherwise approved, are not included for payment.

310.5.2 Performance Graded Asphalt Binder

Document in the Daily Work Report the authorized weight of the asphalt binder incorporated in the completed and approved base course. The asphalt binder will be paid for separately based on this weight. Obtain from the Contractor automatic printout tickets for the asphalt binder, which will be retained by the Resident Construction Engineer. SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection must be completed.

310.5.3 Asphalt Material for Tack Coat

For the purpose of demonstrating compliance, document on SCDOT Form 400.04 – Daily Report of Asphalt Road Inspection the application rate and type of asphalt material used for asphalt tack coat; however, asphalt tack coat will not be paid for separately.

Section 311
Permeable Asphalt Base Course

311.1 DESCRIPTION OF WORK

Permeable asphalt base course consists of crushed stone and a performance graded asphalt binder, properly proportioned and mixed in an approved hot-mix asphalt plant, and placed and compacted on an approved subgrade or subbase. Its purpose is to allow water to adequately drain. The Research and Materials Laboratory and District Asphalt Manager are responsible for inspection and approval of hot-mix asphalt plant operations. The SCDOT Inspector will be responsible for verifying that the Contractor constructs the permeable asphalt base course in accordance with the Contract Plans, Special Provisions and applicable Subsections of Section 401 of the *Standard Specifications*. Pay particular attention to the Contractor's sequence of operations, method of hauling and placement, mix appearance and temperature, compaction method, density of mat and the resultant thickness of the base course. Substandard thickness, overly compacted mats and segregated areas are unacceptable and will require immediate correction by the Contractor. After construction and prior to placement of any subsequent course, obtain final approval of the base course from the Resident Construction Engineer.

311.2 PRECONSTRUCTION CONSIDERATIONS

311.2.1 Contract Document Review

See Section 309.2.1 for guidance on reviewing Contract documents.

311.2.2 Coordination of Project Personnel

See Section 309.2.2 for guidance on coordinating project personnel.

311.2.3 Material Considerations

311.2.3.1 Performance Graded Asphalt Binder

See Section 309.2.3.1 for information on inspecting performance graded asphalt binders.

311.2.3.2 Aggregate Materials

Crushed stone, exclusive of limestone, will typically be required for permeable asphalt base course. Verify that the type and gradation of the aggregate material conform to the requirements specified in the Contract Special Provisions. See Section 309.2.3.2 for additional information.

311.2.3.3 Hot-Mix Asphalt Mixture

Verify that the gradation of the mix is properly established and maintained. The Research and Materials Engineer will verify the percent of asphalt binder for the mixture based on laboratory test results. Percent asphalt will be maintained within the range and tolerance as specified in the Contract Special Provisions. See Section 309.2.3.3 for additional information.

311.2.4 <u>Weather Considerations</u>

Weather plays an important role and is a very controlling factor in the production and compaction of hot-mix asphalt courses. See the provisions of Section 401.17 of the *Standard Specifications* and Section 303.2.4 for additional information.

311.2.5 <u>Sampling and Testing Considerations</u>

See Section 309.2.5 for information on sampling and testing.

311.2.6 <u>Subgrade / Subbase Inspection and Approval</u>

See Section 303.2.6 for information on subgrade and subbase inspection and approval.

311.3 INSPECTION DURING CONSTRUCTION

Section 401 provides an extensive discussion on hot-mix asphalt plant operations and pavement construction, which applies to the construction of permeable asphalt base course. In addition, pay particular attention to the following:

1. <u>Hauling</u>. Verify that the beds of trucks are properly coated with a release agent and that the mixture is adequately protected by a tarp. Release agents must be supplied from a source listed on SCDOT Approval Sheet 17.

2. <u>Mix Inspection</u>. Check the temperature of the loads of mix to ensure that they are between 250°F and 325°F when they arrive at the job site. Visually inspect the loads for conformance. Blue smoke is an indication that the mix is too hot. Crusting of the mix is an indication that it is too cold. A flat, shiny load sitting in the truck is an indication of too much asphalt binder. Watch for segregation. Reject unacceptable loads.

3. <u>Placement</u>. Check the rate of spread for conformance and verify that the course is the proper thickness prior to compaction. Watch for segregation, especially along the edges, at joints and on the end of each load.

4. <u>Compaction</u>. The purpose of the compaction will be to densify the mat sufficiently to support the load of paving equipment. Steel wheel tandem rollers weighing 8 to 10 tons are generally required. Initial rolling should begin when the mat has cooled sufficiently to

support the weight of the rollers. Do not allow the mat to be overdensified as this will hinder the performance of the free-draining layer.

5. Finishing. Do not allow rolling equipment to park on the surface of a freshly compacted mat. Check the surface smoothness, grade and cross-section for compliance using a 10-foot straightedge, engineer's level, total station or other suitable means.

311.4 POST-CONSTRUCTION CONSIDERATIONS

After construction, care should be exercised to ensure that the porous surface of the mat is not clogged with dirt or debris. Ensure that the surface is maintained free of contamination from soil and other materials. Require the Contractor to clean and repair the base course, as needed, in accordance with the provisions of the Contract. See Section 309.4 for additional post-construction inspection considerations.

311.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The guidance presented in Section 310.5 applies to the documentation and payment considerations for permeable asphalt base course.

DIVISION 400
Asphalt Pavements

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

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Section 401
Hot-Mix Asphalt Pavement

401.1 DESCRIPTION OF WORK

A hot-mix asphalt (HMA) mixture is a combination of high-quality, sieve-graded coarse and fine aggregate materials, mineral filler, asphalt binder, admixtures (e.g., anti-stripping agent) and, as permitted by the Contract, recycled materials, such as recycled asphalt pavement, glass and shingles. These component materials must be selected, proportioned and mixed mechanically at an HMA plant based on a Job Mix Formula. One or more types of HMA courses may be specified for the pavement, and mix design, construction, acceptability and payment will depend on the type of HMA course to be constructed. The HMA Mix Design Technician will be responsible for:

- evaluating the suitability and gradation of aggregate material,
- designing the HMA mixture in an SCDOT-approved laboratory, and
- submitting the proposed material sources and Job Mix Formula for approval.

All component materials for the HMA mixture must be supplied from SCDOT-approved sources, as listed on SCDOT Approval Sheets. The design objective is to balance the properties of the mixture (e.g., workability vs. stability), while maintaining established parameters within specified limits (e.g., gradation, asphalt binder content). The properties of primary concern to the HMA Mix Design Technician include:

- moisture susceptibility – ability to resist stripping of asphalt binder;
- stability – ability to resist deformation under applied traffic loading;
- durability – ability to sustain original properties during in-service use and aging;
- permeability – ability to resist water and air entry;
- flexibility – ability to bend slightly under loading without cracking;
- workability – ability to be easily placed and compacted;
- fatigue resistance – ability to resist repeated traffic loading without failure; and
- skid resistance – ability to resist slipping and skidding of vehicular traffic.

Once the material sources and Job Mix Formula have been approved, the mixture will be produced at an HMA plant (e.g., batch plant, drum-mix plant). Prior to production, the HMA plant will be inspected for acceptability by the District Asphalt Manager or the Asphalt Materials Engineer, as appropriate. Scale certification, calibration of proportioning equipment, plant emissions and the following plant components are of primary concern:

- cold aggregate storage and feed system,
- aggregate heating and drying equipment,
- aggregate screening equipment,
- hot aggregate storage and weighing system,
- asphalt binder and admixture storage and metering system,

- mixing equipment, and
- storage silos.

At the start of production, the HMA plant will be calibrated to blend, heat and dry the required proportion of coarse and fine aggregate materials, add the proper quantity of asphalt binder and anti-stripping agent and thoroughly mix these component materials into an HMA mixture suitable for silo storage or immediate hauling, laydown and compaction. The HMA Quality Control Technician will be primarily responsible for monitoring compliance of the parameters established for the component materials and HMA mixture at the plant.

At the project site, the Asphalt Roadway Technicians will be responsible for ensuring that the HMA mixture is hauled, placed and compacted to meet the parameters established in the Contract Plans and Specifications for the HMA course (e.g., density, thickness, cross slope, grade). The Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying Contract compliance and the acceptability of the HMA mixture delivered, placed and compacted. The HMA Quality Manager oversees both plant and roadway operations, troubleshoots production problems and is the Contractor's primary contact with SCDOT personnel. Section 401 of this *Manual* presents significant discussion on topics that are important to the day-to-day responsibilities of both SCDOT and Contractor plant and roadway personnel. Specifically, the content in Section 401 applies to the following Sections of the *Standard Specifications*:

- Section 401 – Hot-Mix Asphalt Pavement,
- Section 402 – Hot-Mix Asphalt Intermediate Course,
- Section 403 – Hot-Mix Asphalt Surface Course,
- Section 404 – Cold-Mix Asphalt Intermediate Course,
- Section 405 – Cold-Mix Asphalt Surface Course,
- Section 409 – Open-Graded Friction Course, and
- Section 410 – Hot-Mix Asphalt Thin-Lift Seal Course.

401.2 HMA QUALITY CONTROL / QUALITY ASSURANCE PROCEDURES

HMA mixtures are typically used for base courses, intermediate courses and surface courses. The Contract Plans and Specifications will designate the structure of the pavement required for the facility. This section describes the Department's HMA Quality Control/Quality Assurance (QC/QA) procedures, including the HMA QC/QA Program; HMA Technician Certification Program; and quality control, acceptance and verification sampling and testing parameters, frequencies, methods and responsibilities.

401.2.1 HMA QC / QA Program: Overview

SCDOT administers all of its HMA construction projects under a statistical HMA QC/QA Program. Under this Program, SCDOT is responsible for establishing verification and acceptance parameters (e.g., samples, tests, target values, acceptance criteria, payment adjustment schedules), while the Contractor is responsible for controlling work and materials to ensure that the HMA pavement is constructed within established parameters. This contributes significantly to the production of a more consistent, higher quality pavement. Field acceptance criteria for HMA mixtures is typically based on:

- binder content (%AC),
- percent air voids (%AV),
- percent voids in mineral aggregate (%VMA), and
- the in-place density of the HMA mat.

Acceptance, rejection or acceptance at an adjusted price will be based on the acceptance criteria and the percentage of the Lot that is within specified limits. Where deficiencies are found, the Contractor is responsible for ceasing production until corrective action can be taken to bring production into compliance.

401.2.2 HMA Technician Certification Program

The HMA Technician Certification Program was jointly developed by SCDOT, FHWA and the Asphalt Paving Industry to ensure that personnel working under the HMA QC/QA Program are properly qualified to perform their respective duties. The HMA Technician Certification Task Force, composed of representatives from SCDOT, FHWA, Clemson University and the Asphalt Paving Industry, provides oversight; and the Department of Civil Engineering, Clemson University, administers the coursework, including formal classes and examination. By implementing this Certification Program, SCDOT can:

- improve the quality of both field and laboratory sampling and testing;
- enhance communications with the HMA paving industry; and
- increase HMA pavement performance and reduce overall life-cycle costs.

The South Carolina Certification Board, composed of one FHWA and eight SCDOT representatives, oversees the implementation of the HMA QC/QA Program and, as needed, the HMA Technician Certification Program.

Additional information regarding the HMA Technician Certification Program is available on the SCDOT website.

401.2.3 HMA Job Mix Formula

401.2.3.1 Design Responsibilities

The control parameters for each type of HMA mixture will be specified. The HMA Mix Design Technician (Level 2S), will be responsible for designing the mixture and preparing the Job Mix Formula in accordance with SC-T-80. The design will be prepared in a laboratory approved by the Research and Materials Engineer. A Job Mix Formula is not required for Sand Asphalt Base Course or Asphalt Aggregate Base Course; however, the asphalt binder content for the required HMA mixture will be verified and a Mix Design Form generated.

401.2.3.2 Submittals

Prior to production, the HMA Mix Design Technician will submit the proposed sources of component materials and the Job Mix Formula for the HMA mixture on the proper SCDOT Construction Forms to the Research and Materials Laboratory for approval. The Job Mix Formula will include the percentage of aggregate passing each required sieve, the percentage of asphalt binder not absorbed by aggregate and the percentage of anti-stripping agent in the HMA mixture. Note that a Job Mix Formula is specific to mixture type and HMA plant supplier and is to be approved by the Research and Materials Engineer for application on individual projects. There will need to be an approved Job Mix Formula submitted to the Resident Construction Engineer for each HMA mix used on any given project.

The Asphalt Materials Engineer will notify the HMA Mix Design Technician of any needed adjustments to the initial Job Mix Formula. Do not allow production to begin without written approval of the material sources and the Job Mix Formula from the Research and Materials Engineer.

401.2.3.3 Revisions

If the HMA Mix Design Technician or HMA Quality Manager determines that a revision to the HMA mixture design is necessary, a copy of the revision and supporting data will be forwarded to the District Asphalt Manager, Research Materials Engineer and District Materials Laboratory, when appropriate. SCDOT approval is necessary for any Job Mix Formula revision. Implementation of the revision must occur between production lots. Pay particular attention to the Contract Specifications with respect to expiration period, number of revisions allowed and the requirements for a new Job Mix Formula.

401.2.4 <u>HMA Production Lot Numbering</u>

Once a series of Lot Numbers has been initialized on a project for a specific type of mixture supplied from a particular HMA plant, the Lot Numbers will run continuously until the type of mixture is no longer required for the project. Lot Numbers will be initialized at the beginning of the project and run continuously throughout the project, regardless of the need for a new Job Mix Formula for the same type of mixture from the same plant. There will be no calibration period. Lot Numbers begin immediately upon production.

401.2.5 <u>HMA Laboratory and Sampling Platform Requirements</u>

The Contractor is responsible for supplying and furnishing the HMA laboratory in accordance with SC-T-81 or SC-T-82, as appropriate, including all supplies necessary to perform quality control testing at the asphalt plant. When SC-T-75 is used, pay particular attention to compliance with the manufacturer’s recommendations for venting, calibrating, operating and maintaining the ignition oven. The Contractor is also responsible for supplying a platform high enough to allow sampling and inspection of the HMA mixture in truck beds. On an annual basis, the SCDOT Asphalt Materials Engineer will inspect the laboratory for acceptability and verify that the HMA Mix Design Technician has calibrated the laboratory equipment in accordance with SC-T-94 and, as needed, check the Technician's calibration records. Non-compliance of laboratory and test equipment is grounds for halting production.

401.2.6 Notification of HMA Production and Acceptance Results

The HMA Quality Manager will notify the District Asphalt Manager prior to each day's production so that SCDOT may arrange for verification testing. Failure to receive such notification is grounds for withholding payment for the day's production. The HMA Quality Manager also is responsible for submitting the results of acceptance tests to the District Asphalt Manager within three production days after the completion of the mixture Lot. Non-compliance is grounds for halting production.

401.2.7 Quality Control Program (Contractor and SCDOT)

401.2.7.1 HMA Quality Control Plan (Contractor)

The Contractor is responsible for preparing and submitting a Quality Control Plan to the Research and Materials Engineer for approval. The Quality Control Plan will define the process control activities for HMA mixture design, production and placement, including inspection, sampling, testing, coordination and adjustment. During the project, verify that the Contractor operates within this Plan. Non-compliance is grounds for halting production.

401.2.7.2 HMA Plant QC Samples and Tests (Contractor)

The HMA Quality Manager will ensure that the HMA Quality Control Technician performs the necessary samples and tests. Note that these are minimum requirements and should be increased, as needed, to ensure compliance. The allowable limits of test parameters will be specified in the Contract. Non-compliance with minimum specified requirements is grounds for halting production.

401.2.7.3 HMA Roadway QC Samples and Tests (Contractor and SCDOT)

The HMA Quality Manager and Asphalt Roadway Technicians are responsible for compaction control, including compaction rollers and the rolling pattern. Verify the proper use of the density gauge to control the compaction process and document the results. The Resident Construction Engineer and Roadway Inspectors are responsible for verifying and documenting results of testing in the Daily Work Report and on SCDOT Form 400.04 – Daily Report of Asphalt Plant Inspection.

401.2.8 Acceptance Program (Contractor)

401.2.8.1 Basis of Payment

Only acceptance samples that have been obtained randomly in accordance with specified requirements will be used for computing daily pay factors. Any other type of sample, with the exception of quality control samples, will be performed for the exclusive use of the Contractor's HMA Quality Manager.

401.2.8.2 HMA Plant Acceptance Samples and Tests

Prior to production, the District Asphalt Manager or Resident Construction Engineer, as assigned, will verify that the HMA Quality Manager has properly calibrated the HMA plant to the Job Mix Formula and field acceptance criteria. The HMA Quality Manager will ensure that HMA plant acceptance sampling and testing is performed. The allowable limits of test parameters will be specified in the Contract.

401.2.8.2.1 Binder Content Analysis (%AC)

The HMA Quality Control Technician will be responsible for determining %AC. Verify that SC-T-62 is used to obtain an HMA mixture sample of the required size and that SC-T-72 is used to split the sample into acceptance, verification and referee samples. The acceptance sample should be tested for compliance and the verification and referee samples should be separately bagged, labeled with the proper SCDOT Sample Identification Card (see Appendix B) and stored. The Asphalt Materials Engineer will be responsible for determining the need to request the verification sample for testing under the Verification Program. The HMA Quality Control Technician must retain the referee sample until otherwise notified by the Asphalt Materials Engineer, and the disposition of samples should follow the specified disposal schedule. When an ignition oven is used to determine binder content, ensure that it is furnished and calibrated in accordance with SC-T-75. If acceptance and referee tests are not within allowable limits, check the HMA Mix Design Technician's calibration log and, as needed, require re-calibration. Complete SCDOT Form 400.01 – Ignition Oven Worksheet.

401.2.8.2.2 Voids Analysis (%AV, %VMA)

Verify that sample specimens are prepared and compacted in accordance with SC-T-66 and that %AV and %VMA are determined in accordance with SC-T-68. The acceptance sample should be tested for compliance and verification and referee samples, as appropriate, should be separately labeled using the proper SCDOT Sample Identification Card (see Appendix B) and stored. The Asphalt Materials Engineer will be responsible for determining the need to request the verification sample for testing under the Verification Program. The Technician must retain the samples until otherwise notified by the Asphalt Materials Engineer, and the disposition of samples should follow the specified disposal schedule. The maximum specific gravity (MSG) will be determined in accordance with SC-T-83. Percent air voids (%AV) will be determined by comparing the bulk specific gravity (BSG) of the compacted mixture to the mixture's maximum specific gravity (MSG). Base course work does not require a %AV analysis.

401.2.8.2.3 Washed Mixture Gradation Analysis

The HMA Quality Control Technician will be responsible for the washed mixture gradation analysis. Verify that acceptance tests for washed mixture gradation are performed for each sublot in accordance with SC-T-63, SC-T-76 and SC-T-92, as appropriate. Payment for asphalt aggregate base course will be based on the evaluation of each sublot, separately.

401.2.8.3 HMA Roadway Acceptance Samples and Tests (Contractor)

The Asphalt Roadway Technician is responsible for evaluating for acceptance the in-place density of the HMA mat in accordance with the minimum requirements. Note that these are minimum requirements and should be increased, as needed, to ensure compliance. The allowable limits of test parameters will be specified in the Contract.

401.2.8.3.1 In-Place Density Analysis (%Maximum Theoretical)

The Asphalt Roadway Technician is responsible for obtaining core samples for in-place density analyses at the locations determined by SCDOT using SC-T-101. This procedure is applicable to most intermediate courses and surface courses (see Section 403 of the *Standard Specifications*) placed at a rate equal to or greater than 140 pounds per square yard. Verify that the Asphalt Roadway Technician obtains one 6-inch core in accordance with SC-T-87 at each randomly selected location, as determined using SC-T-101. Each of these verification samples should be labeled using the proper SCDOT Sample Identification Card (see Appendix B) and stored, as specified. The Asphalt Materials Engineer will be responsible for determining the need to request the verification sample for testing under the Verification Program. The HMA Quality Control Technician must retain the samples until otherwise notified by the District Asphalt Manager or Asphalt Materials Engineer, and the disposition of samples should follow the specified disposal schedule.

401.2.8.3.2 In-Place Density Analysis (%Control Strip Target Density)

The Asphalt Roadway Technician is responsible for performing in-place density analyses using the density gauge, and the District Asphalt Manager or Resident Construction Engineer, as assigned, must witness this procedure. The density gauge must be approved by the Research and Materials Engineer and certified for use and transport by SCDHEC. Certification is the Contractor’s responsibility. Ensure that the Asphalt Roadway Technician adheres to the safety requirements associated with the use of the nuclear gauge and is prepared to mitigate and notify proper authorities in the event of a mishap. Verify that each Lot is subdivided corresponding to the number of density values required and that test locations within each sublot are randomly selected using SC-T-101. Density will be expressed as a percent of target density, as determined from a control strip constructed in accordance with SC-T-65. Calculations will be carried out to the hundredths (0.01) and rounded to the nearest tenth (0.1) in accordance with AASHTO R 11.

401.2.8.4 HMA Check Samples (Contractor)

When an acceptance sample fails to meet specified limits for %AC, %AV, %VMA, Job Mix Formula gradation or dust-to-asphalt ratio, the HMA Quality Manager may opt to obtain another sample. This will be considered a check sample and will not be used to calculate pay factors. If two consecutive samples fail for any acceptance parameter, the HMA Quality Control Technician is required to immediately notify the District Asphalt Manager or Resident Construction Engineer. The HMA Quality Manager will analyze the problem and require adjustment to plant production. After adjustment, production will resume and the third truck load of mix will be sampled. The HMA Quality Manager will suspend further production until the test results on the sample has been obtained. If the test passes, production may resume; however, if the test fails, the mixture in the storage silo will be discarded and the plant cleared of all non-complying material. This procedure may be altered, as needed, by the Asphalt Materials Engineer.

401.2.9 Verification Program (SCDOT)

401.2.9.1 General

The District Asphalt Manager, Resident Construction Engineer and Roadway Inspectors should, on a regular basis, witness and document in the Daily Work Report and on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection and SCDOT Form 400.04 – Daily Report of Asphalt Road Inspection the sampling and testing performed by the Contractor's Technicians. Although SCDOT verification tests will equal or surpass 10% of those required by the Contractor, SCDOT may elect to obtain additional samples or run additional tests for compliance verification. Within the first two days of production, at least one verification test each will be conducted for %AC, %AV, %VMA and in-place density. Under the Verification Program, SCDOT may select any or all of the Contractor's retained verification samples for testing or run tests on independently selected random locations, as appropriate. SCDOT may use the Contractor's test equipment or its own equipment, calibrated in accordance with SC-T-94. The HMA Quality Manager may opt to inspect SCDOT test equipment for concurrence. If non-compliance is observed through verification testing, SCDOT will immediately notify the HMA Quality Manager. The results of verification tests will be provided to the HMA Quality Manager. The District Asphalt Manager will investigate deficiencies and, if not immediately corrected, will request the HMA Quality Manager to halt production until corrective action is taken.

401.2.9.2 HMA Plant Verification Samples and Tests

401.2.9.2.1 Binder Content Analysis (%AC)

For %AC and maximum specific gravity (MSG), SCDOT will compare the results of testing the split samples made for acceptance and verification. If found within allowable difference, no further testing will be performed and the Contractor's acceptance test results will be used to compute the pay factor for the Lot of asphalt binder. If found to be outside allowable difference, the Research and Materials Engineer will test the referee sample and compare the result to the Contractor's acceptance results. If found within allowable difference, no further testing will be performed and the Contractor's acceptance test results will be used to compute the pay factor for the Lot of asphalt binder. If found to be outside allowable difference, then the result of testing the referee sample will be used in lieu of the Contractor's acceptance test results in computing the pay factor for the Lot of asphalt binder. The District Asphalt Manager will immediately investigate (e.g., additional testing, observation of Contractor's procedures) recurring problems and, as needed, halt production of the HMA mixture. Complete SCDOT Form 400.01 – Ignition Oven Worksheet.

401.2.9.2.2 Voids Analysis (%AV, %VMA)

For %AV and %VMA, SCDOT will compare the average value from testing verification samples to the average value obtained from the Contractor's acceptance tests. The verification tests will be obtained from samples obtained from the same Lot as the Contractor's acceptance samples. A statistical analysis will be used, as specified, to compare the verification and acceptance values to determine if the Contractor's acceptance values or additional testing is required to obtain values to compute the Lot pay factor for air voids. Follow the procedure specified in the Contract to perform this task. The District Asphalt Manager will immediately investigate (e.g., additional testing, observation of Contractor's procedures) recurring problems and, as needed, halt production of the HMA mixture.

401.2.9.3 HMA Roadway Verification Samples and Tests

401.2.9.3.1 In-Place Density Analysis (%Maximum Theoretical)

This procedure applies to intermediate courses and all surface courses, unless otherwise specified. The District Asphalt Manager will compare the bulk specific gravity (BSG) value obtained from testing the SCDOT verification core sample with that obtained from the Contractor's acceptance test. If the comparison is within allowable difference, no further testing will be required and the Contractor's value will be used to compute the in-place density Lot pay factor; otherwise, the Research and Materials Engineer will test the referee sample and use the referee test value to compute the in-place density Lot pay factor. The District Asphalt Manager will immediately investigate recurring problems and, as needed, halt production of the HMA mixture.

401.2.9.3.2 In-Place Density Analysis (%Control Strip Target Density)

This procedure applies to Asphalt Aggregate Base Courses and specified surface courses. The District Asphalt Manager, Resident Construction Engineer or Roadway Inspector, as assigned, will obtain independent nuclear density readings for verification testing using the same type of density gauge as the Contractor. For each Lot selected for verification testing, SCDOT will use SC-T-101 to select 10 random locations within the Lot. SCDOT then will obtain one nuclear density value at each of these locations. A statistical analysis will be used, as specified, to comparing the verification and acceptance values to determine if the Contractor's acceptance values or additional testing is required to obtain values to compute the Lot pay factor for in-place density. Follow the procedures specified in the Contract to perform this task. The District

Asphalt Manager will immediately investigate (e.g., additional testing, observation of Contractor's procedures) recurring problems and, as needed, halt production of the HMA mixture.

401.2.10 Acceptance Procedures (SCDOT)

401.2.10.1 HMA Main-Line Paving

Main-line paving refers to the construction of an HMA roadway pavement, including shoulders, ramps and acceleration/deceleration lanes. The Contract will define the following:

- acceptance procedures for the HMA mixture and mat;
- allowable deviations for HMA mixture properties in the Job Mix Formula;
- specification limits for test parameters;
- method for determining percent within limits; and
- methods for determining pay factors for base, intermediate and surface courses.

Only those tests specified as acceptance tests will be used in computing pay factors. The Contractor will be responsible for performing the required quality control and acceptance tests. To assess acceptability, SCDOT will utilize and compare the Contractor's acceptance tests with those obtained from SCDOT verification tests. As needed, the District Asphalt Manager, Asphalt Materials Engineer or Resident Construction Engineer may conduct additional testing and monitor the Contractor's procedures to assess problems and verify compliance.

401.2.10.2 HMA Non Main-Line Paving

Non main-line paving refers to the HMA courses that are not controlled by density requirements, which generally include patching, leveling, less than 8-foot widening, wedges and driveways. The acceptance and pay factors for non main-line paving for %AC, %AV, and %VMA will be based on the absolute average difference from the target value for each acceptance characteristic. The Contract Specifications will define the following for non main-line paving:

- acceptance procedures for the HMA mixture and mat;
- method for determining average absolute difference; and
- method for determining pay factors for non main-line paving lots.

Only those tests specified as acceptance tests will be used in computing pay factors. The Contractor is responsible for performing the specified quality control and acceptance tests. To assess acceptability for payment, SCDOT will utilize and compare the Contractor's acceptance test values with those obtained from SCDOT verification tests. As needed, the District Asphalt Manager, Asphalt Materials Engineer or Resident Construction Engineer may conduct additional testing and monitor the Contractor's procedures to assess problems and verify compliance.

401.2.10.3 HMA Low-Tonnage Paving

Low-tonnage paving refers to production of a specific HMA mixture on a project as described in the Contract Specifications. The acceptance and pay factors for low-tonnage paving for %AC, %AV and %VMA will be based on the absolute average difference from the target value for each acceptance parameter. The Contract Specifications will define the following for low-tonnage paving:

- acceptance procedures for the HMA mixture and mat;
- specification limits for test parameters;
- method for determining percent within limits; and
- method for determining pay factors for low-tonnage lots (i.e., density and non-density).

Only those tests specified as acceptance tests will be used in computing pay factors. The Contractor is responsible for performing the specified quality control and acceptance tests. In-place density acceptance tests do not apply. To assess acceptability for payment, SCDOT will utilize and compare the Contractor's acceptance test values with those obtained from SCDOT verification tests. As needed, the District Asphalt Manager, Asphalt Materials Engineer or Resident Construction Engineer may conduct additional testing and monitor the Contractor's procedures to assess problems and verify compliance.

401.2.11 <u>QC / QA Program Documentation Requirements</u>

The HMA Quality Manager will ensure that all quality control and acceptance inspections and test results are recorded and maintained daily on the appropriate SCDOT Construction Forms, including all observations, records of inspection, mixture adjustments and corrective actions. The HMA Quality Manager will submit this documentation to the District Asphalt Manager, Asphalt Materials Engineer or Resident Construction Engineer, as appropriate, within 30 calendar days of completing the HMA work on the project. The District Asphalt Manager, Asphalt Materials Engineer or Resident Construction Engineer will provide the HMA Quality Manager with reproducible or printable copies of the appropriate SCDOT Construction Forms. During prosecution of the work, verify that these records are being properly maintained and review the documents, as needed, to ensure compliance. All SCDOT personnel are required to maintain thorough and accurate project records in the Daily Work Report and appropriate SCDOT Construction Forms.

401.3 AGGREGATE MATERIALS

401.3.1 <u>Sources of Aggregate Materials</u>

Aggregate materials are commonly used for subbase, base course, Portland cement concrete, drainage features and HMA mixtures and are obtained from excavating pits or by dredging water courses. Explosives are commonly used to blast the rock material in roadway cuts and hillside or subsurface quarries, which will then be processed through crushers to reduce the size of the rock particles, alter their shape and create one or more fracture faces on each particle.

401.3.2 Aggregate Components of HMA Mixtures

401.3.2.1 Coarse Aggregate

Pay attention to the type of HMA surface course to be constructed because the requirements for coarse aggregate will differ based on the type of HMA mixture specified. The coarse aggregate component may consist of crushed stone, gravel, slag, reprocessed aggregate from SCDOT RAP milling projects, or a combination of these materials. Coarse aggregate material must be supplied from a source listed on SCDOT Approval Sheet 2. Prior to production, properties such as density, abrasion loss, fractured faces, gradation, sodium sulfate soundness and maximum absorption will be evaluated by the Research and Materials Engineer to assess suitability. Sampling and testing procedures SC-T-89, AASHTO T 96, AASHTO T 85 and AASHTO T 104 will be used to assess compliance. Other test procedures may be necessary as determined by the District Asphalt Manager or Research and Materials Engineer. To facilitate mix control, the source of aggregate material should not be changed during production.

401.3.2.2 Fine Aggregate

Depending on the type of HMA course to be constructed, the fine aggregate component of the HMA mixture may consist of sand; stone, slag or gravel screenings; or a combination of these materials. Fine aggregate material must be supplied from an approved SCDOT source, as listed on SCDOT Approval Sheet 1. The sampling and testing procedures SC-T-5 and SC-T-34 will be used to evaluate sand, and SC-T-5 and AASHTO T 176 will be used to evaluate screenings. The District Asphalt Manager or Research and Materials Engineer will ensure that the fine aggregate materials stockpiled at the plant are sampled and tested for compliance verification.

401.3.2.3 Mineral Aggregate and Filler

Depending on the gradation requirements of the type of HMA course to be constructed, the mineral aggregate required for the HMA mixture may be composed of fine aggregate material or a combination of coarse and fine aggregate materials. Note that the use of chrome slag is prohibited in HMA surface courses. To facilitate proportioning at the plant, the coarse and fine aggregate components will be stored separately in cold-feed bins, and the percent of each component, coarse and fine, will be based on the material retained or passing the No. 4 sieve, respectively. The District Asphalt Manager or Research and Materials Engineer will ensure that gradation and effective specific gravity of mineral aggregate are tested for compliance verification and that mineral filler conforms to the requirements of AASHTO M 17. Mineral filler is added for stabilization, but the quantity and type added can significant affect the mixture. If too much is added, the mixture may be difficult to roll and may become hard and brittle. During production, the source of mineral filler should not be changed and the amount added should be closely monitored. Note that mineral fillers must be kept dry in storage. If too much moisture is present, the mixture will look shiny and foamy, and the HMA will flatten in the truck bed.

401.3.2.4 Crusher-Run Material

The use of crusher-run material in HMA mixtures is prohibited, with the exception of select low-volume HMA mixes. If it is evident or suspected that crusher-run material is causing segregation in the mix, require the producer to screen the material so that the coarse and fine components can be separately stored in cold-feed bins and combined in the proper proportion at the plant.

401.3.3 Sampling Aggregate Materials

Unless an aggregate sample is truly representative of the material to be tested, the test results may be useless. Sampling accuracy is just as important, if not more so, than testing accuracy. Consider the following when obtaining aggregate samples from plant stockpiles:

1. Coarse Aggregate. Where coarse aggregate samples are obtained from plant stockpiles, the samples should be taken at random locations at or near the top of the stockpile, the base of the stockpile and at some intermediate point. When obtaining the sample, shove a board or piece of metal into the pile of material to prevent it from segregating while the sample is being removed.

2. Fine Aggregate. Where fine aggregate samples are obtained from plant stockpiles, first remove the dry layer of fines where most segregation occurs. Sample the wet or damp material underneath by inserting a sampling tube approximately 1.25 inches in diameter and 6 feet long into the material to obtain the sample.

It is difficult, but not impossible, to obtain accurate and representative samples from plant stockpiles. It is therefore good practice, where practical, to obtain aggregate samples from the cold-feed belt at the plant. Use caution when obtaining aggregate samples from the cold-feed belts. It is first necessary to stop the belt. Then, randomly select an area approximately 3 feet long for the sample. Use a board at each end of the sample to prevent segregation. Clean the entire sample area of the belt, and use a sample splitter to reduce the sample size, if necessary.

401.3.4 Aggregate Proportioning

Many methods are available to proportion aggregate materials to achieve the gradation for the HMA mixture; however, the most common method is trial and error used in conjunction with sound engineering judgment and experience. Generally, all that is needed for the procedure is a mechanical shaker, calculator, pencil and paper. The procedures are as follows:

- select the critical sieves for the blend and the initial proportion settings;
- calculate the blend on each sieve and check the blend against the specified limits; and
- adjust the proportion, as needed, to meet the specified limits.

401.4 ASPHALT MATERIALS

401.4.1 Types of Asphalt Materials

The following describes the types of asphalt materials typically used for HMA mixtures, asphalt tack coats and asphalt prime coats:

1. Asphalt Binder. The term asphalt binder refers, generically, to the asphalt material that is used in HMA mixtures to help bind aggregate particles together. The material is solid or semisolid at ambient temperature and is liquefied by the application of heat. Consider the following:

    a. Asphalt Cement. The term asphalt binder is not synonymous with the term asphalt cement. Asphalt cement is an asphalt binder that is graded based on viscosity and penetration values obtained through standardized testing, predicated on an older grading system. The nomenclature for asphalt cement includes, for example, AC-20 and AC-30. Asphalt cement is rarely used by SCDOT in HMA mixtures.

    b. Performance Graded (PG) Binder. Performance graded binders are based on a performance based specification developed by the Strategic Highway Research Program as part of the Superpave Method of HMA design. The nomenclature for performance graded binders includes, for example, PG 64-22 and PG 76-22. Performance graded binders are used exclusively by the Department for HMA mixtures.

    c. Polymer Modified Asphalt (PMA) Binder. A polymer modified asphalt binder, meeting the requirements of PG 76-22, is typically specified when high traffic loads are of concern. Prior to loading and transport, an elastomer polymer material is blended with a PG 64-22 or PG 67-22 base binder material to meet the specification.

2. Emulsified Asphalt. Emulsified asphalt is an emulsion of asphalt material, water and emulsifying agent that is used for various applications in HMA pavement construction, typically tack coats. It is liquid at ambient temperature. The components of asphalt emulsions tend to separate over time.

3. Cutback Asphalt. Cutback asphalt is a blend of asphalt material and petroleum solvents that is used for various applications in HMA pavement construction, typically asphalt prime coats on subgrade. It is liquid at ambient temperature. Cutback asphalts lose their volatile spirits by evaporation.

Asphalt materials must be supplied from SCDOT-approved sources as listed on SCDOT Approval Sheet 37, for asphalt binders, and Approval Sheet 38, for emulsion and cutback asphalts.

401.4.2 Properties of Asphalt Materials

Asphalt materials, such as asphalt binders for HMA mixtures, are suitable for highway construction because they are adhesive, waterproof, durable and flexible. The flowability (i.e., viscosity) and the specific gravity of an asphalt material changes with temperature. The higher the temperature, the more flowable the material becomes and the greater its volume becomes at the same weight. To assess the material's susceptibility to temperature with respect to flow, the viscosity of the material is typically measured. The specific gravity of asphalt material does not vary substantially with temperature; however, the volume of a given weight of asphalt material will increase with increasing temperature. This property must be considered when determining quantities of liquid asphalt material. Consider the following:

- ensure hauling and storage containers are clean to avoid cross-contamination;
- check storage tanks and coils regularly for signs of damage and leaks;
- ensure a calibrated thermometer is used to obtain temperature readings;
- record the material temperature in the tank regularly and safely;
- ensure the temperature is maintained far below the material's flash point;
- do not take readings near heating coils or the shell or bottom of the tank; and
- use the proper temperature-volume conversion factor to calculate quantities.

401.4.3 Performance Graded Binders

Prior to Superpave, asphalt binders were typically graded and selected based on viscosity and penetration values obtained from standardized tests. These asphalt binders, or asphalt cements, were commonly specified with nomenclature such as AC-20 and AC-30. Performance graded binders are based on a new performance based specification, developed as part of the Superpave Method. The physical properties of performance graded binders are identical to asphalt cements; however, the method of specifying and selecting the binder for an HMA mixture has changed and depends on the pavement's geographic location and application. Binder selection is based on factors such as climate, pavement temperature and traffic loading. Consider the following nomenclature for performance graded binder PG 64-22:

1. PG. The PG in PG 64-22 stands for "Performance Grade."

2. 64. The 64 in PG 64-22 indicates that the binder's physical properties must meet the high temperature requirements at least up to 64°C (147°F), which represents the average 7-day consecutive maximum design temperature. This number would be the high pavement temperature in the climate in which the binder is expected to serve.

3. -22. The -22 in PG 64-22 indicates that the binder's physical properties must meet the low temperature requirements at least down to -22°C (-8°F), which represents the minimum 1-day design temperature. This number would be the low pavement temperature in the climate in which the binder is expected to serve.

401.5 ANTI-STRIPPING MATERIALS

An anti-stripping additive is typically used in an HMA mixture to help prevent the asphalt binder from stripping off the aggregate under the influence of moisture and traffic. Liquid anti-stripping agents must be supplied from SCDOT-approved sources and their use must be approved by the Research and Materials Engineer. If hydrated lime is approved for use as an anti-stripping additive, verify that it conforms to the requirements of AASHTO M 303, Type 1 and is supplied from an SCDOT-approved source, as listed on SCDOT Approval Sheet 39. Alternatively, as approved for use, hydrated lime will be added at a specified rate as a percentage of the weight of dry aggregate.

401.6 RECYCLED MATERIALS

401.6.1 <u>Recycled Asphalt Pavement (RAP)</u>

401.6.1.1 SCDOT RAP Milling Projects

As an integral part of the Department's pavement rehabilitation program, SCDOT routinely performs milling projects on asphalt pavements. The material removed from the surface of the old asphalt pavement will be either reused or disposed of at an approved site. If disposed, the Contractor must dispose of the material in accordance with the requirements of and at a site approved by SCDHEC. However, the milled material, or RAP, tends to be a good source of aggregate and asphalt binder material for new HMA courses. If the RAP material is recycled, it will be properly stockpiled for use on other SCDOT projects. There are critical administrative and testing requirements associated with managing RAP stockpiles and using RAP in new HMA mixtures.

401.6.1.2 RAP Stockpiles

When RAP material is permitted in an HMA mixture it should be free of debris, properly crushed, uniformly graded and stockpiled at an HMA plant. RAP stockpiles will be thoroughly tested prior to use and must be identified and maintained separately. Stockpile identification numbering is critical to SCDOT operations and will be strictly enforced to minimize intermingling of different RAP materials, which causes production problems after the stockpile has been tested and approved for use. The HMA Quality Manager will be responsible for maintaining records at the plant for all RAP stockpiles used on the project.

The District Asphalt Manager will visually inspect RAP stockpiles to ensure compliance. Ensure that stockpile numbers are used to properly track materials from source through production.

401.6.1.3 Recycled HMA Mixtures

The Contract Specifications will define the allowable percent RAP in each mixture; however, a limited amount of RAP will be permitted if the material is introduced in the plant's hot elevator. The percent RAP will directly affect the quantity of screenings and No. 789 stone used in the recycled HMA mixture. The HMA Mix Design Technician will be responsible for submitting the following to the Research and Materials Engineer for approval:

- RAP stockpile records, including results of extraction testing;
- sample of stockpiled RAP material or cores from pavement to be milled; and
- Job Mix Formula reported on Research and Materials Laboratory Form 269.

Note that if the RAP material to be used in the recycled HMA mixture has not yet been milled and stockpiled, extraction testing will be based on a specified minimum number of extraction tests and random field tests conducted by the Research and Materials Engineer or District Asphalt Manager, as appropriate. Approval of the recycled asphalt binder will be based on viscosity criteria in accordance with the specifications.

401.6.2 <u>Asphalt Roofing Shingles</u>

401.6.2.1 Source of Shingles

Asphalt roofing shingles found in construction debris are a potential material source for HMA mixtures. The shingles are generally obtained from landfills, cleaned of foreign matter (e.g., nails) and ground at ambient temperature so that the size of the remaining particles are smaller than 0.5 inch. The shingle material must be free of hazardous materials (e.g., asbestos) and meet the environmental requirements of SCDHEC.

401.6.2.2 Use of Shingles in HMA Mixtures

The use of recycled asphalt shingles is permitted in an HMA mixture, as specified. The Job Mix Formula for each type of mixture will define the allowable quantity of shingles and is generally limited to 3% to 8% by total weight of aggregate. The Job Mix Formula, will be submitted to the Research and Materials Engineer for approval and include the proposed type and quantity of recycled shingles, fine and coarse aggregates, asphalt binder and anti-stripping additive. Gradation and asphalt binder content will be tested in accordance with AASHTO T 27 and SC-T-75, respectively. Because the shingle material contains asphalt material, a correction factor will need to be applied to determine the correct quantity of virgin asphalt binder required for the mixture.

401.7 DESIGN OF HMA MIXTURES

An HMA mixture is a combination of high quality aggregate, asphalt binder and admixtures. The mixture will be designed to meet the physical and chemical properties specified for the particular type of HMA course to be constructed. HMA mixtures are designed by the Contractor and approved by the Research and Materials Engineer.

401.8 HMA MIX PRODUCTION AND HAULING

401.8.1 General

HMA plants mechanically blend aggregate and asphalt binder materials together to produce a hot, homogeneous paving mixture. The HMA Quality Manager, District Asphalt Manager and Research and Materials Engineer are responsible for verifying plant conditions and operations (e.g., certification, scales and weights, materials, mix proportions, mix temperatures). Before production, become familiar with the features of the type of plant being used and thoroughly examine the plant for compliance with the Contract Specifications. Any mechanical or safety deficiencies should be corrected immediately. The Contractor is responsible for ensuring that the plant laboratory is provided in accordance with the Contract Specifications. The laboratory should be located so that production operations are readily visible. The laboratory should contain copies of all necessary reference materials applicable to the project.

401.8.2 Plant and Production Considerations

Consider the following during HMA plant and production inspection:

1. Use of Multiple Plants. The use of multiple plants to supply HMA on a day-to-day basis is generally not permitted unless needed for separate paving operations at different locations on the project. Prior SCDOT approval is required.

2. QC / QA Procedures. Before production, check the Contractor's Quality Control Plan for compliance with the Contract Specifications, and ensure the Contractor has provided the required number and type of Certified HMA Technicians. Make sure you understand both Contractor and SCDOT responsibilities with respect to quality control, verification and acceptance procedures. During production, check that the HMA Technicians are sampling and testing in accordance with the Quality Control Plan. Make sure the Contractor submits the required test reports in a proper and timely manner.

3. Plant Laboratory. Check that the plant laboratory has been certified by the Research and Materials Engineer for compliance with the Contract Specifications, and ensure all test equipment has been properly calibrated.

4. Storage Silos. Requests for overnight storage of HMA will be evaluated based on SC-T-79 and must be approved by the Asphalt Materials Engineer. Reject HMA stored in a silo that does not comply with specified requirements.

401.8.3 Loading and Hauling Considerations

Consider the following during loading and hauling inspection of the HMA mixture:

1. Scale Certification. Check that the truck scale has been properly certified. The seal of current approval should be affixed to the scale.

2. Truck Weighing. Frequently check the truck weighing process to ensure that it is in compliance with the requirements of the Contract Specifications. Pay particular attention

to the weighing platform. It should be clean and free to move with no binding. Check that scale tickets have complete and proper information and are supplied with each load of mix.

3. Release Agents, Tarps and Insulation. Visually inspect haul trucks and truck beds for compliance during loading. Release agents must be supplied from an SCDOT-approved supplier, as listed on SCDOT Approval Sheet 17. Ensure that truck beds are clean, with no foreign substances or dried chunks of mix present. Ensure that proper tarps in good condition are being used on every load.

4. Truck Loading. If trucks are not loaded properly, segregation of the mix is inevitable. Trucks should be laterally centered (i.e., left to right) under the discharge gate of the surge silo. Do not allow trucks to be loaded in one big dump or by slowly driving forward while dropping the mix from the silo. Trucks should be loaded in multiple (e.g., first drop at the rear, second drop at the front, alternating drops in between). From three to seven drops may be necessary depending on the size of the truck (e.g., single unit, semi). Under no circumstance allow the mix to dribble from the bottom gate of the surge silo into the bed of the truck.

5. Mix Appearance. Develop a mental picture of the appearance of the proper mixture when loaded in the truck. A load of mix that peaks more than usual is an indication of a lean mix (i.e., too much fines and/or insufficient asphalt binder). A load that flattens in the truck bed indicates a fat mix (i.e., too much asphalt binder, too much coarse aggregate, and/or insufficient fines). Occasionally check with the Resident Construction Engineer at the laydown and compaction site concerning the workability and uniformity of the mixture being delivered.

401.8.4 Production and Hauling Inspection – Summary

401.8.4.1 Component Materials and Job Mix

The District Asphalt Manager or SCDOT Plant Inspector, as assigned, should inspect the materials and mix at the HMA plant as follows:

- Verify there is an approved Job Mix Formula for the project.
- Check that materials on the Job Mix Formula are being used in the mix.
- Verify compliance of fine and coarse aggregates with Contract Specifications.
- Check that aggregates in stockpiles and bins are not intermixing.
- Verify aggregate stockpiles are constructed to avoid segregation and contamination.
- As applicable, verify compliance of the HMA mixture with respect to:

  - gradation,
  - asphalt binder content,
  - dust-to-asphalt ratio,
  - gradation spread between sieves,
  - air voids,
  - voids in mineral aggregate,

- stability,
- lime rate, and
- other mix properties, as applicable.

401.8.4.2 Production and Hauling Equipment

The District Asphalt Manager or SCDOT Plant Inspector, as assigned, should inspect HMA plant equipment and operation as follows:

- Verify compliance with Contract Specifications and SC-T-94.
- Check that equipment is in good mechanical condition.
- Verify approval of hydrated lime system by Research and Materials Engineer.
- Check proper operation of baghouse.
- Ensure fines are properly reintroduced into the mix.
- Check that scales have been certified within the last 6 months.
- Check the adequacy and accuracy of the plant scale tickets.
- Check compliance of haul trucks and truck-bed covers.
- Verify use of approved release agent in truck beds.
- Ensure field laboratory has been approved by Research and Materials Engineer.
- Verify loader operator is working the full face of stockpiles.

401.8.4.3 Production, Loading and Hauling Operations

The District Asphalt Manager or SCDOT Plant Inspector, as assigned, should inspect production operations at the HMA plant as follows:

- Verify Contractor inspection, sampling and testing of mix production is adequate.
- Check compliance of asphalt binder, aggregate and mix temperature.
- Verify calibration of the plant by the Contractor.
- Verify that cold-feed bins are feeding properly.
- Check that the mix is uniformly coated with asphalt binder.
- Check for segregated mix in truck beds.
- Verify proper loading of trucks (i.e., front, back, middle).
- Verify that hydrated lime is feeding and mixing properly.
- Check that conveying device is depositing mix into center of silo or batcher.
- Verify that batcher is being used at top of the silo.
- Check for proper closure of gates on batcher.
- Ensure mix is not dribbled into truck to complete a load.

401.9 HMA MIX LAYDOWN AND COMPACTION

401.9.1 <u>General</u>

Although construction may take several months, public opinion of the Department is ultimately based on the final quality of the pavement and the effectiveness of traffic maintenance during construction. Unsafe or inefficient traffic operations during construction and bumps, choppy waves, long swells and the early appearance of cracks, potholes and raveling joints are highly criticized. The Resident Construction Engineer, Roadway Inspectors, HMA Quality Manager and Asphalt Roadway Technicians at the laydown and compaction site must be proactive in enforcing the Contract Specifications to ensure the provision of safe and efficient traffic operations and a smooth riding surface. The principal duties of the Resident Construction Engineer and Roadway Inspectors at the laydown and compaction site are to verify that the Contractor constructs the HMA pavement to the lines, grade and cross-section required by the Contract Plans and to the density, riding surface and texture required by the Contract Specifications. To achieve this objective, the Roadway Inspectors must continually monitor surface preparation, mix delivery, paving operations, compaction operations and the finished surface for compliance.

401.9.2 <u>Pre-Paving Considerations</u>

401.9.2.1 General

Prior to starting paving, become thoroughly familiar with the Contract Plans and Specifications, including the requirements of the Quality Control Plan, Job Mix Formula, Contractor's paving plan, and Traffic Control Plan. Verify that the proper Certified Asphalt Roadway Technicians, traffic control and paving and compaction equipment are in place and in conformance before paving begins. Inspect the paving surface for correct grade and cross-section and that the surface has been adequately prepared. If the paving surface is soil or aggregate, check that any required asphalt prime coat has been applied and properly cured and/or that water has been applied for dust control. To ensure paving continuity, check that pavement edges are marked at the correct width and grade by taut stringline or electronic paver guide.

401.9.2.2 Longitudinal Joint and Pavement Marking Plan

The Contractor and Resident Construction Engineer should review and agree on a plan for the location and configuration of longitudinal joints and pavement markings prior to beginning work. The longitudinal joint for the final lift should be offset 6" from the lane line.

401.9.2.3 Contractor's Paving Plan

Prior to the start of work, the Resident Construction Engineer and the Contractor should review the Contractor's plan for paving the project. Review the plan and discuss with the Contractor any needed adjustments. During the project, verify that the Contractor places the HMA as previously agreed upon.

401.9.2.4 Communications During Production and Paving

During the project, quality and safety depend on continued positive and meaningful communication between the Research and Materials Engineer, District Asphalt Manager, Resident Construction Engineer, Roadway Inspectors, HMA Quality Manager, HMA Mix Design Technician and Asphalt Roadway Technicians. Frequent informal meetings provide a forum for meaningful dialog to mitigate potential cost and scheduling problems. In addition, frequent communications between plant and project personnel provides critical feedback to ensure a quality pavement. Key points of discussion should be noted in the Daily Work Report.

401.9.2.5 Weather Considerations

Weather plays an important role in determining whether or not the Contractor should begin or continue with HMA paving, tacking or priming operations. Consider the following guidelines:

1. Wet Weather. Monitor the weather forecast regularly to assess the possibility of rain. The laydown surface must be dry (i.e., no standing water) and the weather conditions must permit the proper handling, finishing and compaction of the mix. If rain is imminent or the surface is wet – DON'T PAVE. As soon as practical, direct the HMA Quality Manager to consider halting production. Paving should not be started again until standing water is no longer visible on the surface. When downpours occur, the paver should be stopped, the receiving hopper covered and the crew advised to wait until there is no standing water on the surface.

2. Cold Weather. The ambient air temperature will be measured in the shade away from artificial heat with a calibrated thermometer in accordance with SC-T-84. During cold weather paving, measure temperature at least once an hour, monitor mix temperature for each truckload delivered and measure mat temperature at final density to ensure conformance with the Contract Specifications. Mix temperatures will be recorded on the mix delivery ticket and Daily Work Report.

401.9.3 Equipment Considerations

401.9.3.1 Paving Machines

One of the most important pieces of equipment is the paver. The paver must be capable of spreading and finishing the HMA mixture to the required cross-section and profile. The self-propelled paver must be equipped with a heated strike-off assembly or activated screed and either mechanical or automatic grade and slope controls. Automatic controls are necessary only if specified in the Contract. If automatic controls fail, allow the Contractor to complete the day's work via manual control. The controls must be fixed prior to resuming production. Check grade and slope controls periodically for proper working order. Consider the following additional points of inspection:

- hoppers and distribution screws or augers are in good condition;
- paver motor governor is operating smoothly without missing;
- track linkage, if present, is properly adjusted and tracks and pins are not excessively worn;

- pneumatic tires, if present, are inflated to correct pressure and chain drives are properly adjusted and not excessively worn;
- tamper bars are adjusted to correct RPM, proper clearance from screed, proper length of stroke and are not excessively worn;
- screed vibrator, if provided, is operating properly;
- strike-off plate is set at proper height above screed;
- screed plates are not excessively worn and are adjusted for proper height, crown and tilt;
- screed heater is operating properly;
- screed extensions, if used, are in a true plane and flush with screed bottom; and
- automatic controls for cross slope, thickness and longitudinal profile, including 40-foot long mobile stringline or ski, leveling reference and grade sensor, have been calibrated and are operating properly

Roadway Inspectors must be familiar with the surface defects that can be caused by improper adjustment or operation of the paver (e.g., segregation, tearing, shoving, gouging). Poor results will not be accepted. If adjusted and operated properly, little hand work should be required. Hand methods and special equipment may be used for small or irregular areas, if previously approved. However, it is poor practice to scatter loose material to improve mat texture due to paver problems. Proper paver speed will result in a quality mat with uniform texture and density across the full width, provided the mixture and other conditions are satisfactory. Paver speed must be in balance with mix delivery and sufficiently slow to avoid tearing the mat. If tearing occurs, repairs must be made and the paver speed adjusted. Stop and go operations of the paver should be avoided.

401.9.3.2 Compaction Equipment

Depending on the sequence of operation established by the Contractor for placing, compacting and finishing, the rollers used for breakdown, compaction and finishing rolling will include steel-wheel rollers, pneumatic-tire rollers, vibratory rollers, or some combination of the three. However established, the rolling operation must compact the HMA mat to target density and provide a smooth surface without excessively crushing the aggregate. Pneumatic-tire rollers are equipped with smooth tires of equal size and ply. Tire pressures and loading of the roller can be varied to achieve the desired contact pressure. Pneumatic-tire rollers should have a contact rolling width of not less that 60 inches and be capable of developing contact pressures from 40 to 90 pounds per square inch (80 psi is recommended). The tire pressure in all wheels should not vary more than 5 pounds per square inch. Vibratory rollers should weigh at least 8 tons with one or both wheels capable of vibrating. In inaccessible areas, hand held rollers and vibrating plates are generally used. Consider the following points of inspection:

- wheels are capable of rolling in a true plane and are free from flat spots or ridges;

- steering and driving mechanism is free of excessive play or backlash;
- motor and transmission free from leaks;
- roller's water tank, wetting mats and spray bars are properly operating;
- pneumatic tires are properly inflated and in good condition without wobble or creep;
- vibration and propulsion controls of vibratory rollers are set and operating properly; and
- total weight, weight per inch of width, average ground contact pressure and/or vibrations per minute and amplitude set and properly documented.

The compaction density obtained by pneumatic-tire and steel-wheel rollers is related to the weight, speed and the number of roller passes. A maximum speed of 3 miles per hour is recommended for steel-wheel static and vibratory rollers and 5 miles per hour for pneumatic-tire rollers. The density obtained by a vibratory roller is primarily related to the frequency (i.e., number of vibrations or downward impacts per minute, VPM) and the amplitude (i.e., the greatest amount of movement in one direction from a position at rest). As the vibratory roller travels, the vibrating drum produces rapid impacts on the surface of the mat. These impacts produce pressure waves of equal frequency that pass through the mix. The pressure waves cause the particles to move closer together, thus densifying the mix.

401.9.3.3 Miscellaneous Equipment

Where rumble strips will be constructed, verify compliance of the milling equipment. It is also good practice before the paving day begins to visually check to see that the Contractor has available an adequate supply of rakes, lutes, shovels, brooms and other needed miscellaneous equipment.

401.9.4 Surface Preparation Considerations

Before placement of the HMA mixture, the surface must be shaped to the correct grade and cross-section and properly prepared. The preparation activities primarily will depend on the type of surface over which the HMA will be placed. Consider the following:

1. Subgrade. The subgrade will be prepared in accordance with the requirements discussed in Section 208.

2. Subbase and Base Course. Subbase and base course will be prepared as discussed in the respective sections of Division 300.

3. Patching and Leveling. Depending on the condition of the underlying surface, rough and uneven asphalt surfaces are typically leveled by either placing a patching and leveling course or by milling high spots on the existing surface. The purpose of the patching and leveling course is to repair potholes, correct surface irregularities (e.g., short dips), shape the cross-section and raise the existing outside edge to provide a uniform template. If designated, the application of asphalt tack coat will be applied before the

patching and leveling course is laid. If patching and leveling is not specified in the Contract, ensure that the Contractor corrects surface irregularities with an appropriate mix material. Where extensive base failures are encountered and no Contract provisions are specified for repairs, notify the Resident Construction Engineer. It may be necessary to modify the Contract to correct the problem.

4. Full-Depth Patching. At locations designated by the Resident Construction Engineer, verify compliance of full-depth patching.

5. Cleaning and Sweeping. Once the underlying surface is repaired, the paving surface must be cleaned of all dust, dirt and caked or loose debris. This is usually accomplished using multiple passes of a mechanical broom and/or flushing with air or water. The limits of cleaning and sweeping are generally beyond the width of paving.

6. Asphalt Prime Coat. Prior to HMA paving, an asphalt prime coat is generally applied over new base construction such as sand-clay base course, coquina shell base course and macadam base course to prevent slippage and base shifting and to protect against weather. Note that an asphalt prime coat is not required when paving directly over the subgrade.

7. Asphalt Tack Coat. Prior to paving over existing pavement, unsealed asphalt surface courses and successive layers of Sand Asphalt Base Courses, including adjacent contact surfaces, an asphalt tack coat will be applied to promote bonding. Consider the following:

   a. Material. Asphalt tack coat will be either asphalt binder or emulsified asphalt. Note that emulsified asphalt must be diluted at the manufacturing plant, not at the project site. Check that the grade of material conforms to specified requirements. The nomenclature used is as follows:

      RS = Rapid Setting (cannot be diluted);
      MS = Medium Setting;
      SS = Slow Setting; and
      HF = High Float.

   b. Rate of Application. Check and record the rate of application on SCDOT Form 400.04 – Daily Report of Asphalt Road Inspection. SCDOT procedure SC-T-86 will apply. The specified rate will be verified and monitored throughout application by the Resident Construction Engineer. Verify uniform application and lapping. Hand sprayers should only be used where necessary, such as for inaccessible areas and contact surfaces. Ensure the Contractor cleans up overspray and does not foul traffic.

   c. Timing of Application. The application of asphalt tack coat should be far enough ahead of paving to allow curing, but not so far in advance that the tack loses its adhesiveness. Contact surfaces (e.g., headers, curbings, gutters, edges of existing pavement, manholes, catch basins) should be tacked just before HMA is placed against them.

401.9.5 Delivery of Mix

401.9.5.1 General

The construction of an HMA pavement begins with the delivery to the paving site of a workable mix that is proportioned and heated to conform to the requirements of the *Standard Specifications* and the Job Mix Formula. The pavement will not perform as intended if the temperature or material proportions exceed the limits specified for the type of HMA course being constructed. For example, if the quantity of asphalt binder is too low, the pavement will become brittle and crack under traffic loading. Brittleness also may occur if the binder material itself is too hard as a result of overheating the mix. Excessive binder material will cause the pavement to move under traffic and push up in waves or cause the binder itself to come to the surface, which causes a hazardous traffic condition during wet weather. During production, it is good practice to visually check the mixture for signs of unacceptability. If a problem is encountered or suspected, contact the HMA Quality Manager immediately to take corrective action.

401.9.5.2 Mix Temperature

Upon delivery to the spreader, mix temperature must be within tolerance of the limits specified in the Contract Specifications. Otherwise, the mix should be rejected. If cold weather production is approved the mix temperature should be increased, but not beyond the master temperature threshold. Monitor mix temperature at both the plant and the paving site. To obtain mix temperature, a calibrated dial-type thermometer can be inserted through the access panel in the gate of the haul truck. When operating under cold weather paving provisions, the temperature of each truckload should be recorded, checked for compliance and documented on SCDOT Form 400.04 – Daily Report of Asphalt Road Inspection.

401.9.5.3 Inspection Upon Delivery

Loads of mix must only be allowed to leave the plant if they can be placed and compacted the same day. To prevent unnecessary heat loss, the tarp over the truckbed should remain in place until just before the truck is emptied. Pay attention to the length of time the load remains in the truck. Excessive haul times and layovers promote heat loss, which may render the mix unacceptable. Visually inspect the mix for acceptability. It is better to reject a bad mix than to reject a bad pavement. Unacceptable mix should be rejected at the plant before it is hauled to the project; however, Roadway Inspectors and Asphalt Roadway Technician's must be able to spot non-complying mix before it is placed and compacted. In addition, a rapid means of communication between plant and roadway personnel is essential to establishing a workable mix and keeping load rejections to a minimum. There are several common mix deficiencies that should be monitored. Consider the following:

1. <u>Mix Temperature</u>. Reject the mixture if its temperature is not within tolerance of the Job Mix Formula and the master range of the Contract Specifications. A mix that is too cold may appear stiff or have an improper coating of the larger aggregate particles. A mix that is too hot may have blue smoke rising from the truck or spreader hopper. Temperature deficiencies are common and should be closely monitored and documented in the Daily Work Report.

2. Asphalt Binder Content. A mix that has too much or not enough asphalt binder should be rejected. If there is too much binder, the mix generally will not peak, but flatten in the truck bed. It may also appear slick under the paver screed. If there is too little binder, the mix may appear granular and lack a shiny black luster. The aggregate also may not be completely coated.

3. Aggregate Proportioning. Reject the mix if aggregate proportioning fails to meet specified requirements. A mix that has too much coarse aggregate generally will have a coarse appearance and exhibit poor workability (i.e., tough to spread and compact). A mix that has too much fine material will usually have a dull brown appearance and be difficult to work with.

4. Moisture Content. Too much moisture in the mix is grounds for rejection. A mix with too much moisture may have steam rising when dumped into the hopper and may be bubbling and popping.

5. Contamination. Check the mix for contamination, which may include gasoline, kerosene, oil, rags, dirt or trash that has inadvertently found its way into the mix. Minor contamination may be removed; serious contamination warrants rejection of the load.

6. Segregation. Segregation of the coarse and fine aggregate components is a very common problem with HMA mixtures and occurs because of improper handling and many other factors. Segregation is serious and is grounds for rejection.

7. Non-Uniform Mixing. Non-uniform mixing produces a mixture that contains spotty, dull brown appearing mix intermingled with mix that has a rich and shiny appearance. This type of mix is unacceptable and should be rejected.

401.9.6 Placement Considerations

Once production has been established, the Contractor will begin placing the mix. It is good practice for Roadway Inspectors to observe the paver operation for obvious substandard or improper operation. Soon after the first load of mix has been spread, check the surface of the mat to ensure that a uniform texture is achieved and that the thickness, grade and cross-section are in compliance with the Contract Plans. Ensure that the Contractor makes any needed repairs to the mat when the material is still hot and properly adjusts the paving operation. Consider the following guidelines:

1. Edge of Pavement. The exact edge of pavement should be established by a string or chalk line for a distance of not less than 500 ft ahead of the paving operation.

2. Screed Temperature. The screed should be heated to the proper temperature before the paving operation begins.

3. Transfer Operation. Verify that the haul truck aligns properly with the paver hopper. Haul trucks should not bump or transfer weight to the paver. Otherwise, the paver may be thrown off line, or the screed may be pushed into the mat. Each truck should stop short of the paver and allow the paver to pick up the truck instead of the truck backing up

and possibly bumping the paver. Use of a material transfer device (e.g., shuttle buggy) is encouraged.

4. Dumping Procedure. Before the tailgate of the truck is opened, verify that the operator first raises the truck bed to move the mix to the tailgate. Once the tailgate is opened, the mix will surge, not dribble, into the hopper, which minimizes segregation. Check that the truck bed is completely emptied. If mix is spilled on the roadway in front of the paver, ensure that it is removed before the paver moves ahead.

5. Hopper Level. Verify that the paver hopper is kept more than half full at all times. The mix level in the hopper should not drop below the bottom of the flow gates. The hopper should not be emptied to the point where slat conveyors are visible, and the hopper should not be so full that mix runs out the front.

6. Clinging Mix. Fresh hot mix that clings to the sides and corners of the hopper should be continually loosened and pushed into a relatively full hopper. Clinging mix cools rapidly and, if permitted to reach the mat, will result in a non-uniform surface texture. Verify that such mix is not pushed into the hopper. Wings on the paver can be folded into a full load if necessary; however, it is preferred that paver wings be dumped and the mix properly disposed of at the end of each day.

7. Paver Movement. The paver should be operated in manner to avoid gradual deceleration and acceleration. This will minimize imperfections and damage to the mat such as holes, tears and drags. Maintaining a constant paver speed will improve rideability. The operator should use the slowest paver speed that will accommodate production and delivery of the mix and maintain a constant head of mix in front of the screed. If the mix pulls or tears under the paver, suspend paving until the cause can be determined and corrected. The speed of the paver may be too fast.

8. Flow Control. Flow gates should be set at a height that permits the slat conveyor and auger to operate at close to 100% capacity. The key to a smooth surface is a constant head of mix in front of the screed, which depends on constant paver speed and continuous operation. The mix in front of the screed should be located near the center of the auger shaft. If automatic flow-control devices are used, the flow-control device should be set at a location near the end plate. This will cause the auger to run continuously and maintain a constant head in front of the screed; otherwise, mix may be carried at the screed's outside edge.

9. Thickness, Grade and Slope Controls. Prior to paving, thickness, grade and slope controls should be established and then monitored during paving for proper operation. If automatic screed controls are used for grade and slope adjustment, it is good practice for the Roadway Inspector to become familiar with their proper operation. Consider the following:

    a. Screed Adjustment. The paver operator should not adjust thickness controls for the purpose of changing the screed's angle of attack, unless the mat thickness actually needs to be adjusted.

    b. Grade Sensor. The grade sensor should be in constant working order. If the wand is raised through input from the stringline or mobile reference, there should be a corresponding movement of the actuator. If not, sensitivity adjustments may be needed. During paving, sensor indicators should properly indicate the signal being received.

c. Tow-Point Actuator. The movement of the tow-point actuator should be smooth, without a constant up and down movement.

d. Stringline. If a stringline is used as the grade reference, the line should be taut without sags between vertical supports, as visually verified by sighting down the line. The vertical supports must not interfere with the path of the wand. Once set, the integrity of the stringline should be protected.

e. Mobile Reference. If a mobile reference (e.g., 40-foot ski) is used for grade control, its length should be sufficient to compensate for variations in surface elevation, and each shoe should be checked to ensure that it is clean and free to move. The sensor should be checked for proper operation.

f. Joint Matching Shoe. If a joint matching shoe is used for grade control, check the shoe for proper operation. It should be clean and free to move.

g. Combined Grade/Slope Control. If the paver has grade control on one side and slope control on the other, regularly check the cross slope for compliance. This is particularly important on wide paving jobs.

h. Failure of Automated Controls. If the automated control system of the paver fails, suspend paving until the Contractor fixes the control system.

10. Joint Alignment. Joints in a lift or course should be offset from the joint in the underlying lift or course in accordance with the Contract Specifications.

11. Temperature of Underlying Lifts. Prior to paving a subsequent lift, check to ensure the interior of the previous lift has cooled appropriately (i.e., typically to about 175°F).

12. Spread Rate. Verify that project stationing has been clearly marked for the purpose of documenting mix placement and yield checks. Review the method that will be used to perform rate checks. The procedures of SC-T-85 will apply. The rate should be checked frequently to ensure the proper quantity of mix is being placed.

13. Hand Methods. Approved hand methods will be used to place mix in areas that are inaccessible to the paver (e.g., turnouts, driveways). Verify that raking is performed without causing the mix to segregate or requiring excessive rework.

14. Height Above Adjacent Structures. Verify that the final surface is approximately 0.25 inches above the edges of adjacent structures such as gutters and manholes.

401.9.7 Compaction Considerations

401.9.7.1 General

The Contractor will be responsible for establishing the number, type and pattern of rollers needed to achieve target density in the HMA mat and for monitoring the density obtained during compaction. Approved hand methods will be used for those areas inaccessible to rollers. The Resident Construction Engineer and Roadway Inspectors will be responsible for verifying and assessing Contract compliance and adjusting payment, if necessary. Sampling, testing and documentation procedures differ based on the type of HMA course being constructed. Know the quality control, acceptance and verification responsibilities of Contractor and SCDOT personnel with respect to sampling, testing and documentation (e.g., SC-T-65, SC-T-101), in-place density, density gauge testing, core sampling and testing. Documentation of the compaction operation and the density obtained are critical project records. Use SCDOT Form 400.16 – In Place Density Contractor QA or SCDOT Form 400.17 – In Place Density Contractor QC / QA PWL, as appropriate.

401.9.7.2 Maximum Compacted Lift Thickness

Based on the thickness specified for the HMA course to be constructed, the course may need to be constructed in multiple lifts. To compensate for the densification that occurs during compaction, the paver will need to place the mixture in a thicker layer than that required for the compacted lift, subject to this maximum criteria. The final compacted lift thickness should not exceed the specified maximum.

401.9.7.3 Factors Influencing Compaction

Factors such as aggregate, asphalt binder, mix properties, mix temperature, lift thickness and weather conditions will affect the compaction of HMA courses. Use Figure 401A to guide decision making when evaluating problems and potential changes to the compaction operation.

401.9.7.4 Temperature Susceptibility

The time available for compaction is related to temperature and the thickness of the HMA material being placed. An increase in lift thickness can substantially increase the time available for the roller to densify the mix. Mix temperature greatly influences the compaction operation and affects mix stiffness and workability. If too high, the mix will move or shove under the roller. If too low, the mix will be difficult to compact. The proper mix temperature will allow sufficient time to achieve the required density before the mat cools too much for further rolling to be effective. An increase in laydown temperature can significantly increase the amount of time available for compaction; however, the feasibility of using this approach depends on the properties and tenderness of the mix at the selected temperature and compaction effort. Ambient temperature is a primary consideration, particularly in the spring and fall seasons. As needed, contact the Asphalt Materials Engineer for information on mix temperature and optimum compaction time. The required density should be obtained prior to the mat temperature reaching 175°F. Mat temperature is normally measured using a non-contact infrared thermometer.

The "tender zone" is a temperature range where compactive effort causes the mix to move or shove under the roller. Above and below the range of the tender zone, the mix is generally stable enough to be rolled. The tender zone greatly affects the rolling sequence and the time allowed for compaction, especially during hot weather. For example, because tender mixes generally cure much slower, the finish rolling operation can be significantly delayed. Tenderness occurs more often with fine-graded surface mixtures and mixes with high asphalt binder content and excessive moisture. Some mixtures can sometimes be problematic, because they often exhibit tenderness within the temperature range required for target density.

Where mix tenderness becomes an issue, it is desirable to compact the mix to target density at a temperature above the tender zone. This may be achieved by performing breakdown and intermediate rolling immediately behind the paver and finish rolling at a temperature below the tender zone. If unsuccessful, breakdown rolling should commence immediately behind the paver and both intermediate and finish rolling should begin as soon as the mix becomes stable. The latter, however, may result in compaction occurring at a temperature less than the desired minimum of 175ºF. Under such situations, the criteria specified in the Contract for minimum density and minimum temperature requirements may be in conflict. It is generally more important to obtain target density than it is to conform to the specified minimum temperature requirement.

The compaction equipment and procedures established by the control strip should be used to circumvent anticipated problems with tender mixes. Be aware, however, that inadvertent changes in mix production (e.g., excessive binder content, wet aggregate, improper gradation) can change the behavior of the mix with regard to the tender zone and should be closely monitored during compaction. If problems are experienced during the project, contact the Research and Materials Engineer for guidance and recommendations.

401.9.7.5 Roller Pattern and Speed

The optimum combination of rollers and the roller pattern for one type of HMA material may not be the same as that required for another. Test sections, such as control strips, are used to establish the most effective combination of rollers and patterns to obtain target density in the HMA mixture being produced. It is not good practice to make more roller passes than required to obtain target density. Two rollers running side by side may produce better results than two rollers operated end to end behind the paver. In general, the compaction operation will be sequenced as follows:

1. Breakdown Rolling. Breakdown rolling is the first series of passes of rollers on the freshly placed mat just behind the paver. It is used to breakdown and consolidate the mix.

2. Intermediate Rolling. Intermediate rolling is the second series of passes of rollers and takes place just after breakdown rolling. It is typically performed to obtain the required mat density before the mix cools to 175ºF.

CHARACTERISTIC	INFLUENCE	COUNTERMEASURE
Aggregate		
Smooth Surfaced	Low interparticle friction.	Use light rollers. Lower mix temperature.
Rough Surfaced	High interparticle friction.	Use heavy rollers.
Unsound	Breaks under steel-wheeled rollers.	Use sound aggregate. Use pneumatic rollers.
Absorptive	Dries mix – difficult to compact.	Increase asphalt binder in mix.
Asphalt Binder		
High Viscosity	Particle movement restricted.	Use heavy rollers. Increase temperature.
Low Viscosity	Particles move easily during compaction.	Use light rollers. Decrease temperature.
High Content	Unstable and plastic under roller.	Decrease binder in mix.
Low Content	Reduced lubrication – difficult to compact.	Increase binder in mix.
Mix Properties		
Excess Coarse Aggregate	Harsh mix – difficult to compact.	Reduce coarse aggregate.
Excess Sand	Too workable – difficult to compact.	Reduce sand in mix. Use light rollers.
Too Much Filler	Stiffens mix – difficult to compact.	Reduce filler in mix. Use heavy rollers.
Too Little Filler	Low cohesion – may come apart.	Increase filler in mix.
Mix Temperature		
High Temperature	Mix lacks cohesion – difficult to compact.	Decrease mix temperature.
Low Temperature	Mix too stiff – difficult to compact.	Increase mix temperature.
Course Thickness		
Thick Lifts	Holds heat – more time to compact.	Roll normally.
Thin Lifts	Loses heat – less time to compact.	Roll before mix cools. Increase mix temperature.
Weather Conditions		
Low Air Temperature	Cools mix rapidly.	Roll before mix cools.
Low Surface Temperature	Cools mix rapidly.	Increase mix temperature.
Windy Conditions	Cools mix – crusts surface.	Increase mix temperature.

FACTORS INFLUENCING COMPACTION OF HMA MIXTURES
Figure 401A

3. <u>Finish Rolling</u>. Finish rolling is performed after intermediate rolling to improve the finish of the surface. It is performed while the mix is warm enough to permit the removal of roller marks.

Once the roller pattern has been established to obtain target density for the mixture, the method should not changed unless the mixture or lift thickness changes. Monitor the roller pattern to ensure that the same compactive effort is being applied at all points transversely across the lane being paved. The following rolling sequence, in the order listed, is generally used when paving with two pavers (i.e., in tandem) or abutting a previously placed lane:

- transverse joints,
- longitudinal joints,
- edges,
- breakdown rolling,
- intermediate rolling, and
- finish rolling.

Rollers should be oriented with the drive wheel toward the paver. Rolling should begin at the edge of the pavement and proceed longitudinally parallel to the roadway centerline. Each trip should overlap the proceeding trip. Rolling should gradually progress from the edge of the pavement to the crown of the cross-section. On superelevated curves, rolling should begin at the low side and progress to the high side by overlapping longitudinal strips parallel to the centerline. Breakdown and intermediate rollers should be operated with the drive wheel as close to the paver as practical. Roll as close to the paver as the stability of the mix will permit. Shoving or cracking of the mat or having the mix pick up on the roller wheels is a sign of mix instability and tenderness. If the mat is unstable or subject to too much lateral displacement, drop the rollers back a sufficient distance behind the paver to eliminate displacement and not unduly influence the pattern for intermediate and finish rollers. The finish rolling should be completed while the mat is sufficiently workable for the removal of roller marks.

Establishing roller speed is very important. A decrease in speed will increase the compactive effort applied to the mix; however, the objective is to obtain target density before the mix cools below the minimum specified temperature. Roller speed will depend on the roller type and its position in the roller pattern. A maximum speed of 3 miles per hour is recommended for steel-wheel static and vibratory rollers and 5 miles per hour for pneumatic-tire rollers. In general, rollers should be operated at a slow and uniform speed with smooth deceleration and acceleration to avoid shoving the mix. Rollers that are used in the breakdown position are generally run at approximately 2.5 to 3.0 miles per hour. If rollers cannot keep up with the paver because of laydown productivity, do not change the rolling pattern or increase the roller speed. Add another roller or slow down the paver to better balance compaction with production.

During rolling, the roller wheels should be kept moist with only enough water to avoid picking up the mix. This, as well as tire temperature, is especially important where pneumatic-tire rollers are used. Changes in direction should be effected gradually and rollers allowed to roll or slowly brake to a complete stop before reversing. Stopping points for alternate trips should be staggered at least 3 feet. It is best to park rollers off of the new mat, or on a portion that has cooled; however, where rollers have to park on the mat, they should do so at a 45-degree angle with the centerline so that subsequent rolling will remove any depressions.

401.9.7.6 Vibratory Roller Considerations

Compaction of an HMA course is a complex process made even more complicated by the use of vibratory rollers. Various makes and models are available for various compaction needs. This section emphasizes their characteristics and proper operation, with which the Roadway Inspector should become familiar. The addition of a vibratory mode to static rollers makes it possible to increase and vary the total force applied to the pavement. This makes the roller versatile and able to achieve satisfactory results under a wide variety of conditions, including fewer roller passes. No vibratory roller compacts by vibration alone; and, at times, its static weight must be considered to avoid overstressing the pavement, even when the vibratory mode is not being used. The features of the vibratory roller that influence compaction are:

- frequency in vibrations per minute;
- amplitude of the up and down movement of the roller;
- downward force applied; and
- the travel speed of the roller.

Each of the above factors must be set and maintained in proper relationship with each other to achieve target density. Usually, vibratory rollers can operate at higher mix temperatures because of their ability to adjust the total force applied to the mix. As a result, density can usually be achieved with fewer roller passes. Although operating a vibratory roller, in many respects, is no different than operating a static roller, the following guidelines should be considered:

1. Tandem Vibratory Rollers. Some tandem vibratory rollers provide vibration in either or both rollers. Depending on the stability and the temperature of the mix, the breakdown rolling operation may be performed with both rollers vibrating, with only one roller vibrating, or none vibrating. However, watch for shearing or shoving of the mat and, if necessary, reduce the compactive effort by lowering or turning off the vibratory mode in either the forward or both rollers. After satisfactory breakdown rolling, the vibration can be increased for secondary and intermediate rolling. Finishing rolling (i.e., to iron out roller marks) is accomplished most effectively in the static mode.

2. Rolling Pattern. The basic rolling pattern is similar to that which is used for static rollers, except that after the roller completes a pass toward the paver, the roller should be reversed along the same path. The vibratory mode of the roller must be turned off when the roller stops to reverse direction. The adjacent pass then proceeds in the same manner (i.e., in and out, back and forth) on the same path with overlap. Vibratory rollers should be operated as close as practical behind the paver.

3. Frequency / Amplitude Adjustment. Frequency and amplitude must be properly selected. When running the test pattern, try to select the highest frequency that will result in the fewest number of passes without blemishing the mat. In general, at least 8 to 10 impacts per foot are needed to obtain adequate density and layer smoothness.

4. Roller Speed. There is an important relationship between vibration frequency and roller speed. The spacing between tamps will be too great at high speeds, resulting in low density and roughness. The roller speed should be selected so that the distance between blows of the roll is approximately equal to the depth of the mat being placed,

without exceeding the maximum allowable operating speed. Remember, thin lifts can be easily over-compacted. The amplitude value is very critical and should be kept as low as practical.

5. Longitudinal Joints. The longitudinal joint is not “pinched” by having most of the roller on the previously compacted lane, but with most of the roller on the uncompacted material. The joint may be pinched in the standard manner with the vibratory mode turned off.

401.9.8 Other Considerations

401.9.8.1 Joint Construction

To ensure pavement durability and a smooth riding surface, Roadway Inspectors should pay particular attention to how the Contractor constructs pavement joints. Consider the following:

1. Longitudinal Joints. Longitudinal joints are used between two adjacent lanes of paved mix and will be rolled directly behind the paver. The paver will overlap the adjacent lane by approximately 1 to 2 inches; if greater, raking is usually required. Minimal raking should be needed. Ensure rakers do not broadcast material across the newly placed mix. Excess material should be carefully pushed to within 1 to 2 inches of the joint on the uncompacted side. Extraneous mix must be removed by broom or lute before rolling. Rolling is usually accomplished from the hot side, overlapping the cold mat. In multiple lifts or courses, the longitudinal joint in the top layer will be offset 6 inches from the centerline or lane line, and the longitudinal joints of underlying layers will be laterally offset a minimum of 6 inches from the previous lift. The Contractor should start placement of the adjoining lane in sufficient time to close the joint at the end of the day. If the joint is not closed, a hazardous traffic condition is created, and proper traffic control devices must be erected.

2. Transverse Joints. Transverse joints at the beginning and end of the project and at other locations where the new HMA terminates against an existing asphalt pavement will be “heeled-in” in accordance with the Contract Plans. The heeled-in joint will provide a smooth transition between the old and new surface. The Contractor should use a straightedge or stringline to ensure smoothness of the joint. Construction joints occur where one day’s operation ends and the next day’s operation begins. If required, treated paper is normally used as the bond breaker. Prior to beginning the day’s operation, a transverse vertical cut will be made in the mat to the full depth of the new course, and the vertical face tacked prior to paving. Because the mix placed on the downstream side must be higher than the compacted side to allow for compaction, screed adjustments are needed initially. Minimal raking should be necessary; however, if performed, rakers should not disturb the paver-placed mix except to clear away extraneous material. Ideally, the joint should be compacted in a transverse roller direction. However, on a practical basis, the joint can be properly compacted in the longitudinal direction. Construction joints in overlying layers should be offset by a minimum of 6 feet. All construction joints should provide a smooth transition free from irregularities.

401.9.8.2 Rumble Strips and Pavement Markers

When specified in the Contract, rumble strips will be milled into the mainline paved shoulders. Verify that the Contractor mills rumble strips in accordance with the dimensions specified and at the locations designated on the Contract Plans. In addition, check compliance of the type and location of placement of raised pavement markers.

401.9.9 <u>Laydown and Compaction Inspection – Summary</u>

401.9.9.1 Job Mix and Asphalt Prime and Tack Materials

The Resident Construction Engineer or SCDOT Roadway Inspector, as assigned, should inspect materials at the project site as follows:

- Ensure asphalt prime and/or tack is supplied from an approved source.
- Ensure tack is not diluted on site.
- Determine quantity of asphalt in emulsion, if required.
- Verify appearance and temperature of mix.
- Retain original plant tickets and note rejected mix.

401.9.9.2 Laydown and Compaction Equipment

The Resident Construction Engineer or SCDOT Roadway Inspector, as assigned, should inspect equipment and operation at the project site as follows:

- Check that paver complies with Contract Specifications as follows:
  - Screed checked for trueness using a stringline.
  - Equipped with full-width augers.
  - Equipped with full-width vibratory screed.
  - Uses automatic leveling ski of proper length.
  - Hopper kept more than half full at all times.
  - Material kept at mid point of augers.
  - Producing an acceptable finish without segregation and within tolerance.
  - Placing mix at proper thickness.
  - Rate adjustment made for full length of screed, not just one side.
  - Moves at a consistent speed.
- Check compliance of static steel-wheel rollers and pneumatic-tire rollers.
- Verify compliance of vibratory rollers at highest frequency and proper amplitude.
- Check compliance of roller operation as follows:
  - Correct tire pressure in pneumatic-tire rollers.
  - Density obtained before mat cools.
  - Roller marks removed.
  - Not picking up material.
  - Traveling at proper speed.

- Producing required density with consistent roller pattern.
- Not crushing aggregate.
- Not operating in vibratory mode on final pass.
- Intermediate rolling completed before pavement temperature below 175°F.
- Ceases rolling after roller pattern achieved.
- Not stopping on a hot mat.
- Changes direction gently while at an angle to lane being compacted.

• Check compliance of tack distributor as follows:

  - Equipped with proper spread rate and temperature controls.
  - Capable of positive cut-off.
  - Spray bar/nozzle delivering material uniformly without streaking.
  - Spray width properly set.
  - Spray bar used to apply asphalt tack coat.
  - Hose used only when situation demands.

401.9.9.3 Laydown and Compaction Operations

The Resident Construction Engineer or SCDOT Roadway Inspector, as assigned, should inspect construction operations at the project site as follows:

• Verify stations have been established to allow field checks on material placement.
• Check that weather and surface temperature are acceptable for paving.
• Ensure subgrade or existing pavement has been properly prepared as follows:

  - Graded and compacted properly.
  - Soft spots removed and corrected.
  - Cross slope, elevation and alignment checked.
  - Distressed pavement has been patched.
  - Cracks are properly sealed.
  - Surface dry and swept clean for full width.

• Check compliance of prime or tack application as follows:

  - Type and grade identified by Certificate of Compliance and delivery ticket.
  - Properly sampled.
  - Applied at proper rate and temperature.
  - Properly diluted with water.
  - Properly stored.
  - Allowed to break after application.
  - Compliance of application rate.
  - Producing desired results.
  - Verified by test section.
  - Placed on edges of pavement and curbs.
  - Approved by Resident Construction Engineer.

- Verify that density requirements are being met.
- Check compliance of longitudinal joints in relation to lane lines and offset in multiple lifts.
- Ensure that transverse joints are smooth, within tolerance and straightedged.

401.9.9.4 HMA Construction Troubleshooting Guidelines

Equipment and mat problems are defects that occur in the HMA mixture during or soon after laydown and compaction. These problems can be divided into two basic categories: equipment-related problems and mixture-related problems. By observing the surface texture behind the paver and checking the surface with a straightedge, a malfunction in the paver or non-uniformity of the mix can be easily detected. Segregation is a common and persistent problem with HMA mixtures that must be closely monitored by Roadway Inspectors. At key points during HMA construction (e.g., material stockpiling, aggregate blending, mixing, conveying, storing, loading, unloading, laydown), the mixture has an opportunity to segregate. Segregation creates a non-uniform mixture that usually results in gradation that does not conform to the Job Mix Formula. Where segregation occurs, a concentration of coarse materials will appear in some areas of the mat, while other areas will exhibit finer gradation. Pavement problems associated with segregation are serious and will result in poor pavement performance and durability (e.g., potholes), undesirable surface textures, shorter pavement life and higher maintenance costs. The Roadway Inspector at the laydown site must insist on prompt action to locate and correct any trouble that occurs. Use the guidelines in Figure 401B to troubleshoot common problems with HMA mixtures. Pay attention to the *Standard Specifications* with respect to corrective work and related payment adjustments.

401.10 POST-CONSTRUCTION CONSIDERATIONS

401.10.1 <u>Acceptability of Final Surface, Crown and Grade</u>

After compaction, verify that the finished surface is smooth, uniform in texture and true to the specified crown and grade. Where Cross-Slope Verification is specified in the Contract, it may be performed by an independent vender listed on SCDOT Approval Sheet 52, a manual survey, or a combination of both. Ensure the Contractor corrects mat and cross-slope deficiencies to within the limits specified in the Contract. Where checked with a 10 foot straightedge applied parallel to the centerline of the pavement, the finished surface of Intermediate Courses will not vary more than 0.25 inch and the finished surface of Surface Courses will not vary more than 0.125 inch, as measured from the bottom of the straightedge to the top of the finished surface.

401.10.2 <u>Smoothness of Final Surface</u>

As specified in the Contract, the final riding surface will be subject to rideability testing to assess its smoothness. SCDOT will test the surface in accordance with the Test Method for Determining Pavement Roughness. Pay particular attention to the rideability criteria and schedule of payment adjustments, because they differ for new construction and resurfacing projects. The Resident Construction Engineer will contact the Pavement Evaluation Unit when the pavement is ready for testing. The Pavement Evaluation Unit will run the test and prepare a report, indicating whether or not the ride conforms to specified requirements.

TROUBLE	POSSIBLE CAUSES	POSSIBLE TREATMENT
Mat Tearing on Edges	• End plate not square. • Cold material building up at end of feeder screws. • Extensions installed incorrectly. • Feeder gate closed down too far.	• Adjust. • Clean off material buildup. • Check installation. • Open gates.
Screed Raises Each Time Machine Starts Forward	• Feeder screws — loaded too heavy. • Sensor mounting. • Feeder screws worn out. • Sitting long periods between loads. • Temperature varying in mix.	• Check feeder control paddles. • Refer to Auto Grade Control information. • Replace. • Correct problems at plant or with trucks. Slow down paver speed. • Correct problem at plant.
Feeder Screws Shadows	• Feeder screws loaded too heavy. • Feeder screws high. • Feeder screws worn out. • Segregation in mix.	• Check feeder control paddles. • Lower feeder gates. Lower feeder screws. • Replace. • Correct problem at plant.
Streak at Quarter Point (wide width)	• Screed out of adjustment. • Feeder gates closed down too far.	• Adjust torque arms. • Raise feeder gates.
Bright Streak Down Center	• Too much lead crown. • Feeder screws worn out. • Feeder gates open too far.	• Adjust torque arms. • Replace. • Lower gates.
Unable to Control Screed	• Cold screed. • Mat thinner than largest aggregate. • Screed pivot loose. • Unstable mix.	• Heat screed. • Increase mat thickness. • Tighten at torque tube and leveling arm connection. • Correct problem at plant.
Fluctuating Mat Texture	• Temperature varying in mix. • Head of material fluctuating. • Sitting long periods between loads. • Vibratory running too slow. • Mat thinner than largest aggregate. • Extensions installed incorrectly. • Screed plate worn out. • Running hopper empty between loads. • Trucks holding brakes. • Feeder screws worn out. • Cold screed. • Material too cold. • Segregation in mix. • Pre-strike off not adjusted properly.	• Correct problem at plant or with trucks. • Adjust feeder control paddles. • Correct problem at plant or with trucks. Slow down paving speed. • Increase vibrating drive speed. • Increase mat thickness. • Check installation. • Replace. • Do not run feeders empty. • Instruct drivers. • Replace screws. • Heat screed. • Correct problem at plant. • Correct problem at plant. • Adjust pre-strike off.

HMA CONSTRUCTION TROUBLESHOOTING GUIDELINES
Figure 401B

TROUBLE	POSSIBLE CAUSES	POSSIBLE TREATMENT
Heat Checking – short transverse cracks during compaction	• Tender mixture. • Uneven cooling of mat during compaction	• Adjust paving speed. • Adjust roller pattern – roll while mix is above 240°F. • Verify mix design's stability and component materials.
Screed Marks	• Trucks bumping Finisher. • Sitting long periods of time between loads. • Pre-strike off not adjusted properly.	• Instruct drivers. • Correct problem at plant or with trucks. Slow down paving speed. • Adjust pre-strike off.
Ripples	• Head of material fluctuating. • Feeder screws loaded too heavy. • Auto grade control hunting. • Speed too fast. • Screed plates worn out. • Roller in poor mechanical condition. • Feeder screws worn out. • Unstable mix. • Too much crown. • Not enough lead crown. • Trucks holding brakes. • Temperature varying in mix. • Pre-strike off not adjusted properly. • Too much play in thickness control.	• Adjust feeder control. • Check feeder control. • Adjust sensitivity. • Cut down on paver speed. • Replace screed plates. • Repair roller. • Replace feeder screws. • Check problem with plant. • Adjust torque arms. • Adjust torque arms. • Instruct drivers. • Correct problem at plant. • Adjust pre-strike off.
Poor Surface Texture	• Head of material fluctuating. • Feeder screws loaded too heavy. • Extensions installed incorrectly. • Trucks holding brakes. • Material too cold. • Excessive moisture in mix. • Speed too fast. • Temperature varying in mix. • Screed plates worn out.	• Adjust feeder paddles. • Check feeder control paddles. • Check installation. • Instruct drivers. • Correct problem at plant. • Correct problem at plant. • Cut paving speed. • Correct problem at plant. • Replace screed plates.
Wavy Surface (Long)	• Running hopper empty between loads. • Head of material fluctuating. • Feeders loaded too heavy. • Temperature varying in mix. • Overcorrecting thickness controls. • Poor grade reference. • Feeder screws worn out. • Feeder gates open too high. • Segregation in mix. • Sitting long periods between loads.	• Cut paving speed. Do not run feeders empty. • Adjust feeder control paddles. • Adjust feeder control paddles, lower feeder gates. • Correct problem at plant. • Instruct screed operator. • Improve reference. • Replace feeder screws. • Lower feeder gates. • Correct problem at plant. • Correct problem at plant or with trucks. Slow down paving speed.

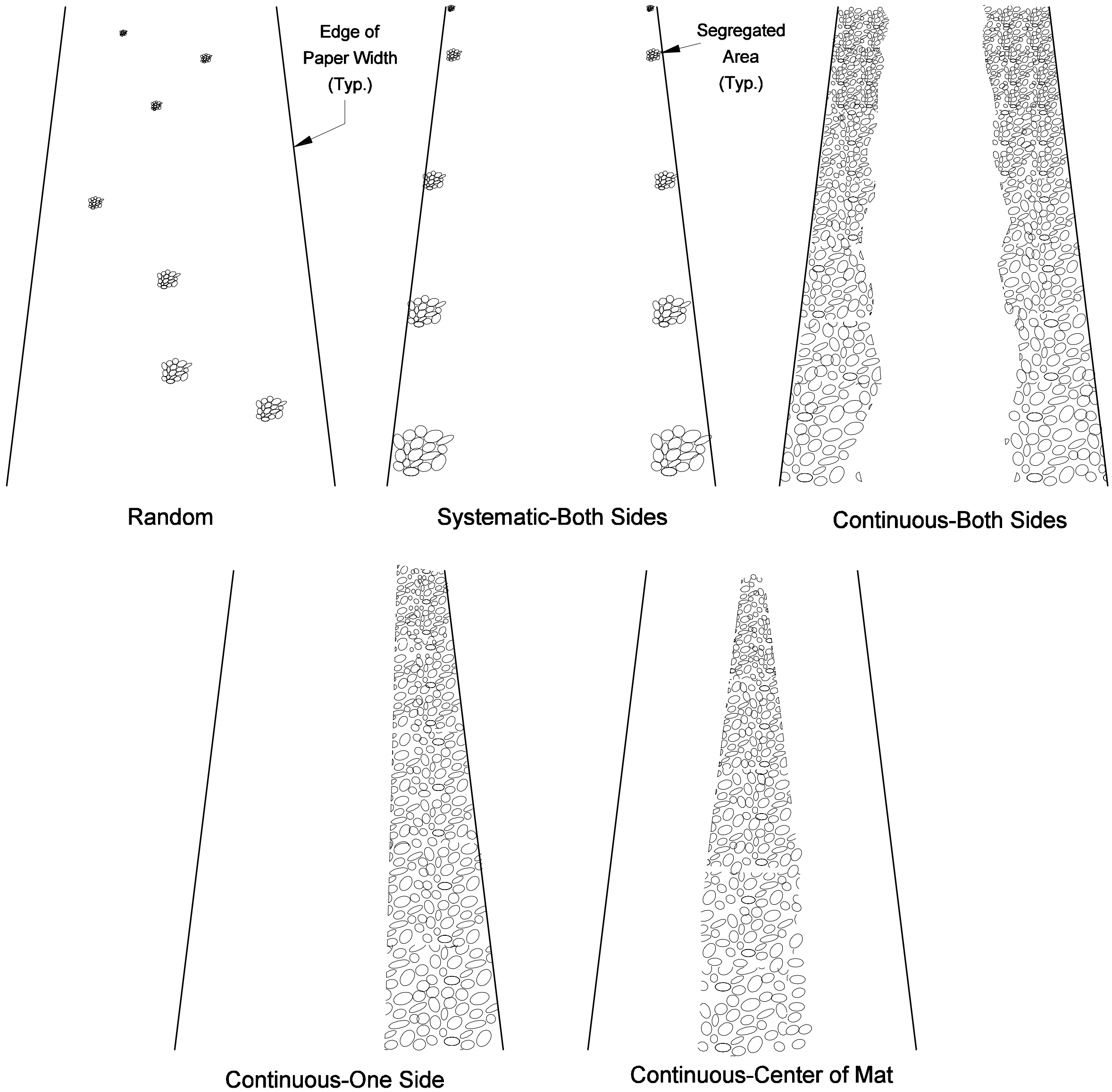
HMA CONSTRUCTION TROUBLESHOOTING GUIDELINES
Figure 401B
(Continued)

TROUBLE	POSSIBLE CAUSES	POSSIBLE TREATMENT
Wavy Surface (Short)	• Auto grade control hunting. • Head of material fluctuating. • Feeder screws loaded too heavy. • Overcorrecting thickness control screws. • Segregation in mix. • Feeder screws worn out. • Roller in poor mechanical conditions.	• Adjust sensitivity. • Adjust feeder control paddles. • Lower feeder gates. • Instruct screed operator. • Correct problem at plant. • Replace feeder screws. • Repair or replace roller.
Rich or Fat Spots (Bleeding)	• Excessive moisture in mix. • Poor rolling operation. • Pre-strike off not adjusted properly. • Vibratory running too fast. • Eccentric weights set wrong.	• Correct problem at plant. • Instruct roller operator. • Adjust pre-strike off. • Cut vibrating drive speed. • Correct weight, check timing.
Poor Longitudinal Joint	• Not rolling joint soon enough. • Overcorrecting thickness control screws. • Feeder screws loaded too heavy. • Too much or too little screed overlap. • Poor raking.	• Instruct roller operator. • Instruct screed operator. • Lower feeder gates. • Correct steering. • Instruct raker in proper procedures.
Poor Compaction	• Vibratory running too slow. • Eccentric weight set incorrectly.	• Increase vibrating drive speed. • Reset, check timing.
Tearing Full Width of Mat	• Speed too fast. • Temperature varying in mix. • Screed plates worn out. • Cold screed. • Mat thinner than largest aggregate. • Material too cold. • Excessive moisture in mix. • Pre-strike off not adjusted properly. • Vibratory running too slow.	• Cut down on paving speed. • Correct problem with trucks or with the plant. • Replace. • Heat screed. • Increase thickness. • Correct problem at plant. • Correct problem at plant. • Adjust pre-strike off. • Increase vibrating drive speed.
Streak Down Center of Mat	• Not enough lead crown. • Feeder gates closed down too far. • Feeder screws worn out.	• Adjust torque arms. • Raise feeder gates. • Replace.
Segregation in Mat	• Worn augers. • Segregated mix in trucks. • Running feeders out of mix between trucks.	• Replace screws. • Load trucks in large batches and multiple batches at plant. Don't "dribble" mix into trucks. • After truck pulls out, dump hopper and stop paver before mix falls below fender gates.

HMA CONSTRUCTION TROUBLESHOOTING GUIDELINES
Figure 401B
(Continued)

TROUBLE	POSSIBLE CAUSES	POSSIBLE TREATMENT
Systematic Spot Segregation on Both Sides	• Surge or Storage Silo	• Adjust timing on batcher gates or make sure batcher full indicator is working properly. • Make sure batcher gates are not leaking. • Adjust production rate to lower level of material in silo to prevent cone formation. • Make sure material drops vertically into batcher.
	• Truck	• Load trucks in multiple drops (front, back, center).
	• Paver	• Prohibit emptying hopper between loads. • Minimize dumping of hopper wings. • Maintain constant gate opening between loads. • Make sure auger is not prematurely turned off or otherwise starved for mixture.
Continuous Segregation Both Sides	• Surge or Storage Silo	• Make sure batcher gates open and close at the proper time or batcher full indication.
	• Paver	• Make sure augers are not starved for mixture. • Check for worn or improperly installed augers. • Prohibit excessive raking of longitudinal joints on multiple lane paving.
Continuous Segregation One Side	• Surge or Storage Silo	• Eliminate horizontal trajectory of materials being placed in silo or batcher.
	• Paver	• Check for worn or improperly adjusted gate on affected side. • Check for worn or improperly installed auger on affected side. • Prohibit excessive raking of longitudinal joint.
Continuous Segregation Center of Mat	• Paver	• Check for worn or improperly installed reverse augers.
Random Segregation	• Segregated Stockpile	• Use multiple stockpiles of single-sized aggregates. • Construct stockpile in layers for multiple sized materials. • Place material in stockpile rather than casting material.
	• Cold Bins	• Do not load out of bottom of segregated stockpile or other segregated areas. • Load into center of cold bins. • Avoid forming cone in cold bins. • Adjust loading operation to maintain constant aggregate level; do not empty bins. • Check for occasional aggregate spillage between bins due to overloading; install bulkheads if necessary.
	• Surge or Storage Silos	• Make sure batcher gates are operating correctly. • Make sure level of mixture is always above cone on bottom of silo.
	• Truck Loading/Unloading	• Load all trucks in multiple drops (front, back, center). • Surge tail gate during unloading.
	• Paver	• Maintain constant gate opening. • Maintain constant auger speed and operation. • Maintain uniform speed of paving operations. • Prohibit random dumping of wings. • Prohibit improper raking operations.

HMA CONSTRUCTION TROUBLESHOOTING GUIDELINES
Figure 401B
(Continued)



HMA CONSTRUCTION TROUBLESHOOTING GUIDELINES
Figure 401B
(Continued)

Distribution of the report will include the Resident Construction Engineer, District Engineering Administrator, Director of Construction and the Contractor. In some cases, prior to resurfacing, the existing pavement must be tested to obtain a baseline ride index value. The Resident Construction Engineer should contact the Pavement Evaluation Unit prior to resurfacing if the initial rideability test results have not yet been received. Upon completion of the overlay, the Resident Construction Engineer will contact the Pavement Evaluation Unit to perform final rideability testing, as soon as practical.

401.10.3 Protection from Damage

To minimize water from infiltrating and deteriorating the base course, where Intermediate Courses or Surface Courses are placed over a Graded Aggregate Base Course or a Sand-Clay Base Course, verify that the placement of the HMA course follows closely behind the base course. On a day-to-day basis, ensure that the Contractor protects the new HMA surface from damage, and require repair work, as needed based on the Contract provisions.

401.11 DOCUMENTATION AND PAYMENT CONSIDERATIONS

In general, the Resident Construction Engineer and SCDOT Inspectors must review the Contract and clearly understand, for each pay item:

- key points of inspection;
- acceptance criteria;
- applicable deductions for non-compliance;
- criteria for outright rejection;
- unit of measurement used to determine the quantity for payment;
- measurements that need to be obtained to calculate the quantity;
- location where the measurements need to be obtained (i.e., field or plants);
- work and materials that should not be measured separately for payment;
- calculations required for determining progress payments; and
- supplemental documents required (i.e., automatic printout tickets, invoices).

The criteria for measuring and paying for Division 400 pay items will be defined in the Contract Specifications and are primarily based on the weight of accepted and approved mix. The net weight of each load of HMA mixture and the accumulated net weight of the loads for the day's production will be recorded on the load ticket. Retain the original copy of the plant ticket for each load delivered to the project. Check all information on the ticket, including the calculations. Note on the tickets any quantity changes due to rejection, including the reason for the rejection. As needed, perform spot checks of truck weights on approved platform scales. Pay particular attention to the provisions for price and payment adjustments that are specified for the type of HMA course to be constructed. Record pay quantities in the Daily Work Report and monthly price adjustments should be calculated and retained in the project files.

Section 402
Hot-Mix Asphalt Intermediate Course

Section 401 presents preconstruction, construction and post-construction responsibilities of SCDOT and Contractor plant and roadway personnel that are applicable to the construction of Hot-Mix Asphalt Intermediate Courses. Prior to construction, review the materials, construction, sampling, testing, acceptance, documentation and payment requirements specified in Section 402 of the *Standard Specifications*, applicable Supplemental Specifications and the Special Provisions of the Contract.

Section 403
Hot-Mix Asphalt Surface Course

Section 401 presents preconstruction, construction and post-construction responsibilities of SCDOT and Contractor plant and roadway personnel that are applicable to the construction of Hot-Mix Asphalt Surface Courses. Prior to construction, review the materials, construction, sampling, testing, acceptance, documentation and payment requirements specified in Section 403 of the *Standard Specifications*, applicable Supplemental Specifications and the Special Provisions of the Contract.

Section 404
Cold-Mix Asphalt Intermediate Course

Section 401 presents preconstruction, construction and post-construction responsibilities of SCDOT and Contractor plant and roadway personnel that are applicable to the construction of Cold-Mix Asphalt Intermediate Courses. Prior to construction, review the materials, construction, sampling, testing, acceptance, documentation and payment requirements specified in Section 404 of the *Standard Specifications*, applicable Supplemental Specifications and the Special Provisions of the Contract.

Section 405
Cold-Mix Asphalt Surface Course

Section 401 presents preconstruction, construction and post-construction responsibilities of SCDOT and Contractor plant and roadway personnel that are applicable to the construction of Cold-Mix Asphalt Surface Courses. Prior to construction, review the materials, construction, sampling, testing, acceptance, documentation and payment requirements specified in Section 405 of the *Standard Specifications*, applicable Supplemental Specifications and the Special Provisions of the Contract.

Section 406
Asphalt Surface Treatment – Single Treatment

406.1 DESCRIPTION OF WORK

Asphalt surface treatment is a broad term describing several types of asphalt and asphalt-aggregate applications. A single surface treatment involves spraying asphalt material on the surface followed immediately by application of an aggregate cover, which is rolled as soon as practical. For multiple surface treatments, the process will be repeated a second or third time with the aggregate size becoming smaller with each application. Section 406 of this *Manual* applies to the following sections of the *Standard Specifications*:

- Section 406 – Asphalt Surface Treatment – Single Treatment
- Section 407 – Asphalt Surface Treatment – Double Treatment
- Section 408 – Asphalt Surface Treatment – Triple Treatment

The sequence of operations for asphalt surface treatment is as follows:

1. Prepare Surface. Clean the surface to be treated with a rotary broom or other approved method.

2. Prime Surface. Prime the clean, dry surface, if the treatment requires prime, and allow the prime to cure.

3. Application of Asphalt Material. Spray the surface with asphalt material at the specified rate of application.

4. Application of Cover Aggregate. Spread cover aggregate at the specified rate of application immediately behind the asphalt spray application (i.e., emulsion still brown in color) to achieve maximum aggregate wetting.

5. Rolling. Immediately roll the aggregate to seat the particles in the asphalt membrane. The asphalt emulsion should break just after the first roller pass has been made.

Note that when asphalt surface treatment – double treatment is specified, Step 3 through Step 5 will be repeated twice and, similarly, three times for asphalt surface treatment – triple treatment.

406.2 PRECONSTRUCTION CONSIDERATIONS

Consider the following prior to construction of the asphalt surface treatment:

1. Weather and Seasonal Limitations. Check compliance of the weather and seasonal limitations. Asphalt surface treatment is generally placed between March 15 and October 15 when temperature requirements are met. The treatment cannot be applied on a wet surface or when the temperature will fall below 60°F within 12 hours after placement.

2. Materials. Check the type of asphalt material for compliance (e.g., cut-back, emulsified, asphalt binder). Pay particular attention to the heating temperature requirements prior to spraying. Verify compliance of the types, properties and gradation of aggregate materials. Test procedure AASHTO T 96 will apply.

3. Equipment. Check that the distributor equipment meets specified criteria and is properly calibrated. Verify conformance and good working order of aggregate spreaders and steel-wheel tandem rollers.

4. Sampling and Testing. Review and understand the applicable criteria for the Quality Control Samples and Tests and the Independent Assurance Samples and Tests for asphalt and aggregate materials used for Asphalt Surface Treatment (see Section 106).

5. Surface Preparation. Ensure that the surface to be treated is clean and dry and that the base has been approved by the District Construction Engineer.

6. Application of Asphalt Prime Coat. When specified, check compliance of the application of asphalt prime coat. Where traffic is to be maintained, the operation should not allow traffic on the primed base without the use of an approved sand cover. The prime must be allowed to cure for 7 days prior to surfacing.

406.3 INSPECTION DURING CONSTRUCTION

406.3.1 Application of Asphalt Material

It is essential that the distributor be capable of distributing the asphalt uniformly over the surface to be treated. For optimum results, consider the following:

1. Spray Nozzles. Maintain uniform pressure on all spray nozzles. The fan of the spray from each nozzle must be uniform and set at the proper angle with the spray bar so that the spray fans do not interfere with each other.

2. Spray Bar. The spray bar must be maintained at the proper height above the surface to provide complete and uniform overlap of the spray fans.

3. Distributor Speed. The speed of the distributor truck must be uniform. Calibration using a test section and check of application rate is advisable.

4. Streaking. To avoid streaking, check the spread of the distributor spray bar. Valve action should be instantaneous, both in opening and cut-off. Check the spraying operation frequently to ensure that nozzles are the proper height from the surface and are fully operational.

5. Alignment. To obtain good alignment, verify that the Contractor places a stringline to guide the distributor operator. The stringline should be placed using points or stakes furnished by the Survey Party.

6. Spray Width. Do not assume that the correct width has been established on the spray bar. The width of the spray should be initially and subsequently checked at frequent intervals, especially when the width of surfacing changes.

7. Length of Application. The length of application of the asphalt material should be limited to an area that can be promptly covered with aggregate.

8. Temperature of Asphalt Material. Monitor the temperature of the asphalt material. It varies based on the type being sprayed and will be important in determining volumetric quantities.

9. Starting and Stopping. Ensure building paper is used properly at locations where the distributor starts and stops.

10. Excess and Overspray. Watch for excess deposits of asphalt material and ensure that it is removed. Ensure that overspray on structures is properly cleaned.

406.3.2 Spreading of Aggregate

An adequate supply of aggregate should be on hand to promptly cover the asphalt material. It is essential that asphalt binder and emulsion be covered quickly so that good wetting and binding of the aggregate is achieved. A simple rule of thumb is that when rapid-setting emulsions are used, the emulsion should break just after the first roller pass has been made.

406.3.3 Determining Rate of Spread

406.3.3.1 Asphalt Material

The application rate, in gallon per square yard, of asphalt material should be calculated for each distributor shot with the temperature of 60°F being used as the basis to determine the volumetric quantity of the asphalt material. Document these calculations and the rate of application in the Daily Work Report. Such documentation must be retained in the project files by the Resident Construction Engineer.

The distributor will be equipped with a volume measuring gauge or a calibrated tank with a measuring stick for determining the quantity in the tank. Usually the distributor is equipped with both devices. It is acceptable to use either device, provided they are accurate. The contents of the distributor tank should be determined while the tank is level. It is the responsibility of the Roadway Inspector to check the reading of the measuring device before and after the application of each shot. The accuracy of the volume measuring device should be checked against the volume of the material delivered by the asphalt tanker. A discrepancy of any significant magnitude should be investigated.

406.3.3.2 Aggregate Material

During the operation, regularly check the rate of spread of the aggregate material. When the haul trucks of aggregate are delivered with automatic weigh tickets, the spread can be easily determined by dividing the weight of material by the area, in square yards, of the treated surface. If this method is used, retain the original weigh tickets in the project files. However, trucks are often loaded from stockpiles with no readily available means of weighing. In this case, to determine the weight of aggregate in the truck, strike off the stone in the truck, calculate the volume occupied in cubic feet and multiply this volume by 100. This will yield the weight of aggregate in pounds, assuming an approximate density of 100 pounds per cubic foot. Once the weight in the truck is found, check the rate of spread. A quick method to check the rate spread is to place a square yard of building paper on the surface after the asphalt has been shot. Once the aggregate spreader has passed over the paper, remove and weigh the aggregate. This is also a good method to correlate visual appearance with rate of application. If this method is used, ensure that the area covered by paper is repaired.

406.3.4 Rolling and Dragging

The purpose of the rolling operation is to seat the aggregate into the asphalt material, which provides the bond necessary to resist traffic stresses. Rolling should begin immediately after distribution of the cover material and continue until the aggregate is properly seated in the asphalt material. If the aggregate turns over under rolling, the rolling (i.e., when emulsion is used) may be briefly delayed until the asphalt material will hold the aggregate. The steel-wheel roller should make only one or two passes over the aggregate, because excess rolling will crush the aggregate. Because a steel-wheel roller will tend to roll over high spots and bridge low spots, a pneumatic-tired roller should be used until the aggregate is properly seated. Verify that brooming and rolling continues until a smooth surface is provided with the aggregate being thoroughly keyed into the asphalt material. Rolling should be performed in the longitudinal direction beginning at the outer edges and working toward the center with overlap on each pass.

406.4 POST-CONSTRUCTION CONSIDERATIONS

Traffic will be permitted on the treated surface as soon as the aggregate is spread and rolled. Ensure that loose excess cover aggregate is removed. As needed, verify the proper use of seal stone prior to opening to traffic. Verify that the surface is maintained and that spotty or bleeding areas and deficiencies are repaired in accordance with the provisions of the Contract.

406.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Document the area calculations (i.e. length x width) of the treated surface in the Daily Work Report. Measurement for payment will be based on the actual area of treatment accepted in place for the type specified in the Contract. Retain the weigh tickets, when available, in the project files. See Section 401.11 for information on documentation and payment.

Section 407
Asphalt Surface Treatment – Double Treatment

Section 406 presents preconstruction, construction and post-construction responsibilities that are applicable to the construction of asphalt surface treatment – single treatment, which are applicable to Section 407 of the *Standard Specification*s for asphalt surface treatment – double treatment. Prior to construction, review the materials, construction, sampling, testing, acceptance, documentation and payment requirements specified in Section 407 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions.

Section 408
Asphalt Surface Treatment – Triple Treatment

Section 406 presents preconstruction, construction and post-construction responsibilities that are applicable to the construction of asphalt surface treatment – single treatment, which are applicable to Section 408 of the *Standard Specification*s for asphalt surface treatment – triple treatment. Prior to construction, review the materials, construction, sampling, testing, acceptance, documentation and payment requirements specified in Section 408 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions.

Section 409
Open-Graded Friction Course

Section 401 presents preconstruction, construction and post-construction responsibilities of SCDOT and Contractor plant and roadway personnel that are applicable to the construction of Open-Graded Friction Courses. Prior to construction, review the materials, construction, sampling, testing, acceptance, documentation and payment requirements specified in Section 409 of the *Standard Specifications*, applicable Supplemental Specifications and the Special Provisions of the Contract.

Section 410
Hot-Mix Asphalt Thin-Lift Seal Course

Section 401 presents preconstruction, construction and post-construction responsibilities of SCDOT and Contractor plant and roadway personnel that are applicable to the construction of Hot-Mix Asphalt Thin-Lift Seal Courses. Prior to construction, review the materials, construction, sampling, testing, acceptance, documentation and payment requirements specified in Section 410 of the *Standard Specifications*, applicable Supplemental Specifications and the Special Provisions of the Contract.

DIVISION 500
Concrete Pavement

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

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Section 501
Portland Cement Concrete Pavement

501.1 DESCRIPTION OF WORK

The performance of Portland cement concrete (PCC) pavement depends primarily on design adequacy, the quality of materials used in the work and the quality achieved during production, placement, consolidation, finishing and curing of the PCC mixture. Misunderstood or misapplied specifications or the use of poor construction techniques and improper equipment operation can greatly affect pavement quality. PCC pavement construction is a highly mechanized operation that requires continual inspection of work and materials and a working knowledge of numerous types of equipment. The Resident Construction Engineer and SCDOT Inspectors should become thoroughly familiar with the material, equipment and construction requirements of the Contract Plans and Specifications.

501.2 CONCRETE QC / QA CONSIDERATIONS

The Contractor is responsible for developing a quality control plan that establishes the personnel, methods and procedures that will be used during the project to control the quality of work and materials. The plan must be consistent with the QC / QA requirements specified in the Contract. The minimum level of Quality Control Samples and Tests are presented in Section 106. The quality control plan will usually be reviewed with the Resident Construction Engineer and Research and Materials Engineer at the Preconstruction Conference or pre-paving meeting, if required. Do not permit the Contractor to begin work until the quality control plan has been discussed and agreed upon. During construction, observe that the Contractor operates in accordance with the plan. A Batch Plant Technician, delivery tickets or SCDOT Form 700.04 – Ready Mix Concrete Report are not usually required when a dedicated central-mix plant is used to produce concrete exclusively for the paving project. Unless otherwise specified, the Research and Materials Laboratory will furnish the molds and test equipment for the field laboratory to perform flexural testing of the required concrete beam specimens. See Section 701.2 for additional information pertaining to concrete QC / QA.

501.3 PCC MIX MATERIALS

Many materials used on PCC pavement construction projects are supplied from pre-approved sources. SCDOT Inspectors will be responsible for ensuring that materials required for PCC pavement construction are supplied from sources listed on the following Approval Sheets:

- Approval Sheet 1 – Fine Aggregate Sources for Concrete,
- Approval Sheet 2 – Coarse Aggregate Sources,
- Approval Sheet 3 – Fly Ash for Portland Cement Concrete,

- Approval Sheet 5 – Chemical Admixtures and Air Entrainment Agents for Concrete,
- Approval Sheet 6 – Authorized Portland Cement and Non-Steel Slag Manufacturers,
- Approval Sheet 8 – Silicone Sealants for Portland Cement Concrete Pavement Joints,
- Approval Sheet 18 – Authorized Type I (SM) Slag-Modified Portland Cement Manufacturers,
- Approval Sheet 28 – Ready-Mix Concrete Plants Inspected by SCDOT,
- Approval Sheet 32 – Stabilizer Agents for Mixer Drum Wash Water, and
- Approval Sheet 33 – Curing Compound for Concrete Structures.

In addition, on reconstruction projects, the Contract Plans may allow PCC pavement recycling. The pavement generally will be broken in place, crushed and screened. The resulting aggregate material then will be reused in the new PCC mixture. Existing reinforcing steel, HMA overlay material, joint sealant, and other foreign materials, if present, will be removed and disposed of properly to minimize contamination of the recycled aggregate material. Where used, observe the breaking operation for extensive disturbance of the underlying subgrade or base material. Such disturbance may require reworking of the subgrade or base. The SCDOT Inspector will obtain all cementitious samples with Mill Test Reports in accordance with the frequency defined in Section 106. Plant Technicians need to ensure that materials used in the mix are from the same source as in the approved mix design. The Contractor will be responsible for notifying the Resident Construction Engineer prior to any desired change in material sources for the PCC mixture. Such changes will require the Contractor to submit a new Mix Design for review by the Research and Materials Engineer. See Section 701.2.4 for additional information on PCC mix materials.

501.4 PCC PAVEMENT MATERIALS

501.4.1 Tie Bars

Ties bars are never coated with wax or grease during installation. Tie bars are typically used on longitudinal construction joints and other locations where the two slabs are not intended to move independently. Tie bars must develop a bond with the concrete, which is why deformed steel bars are used. Where used, tie bars will be deformed steel bars conforming to the Contract Specifications. Verify that the tie bars are the proper size, length and grade.

501.4.2 Dowel Bars

Dowel bars are typically used on transverse construction joints and other locations where the two slabs are intended to move horizontally independent of each other. Dowel bars will be plain, round bars conforming to the criteria specified in the Contract. Verify that they are delivered in a smooth condition. It is preferred that dowel bars be coated with an acceptable waxy material applied at the fabrication facility, however, the Contractor may be allowed to apply by hand an acceptable grease just prior to installation. The purpose of this coating is to break the bond between the steel and the concrete, which is important for the device to serve its intended function. The Contractor must indicate the method of coating prior to initiating work. Contact the Pavement Systems Manager at the Research and Materials Laboratory if there is any doubt regarding compliance of the coating material. When the coating is applied by hand, pay particular attention to how the grease is applied. It should be applied around the entire circumference of the dowel, not just to the top of the dowel prior to installation, which is a poor construction shortcut. The hand-applied coating should be a light, uniform coating with a minimal number of large globs, because such globs tend to dry out and cause voids to develop next to the dowel. These are primary reasons why factory-applied coatings are preferred.

501.4.3 Curing Materials

See Section 702.2.5.5 for information on curing materials.

501.4.4 Joint Sealant Materials

See Section 702.2.5.4 for information on joint sealant materials.

501.5 PCC MIX PRODUCTION AND HAULING

Upon preliminary approval, the proposed Mix Design will be used to produce an initial trial batch, which will be sampled and tested for 14-day flexural strength as well as properties as discussed in Section 701.2.6. Section 106 documents the Quality Control Samples and Tests and Independent Assurance Samples and Tests required to monitor PCC mix properties (e.g., slump, air content, test cylinders, flexural beams). Unless otherwise directed, SCDOT Inspectors, as assigned, will sample and test the PCC mixture during production, including the preparation of test beams for flexural strength testing. The test specimens will be molded and cured in accordance with SC-T-46 (see Appendix C). The Resident Construction Engineer will use the results of testing these specimens to determine compliance of 14-day flexural strength and the need for any mix adjustment, replacement of concrete or acceptance with a reduced pay factor. See Section 701 for additional information on PCC mix production and hauling considerations.

501.6 PCC PAVEMENT CONSTRUCTION

501.6.1 Preconstruction Conference

A Preconstruction Conference (see Section 108.2) will be held prior to starting each SCDOT construction project. The purpose of this Conference is to ensure that a working understanding is established among all parties involved in the project, thus enhancing coordination and reducing miscommunication and delays. The Conference will establish an overall cooperative tone and ensure that all parties involved understand the project and are ready for production work. In general, attendees should include the Research and Materials Engineer, Resident Construction Engineer, SCDOT Inspectors, Contractor Superintendent, Batch Plant Inspector, Concrete QC / QA Technicians and other key personnel to discuss contractual items such as scope of work, scheduling requirements, project meetings, quality control, mix design, placement method, maintenance of traffic, job safety and any special requirements of the project. Key pay items in the Contract should be discussed so that all affected parties will understand the schedule, materials, construction methods, sampling and testing responsibilities, acceptance criteria and method of measurement and payment.

501.6.2 Communications During Production and Paving

During the project, quality and safety depend on continued positive and meaningful communication between the Research and Materials Engineer, Resident Construction Engineer, Roadway Inspectors, Batch Plant Inspector, if applicable, and Concrete QC/QA Technicians. Frequent informal meetings provide a forum for meaningful dialog to mitigate potential cost and scheduling problems. In addition, frequent communications between plant and roadway personnel provides critical feedback to ensure that a quality pavement is being produced, especially when adjustments to the mix design are needed. Key points of discussion should be noted in the Daily Work Report.

501.6.3 Safety Considerations

Job safety at both the PCC production facility and the paving site cannot be overemphasized. Both SCDOT and Contractor personnel must continually practice safe working habits. OSHA regulations must be understood and followed by all personnel. Each person should clearly understand what is expected of them and how to perform their assigned tasks. Dust, noise, haul trucks, pavers and traffic moving through the work area all pose potential hazards. New personnel should be properly instructed, and seasoned personnel should not become careless. Constant care and vigilance are needed to prevent accidents and injury. It is wise to periodically remind personnel that they are operating in a potentially dangerous environment. If an unsafe work practice is observed, corrective action should be taken immediately, even if the operation must be delayed. See Section 107 for additional information.

501.6.4 PCC Paving Equipment

The Resident Construction Engineer and SCDOT Inspectors will be responsible for inspecting the following PCC pavement construction equipment:

- subbase planer;
- slip-form paver, forms and concrete spreaders, as applicable;
- finishing machine, vibrators, tube finishers and hand tools;
- transverse groover;
- equipment used to apply curing materials;
- equipment used to apply material for rain protection;
- concrete saws used for cutting joints; and
- equipment used to heat and apply joint filler and sealants.

Slip-form paving is typically used on SCDOT PCC paving projects. The use of stationary forms and other concrete placement methods may be necessary for irregular areas along the project, but requires prior approval of the Resident Construction Engineer. Use the following guidelines when inspecting PCC paving equipment:

1. Type. Verify that the Contractor has provided the type of equipment required for the project. It is recommended that manufacturer's brochures of the equipment be obtained from the Contractor and reviewed prior to initiating paving.

2. Capacity and Number. Verify that the equipment provided on the project is sufficient, in terms of capacity and number, to perform the work in a continuous and timely manner.

3. Condition. Check that the Contractor maintains equipment in good working condition and has sufficient spare parts and backup equipment on-hand to minimize unnecessary delays due to mechanical breakdown. This is especially important for concrete saws.

4. Calibration. For construction equipment that requires calibration before use, such as the slip-form paver, ensure that the equipment is properly set to meet specified results and perform periodic inspections, as needed, to determine if recalibration is necessary.

5. Operators. Although the equipment may be acceptable, the use of inexperienced operators can often lead to unacceptable results. Where this matter is suspected, discuss this situation with the Resident Construction Engineer and, as needed, direct the Contractor Superintendent to provide an experienced operator.

501.6.5 PCC Paving Limitations and Pavement Protection

Normally, the mixing and placement of concrete should be conducted only when the ambient temperature is within specified limits. Refer to the Contract Specifications for temperature restrictions. In addition, check that the Contractor has sufficient material on hand to protect exposed surfaces of unhardened concrete from rain. The washing effect of sudden showers and downpours will remove the cement paste from fresh concrete surfaces. If rain is imminent, the Contractor should cease mixing, paving and finishing operations and immediately cover the exposed unhardened surface. Under such cases, the Contractor still must finish the surface of the freshly poured concrete. This may be accomplished as follows:

1. Brief Showers. If the shower is brief, the Contractor may completely remove the protective covering after it rains and then finish the surface.

2. Continuous Showers. For continuous showers, the Contractor must repeatedly roll back the protective covering approximately 3 feet at a time to finish the surface and replace the covering without marring the finished surface.

As soon as practical, inspect the surface for defects, and immediately inform the Contractor of any needed repairs. Note your findings and directives to the Contractor in the Daily Work Report. In addition, the edges and the surface must be protected against damage from vehicular traffic and construction equipment. The edges of slabs in areas where traffic is permitted to cross new pavement prior to shoulder construction are especially susceptible to damage. Wood blocking, for example, may be used along the edge of the slab to minimize potential damage from cross traffic. Visually inspect edges prior to acceptance, and ensure that the Contractor repairs any damage.

501.6.6 Subbase and Base Course Construction

A PCC pavement generally requires the construction of a base course, primarily to prevent the erosion of the subgrade by the pumping action of concrete slabs, which can lead to premature pavement failure. The Contract Plans and Specifications will designate the type of base course and subbase, if required, to be constructed over the subgrade. It is important that the construction of underlying layers be carefully constructed, including removal of soft spots, installation of drainage facilities, compaction to target density, trimming to grade and cross-section and protection from rutting and damage. The use of scratch planers with spikes or teeth is not permitted. The subgrade, subbase and base course will require progressive approval by the District Construction Engineer. Pay attention to the grade and compaction of the area beyond the edge of paving, because it will be used either as a wheel track for the slip-form paver or as the foundation for fixed forms. Do not allow construction vehicles to traverse this area. Undulations in the grade and settlement of the forms will invariably be reflected in the surface of the PCC pavement. Unless a waterproof base material is used, the grade must be kept uniformly moist at the time concrete is placed. Verify that the base is sprinkled sufficiently ahead of the paving train to keep the material moist without ponding water. See Division 300 for additional information on pavement structures and subgrade, subbase and base course construction.

501.6.7 Placement of Reinforcing Steel

Ensure that dowel bars and tie bars are placed in accordance with the dimensions and provisions of the Contract Plans and Specifications. Ensure that dowels are of the correct size and length. Note that, although required for dowel bars, grease or wax must not be applied to tie bars. Check load transfer devices to ensure that they are correctly located, within tolerance, firmly fastened, properly lubricated and that the shipping braces have been cut, where applicable. Ensure that joint locations are properly and accurately marked for the saw crew.

501.6.8 Concrete Delivery

If appropriate, document on SCDOT Form 700.04 – Ready Mix Concrete Report the quantity of water or admixture added to the concrete, check that the water-cement ratio has not been exceeded and ensure that the truck mixer uses the correct number of revolutions prior to discharging the mixture. Check and record compliance of concrete and air temperature. Regardless of the construction method used, the concrete must be placed so that a minimum of rehandling is necessary. Verify that footprints in fresh concrete are vibrated, and check for signs of segregation. Serious segregation is grounds for rejection. Check slump for compliance with the construction method being used. Concrete consistency should be similar from load to load. Pay attention to compliance of the elapsed time of concrete delivery from the time water was introduced to the cement. Observe the discharge operation for complete removal of the batch from the truck. This is especially important if non-agitating trucks are used.

501.6.9 Slip-Form Paving

Slip-form paving is typically used for SCDOT PCC paving projects. The Resident Construction Engineer, however, may permit fixed-form, lane-by-lane construction on variable width, small or otherwise restricted sections. The slip-form paving train is designed to spread, consolidate, screed, float-finish and texture concrete and place curing material in a single pass. The primary components of the slip-form paver include auger spreader, spud vibrators, oscillating screeds, tamping bars, pan floats and sliding forms. The rigid sliding forms on either side of the paver progressively form the concrete slab. The screeds roll excess concrete in a forward direction to fill low spots. Concrete distribution and consistency are extremely critical, because non-uniform distribution and piles of "dry" concrete will cause the paver to float above true grade, resulting in surface undulations. To ensure pavement smoothness, it is critical that excess concrete ahead of screeds be sufficiently small to allow rolling rather than shoving. Consider the following:

1. Line and Grade. Verify proper adjustment of the sensitivity of the feeler sensors and the tightness of the guide wire to ensure that adequate control of line and grade will be maintained. It is good practice to periodically walk ahead of the paver to check that the wheel-track path is in a smooth condition and that the guide wire is taut without measurable sag. Irregularities will be reflected in the finished surface.

2. Dowel Assemblies. Haul trucks are generally used to place concrete on dowel assemblies immediately ahead of the paver. Verify that the haul trucks operate away from the wheel-track path of the paver and that placement of the concrete does not displace the dowel assemblies.

3. Screeds. Check screeds with a stringline to ensure proper cross-section.

4. Vibrators. Verify the type and number of vibrators are adequate for proper consolidation across the full width and depth of the slab. Check compliance of vibrator frequency using a tachometer or verify the vibration frequency on the paver console, if so equipped.

5. Paver Speed. As practical, the slip-form paver should be operated in a continuous forward motion at a speed that is coordinated with production and delivery. If the paver must be stopped, verify that all vibratory and tamping elements are turned off.

6. Slump. Check compliance of concrete slump. Slump should be low enough to allow concrete to roll in front of the screed, but stiff enough to prevent appreciable edge slumping. Pay particular attention to edge slumping along longitudinal joints.

7. Hand Redistribution. If operated properly, minimal hand redistribution will be necessary. As practical, limit handwork and advise the Contractor to adjust the operation.

501.6.10 Fixed-Form Paving

501.6.10.1 Forms

Fixed forms are generally used where slip-form paving is not practical. Forms that are used in fixed-form paving serve as a track for paving equipment, laterally support the concrete slab and establish the profile and alignment of the pavement. They must be set properly and sufficiently in advance of paving to promote the development of a quality riding surface in a continuous operation. Verify compliance of form type, number, dimension and condition. Straight forms will be used on tangent sections, and flexible forms will be used on curved sections. The use of battered forms is not permitted.

501.6.10.2 Form Setting and Removal

Improper setting of forms will create unacceptable undulations in the final pavement surface. The entire length of each form must be firmly seated on a compacted base that is true to grade. It is preferable to trim a higher base than to bring low spots up to grade in compacted lifts. Forms must be capable of withstanding vibrations and the load of finishing equipment. Settlement of forms under the load of paving equipment is a major source of surface undulations. Settlement or springing of forms is unacceptable. Check that the forms are tightly secured and free from play or movement. Require resetting where excessive movement is observed. Sight along the top of forms and use a stringline to check for grade undulations and obvious irregularities in alignment. Measure the width between forms for compliance. The base should be wetted and the forms cleaned and oiled well ahead of paving, then the base re-sprinkled just ahead of concrete placement. This is essential to prevent loss of moisture from the concrete into the base. Watch for ponding of water. Note that wetting of the base may not be necessary if a waterproof base course has been constructed. Forms should generally not be removed until the concrete has set for at least 8 hours. Once removed, check for honeycombed or damaged areas and verify the immediate application of curing compound to the horizontal and vertical surfaces of the slabs.

501.6.10.3 Concrete Placement

Concrete will be placed between the forms and between transverse joints ahead of the spreader. The use of intermediate bulkheads between transverse joints is generally unacceptable. Verify that the concrete is discharged from the container while it is moving away from the spreader. Concrete that is “dumped” in piles promotes segregation, causes non-uniformity, increases strain on the spreader and requires unnecessary hand redistribution. Where hand redistribution is necessary, it must be performed with shovels, not rakes. Do not permit construction personnel to walk through fresh concrete with boots caked with dirt or mud, and verify that footprints are properly vibrated. Minimal handwork should be needed.

501.6.10.4 Concrete Spreading

The mechanical spreader is a self-propelled machine equipped with a screw or plow type device to distribute the concrete between the forms, an adjustable screed to strike-off the concrete, internal vibrators to consolidate pavement edges and a vibrating pan or other system to consolidate the concrete. The function of the spreader is to distribute and strike-off the proper amount of concrete for finishing, to consolidate the edges and prevent honeycombing and to perform initial consolidation of the concrete slab. The bottom elevation of the distributor and the strike-off assembly will be adjustable. When checking the adjustment of the spreader, the strike-off should be set level with the top of the forms at which time the gauge should read zero. The strike-off then should be adjusted for proper thickness. Finally, the distribution device should be adjusted so that a small uniform quantity of concrete is rolled in front of the strike-off screed. Low areas in front of the screed should be filled with concrete from the mixer. Mortar is not to be used for this purpose.

501.6.10.5 Transverse Finishing

The transverse finishing machine is equipped with two transverse screeds. The purpose of this machine is to make the surface of the fresh concrete conform to the final profile and cross-section. It should be used to cut and drift material as necessary and should never leave such work for the final finishing float. Two passes of the finishing machine are usually adequate to tamp and shape the pavement surface. The number of passes necessary can be judged by observing the uniformity of the roll or excess mix carried on the rear screed. The front screed should always carry against it a uniform roll of concrete the full width of the pavement, a heavy wave being carried the first time over and lighter waves on each successive trip. The rear screed should be pushing a 2- to 3-inch roll over the entire width on the final pass, using shovelers to work the material manually to the high side, where necessary. Generally the front screed is set slightly higher than the one in the rear. If the rear screed is not pushing the required roll of mortar, it indicates the front screed is set too low. On the high sides of superelevated curves, the concrete must not be permitted to slough away from the forms. The finishing machine should be equipped with adequately maintained scrapers at each wheel to prevent intrusion of mix between them and the top of the forms. Verify that the top of forms are kept free of accumulated material and that the screed wearing plates which ride on the forms are not excessively worn. Use the following procedures to check screed adjustment:

- center the screed and lift off forms;
- stretch fine wires taut between the forms at the front and back of each screed;
- place blocks of uniform thickness on top of the wires at each form; and
- lower the screeds.

The proper crown is placed in the screed by measuring between the taut wire and the face of the screed and adjusting the hanger bolts. The front screed should be tilted with the front edge slightly higher. The rear screed should be set flat or with a tilt not exceeding specified tolerance. Where two finishing machines are used, the screeds on the rear machine should have little or no tilt.

501.6.10.6 Float Finishing

Float finishers, in general, greatly affect the finished surface because they correct irregularities that are left by proceeding operations. Therefore, adjustment of the float finisher is extremely critical. During the following procedures, the longitudinal float finisher should be loaded with approximately the same weight, including the operator, that it will carry during operation. Verify the alignment of the float along its centerline and both edges as follows:

- Check the height of the transfer tracks that carry the float assembly, at the front and the rear of the machine, to ensure that all four ends are equidistant from the horizontal plane formed by the bottom of the wheels.

- Place taut wires across the top of the forms and verify that the tracks are adjusted to conform to the desired cross-section of the finished surface.

- Stretch two wires across the top of the forms at a distance apart equal to the length of the float. When the float is lowered, all four corners of the float should be the same distance from the wires at a distance equal to the ordinate of the desired cross-section.

To ensure proper operation after alignment, verify that the scrapers are in good condition and in solid contact with the flanged wheels or forms at all times. It is unacceptable for the operator to adjust the float to compensate for either a surplus or a deficit of concrete.

The transverse float finisher is an acceptable alternative to the longitudinal float finisher. The transverse float finisher is carried on a long wheel base frame that rides on the forms and finishes the concrete with transverse oscillating screeds and a stationary float. The front screed normally rides on the forms and may be checked in a similar manner to that described for the transverse finishing machine. The second screed and the float do not ride on the forms but are suspended from the frame; therefore, their elevation is much less affected by form irregularities. Check that both screeds and the float are adjusted to the proposed cross-section. When in the down position, verify that the ends of the screeds and the float are set about the same elevation as the top of the forms. Once the operation is started, it is acceptable to make small final adjustments to match the desired cross-section and proper surface finish.

501.6.11 <u>Concrete Consolidation</u>

Consolidation subsides plastic concrete while filling internal voids and removing entrapped air, not entrained air. If the concrete is not adequately vibrated, an excessive quantity of entrapped air will remain and optimum consolidation will not be achieved. Overconsolidating, however, is highly undesirable, because it removes entrained air, segregates component materials and leaves a layer of low-strength mortar on the pavement surface. In both slip-form and fixed-form paving methods, mechanical vibrators of different types are used to consolidate the plastic concrete as it is placed. Vibrators are typically attached to the back of the spreader, the front of the finishing machine or on a separate piece of equipment. The vibrators will be either the surface type (e.g., screed, pan) or the internal type (e.g., immersed tube, gang-mounted spuds) and will be mounted in such a manner that they will not come into contact with reinforcing steel, joint assemblies, forms, subgrade or base course. However, the entire width of the pavement must be vibrated to adequately consolidate the slab throughout the full depth of the plastic concrete. Hand-operated vibrators will also be used. Consider the following guidelines:

1.

Abutting Slabs / Forms. Special attention must be given to properly consolidate concrete along the face of abutting slabs and side forms. Visually check that these areas are properly consolidated with hand-operated vibrators without contacting the forms.

2. Load Transfer Devices / Joint Assemblies. Hand-operated vibrators must be used to consolidate concrete near load transfer devices and joint assemblies. Ensure that this operation does not displace the devices or overconsolidate the concrete.

3. Overconsolidation. Vibrators must be kept moving and not held in one location for more than 15 seconds. Do not permit equipment-mounted vibrators to be operated when the equipment is stopped.

4. Frequency / Amplitude. Many paving machines have direct electronic indicators of vibrator frequency on the instrument panel. For older machines, the Contractor should have a reed tachometer capable of directly displaying the vibrator frequency. Vibrator frequencies should be checked at the start of paving and anytime inadequate consolidation is suspected. Check the frequency of vibrators often for compliance using the tachometer. See the Contract Specifications for frequency and amplitude requirements.

5. Working Radius. Spud vibrators typically have an effective working radius of between 5 to 10 inches, depending on their diameter, amplitude and frequency. For practicality, spud vibrators should achieve an effective consolidation radius of approximately 9 inches. In general, the higher the frequency, the better the consolidation.

6. Surcharge. Spud vibrators must not be drowned in an excessive surcharge of concrete. The surcharge should generally not exceed 6 to 8 inches.

7. Speed of Travel vs. Consolidation. The equipment speed greatly affects the length of time that gang-mounted vibrators influence the plastic concrete. In general, the speed of travel should be 12 feet per minute or less. A maximum vibrator spacing of 24 inches will generally require less than 10 feet per minute of forward travel, and a maximum spacing of 18 inches will require a speed of 10 to 20 feet per minute.

501.6.12 Surface Correction and Finishing

After the floating operation is complete and while the concrete is still in its plastic state, any excess water should be removed from the surface using a 10-foot straightedge and the surface tested for trueness in the prescribed manner. If high or low spots are found, concrete will be added or removed and the area refinished and rechecked. Pay particular attention to the surface elevation across joints. The straightedge used for testing should not be used for finishing concrete. Checking of the surface must continue until it is free of irregularities. The addition of water to the surface for the purpose of finishing will not be permitted, because it weakens the pavement’s surface. However, a fog spray may be approved to assist in curing and, if permitted, will be strictly controlled. Prior to the concrete taking its initial set, the edges at forms and joints will be worked as specified. The final surface texture will be produced using either a burlap or turf drag or transverse groover to provide a non-skid surface. Refer to the provisions of the Contract for the specified finish. If a burlap or turf drag is used, the final texture will be produced by dragging wet burlap over the surface as many times as necessary to produce the desired results. The burlap must be maintained in a moistened and clean condition at all times. Where a transverse groover is used, check the tining for proper size, shape and depth. The tines must be maintained at the proper tension, spacing and cleanliness to produce the proper finish. As specified, verify that project stationing is being stamped into the pavement at the correct locations. If rumble strips are designated, ensure that they are placed at the proper time, location, size, shape and depth and that they do not interfere with joints or ramps.

501.6.13 Joint Construction

Ensure that joints are constructed in accordance with the dimensions, methods and provisions specified in the Contract Plans and Specifications. Consider the following:

1. Longitudinal Construction Joints. Check that longitudinal construction joints are properly located with respect to lane lines. Check the installation of keyways for compliance. Where tie bars are installed, check that they are of the correct type, grade, size and length. Verify that they are inserted by approved methods ahead of vibrators and at the proper location and spacing.

2. Longitudinal Weakened Plane Joints. Check that longitudinal weakened plane joints are properly located with respect to lane lines. Where tie bars are installed, check that they are of the correct type, grade, size and length. Verify that they are inserted by approved methods ahead of vibrators and at the proper location, depth and spacing.

3. Transverse Weakened Plane Joints. Check that transverse weakened plane joints are properly located and constructed with respect to load transfer devices and joints in adjacent widening and shoulders.

4. Expansion Joints. Ensure that preformed joint filler material is properly placed at all structures, manholes, inlets and other projections into the pavement.

It is critical that sawing of joints be performed before random cracking of the concrete starts, even if the operation must be performed at night. The Contractor should have one or more backup saws in case of failure.

Transverse joints, because of their function to relieve early shrinkage stress within the pavement, must be cut as soon as the concrete has hardened enough to support the saw equipment without excessive raveling of the cut. Some raveling of green concrete should be expected when sawing joints, which can be considered a rough guide to govern the time at which sawing of joints should begin. Require immediate correction of the operation if excessive raveling occurs during sawing. If a sharp edge joint is being obtained on control cutting, it can generally be regarded that the concrete has hardened excessively and sawing is being conducted late. Verify that joints are centered over load transfer devices.

501.6.14 Concrete Curing

The most commonly used curing method is spray-on, white-pigmented curing membrane (clear curing membranes are not allowed on pavements). The purpose of applying this membrane to the surface is to maintain the cement in a hydrated state while the concrete cures after its initial set. If water is allowed to evaporate too quickly, it will damage the pavement, causing hairline cracking and a weak surface that has little resistance to traffic abrasion. The curing membrane should be applied when the surface is still moist, but absent of free water. Verify that the curing membrane is listed on SCDOT Approval Sheet 33 and applied at the proper time. The curing compound will be applied with spraying equipment that can apply a smooth, even-textured coating. During windy conditions, it will be difficult to apply such a coating. Ironically, this condition is when the curing membrane is needed most, because the wind and sun combination promotes accelerated evaporation. Verify the rate of application of the curing compound and watch for areas that are not uniformly coated. When side forms are removed, the sides of the slab are to be cured in the same manner. This applies to slip-form paving too. Upon form removal, ensure that the curing compound is applied without delay. If the curing membrane is damaged by rain, verify proper reapplication of the material.

501.6.15 Joint Sealing

Prior to cleaning and sealing of concrete pavement joints, verify that the joint reservoir dimensions (i.e., depth and width of the final saw cut) are in accordance with the Contract Plans. If the actual dimensions do not conform to those shown on the Plans, contact the Pavement Design Engineer prior to beginning the sealing of the joints.

501.6.15.1 Silicone Sealant

Silicone sealant should not be applied until the new concrete pavement has cured a minimum of 7 full days; longer times are preferred. Sealant should not be applied when the temperature is below 45°F. Final cleaning of the joint, installation of the backer rod and application of the sealant must be performed on the same day. Prior to installing the backer rod and the joint sealant, it is essential that the joint surface be clean and dry. Solvents must not be used in the cleaning process. Sandblasting is the preferred method of cleaning. Sandblasting should be performed in two passes, one pass for each joint face. During this operation, the nozzle should be no more than 2 inches from the face of the joint. One pass of a high-pressure air blast is then necessary to remove any residual dust and sand. The Contractor cannot begin sealing the joints until the SCDOT Inspector approves the cleaning of the joint reservoir. Prior to installing the backer rod, rub your finger across the joint face to verify that it is both clean and dry. If any dust shows on your finger, do not allow sealant to be placed until the joint is adequately cleaned.

After the joint faces have been properly cleaned, backer rod shall be installed as per the Contract Plans. Ensure that the backer rod is installed to the manufacturer's recommendations and not stretched during installation. The backer rod should fit firmly in the joint reservoir. Verify the proper installation depth of the backer rod. This depth is critical to the performance of the sealant. Sealant should not be applied if the face of the joint is not clean and dry. The sealant shall be applied in a continuous operation to properly fill the joint; stopping and starting is not permitted. The sealant should be recessed 0.25 inch from the concrete surface, with any excess being removed from the pavement surface. If tooling of the silicone is required, it should be performed within 10 minutes of application. Resealed joints may be reopened to traffic when the silicone sealant reaches a tack-free condition. This condition is typically reached in approximately 60 minutes, depending on temperature and humidity.

501.6.15.2 Neoprene Sealant

Neoprene sealant should not be installed until the new concrete pavement has cured a minimum of 7 full days; longer times are preferred. Sealant should not be installed when the temperature is below 45°F, nor when the temperature is above 85°F. Final cleaning of the joint and installation of the neoprene sealant must be performed on the same day.

Prior to installing the neoprene sealant, it is essential that the joint surface be reasonably clean and dry. The joint should be air-blasted to remove any debris. The Contractor cannot begin sealing the joints until the SCDOT Inspector approves the cleaning of the joint reservoir. Care should be taken during the installation process to ensure that the neoprene is not stretched. This can be done by comparing the distance between two marks on the seal measured before and after installation. The SCDOT Inspector should also ensure that the neoprene has not been twisted or damaged, and is recessed in accordance with the Contract Plans. Splicing of the material should not be permitted without the prior approval of the Pavement Design Engineer, and should be performed in accordance with the neoprene supplier's instructions.

501.6.15.3 Hot-poured Rubber-Asphalt Sealant

Procedures for cleaning and preparing the joint prior to sealing are the same as for the silicone sealant. However, sealant dimensions may vary from those used for silicone, and the backer rod must be of the type capable of withstanding the high sealant temperatures. Ensure that the kettles used for melting the sealant are operating at a temperature within the specification requirements. Sealant is placed at a high temperature; care should be exercised to avoid contact with the hot sealant.

501.6.16 <u>Pavement Thickness Determination</u>

The provisions of the Contract will require the pavement to be cored at specified intervals so that the slab thickness can be determined by caliper measurement. Calipers may be obtained from the Research and Materials Laboratory. Slab thickness should be determined as soon as a sufficient length of pavement has been poured and reached adequate strength to support the coring equipment. Unless otherwise specified, the Contractor will perform this task with oversight by SCDOT Inspectors at locations specified by the Resident Construction Engineer. Measure and document in the Daily Work Report the location and results of thickness coring testing. If the measurement or average of measurements is less than the thickness specified in the Contract Plans, the area of pavement represented by the deficient cores will be either accepted, replaced or subject to a reduced payment depending on the severity of the deficiency.

Ensure that coring is performed to miss tie bars, dowels and other embedded items and is no closer than 2 feet from joints. Ensure that all cored locations are backfilled with PCC mix or an approved grout material.

501.6.17 Pavement Rideability

The following factors are primary contributors to roughness of the final PCC pavement surface:

1. Concrete Mix. Inconsistent concrete mix properties may change the hydraulic forces acting on the paver and on the final pavement profile.

2. Guide Wire Sags. The paver guide wire must be set at the proper profile and kept taut. Sags in the guide wire will invariably be reflected as undulations in the pavement surface. The use of high-tension aircraft cable is recommended to reduce sags in the line. It is also recommended that that the guide wire supports be spaced at no more than 25-foot intervals. All construction personnel must pay particular attention to avoid brushing or snagging this line.

3. Frequent Starts and Stops. Frequent stopping and starting of the paver may result in roughness in the pavement surface. The Contractor should provide sufficient trucks to keep the paver continuously charged and moving under normal circumstances. The Contractor should keep the paver moving as much as possible. If it is necessary to stop the paver, ensure that all vibrators are also stopped.

4. Excessive Hand Finishing. Excessive hand finishing tends to create roughness in the final pavement surface. If repeated hand finishing is observed, adjustments in the Mix Design may be needed to ensure a workable concrete mixture.

The Pavement Evaluation Unit of the Research and Materials Laboratory will measure the rideability of the pavement surface. The Resident Construction Engineer will contact the Pavement Evaluation Unit to schedule the testing at least 5 days in advance of need. The Contractor is responsible for providing a clean surface free of obstacles and the necessary traffic control for SCDOT to safely conduct the test. On large paving projects, testing should be performed on subsections, rather than waiting for the entire project to be completed. This will allow early detection of ride quality problems and will allow the Contractor to adjust the paving operation, if necessary. The Contract Specifications will define the method of measurement, the allowable roughness and the pay schedule for the project.

501.7 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The criteria for measuring and paying for PCC pavement construction will be defined in the Contract Specifications and is primarily based on the surface area of pavement placed and accepted, adjusted for thickness, smoothness and other deficiencies as needed. Document all measurements and field notes in the Daily Work Report and applicable SCDOT Construction Forms.

Section 502
Concrete Pavement Patching

502.1 DESCRIPTION OF WORK

Full-depth patching generally consists of removing and replacing deteriorated concrete pavement sections to the full depth of the concrete slab. The Resident Construction Engineer and SCDOT Inspectors will inspect the Contractor's work and materials. Section 501 presents guidance on PCC pavement construction that, in general, can be applied to other work with Portland cement concrete.

502.2 PRECONSTRUCTION CONSIDERATIONS

502.2.1 Materials Considerations

Verify that the type of Portland cement, aggregate and admixture materials required for the PCC patch mixture are supplied from SCDOT-approved sources, as discussed in Section 501.3. When the use of rapid patch material is specified, verify that it is supplied from a manufacturer listed on SCDOT Approval Sheet 22. Retain in the project files the manufacturer's Certificates of Compliance for materials received at the job site. Check that dowel bars and tie bars are of the type required by the Contract. SCDOT does not pre-approve reinforcing steel, therefore, obtain and submit the required samples for testing by the Research and Materials Laboratory. See Section 501.4 for additional information. Check the epoxy adhesive material for compliance and, as needed, have the Contractor verify the pullout strength through demonstration, as provided for in the Contract.

502.2.2 PCC Patch Mix Design

The Contractor will submit a proposed Mix Design to the Research and Materials Laboratory for approval. Ensure that the Mix Design for the PCC patch mixture has been approved by the Research and Materials Engineer.

502.2.3 Patch Area

The Resident Construction Engineer will mark the boundary for the area to be patched. The boundaries of the patch area must be in accordance with the Contract Plans and Specifications.

502.2.4 Air Temperature

Prior to patching, check the air temperature for compliance. The air temperature should be 40°F and rising, unless otherwise specified.

502.3 INSPECTION DURING CONSTRUCTION

502.3.1 Removal of Pavement

Without damaging the concrete to remain, a diamond tipped blade will be used to cut the existing pavement as marked by the Resident Construction Engineer and to the depth of the underlying base course. Overcuts into the adjacent slabs must be sealed with epoxy.

502.3.2 Inspection of Base Course

Once the defective concrete has been removed, inspect the soundness of the underlying base course. The base may need to be removed and replaced with suitable material and reworked. All materials must be thoroughly compacted using vibratory compactors to proper grade depth.

502.3.3 Inspection of Adjacent Concrete

Check the soundness of the vertical faces of the adjacent concrete pavement. The limits of patching may need to be extended. The vertical faces must be protected from damage.

502.3.4 Installation of Dowels / Tie Bars

After removing the deteriorated pavement, new dowels and tie bars will generally be placed in the vertical faces of the remaining concrete slabs. The details for installing dowels and tie bars in joints will be provided in the Contract Plans. Contact the Pavement Design Engineer for any needed clarification on the installation of these devices.

502.3.5 Preparation of Patch Area

Sandblasting and compressed air will be used to clean the contact surfaces of the slabs adjacent to the patch.

502.3.6 Concrete Placement / Consolidation

Prior to placing concrete, the base should be moist. Check that the concrete is properly placed in the patch reservoir without segregation. Hand-operated spud vibrators, set to the proper frequency, will be used to consolidate the concrete.

502.3.7 Surface Texture

Verify that the surface of the patched area has been textured to match the surface of the adjacent pavement.

502.3.8 <u>Concrete Curing</u>

Ensure the Resident Construction Engineer has approved the method of curing. Check that the curing compound has been applied at the proper rate to the surface of the patched area. Ensure that curing blankets have been placed to protect the pavement until sufficient strength is attained. The blankets should not be placed until the concrete has set sufficiently to prevent damage by the blankets.

502.3.9 <u>Joint Sealing</u>

Joints should be sealed in accordance with the Contract Plans and Specifications. See Section 504 for additional information.

502.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to opening to traffic, verify that the concrete used for the full-depth patch has attained the strength required by the Contract Specifications.

502.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure full-depth patching by the surface area of the accepted patch. Retain delivery tickets and SCDOT Form 700.04 – Ready Mix Concrete Report. See Section 501.7 for information on documentation and payment considerations.

Section 503
Grinding and Texturing Existing Concrete Pavement

503.1 DESCRIPTION OF WORK

Pavement grinding and texturing is typically specified to restore the riding quality and texture of the surface of an existing PCC pavement. With the exception of joint sealing, all other rehabilitative methods specified will be performed before the grinding operation. The Contract Plans will designate the limits of treatment.

503.2 PRECONSTRUCTION CONSIDERATIONS

Check the grinding and texturing machine for compliance with specified criteria. Ensure the equipment does not cause strain or damage to the pavement. Ensure the Contractor performs a demonstration section for inspection and approval by the Resident Construction Engineer. The spacing between grinding blades should be adjusted to provide the proper longitudinal corduroy effect, which will be affected by the hardness of the aggregate in the existing PCC pavement.

503.3 INSPECTION DURING CONSTRUCTION

While the grinding machine may operate in either direction, the support equipment should be oriented in the direction of traffic to reduce confusion to motorists. Grinding should progress from the low side of the cross slope to the high side to avoid ponding of water at the shoulder or longitudinal joint. Traffic cones will be removed behind the operation, and the pavement markings that are removed will be immediately replaced. Before marking, ensure that the surface is clean and dry. Water used to cool the cutting blades also controls dust. Verify that the water is removed from the surface (e.g., vacuumed) and the slurry disposed of properly.

503.4 POST-CONSTRUCTION CONSIDERATIONS

Acceptance of the work will be based on evaluation of surface smoothness, as defined in the Contract Specifications.

503.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure grinding and texturing existing concrete pavement by the area treated in place. Payment will be based on the Contract unit price. See Section 501.7 for additional information on documentation and payment. Document all measurements and field notes in the Daily Work Report.

Section 504
Cleaning and Resealing Joints in PCC Pavement

504.1 DESCRIPTION OF WORK

Cleaning and resealing joints is used to restore existing PCC pavements. The work involves cleaning, preparing and sealing joints in the surface of the existing PCC pavement. This retards moisture from infiltrating the underlying layers of the pavement structure and prevents debris from entering the joint, which can cause premature failure of the pavement structure.

504.2 PRECONSTRUCTION CONSIDERATIONS

Check that the joint sealant material is of the type specified in the Contract. See Section 501.3 for additional information on SCDOT-approved materials. Check the equipment for cleaning and sealing joints for compliance with specified criteria.

504.3 INSPECTION DURING CONSTRUCTION

See Section 501.6.15 for information on joint sealing.

504.4 POST-CONSTRUCTION CONSIDERATIONS

Do not permit any vehicles on the treated section for a minimum of 2 hours after sealing. Watch for damage caused by traffic of the treated joints and require repair work to be performed based on the provisions of the Contract.

504.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure and document cleaning and resealing joints by the length of joints that were treated and approved. Payment will be based on the Contract unit price. Document all measurements and field notes in the Daily Work Report.

Section 505
Routing and Sealing Cracks in PCC Pavements

505.1 DESCRIPTION OF WORK

Routing and sealing cracks is used to restore existing PCC pavements. The work involves routing, cleaning, and sealing cracks with sealant. This retards moisture from infiltrating the underlying layers of the pavement structure and prevents debris from entering the joint, which can cause premature failure of the pavement structure. Cracks will be identified and marked by the Resident Construction Engineer.

505.2 PRECONSTRUCTION CONSIDERATIONS

Check that the joint sealant material is of the type specified in the Contract. See Section 501.3 for additional information on SCDOT-approved materials. Check the equipment for cleaning and sealing joints and cracks for compliance with specified criteria. A concrete saw with a pivotal router blade should be used to provide a joint reservoir.

505.3 INSPECTION DURING CONSTRUCTION

Ensure that the old sealant is removed and the crack refaced and cleaned as prescribed. Verify that the cracks are widened to the width and depth shown on the Contract Plans or as directed by the Resident Construction Engineer. For cracks 0.375 inch or greater in width, a backer rod will be installed at a uniform depth to prevent the entrance of sealant below the specified depth. Ensure the backer rod is installed to the manufacturer's recommendation and not stretched during installation. A blocking medium is optional for cracks less than 0.375 inch in width, as long as the seal produced is satisfactory. Verify that the sealant is installed in accordance with the Contract Specifications.

505.4 POST-CONSTRUCTION CONSIDERATIONS

Do not permit any vehicles on the treated section for a minimum of 2 hours after sealing. Watch for damage caused by traffic of the treated cracks and require repair work to be performed based on the provisions of the Contract.

505.5 DOCUMENTATION FOR PAYMENT

Measure and document routing and sealing cracks by length (rounded to the nearest 0.1 foot) of cracks that were treated and approved. Payment will be based on the Contract unit price. Document all measurements and field notes in the Daily Work Report.

DIVISION 600
Traffic Control

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

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Section 601
Work Zone Traffic Control

601.1 DESCRIPTION OF WORK

Section 601, Section 602 and Section 603 of the *Standard Specifications* govern the work zone traffic control, devices and procedures for SCDOT projects. The Contractor is responsible for providing a Traffic Control Plan for the control and maintenance of traffic during construction, which will include the methods of handling traffic, devices and procedures necessary for the safe passage of traffic through and around the work zone with minimum inconvenience to the public. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the Contractor complies with the Contract Plans and Specifications, the Traffic Control Plan and the *MUTCD*. All construction personnel are obligated to immediately report for correction any problems identified with traffic control.

601.2 PRECONSTRUCTION CONSIDERATIONS

601.2.1 Primary References

The following references should be reviewed, as needed, for work zone traffic control on SCDOT projects:

1. *MUTCD*. SCDOT has adopted verbatim the *Manual on Uniform Traffic Control Devices for Streets and Highways – Millennium Edition*. The purpose of the *MUTCD* is to establish uniformity in the design and use of traffic control devices. Major consideration is given to the standards for signs, signals and markings and how and when they should be used, with less emphasis placed on how and when a particular road should be marked. Part 6 – Temporary Traffic Control applies to traffic control in the work zone on SCDOT projects. The *MUTCD* is a minimum requirement. SCDOT reserves the right to exceed the requirements of the *MUTCD*.

2. *SCDOT Construction Manual* and *SCDOT Standard Specifications*. The following sections apply to work zone traffic control on SCDOT projects:

   - Section 104.6 – Detours and Haul Roads,
   - Section 104.7 – Maintenance and Maintaining Traffic,
   - Section 107.11 – Traffic Control,
   - Section 107.12 – Payment for Traffic Control,
   - Section 107.13 – Correcting Low Shoulder Conditions,
   - Section 107.14 – Railway Highway Provisions,
   - Section 107.20 – Opening of Section of Highway to Traffic,
   - Section 601 – Work Zone Traffic Control,
   - Section 602 – Traffic Control Devices in the Work Zone, and
   - Section 603 – Work Zone Traffic Control Procedures.

3. *SCDOT Approved Products List for Traffic Control Devices in Work Zones*. This publication presents SCDOT-approved products that are permitted on SCDOT construction projects for traffic control purposes. The products listed in this publication meet NCHRP Report 350 requirements for their intended application. Products not listed in this publication must be approved by the Director of Traffic Engineering prior to use. This publication is available on the SCDOT Internet Web Site.

4. *South Carolina Advanced Work Zone Safety Guidelines*. This publication presents background information, practical criteria and typical examples on topics related to work zone traffic control for multilane roadways, expressways and freeways and mobile operations. This information is intended to illustrate the principles of proper work zone traffic control, but is not a standard.

5. *South Carolina Work Zone Safety Guidelines*. This publication presents basic guidelines for work zone traffic control and examples of typical traffic control applications for two-lane and multilane work zones.

6. *SCDOT Flagger's Handbook*. This publication provides instructional guidance on proper flagging procedures.

601.2.2 Traffic Control Plan

The Contractor is responsible for submitting SCDOT Form 600.01 – Traffic Control Plan for the project, which may consist of drawings and documentation to address the traffic control devices and methods of handling traffic required for the project. The Traffic Control Plan will be project specific; and, in multi-phase projects, each method of handling traffic presented will be specific to its respective construction phase. The Traffic Control Plan must comply with all “shall” and “should” provisions of the *MUTCD* and all requirements specified in the Contract, including applicable Supplemental Specifications, Special Provisions and *Standard Drawings*. Note that documentation and drawings from the manufacturer of SCDOT-approved proprietary systems (e.g., crash attenuation systems) are included in this requirement, whether they are incorporated directly or by reference in the Contract.

At the Preconstruction Conference, the Contractor will submit the Traffic Control Plan to the Resident Construction Engineer for District Engineering Administrator approval. Review the Traffic Control Plan to understand the types and locations of traffic control devices required in each method of handling traffic for each construction phase of the project. Pay particular attention to how each method of handling traffic will be transitioned from one phase to the next. This review by the Resident Construction Engineer and Roadway Inspectors cannot be overemphasized. Some projects are straightforward, however, multi-phase projects can be rather complicated. Any revisions to the Traffic Control Plan proposed by the Contractor must be approved by the District Engineering Administrator prior to implementation. Any revisions to the Traffic Control Special Provisions in the Contract must be approved by the Director of Traffic Engineering.

601.2.3 Responsibilities of Project Personnel

601.2.3.1 Contractor Personnel

The Traffic Control Supervisor (i.e. the Contractor's responsible person as indicated on SCDOT Form 600.01) must have a current copy of the *MUTCD*, the SCDOT-approved Traffic Control Plan and the Contract Plans and Specifications, including applicable Supplemental Specifications, Special Provisions, *Standard Drawings* and manufacturer's documentation and drawings. All traffic control activities (i.e., devices and methods) must comply with the governing provisions of these documents. The Traffic Control Supervisor and Contractor personnel, such as flaggers, must be properly trained in their respective traffic control duties. The Traffic Control Supervisor must be available 24 hours a day, be prepared to contact emergency response personnel (e.g., Highway Patrol, ambulance, sheriff, Resident Construction Engineer) and ensure that the appropriate devices are on hand for use at night in case of an emergency. The Traffic Control Supervisor will inspect the job site during working and non-working hours to ensure that traffic control devices and methods of handling traffic are established and maintained in compliance for each phase of the project.

601.2.3.2 SCDOT Personnel

The Resident Construction Engineer and Roadway Inspectors will be responsible for inspecting work zone traffic control devices and methods to verify compliance with the *MUTCD*, the Traffic Control Plan and the Contract Plans and Specifications, including applicable Supplemental Specifications, Special Provisions, *Standard Drawings* and manufacturer's documentation and drawings. Immediately notify the Contractor of any non-compliance. At a minimum inspections will be performed on a weekly basis. Additional nighttime inspections will be conducted at least once a month and each time the method of handling traffic is changed. Use SCDOT Form 600.02 – Work Zone Traffic Control Inspection and the Daily Work Report to document findings, specifically noting non-compliance and directives to the Contractor. Obtain the concurrence signature of the Contractor's Traffic Control Supervisor on each completed Form, which will be retained by the Resident Construction Engineer. Contact the Director of Traffic Engineering, as appropriate, for any needed assistance. Traffic Engineering conducts random semi-annual inspections of SCDOT construction projects to verify the quality of traffic control provided statewide and to ensure the acceptability of the traffic control activities performed by both Contractor and SCDOT construction personnel.

601.2.3.3 South Carolina Highway Patrol

The South Carolina Highway Patrol may be required for protective and enforcement services. This will depend on the particular needs of the method of handling traffic in place for the active construction phase of the project. SCDOT maintains a standing Agreement with the South Carolina Department of Public Safety for such services. When required, the procedures for securing the services of the Highway Patrol are detailed in the Agreement.

601.2.4 Materials Considerations

601.2.4.1 Certification of Traffic Control Devices

All traffic control devices used on SCDOT projects must meet NCHRP Report 350 requirements for their intended application and must be listed on the SCDOT publication *Approved Products List for Traffic Control Devices in Work Zones* available on the SCDOT Internet Web Site under Traffic Engineering. Obtain from the Contractor the certification letter for all Category II and Category III devices that will be used on the project. Certification by the Contractor for Category I devices will not be necessary. The certification letter will state that all the traffic control devices intended for use on the project are NCHRP Report 350 compliant and will include the device name, model number, description, manufacturer and a copy of the portion of the *Approved Products List* for each device. In addition, for those devices that must be reflectorized, the letter will include certification for the reflective sheeting. Contractor certification will be as follows:

1. Category I Devices. Certification will not be required for the following Category I devices:

   - cones,
   - oversized cones, and
   - portable plastic drums.

2. Category II Devices. Certification will be required for the following Category II devices:

   - Type II barricades,
   - Type III barricades,
   - portable sign supports, and
   - sign substrutums for portable sign supports.

3. Category III Devices. Certification will be required for the following Category III devices:

   - truck-mounted attenuators,
   - portable terminal impact attenuators,
   - water-filled longitudinal barriers,
   - concrete longitudinal barriers,
   - ground-mounted U-channel posts,
   - breakaway assemblies for ground-mounted U-channel posts, and
   - ground-mounted square post anchor and breakaway assemblies.

601.2.4.2 Construction Signs and Reflective Sheeting Materials

Verify compliance of sign blank, roll-up sign and sign stand materials. Verify that sign blanks are the proper thickness and material. Reflective sheeting used on drums, barricades, cones, tubular markers and vertical panels must be Type III (i.e., high intensity, encapsulated glass bead). Reflectorize all rigid construction signs with either Type VII, Type VIII or Type IX prismatic retroreflective sheeting. Type III High Intensity Retroreflective Sheeting is no longer approved for reflectorization of rigid construction signs. Sheeting must be supplied from a source listed on SCDOT Approval Sheet 20. Obtain the certification letter for these materials.

601.2.4.3 Pavement Marking and Delineation Materials

Verify compliance of the types of materials required for pavement markings and delineation. Sampling and testing will be in accordance with the Quality Control Samples and Tests presented in Section 106. Where used for marking and delineation purposes, the following materials must be supplied from a source listed on the material's respective SCDOT Approval Sheet:

- Approval Sheet 21 – Preformed Markings,
- Approval Sheet 40 – Methyl Methacrylate Acrylic Traffic Marking Material,
- Approval Sheet 42 – Adhesives for Raised Pavement Markers,
- Approval Sheet 47 – Hot Applied Preformed Thermoplastic Pavement Markings, and
- Approval Sheet 50 – Flexible Delineator Post.

Traffic paint will be pretested and approved by the Research and Materials Engineer prior to delivery to the project. Samples from the manufacturer will be submitted directly to the Research and Materials Engineer for testing and approval. A material approval number will be issued to the manufacturer for use in identifying the paint as being pretested and approved for the project. The approval number will appear on the delivery ticket and the manufacturer's certification letter. Obtain and forward a copy of the certification letter to the Research and Materials Engineer. If the material is of questionable quality, contact the Research and Materials Engineer to sample the material at the job site.

Thermoplastic and epoxy pavement marking materials will be accepted based on the manufacturer's certified test results. Obtain and forward a copy of the manufacturer's certified test results to the Research and Materials Engineer. Check to ensure that the batch number of the material corresponds to the test results provided.

Raised pavement markers must be tested and approved prior to use. The Resident Construction Engineer can check if a particular Lot of pavement markers has been previously tested by searching Matlab on the Department's Intranet site for the appropriate lot number. If pavement markers have been tested, no additional tests are needed. Otherwise, obtain and forward samples to the Research and Materials Laboratory for testing. A minimum of 25 markers of each type to be placed, selected at random from each shipment or Lot, will constitute a representative sample. Obtain and forward with the samples a copy of the manufacturer's certified test results. Ensure that the manufacturer's application recommendations are followed. Ensure that the adhesive material is supplied from a source listed on SCDOT Approval Sheet 42. Obtain from the Contractor and forward to the Research and Materials Engineer the manufacturer's certification letter stating that the material complies with specified requirements. Sampling of adhesive will not be necessary.

601.2.4.4 Temporary Concrete Barriers

Temporary concrete barriers must be produced from a source listed on SCDOT Approval Sheet 54 and on the Traffic Engineering Section of the SCDOT Internet Web Site. The *Standard Drawings* should be reviewed to determine the proper size and shape.

601.2.5 Procedure for Reporting Emergency Road Conditions

When a situation such as a multi-vehicle pileup or tanker crash causes serious damage to traffic control or a highway structure, the Resident Construction Engineer will be responsible for assessing the seriousness of the situation and determining whether or not it is necessary to close the facility. If such action is warranted, the Resident Construction Engineer will immediately notify the District Engineering Administrator of the following and follow up by e-mail:

- road number and name,
- closure termini,
- date and time closed,
- reason for closure, and
- estimated date and time to re-open.

The District Engineering Administrator will immediately notify the Director of Maintenance and Director of Construction. The Communications Office will be responsible for informing the media. Every effort should be made to re-open the facility at the earliest practical time to minimize public inconvenience. Notification of re-opening will be handled with equal dispatch.

601.3 INSPECTION DURING CONSTRUCTION

601.3.1 Overview

Check for compliance of the placement or installation of all traffic control devices (e.g., signs, pavement markings, cones, barricades, barriers, attenuators) required for the active method of handling traffic, as documented in the Traffic Control Plan, with respect to type, size, dimension, color, reflectorization, message, lateral and longitudinal placement, spacing and taper, as appropriate. Verify that the Contractor maintains the travel pattern in compliance with the Traffic Control Plan for the project phase under construction. Pay attention to the requirements for detours. Ensure that traffic control devices are being properly maintained, all lights operating, reflective sheeting kept clean, damaged devices replaced, worn markings replaced, correct placement of devices maintained, etc.

601.3.2 Conflicting Devices and Markings

Ensure that permanent signs (e.g. speed limit) that conflict with temporary traffic control signs are completely covered or removed, as appropriate. Verify that conflicting pavement markings are properly eradicated. Painting over markings for the purpose of eradication is strictly prohibited. When temporary traffic control devices (e.g., construction signs, changeable message signs) are not in effect or have served their purpose, verify that they are changed, covered, obscured or removed, as appropriate.

601.3.3 Construction Signs

Verify compliance of construction signs, changeable message signs and advance warning arrow panels with respect to sign material, type, size, color, message, mounting base and height, lateral placement, distance between signs and longitudinal placement from the work zone. Ensure these devices are visible from all approach lanes and adjusted, as necessary, for vertical and horizontal alignment. The faces of construction signs must be kept clean and the message conveyed must be clearly visible and appropriate. All signs mounted on portable sign supports will have a minimum mounting height of 5 feet from the ground to the bottom of the sign. All signs mounted on ground-mounted U-channel posts will have a minimum mounting height of 7 feet from the ground to the bottom of the sign.

601.3.4 Temporary Pavement Markings

Check for proper eradication of pavement markings. Painting over markings for the purpose of eradication is strictly prohibited. Verify compliance of markings with respect to surface preparation, material (e.g., paint, tape), type (e.g., lines, words), application (e.g., no passing), color, reflectorization (e.g., glass beads), lateral and longitudinal placement, length, width, spacing and message, as appropriate. The purpose of these markings is to channelize traffic and provide delineation for the travel lanes during each construction phase. Verify the Contractor re-establishes pavement markings within the specified time period once eradicated, covered by a subsequent course or upon changing traffic patterns. The typical application of pavement marking materials is as follows:

1. Paint. Paint is typically used on pavement courses other than the final surface course, unless permanent pavement markings will be placed directly over them. When no longer needed, these markings must be eradicated by an acceptable method as directed by the contract specifications or preferably overlaid by a subsequent course.

2. Temporary Thermoplastic. Thermoplastic is typically applied to asphalt pavement courses where the traffic must be maintained for greater than 4 months or as specified in the Traffic Control specifications. Its use is prohibited on the final surface course in a temporary marking scheme. When no longer needed, these markings must be eradicated by an acceptable method as directed by the contract specifications or preferably overlaid by a subsequent course.

3. Temporary Epoxy. Epoxy is typically applied to concrete pavement courses where the traffic must be maintained for greater than 4 months or as specified in the Traffic Control specifications. Its use is prohibited on the final surface course in a temporary marking scheme. When no longer needed, these markings must be eradicated by an acceptable method as directed by the contract specifications or preferably overlaid by a subsequent course.

4. Tape. Tape is typically applied to areas where the Contractor will modify the pattern but maintain the traffic on an existing pavement or final surface. These markings are removable.

5. Temporary Raised Pavement Markers. Ensure that temporary raised pavement markers are applied in accordance with the *Standard Specifications*.

Ensure that the Contractor properly maintains or re-establishes worn or damaged temporary pavement markings. The use of temporary raised pavement markers in a temporary scheme will be specified in the Contract for each project, normally under the Staging Section of the Special Provisions.

601.3.5 Cones, Barricades and Barriers

Verify compliance of the installation and maintenance of all cones, oversized cones, barricades, concrete median barriers and other traffic control devices required for the active method of handling traffic with respect to type, size, dimension, color, reflectorization, mounting base and height, lateral and longitudinal placement, spacing and taper, as appropriate. Consider the following:

1. Oversized Cones. The substitution of oversized cones for portable plastic drums is permitted only within lane closures. Oversized cones are prohibited for any purpose other than as the traffic control device used within lane closures. Substitution of portable plastic drums with oversized cones during nighttime shoulder closures is prohibited.

2. Barricades. Pay particular attention to the supplementary signs and warning lights that are permitted to be attached to Type III barricades.

3. Reflectors on Temporary Concrete Barriers. Verify that the reflective discs, or approved equal, and delineators affixed to temporary concrete barriers placed parallel to the roadway are of the specified material, proper size and color and properly mounted at the correct spacing, as detailed on the *Standard Drawings*.

4. Guardrail. Verify that guardrail is removed and replaced within the specified period and that the operation does not occur during restricted hours. Verify compliance of the allowable length of removal. Pay particular attention to the restrictions in the vicinity of bridge piers. Verify that the Contractor closes the shoulder or lane, as appropriate for hourly restrictions, at locations where more guardrail is removed than can be replaced in the same day.

601.3.6 Portable Terminal Impact Attenuators

The posted speed limit in place prior to construction will be used to determine attenuation. Test Level 3 – 70 mph units are required on all roadways with speed limits of 65 mph or greater. Test Level 3 – 60 mph units are only permitted on roadways with speed limits of 60 mph or less. Test Level 2 units are only permitted on roadways with speed limits of 45 mph or less. Ensure that attenuators are installed in compliance with the manufacturer's recommendations. Ensure that the grade is flat and that the studs and diagonal sign are properly installed. Check installation height, orientation and direction of cartridges for compliance. Closely inspect all parts of the attenuator and all anchors after being hit. Verify that rails are kept clean from construction debris and concrete splatter and the proper clear zone is maintained around the attenuator.

601.3.7 Equipment Operation and Backup

Ensure that Contractor personnel know how to operate and maintain devices such as changeable message signs, arrow panels, shadow vehicles and crash attenuators. Verify the availability of backup devices for immediate replacement of any failed or damaged units. If an advance warning arrow panel, changeable message sign, truck mounted attenuator or portable terminal impact attenuator is struck by an errant vehicle or has a failure, notify the Contractor to eliminate the hazard immediately. Verify that the repair or replacement is in strict accordance with the manufacturer's criteria. If the Contractor fails to provide proper notification and evidence of conformity, the Resident Construction Engineer will immediately suspend all work. The suspension will remain in effect until the needed repair or replacement is resolved.

601.3.8 Flagger Operations

The need for flaggers may occur when two opposing directions of traffic must share a common travel lane, during a lane closure on a two-lane, two-way roadway, during an intermittent ramp closure or an intermittent encroachment of the Contractor's equipment on the roadway. Also, a flagging operation may be necessary to direct traffic around construction activities or when it is necessary to maintain continuous traffic at reduced speeds. Verify training of all flaggers, that they are equipped with regulation equipment and that they are positioned properly and conducting the flagging operation in accordance with the Traffic Control Plan and the *MUTCD*. Verify the proper placement of advance warning signs for flaggers. Ensure that each flagger is equipped with a proper "Stop/Slow" paddle and an approved safety vest. SCDOT prohibits the use of flags, except during emergency situations.

601.3.9 Detour Considerations

Where detours are required, verify that the Contractor has an approved Detour Plan. Ensure that the media has been notified. Verify compliance of all detour signs in place and ensure they are being maintained as specified by the Traffic Control Plan and the *MUTCD*.

601.3.10 Lane Closure Restrictions

Where lane closures are required, check compliance of the signing, channelization and taper at the lane transition. The contract will specify the requirements based on traffic volume and the physical characteristics of the roadway and construction activity. Verify that lanes are not closed to traffic during periods for which they are specified to remain open. Strictly enforce the monetary penalties associated with non-compliance. Where unusual backups occur during periods when lane closure is permitted, immediately notify the Resident Construction Engineer to determine if it is necessary to direct the Contractor to open the lane.

601.3.11 Construction Vehicle Access

Verify that construction vehicles that access open travel lanes do not create a hazard or impediment to the normal flow of traffic. Verify the proper use of lead and shadow vehicles with advanced warning panels and truck-mounted attenuators where disruption occurs. Ensure that these vehicles maintain the proper speed and distance from one another.

601.3.12 Lane and Shoulder Drop-Offs

Pay attention to vertical drop-offs within the traveled way (i.e., between adjacent lanes, along shoulders). If the drop-off exceeds 1 inch when the pavement is planed or milled, or 2 inches when the new pavement is placed, notify the Contractor immediately and follow-up in writing if the problem is not mitigated immediately.

601.3.13 Overhead Structure Work

During work on bridge beams or overhead sign structures, verify that temporary lane closures or pacing operations, with assistance of the Highway Patrol, are properly conducted. When working over traffic, ensure that the Contractor provides suitable safety platforms to catch falling materials and that the platforms do not encroach on the required vertical clearance.

601.3.14 Widths, Tapers and Clear Zone Considerations

Verify that travel lane and shoulder widths are maintained as specified by the Traffic Control Plan. Where needed in the method of handling traffic, verify that traffic control devices are placed and maintained at the proper spacing and taper at lane transitions, as defined in the Traffic Control Plan and the *MUTCD*. Verify that all clear zones are being maintained. The Special Provisions will define the lateral offset from the edge of the traveled way for which it is permissible for the Contractor to work, operate equipment, store materials and park vehicles. This lateral distance will depend on the type, location and speed of the facility. In general, excavation, structures, stockpiles, equipment and vehicles must be located outside the clear zone or, if within the clear zone, located behind a protective barrier, such as guardrail or concrete median barrier. If work encroaches the clear zone, the Contractor will need to establish a shoulder closure or lane closure, as appropriate. If signs or other types of traffic devices are within the clear zone, they must meet NCHRP Report 350 criteria for their intended application (e.g., yielding or breakaway assemblies).

601.4 POST-CONSTRUCTION CONSIDERATIONS

When the work is substantially complete and normal traffic flow has resumed, the Resident Construction Engineer will request the Contractor in writing to remove the permanent construction signs and traffic control. Ensure that all construction signs and traffic control devices are promptly removed from the project after all major items of work have been completed. Ensure compliance of the re-establishment of permanent signing, permanent pavement markings and permanent barriers. SCDOT assumes the responsibility of maintenance of traffic upon removal of the temporary traffic control.

601.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Check the provisions of the Contract for the measurement and basis of payment for individual pay items related to temporary traffic control. Many variations exist, which will vary on a project-to-project basis. Lump sum payment, scheduled on a percentage completed basis, is common. Record all measurements for payment in the Daily Work Report. Record observations and directives to the Contractor on SCDOT Form 600.02 – Work Zone Traffic Control Inspection and reference the activity in the Daily Work Report. Retain these Forms and a copy of all manufacturer's certifications.

Section 602
Traffic Control Devices in the Work Zone

Work zone traffic control devices will be governed under the provisions of Section 602 of the *Standard Specifications*, including applicable Supplemental Specifications, Special Provisions, *Standard Drawings* and manufacturer's documentation and drawings for the SCDOT-approved proprietary devices used on the project. The Resident Construction Engineer and Roadway Inspectors will be responsible for inspections to ensure that the Contractor is operating in compliance with the approved Traffic Control Plan and the Contract Plans and Specifications. See Section 601 for additional information.

Section 603
Work Zone Traffic Control Procedures

Work zone traffic control procedures will be governed under the provisions of Section 603 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the Contractor operates in compliance with the approved Traffic Control Plan and the Contract Plans and Specifications. See Section 601 for additional information.

Section 604
Permanent Pavement Markings

604.1 DESCRIPTION OF WORK

When pay items governed under Section 604 of the *Standard Specifications* are designated in the Contract, the Contractor will be responsible for furnishing, preparing the surface and applying reflectorized pavement markings of the type specified (e.g., paint, thermoplastic, epoxy). The markings will be either white or yellow of the width, length, thickness and pattern as designated in the Pavement Marking Plans of the Contract, including appropriate *Standard Drawings* and the MUTCD. Note that the Contractor will be responsible for determining no passing zones and for providing the Resident Construction Engineer with the data used to establish these pavement marking applications. During the work, the Contractor also will be responsible for the temporary traffic control and protection of the pavement markings during construction. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the work and materials comply with the requirements of the *MUTCD* and the Contract Plans and Specifications.

604.2 PRECONSTRUCTION CONSIDERATIONS

604.2.1 Materials Considerations

Verify compliance of the types of materials required for pavement markings. Sampling and testing will be in accordance with the Quality Control Samples and Tests presented in Section 106. Where used for pavement marking, the following materials must be supplied from a source listed on the material’s respective SCDOT Approval Sheet:

- Approval Sheet 21 – Preformed Markings,
- Approval Sheet 40 – Methyl Methacrylate Acrylic Traffic Marking Material, and
- Approval Sheet 47 – Hot Applied Preformed Thermoplastic Pavement Markings.

Traffic paint will be pretested and approved by the Research and Materials Engineer prior to delivery to the project. Samples of the batch from the manufacturer will be submitted directly to the Research and Materials Laboratory for testing and approval. An approval number will be issued to the manufacturer for use in identifying the batch of paint as being pretested and approved for the project. The delivery ticket and manufacturer’s certification letter will include the following information:

- date,
- consignee and recipient name,
- purchase order number,
- type of paint and number of gallons shipped, and
- batch number and laboratory number for the approved batch.

Obtain and forward a copy of the manufacturer's certification letter to the Research and Materials Engineer. If the material is of questionable quality, contact the Research and Materials Engineer to sample the material at the job site. Epoxy, thermoplastic and intermixed glass bead materials that are used for pavement marking will be accepted based on the manufacturer's certified test results. Obtain and forward a copy of the manufacturer's certified test results to the Research and Materials Engineer. A sample of glass beads should be submitted to the Research and Materials Laboratory. Pay particular attention to the warranty requirements for epoxy material.

604.2.2 Equipment Considerations

Verify compliance of the required application, cleaning, heating and mixing, as applicable for the type of pavement marking material to be applied. Pay particular attention to the ability of the applicator to apply the correct thickness, width and length of material, with a clean cut-off. The applicator should be capable of traveling a constant speed while applying the marking material in the required alignment and pattern. The applicator also must be able to immediately deposit the proper quantity of glass beads on the material for reflectivity. Applicators should travel with the flow of traffic using properly equipped lead and shadow vehicles and traffic control devices.

604.2.3 Application Restrictions

Check for restrictions on weather, season, ambient temperature, relative humidity and hours of operation prior to application. Ensure the proper traffic control is in place to protect the markings. For application of hydrocarbon thermoplastic on a new asphalt surface, ensure that the asphalt surface has been in place a minimum of 20 days prior to application. For alkyd thermoplastic, ensure that the asphalt surface has been in place a minimum of 7 days prior to application.

604.3 INSPECTION DURING CONSTRUCTION

604.3.1 Surface Preparation

Check to ensure that conflicting pavement markings are properly removed. Pay particular attention to specified removal requirements on concrete surfaces. Ensure that the surface is thoroughly cleaned of all dust, dirt, grease, oil and foreign matter just prior to application. The surface must be dry prior to application. A primer sealer may need to be applied, depending on the type of marking material and the surface it is being applied to. On new concrete surfaces, ensure that the curing compound is removed prior to application.

604.3.2 Material Preparation

Verify that the marking material is properly mixed, agitated and heated, as appropriate. Pay particular attention to time limit restrictions after mixing and heating. Ensure that the proper type and quantity of glass beads are immediately applied to the marking material.

604.3.3 Application of Markings

Verify that the correct color of marking material is placed at the correct location, pattern and alignment on the pavement surface. Pay particular attention to lateral distances, longitudinal spacing patterns and relationship to longitudinal joints. As applicable, verify the thickness of the marking material. Ensure compliance with the *MUTCD* and the Contract Plans and Specifications. Check the rate of application of marking and glass bead materials for compliance.

604.4 POST-CONSTRUCTION CONSIDERATIONS

Check line thickness, width, adhesion and cycle length for compliance. Verify that the final markings are free from waviness and that lateral deviations do not exceed specified tolerance. Greater deviation from allowable tolerance is sufficient cause for requiring the Contractor to remove and correct the markings. The Contractor is also required to remove and correct any symbol markings not meeting specified dimensional requirements. Observe the markings both during the day and at night for acceptability. Verify that overspray is properly cleaned. Enforce the provisions of the Contract with respect to any required rework. Ensure that all markings are sufficiently dry before opening to traffic. Final acceptance of permanent marking will occur after the 180 day warranty period.

604.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measurement for payment for permanent pavement markings will be determined either by unit length of line type or each type of symbol applied and accepted. Document measurements in the Daily Work Report. Payment will be based on the Contract unit price. Retain all field notes and copies of all manufacturer’s certifications.

Section 605
Permanent Raised Pavement Markers

605.1 DESCRIPTION OF WORK

When permanent raised pavement markers are specified in the Contract, the Contractor will be responsible for furnishing, preparing the surface, applying adhesive and retroreflective pavement markers of the type, color and dimensions and at the locations designated on the Contract Plans and Specifications. During the work, the Contractor also will be responsible for the temporary traffic control and protection of the markers during construction. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the work and materials comply with the requirements of the *MUTCD* and the Contract Plans and Specifications.

605.2 PRECONSTRUCTION CONSIDERATIONS

Raised pavement markers must be tested and approved prior to use. The Resident Construction Engineer can check if a particular Lot of pavement markers has been previously tested by searching Matlab on the Department's Intranet site for the appropriate lot number. If pavement markers have been tested, no additional tests are needed. Otherwise, obtain and forward samples to the Research and Materials Laboratory for testing. A minimum of 25 markers of each type to be placed, selected at random from each shipment or Lot, will constitute a representative sample. Obtain and forward with the samples a copy of the manufacturer's certified test results. Ensure that the manufacturer's application recommendations are followed. Ensure that the adhesive material is supplied from a source listed on SCDOT Approval Sheet 42. Obtain from the Contractor and forward to the Research and Materials Engineer the manufacturer's certification letter stating that the material complies with specified requirements. Sampling of adhesive will not be necessary.

605.3 INSPECTION DURING CONSTRUCTION

Verify compliance of any application restrictions, including season, temperature and weather. Ensure that lane line raised pavement markers, edgeline markers, centerline markers and entrance and exit ramp markers are located as shown on the Contract Plans, including *Standard Drawings*. Verify that the markers are properly bonded to the pavement surface using either the epoxy or asphalt adhesive, as specified.

605.4 POST-CONSTRUCTION CONSIDERATIONS

Delay final inspection and acceptance of the permanent raised pavement markers for a period of 180 days after the last date of marker placement. Inspect the markers both during the day and at night for acceptance. Enforce the provisions of the Contract with respect to repairs and replacement.

605.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measurement for payment for permanent raised pavement markers will be based on each type of unit installed and accepted. Document measurements in the Daily Work Report. Payment will be made based on the Contract unit price. Retain all field notes and copies of all manufacturer's certifications.

Section 606
Reserved

Section 607
Permanent Terminal Impact Attenuator

607.1 DESCRIPTION OF WORK

An impact attenuator is installed to control the deceleration of an impacting errant vehicle and to dissipate its kinetic energy. When struck from the front, the unit will bring the errant vehicle to a safe and controlled stop. When struck from the side, the unit will redirect the errant vehicle. The Contractor will be responsible for furnishing, assembling and installing the device at the specified location to protect the approaching terminal end of a concrete barrier wall or other similar fixed-object hazard. The installation will be governed by the documentation and drawings of the manufacturer of the SCDOT-approved system. SCDOT approval of such systems is primarily based on whether or not the system is NCHRP Report 350 compliant for the unit's intended application. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring the unit is installed in compliance with the requirements of the Contract Plans and Specifications and the manufacturer's recommendations.

607.2 PRECONSTRUCTION CONSIDERATIONS

Ensure the impact attenuator is of the type specified in the Contract. Verify the proper submittal of the required installation manual. Inspect the Shop Plans and detailed specifications from the manufacturer. Verify that the Shop Plans and specifications include performance criteria, installation drawings and instructions that completely describe the installation of the attenuator system. Inspect all parts and materials to ensure conformance with specifications. Verify the cartridges are of the type specified for the intended application and that they are new. Damaged cartridges exhibiting pulled staples, wrinkles in the plastic container package or exposed internal material should be replaced immediately. Verify that the nose assembly and required signs are of the proper type and color and have the required type of reflective sheeting.

607.3 INSPECTION DURING CONSTRUCTION

Verify that all obstructions are cleared from the surrounding and approach areas for the specified length. Verify that the approach grade is smooth and flat and conforms to the roadway grade, as specified. Pay attention to superelevated areas. Where installed in two-way traffic situations, verify the proper installation of the transition panel and that the installation minimizes impact or snagging from the rear. Verify that the transition panel does not impede the movement of fender panels. Ensure that the top of the foundation is at the same grade elevation as the adjacent travel lane or paved shoulder. Verify that the foundation is constructed to be compatible with the anchor system and that the anchor system conforms to specified requirements. Ensure that the grout used for the anchor system is of the proper type and installed as specified.

607.4 POST-CONSTRUCTION CONSIDERATIONS

Inspect the impact attenuator, including all parts and materials, immediately after installation to ensure compliance with all specifications. Maintenance of the unit will require immediate attention, as specified in the Contract Specifications, if struck by a vehicle.

607.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measurement for payment for permanent terminal impact attenuators will be based on each unit installed and accepted. Document measurements in the Daily Work Report. Payment will be made based on the Contract unit price. Retain all field notes and manufacturer's documentation.

Section 608
Permanent Signing

608.1 DESCRIPTION OF WORK

When permanent signing is specified, the Contractor will be responsible for furnishing sign blank, reflective sheeting, sign fabrication and furnishing sign posts as required by the Contract Plans and Specifications. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring compliance of the sign materials and fabrication.

608.2 PRECONSTRUCTION CONSIDERATIONS

608.2.1 Aluminum Sign Blanks

Obtain the manufacturer's Mill Test Reports and material certifications from the Contractor and forward a copy to the Research and Materials Laboratory. Failure to provide Mill Test Reports and materials certifications is grounds for rejecting the material. Check the size, holes, corner radii and type of material for compliance.

608.2.2 Reflective Sheeting

Reflective sheeting for highway signing must be supplied from a supplier listed on SCDOT Approval Sheet 20. For sheeting types see the latest Engineering Directive Memorandum Number 4 – Reflective Sheeting for Signs.

Obtain from the Contractor the manufacturer's certificate of compliance. Pay particular attention to the requirements of performance warranties. Check for proper application and splicing of sheeting and the overall quality of the fabricated sign.

608.2.3 Sign Posts

Obtain from the Contractor the manufacturer's Mill Test Reports and material certifications for the sign posts furnished for the project. Failure to provide Mill Test Reports and materials certifications is grounds for rejecting the material. Verify the metal type, galvanization, dimensions, weight of post, lengths and compliance with yielding or breakaway system criteria, as applicable.

608.3 INSPECTION DURING CONSTRUCTION

When permanent highway signing is installed, verify compliance with respect to the type, color, size, message, placement location, lateral offset, mounting height, orientation and reflectorization. Pay particular attention to the installation details and assembly of breakaway sign supports.

608.4 POST-CONSTRUCTION CONSIDERATIONS

The Resident Construction Engineer in consultation with Traffic Engineering will be responsible for the final acceptance of all highway signing materials.

608.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measurement and payment for permanent signing will be based on bid items as specified in the contract. Retain all Mill Test Reports and copies of all manufacturer's certifications.

DIVISION 700
Structures

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

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Section 701
Portland Cement and Portland Cement Concrete

701.1 DESCRIPTION OF WORK

The requirements for Portland cement and Portland cement concrete are governed by the provisions of Section 701 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. The Contractor will be responsible for furnishing the required component materials, properly storing and handling the materials and for proportioning, mixing and delivering an acceptable concrete mixture of the specified class.

701.2 PRECONSTRUCTION CONSIDERATIONS

701.2.1 Concrete Quality and Temperature Control

The Contractor is responsible for all personnel, methods and procedures to control the quality of work and materials during the project, which must be consistent with the QC/QA requirements specified in the Contract and required by the Research and Materials Engineer. The minimum level of Quality Control, Quality Acceptance and Independent Assurance Samples and Tests are presented in Section 106. During periods of extreme hot or cold temperatures, concrete production will not be permitted without a Cold and Hot Weather Batching and Mixing Plan accepted by the District Construction Engineer. The Cold and Hot Weather Batching and Mixing Plan describes methods that will be used to control concrete temperatures within specified limits during batching, mixing, placement and curing. Control methods include, but are not limited to:

- scheduling finishing and curing immediately behind the pour;
- heating of mixing water and using heated and insulated aggregate bins;
- using insulated forms and curing blankets (requires product data sheet);
- using tarps and dry heat, while maintaining moisture during curing;
- sprinkling of aggregate and using chilled mixing water, shaved ice or special cement;
- prewetting forms and subgrade, where applicable;
- erecting windbreaks;
- using a fog spray to promote evaporative cooling without damaging surface; and
- rescheduling.

Temperatures must be in accordance with the Contract Specifications for the type of work. The Contractor will submit the Cold and Hot Weather Batching and Mixing Plan and the topic of quality and temperature control will be discussed at the Preconstruction Conference or Pre-Pour Conference, if required. Do not permit the Contractor to begin work until the methods of quality and temperature control have been discussed and agreed upon. Prior to beginning work, ensure that the required materials for temperature control are at the job site. During construction, observe Contractor operations and monitor the temperature of the concrete for compliance at the plant and prior to placement. Contact the District Office or Bridge Construction Engineer, as needed, for assistance.

701.2.2 Certification of Concrete QC / QA Personnel

The Department requires certification of all SCDOT and Contractor personnel involved with inspecting, sampling and testing concrete. All such personnel must be certified by the SCDOT Certification Program. It is the responsibility of the Resident Construction Engineer to ensure that all Concrete QC / QA Technicians and Concrete Technicians are SCDOT-certified. See the SCDOT Technician Certification Policy for additional information.

701.2.3 Responsibilities of Concrete QC / QA Personnel

The provisions of the Contract will define the QC / QA sampling and testing responsibilities of SCDOT and Contractor personnel. If Contractor QC / QA is specified, the SCDOT Inspector will observe the Contractor's Concrete QC / QA Technician perform the required QC / QA sampling and testing; otherwise, the SCDOT Inspector will perform these duties. The SCDOT Inspector has the authority to instruct the Contractor to correct minor problems; however, if major problems are encountered, notify the Contractor to halt work and contact the Resident Construction Engineer. The Resident Construction Engineer will assess the situation and determine the best course of action to take in the interest of the Department, which may include:

- rejecting the work or material and requiring replacement at no additional cost,
- accepting the work or material with a reduction in payment to the Contractor, or
- requiring the work or material to be modified or improved to correct the deficiency.

The SCDOT Inspector will document the work performed each day, including material quantities and any noteworthy observations. These records will be recorded in the Daily Work Report and appropriate SCDOT Construction Forms for use by the Resident Construction Engineer. The disposition of all failing materials will be reported on SCDOT Form 100.09 – Report of Disposition of Materials Failing to Meet Specifications. The Resident Construction Engineer will approve the Daily Work Reports in SiteManager's Daily Diary and, at the end of each month, will use the approved entries as the basis for generating the Monthly Estimate, which will be forwarded to the Central Office to initiate payment to the Contractor.

When structural concrete is furnished by a transit or central-mix plant (e.g., Ready-Mix plant), an SCDOT-certified Concrete Technician must be present, who may be an employee of SCDOT, the Contractor, a concrete supplier or an independent testing laboratory, as defined in the Contract. The Concrete Technician will maintain records of mix design, batch proportioning and quantities of materials delivered to the project. Retain copies of these records in the project files, and do not accept delivery of batched concrete without proper compliance documentation, which must be signed and certified by the Concrete Technician on SCDOT Form 700.04 – Ready Mix Concrete Report. Note that, unless otherwise directed by the Resident Construction Engineer, these provisions are not required for Class 2500 concrete.

701.2.4 PCC Mix Materials

701.2.4.1 Material Source Approval

Many materials used for concrete construction are supplied from pre-approved sources. The Research and Materials Engineer is responsible for the evaluation and approval of these sources. SCDOT Inspectors will be responsible for ensuring that materials required for concrete construction are supplied from sources listed on the following SCDOT Approval Sheets:

- Approval Sheet 1 – Fine Aggregate Sources for Concrete,
- Approval Sheet 2 – Coarse Aggregate Sources,
- Approval Sheet 3 – Fly Ash for Portland Cement Concrete,
- Approval Sheet 5 – Chemical Admixtures and Air Entrainment Agents for Concrete,
- Approval Sheet 6 – Authorized Portland Cement and Non-Steel Slag Manufacturers,
- Approval Sheet 18 – Authorized Type I (SM) Slag-Modified Portland Cement Manufacturers,
- Approval Sheet 28 – Ready-Mix Concrete Plants Inspected by SCDOT,
- Approval Sheet 32 – Stabilizer Agents for Mixer Drum Wash Water, and
- Approval Sheet 53 – Corrosion Inhibitors for Concrete.

The Contractor is responsible for notifying the Resident Construction Engineer prior to any change in material source, which may require submission of a new Mix Design for review by the Research and Materials Engineer.

701.2.4.2 Cementitious Materials

The cementitious material used in concrete is primarily Portland cement, but may also include fly ash, silica fume or water-granulated blast-furnace slag. The maximum allowable quantity of fly ash and slag will be defined in the Contract Specifications. Verify that cementitious materials are supplied from a source listed on SCDOT Approval Sheet 3, SCDOT Approval Sheet 6 or SCDOT Approval Sheet 18, as appropriate, and that its source is the same as that designated on the Mix Design. Sampling and testing will be performed in accordance with SC-T-47 (see Appendix C) and the frequency schedules presented in Section 106. Obtain the Mill Test Reports for fly ash, slag and cement. All Mill Test Reports must contain the required statement of certification. Ensure that a properly completed Sample Identification Card (see Appendix B) is affixed to the sample when shipped to the Research and Materials Laboratory with a copy of the Mill Test Report. Consider the following when completing the Sample Identification Card:

1. Portland Cement. For Portland cement, the Sample Identification Card must contain the following:

    - manufacturer;
    - type of cement;
    - silo number and grind date for domestic cement;
    - ship name and arrival date for foreign cement;
    - supplier source and location;
    - quantity shipped;
    - date shipped; and
    - destination.

2. Fly Ash. For fly ash, the Sample Identification Card must contain the following:

    - supplier source and location;
    - shipping identification (e.g., silo, truck, as appropriate);
    - quantity shipped;
    - date shipped;
    - purchaser; and
    - destination.

3. Slag. For slag, the Sample Identification Card must contain the following:

    - producer, source and location;
    - grade;
    - date of shipment;
    - tanker number;
    - silo number; and
    - date of production.

4. Silica Fume. Do not sample. Obtain the certification and send it to the Research and Materials Engineer.

The Research and Materials Laboratory will perform tests on samples received. If tests confirm that a shipment is not in compliance, use of the source will be discontinued until compliance can be verified. Material that fails compliance testing will be promptly removed so that it will not be incorporated in the work. The Contractor is responsible for replacing Portland cement concrete produced with defective cement.

Cementitious materials from different sources and of different types must be stored separately in weatherproof facilities. Bulk cement is typically stored in bins or silos and bagged cement is typically stored in buildings or covered pallets. This material must be kept dry. Dark clumps are a sign of previous wetting and may be grounds for rejection. Material that is lumpy, caked, or discarded from open or otherwise damaged bags must not be used. In addition, the material must be handled in such a manner to prevent loss due to dusting, which can greatly affect the water-cement ratio of a batch. During production, cement will be measured by weight in a certified weigh hopper that is separate from that used for aggregate material. Do not permit the use of fractional bags of cement, unless the cement is being proportioned by weight in a weigh hopper.

701.2.4.3 Aggregate Materials

The Mix Design assumes aggregate to be in a saturated surface-dry condition. As such, determining the amount of free moisture is necessary to ensure that the maximum allowable water-cement ratio is not exceeded. A minimum of two moisture tests should be performed daily on fine aggregate. The moisture of the coarse aggregate is assumed to be 0.5%. The need for additional testing will depend on the uniformity of the supply and any appreciable changes in weather, such as after it rains. Consider the following:

1. Fine Aggregate. Fine aggregate will be natural sand, manufactured sand, or a blend of the two, supplied from a source listed on SCDOT Approval Sheet 1. If a blend is used, the components must be stored and batched separately. Fine aggregate must meet specified criteria for organic impurity (AASHTO T 71), soundness (AASHTO T 104) and gradation and will be subject to sampling and testing as discussed in Section 106. Upon delivery, visually inspect the fine aggregate for unacceptable lumps, organics, trash and debris. Sampling and Testing Methods SC-T-2, SC-T-3 and SC-T-4 will apply (see Appendix C).

2. Coarse Aggregate. Coarse aggregate will be clean, tough, durable gravel, crushed gravel, crushed stone, crushed slag or an approved combination supplied from a source listed on SCDOT Approval Sheet 2 and appropriate for the concrete type being used. Where routine testing of material has not been performed during prolonged stockpiling, obtain and forward samples to the Research and Materials Laboratory prior to use. Coarse aggregate must meet specified criteria for Los Angeles Abrasion (AASHTO T 96), soundness (AASHTO T 104), gradation and will be subject to sampling and testing as discussed in Section 106. Sampling and Testing Methods SC-T-1, SC-T-3 and SC-T-4 will apply (see Appendix C).

Aggregate materials from different sources or of different grading must be separately maintained in stockpiles and bins to avoid intermixing, segregation and contamination. Check the location and preparation of stockpiles, the use and maintenance of bins and the handling of aggregate materials for compliance. Stockpiles should generally be constructed on a clean, well-drained foundation in 3-foot layers without coning. Become familiar with the appearance of the graded aggregate and monitor its handling from stockpile to bin. Check for signs of segregation, intermingling, contamination and breakage. Segregation is common and typically begins with improper handling. Serious segregation is grounds for rejection. In addition, the Mix Design assumes the aggregate to be in a saturated surface-dry condition. Excessively dry conditions may warrant wetting at night and sprinkling during the day, with the excess water being allowed sufficient time to drain (i.e., typically 12 hours). Verify that moisture tests are conducted as specified, and require additional testing as conditions warrant. Such monitoring is critical to maintaining slump and the water-cement ratio within tolerance. The water content must be field adjusted to compensate for changes in moisture in the aggregate. All moisture adjustments must be made in accordance with the batch chart supplied by the Structural

Materials Engineer for the Mix Design. During production, each fine and coarse aggregate fraction for the batch will be weighed separately in the weigh hopper on certified scales. Once established for production, do not permit a change in material source without written authorization from the Research and Materials Engineer.

701.2.4.4 Water and Stabilizer Agents

Water used in mixing, fogging or curing concrete and for mixer drum washing must meet the requirements of the tests defined in the Contract Specifications. Stabilizer agents used for mixer drum wash water must be supplied from a source listed on Approval Sheet 32. Water from a public supply or a previously approved source does not need to be sampled or tested prior to use. However, water from other sources must be tested and approved by the Research and Materials Engineer and frequently monitored for compliance. A minimum of 1 gallon of water will be submitted to the Research and Materials Laboratory in a plastic container. Metal containers must not be used. Testing of water samples requires a minimum of 8 calendar days, so the sample should be submitted well in advance of the proposed date of use. Where water is drawn from a stream or reservoir, ensure that the pipe intake is covered with wire mesh and maintained clean. Where water is hauled to the job site, check that haul containers are clean and properly covered.

Water used in the concrete mix will be measured by either volume or weight, assuming 8.33 pounds per gallon. If measured by volume, a calibrated auxiliary tank may be used. If weighed, it must be weighed separately on a certified scale. The accuracy of measuring water will be frequently checked to ensure that the quantity delivered is within specified tolerance. Pay particular attention to leaks in water containers and dispensing lines that would reduce the quantity once measured for a batch.

701.2.4.5 Admixture Materials

Admixtures are those ingredients in concrete, other than Portland cement, water and aggregate materials, that are added immediately before or during mixing to adjust properties of concrete, such as workability, finishability, strength, durability, watertightness and wear resistance. The primary reasons for using admixtures are to achieve certain properties in concrete more effectively than by other means; to ensure concrete quality during mixing, transporting, placement and curing in adverse weather conditions; and to overcome certain emergencies during concrete placement. Admixtures commonly used in concrete include:

1. Air-Entraining Admixtures. Air-entraining admixtures are used to entrain very small air bubbles in the concrete. Air-entrainment will dramatically improve the durability of concrete exposed to moisture during cycles of freezing and thawing and chemical deicers. The workability of fresh concrete is also improved significantly and segregation and bleeding are reduced or eliminated. Air-entrainment is required for Class 2500, Class 3000, Class 4000, Class 4000S and Class 6500. Also, certain structural elements require air-entrainment, regardless of the class, as specified in the Contract Specifications.

2. Water-Reducing Admixtures. Water-reducing admixtures may be used to reduce the quantity of mixing water by 5% to 30%. Water reducers may be added to concrete without reduction in water to improve workability. The major benefit of reducing mixing water is the increase in concrete strength.

3. Retarding Admixtures. Retarding admixtures are used to retard the rate of setting when concrete is exposed to high temperature during placement, hauled a long distance, or a large quantity is being placed. A practical alternative is to cool the mixing water or the aggregates. A water-reducing set retarding admixture is commonly used in concrete that is deposited under water and in concrete that is not likely to reach its final position in the forms prior to taking its initial set. Some reduction in strength at an early age will accompany the use of retarders.

4. Accelerating Admixtures. Accelerating admixtures are used to accelerate the strength development of concrete at an early age. This, however, can also be achieved by using high-early strength Portland cement, lowering the water-cement ratio by adding cement and by curing at higher temperatures. Calcium chloride is commonly used as an accelerating admixture, but may cause drying shrinkage, corrosion and discoloration. Calcium chloride is forbidden in steel reinforced concrete.

5. Corrosion Inhibitors. Where a corrosion inhibitor is specified, verify that it is supplied from the source specified on the Mix Design.

Sampling and testing of approved admixtures will not be required during the project; however, SCDOT Inspectors must ensure that the admixture is properly identified, is supplied from a source listed on SCDOT Approval Sheet 5 and appears in good condition. If material quality is questionable, suspend use and contact the Research and Materials Engineer.

Admixtures from different sources and of different types must be stored separately in closed containers to prevent contamination and dilution. Admixtures will be dispensed in the proportion recommended by the manufacturer. The accuracy of the dispensing method (e.g., graduated sight tube, metering device) will be frequently checked to ensure the quantity is within specified tolerance. Pay particular attention to leaks in containers and dispensing lines that would reduce the quantity once measured for a batch. The most common admixture used is an air-entraining agent. The addition of air-entraining admixture to adjust air content is permitted after mixing using the method prescribed in the Contract for the class of concrete being produced.

701.2.5 PCC Plant and Hauling Equipment

701.2.5.1 Certification and Inspection

Prior to producing concrete for SCDOT projects, the Contractor will make arrangements for a thorough compliance inspection of concrete production and transport facilities (e.g., batch plant, Ready-Mix plant, scales, meter proportioning equipment, trucks, field laboratory, sampling and testing equipment, material sources, mix design, batch charts, personnel) to be performed by the Research and Materials Engineer on an annual basis. These items will be inspected for Contract compliance and any required certifications from SCDOT. Inspections then will be performed at least annually and at other times during production, as deemed necessary. Note that Ready-Mix plants will be inspected and approved in accordance with SCDOT Approval Policy 28 and, if proposed for use on the project, must be listed on SCDOT Approval Sheet 28. The Plant Approval Letter must be current and accurately document the concrete to be supplied for the project (e.g., type, batch size). The Plant Approval Letter will include the following information:

- plant identification, type and capacity;
- date of last inspection;
- list of SCDOT-approved stockpiled materials;
- date of last scale certification;
- date that scales need to be re-certified; and
- a list of approved truck mixers to be used on the project.

Mixing drums will have a manufacturer's rating plate showing drum capacity and recommended drum or blade operating speed (i.e., revolutions per minute). Each truck mixer will receive an SCDOT approval decal showing truck identification number and maximum gross volumetric drum capacity for both agitating and mixing operations. The concrete volume in the drum cannot exceed the maximum rating, and truck identification numbers must be used to document the concrete supplied to the project. Prior to production, ensure that production and transport facilities have been inspected and approved, displaying current un-expired SCDOT approval decals. Become familiar with typical operation and condition and periodically check for signs of unacceptable use or condition. Do not adjust equipment settings, scales or metering equipment, because this is the Contractor's responsibility.

701.2.5.2 Scales and Metering Devices

The Contractor is responsible for maintaining and calibrating scales and metering devices used for proportioning materials for concrete batches. Although SCDOT Inspectors will verify and document checks of scales and metering devices, they should never attempt to repair or adjust such equipment. If problems are encountered, halt production and ensure that the device is serviced and recalibrated by a qualified technician. Consider the following:

1. Scale Certification. If the concrete plant is within South Carolina, scales will be inspected annually for accuracy by the Division of Weights and Measures, South Carolina Department of Agriculture or by other qualified scale service agents. The Letter of Certification or Seal on the scale indicates only that the device was within tolerance at the time it was tested. Periodic checks must be made to ensure compliance, because dirt on balance arms, wear of knife edges and foundation settlement can change scale sensitivity and accuracy.

2. Metering Device Checks. Water and admixture dispensers should be checked at frequent intervals. Such devices can be checked by drawing off and measuring a quantity of material to determine if the proportion is within specified tolerance of the quantity required for the batch. If the device fails to meet this criteria, inform the Contractor to halt production and have the problem corrected. Repeat the test to verify proper recalibration of the device.

701.2.5.3 Concrete Mixers

The purpose of the mixer is to combine the proportioned component materials into a homogenous mass, ensuring that all aggregates are thoroughly coated with cement paste. The purpose of the truck mixer, when used as an agitator, is to prevent segregation of the mix en route to the site. Mixing time and number of revolutions will be specified and should be checked periodically using the drum revolution counter after zero reset. This criteria may be adjusted for field conditions based on the recommendations of the Research and Materials Engineer. Mixers should be inspected periodically for accumulation of hardened mortar and wear of blades. Such inspections are critical to ensuring optimum mixer performance. Consider the following:

1. Blade Wear. The mixer's blades should be carefully inspected and monitored for wear. The majority of wear will occur at the center of the blade with very little wear at the tips. If worn 1 inch or more below the original height of the manufacturer's design, discontinue use of the mixer until the blades can be repaired or replaced. The Contractor is responsible for providing the manufacturer's brochure showing the original dimensions and arrangement of the blades. To check blades for excessive wear, permanent marks (e.g., holes 0.25 inches in diameter) can be provided 1 inch from the edge of new blades near the midpoint of the length of each blade. This will provide a quick visual check for excessive blade wear.

2. Cleaning. The throat of the drum and the mixing blades can become fouled with hardened or semi-hardened concrete and, if left unchecked, can cause ineffective mixing and fouling of subsequent batches. Ensure that mixers are properly cleaned at suitable intervals. Causes of obvious mortar leaks and spills should be corrected immediately.

3. Wash Water and Stabilizers. Wash water, if not completely drained from the mixer, will invariably be used in a succeeding batch. During daily production, require the mixer to be completely drained between batches. If a stabilizer agent is used for overnight or weekend treatment, ensure the procedure complies with current SCDOT policy for the brand of stabilizer used. These provisions must be strictly enforced.

701.2.6 PCC Mix Design

Many factors can influence the physical properties of concrete. As such, several trials may be necessary to initially establish an acceptable concrete mix. The design process will begin at least 45 days prior to concrete placement and will include the evaluation of trial batches mixed from component materials proposed for the project. The allowable material proportions for the class of concrete required will be defined in the Contract Specifications. The Mix Design will be developed by either an AASHTO-accredited independent laboratory or the Contractor's Concrete QC / QA Technician in an SCDOT-approved laboratory. The Contractor will submit the Mix Design, including mixing sequence, to the Research and Materials Engineer for review. The Mix Design will address the following specified criteria:

- mix proportioning for the required class of Portland cement concrete;
- required type and gradation of aggregate;

- allowable fine-to-coarse aggregate ratio, based on volume and adjusted for workability;
- saturated surface-dry aggregate and specific gravities of materials;
- minimum Portland cement content;
- allowable percentage and ratio by weight of other cementitious materials;
- maximum water-cement ratio (i.e., water to all cementitious material by weight);
- allowable range of air-entrainment and other needed chemical admixtures;
- minimum 28-day compressive strength;
- maximum concrete temperature; and
- consistency and workability (i.e., slump) for the method of concrete placement.

Upon satisfactory review, the Mix Design will be used to produce an initial trial batch, which will be sampled and tested for air content, slump, unit weight, temperature, 28-day compressive strength and time of set. As needed, proportioning will be adjusted and additional trial batches will be produced, sampled and tested until the Mix Design and mixing sequence demonstrate that the concrete meets specified criteria. Testing of trial-batches will be performed by either the Research and Materials Laboratory or the Contractor's Concrete QC / QA Technician in an SCDOT-approved laboratory under the direct supervision of Research and Materials Laboratory personnel. The Mix Design, documenting the mix proportions and water-cement ratio required to produce concrete of the specified strength, will be forwarded to the Contractor and Resident Construction Engineer.

701.3 INSPECTION DURING CONSTRUCTION

701.3.1 Batching and Mixing

Portland cement concrete will be batched and mixed in an SCDOT-approved plant and transported to the project site. Material proportioning will be performed using pre-approved scales and metering equipment, based on an Mix Design. Compliance of concrete production and hauling cannot be overemphasized. These operations are key to producing a high-quality concrete. Quality greatly depends on the attention given during each step of production and placement. No amount of extra effort at the job site can compensate for errors at the plant. For the purpose of checking yield, the volume occupied by the concrete should be computed based on the Mix Design. The Batch Chart will specify the weights to be used in the batching process depending on the moisture condition of the aggregate. A decrease in cement content or the addition of water in excess of that allowed on the Batch Chart will not be permitted unless authorized in writing by the Resident Construction Engineer. Do not accept any concrete that is not within the specified slump, air content, or temperature and pay particular attention to compliance with the criteria specified for the elapsed time of haul after water has been added to the cement. Where truck mixers are used and all materials have been charged into the mixer, the revolution counter must be set to zero and mixed at mixing speed for the specified number of revolutions before leaving the plant.

701.3.2 Sampling and Testing

Accurate and representative sampling of work and materials cannot be overemphasized. An improperly taken sample may not be truly representative; and if testing is performed on such a non-representative sample, the test results will be meaningless with respect to assessing quality and adherence to specified requirements. Section 106 documents the sampling and testing required to monitor concrete mix properties (e.g., slump, air content, temperature, cylinders). Review the sampling and testing procedures required (see Appendix C). See Appendix B for information on Sample Identification Cards. At a minimum, slump and air tests should be performed when cylinders are made. When the results of slump tests or air content tests are not within specified tolerance, reject the mix and inform the Contractor. Verify that concrete test cylinders are made at the proper schedule and in accordance with the specified test procedure. When specified, the Contractor will provide a satisfactory curing box for the 28-day test cylinders to maintain the cylinders at specified temperature until they can be shipped for testing. Additional cylinders may be used to assess the timing for form removal and opening to traffic.

The minimum frequency of sampling concrete for structures will be every 50 cubic yards placed on small pours and every 100 cubic yards placed on large pours. However, this frequency is insufficient for bridge and culvert pours in which the total amount of concrete placed is less than 50 cubic yards. On pours of less than 50 cubic yards, a sample of concrete must be obtained for each pour of each structural item (i.e., one sample per each footing, column, culvert wall, etc.). If one truck load of concrete is used to pour more than one structural item (e.g., one truck load used to pour two footings), only one sample is required. This will increase the number of samples taken, but ensure that each structure meets Contract Specifications.

701.4 POST-CONSTRUCTION CONSIDERATIONS

If testing of cylinders indicates that the concrete has not attained the specified 28-day design strength, enforce a reduction in payment, as specified. Pay particular attention to concrete that has not attained at least 90% of the minimum specified strength and enforce the provisions of the Contract with respect to obtaining core samples or other approved methods for acceptability testing. The Resident Construction Engineer and, as needed, the Bridge Construction Engineer and Bridge Design Engineer will determine the limits of concrete that can remain in-place at a reduced price or that must be removed and replaced entirely. If prestressed concrete has not attained the minimum specified strength, notify the Bridge Construction Engineer for additional requirements. Watch for damage to reinforcing steel during coring and ensure the Contractor properly fills all core holes with an approved non-shrink structural grout material. SCDOT Inspectors must keep accurate records of sampling and testing on SCDOT Form 700.04 – Ready Mix Concrete Report including slump, air, temperature, location of truck unloading, etc.

701.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The quantity of concrete measured for payment will be the number of cubic yards of concrete of each class within the neat lines of the structure as shown on the Contract Plans or as approved by the Bridge Construction Engineer or Road Construction Engineer. Deductions will be made from the quantity for the volume of embedded items other than reinforcing steel and other minor items such as drains, anchor bolts, etc. No deduction will be made for chamfers of 0.75 inch size or smaller. Document these quantities in the Daily Work Report. Retain all materials certifications, invoices and similar documentation.

Section 702
Concrete Structures

702.1 DESCRIPTION OF WORK

The Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the work and materials required for each structural element are in compliance with the requirements of the Contract Plans and Specifications, including applicable Special Provisions and Working Drawings.

702.2 PRECONSTRUCTION CONSIDERATIONS

702.2.1 Pre-Pour Conference and Checklist

A Pre-Pour Conference will be held prior to all bridge deck construction and for other structural pours as deemed necessary by the Bridge Construction Engineer or Resident Construction Engineer. Review the minutes of the Pre-Pour Conference, if held, and use SCDOT Form 700.01 – Concrete Pour Inspector's Checklist.

702.2.2 Concrete Quality and Temperature Control

Ensure that the Contractor's Cold and Hot Weather Batching and Mixing Plan has been accepted by the District Construction Engineer. See 701.2.1 for additional information on concrete quality and temperature control.

702.2.3 Mass Concrete Placement Plan

If mass concrete placement will be performed, as defined in the Contract, ensure the Contractor has submitted a Mass Concrete Placement Plan and that the Bridge Construction Engineer has accepted the Plan.

702.2.4 Crane Safety Considerations

Ensure that the Contractor has provided the Crane Safety Submittal List to the Resident Construction Engineer, that the requisite plans have been reviewed and that the Contractor, or subcontractor, operates in accordance with the crane safety requirements.

702.2.5 Material Considerations

702.2.5.1 Material Source Approval

The Research and Materials Engineer is responsible for evaluating material sources. SCDOT Inspectors will be responsible for ensuring that materials required for concrete structures are supplied from sources listed on the following SCDOT Approval Sheets:

- Approval Sheet 7 – Spray-On / Brush-On Surface Coatings for Concrete Finish,
- Approval Sheet 8 – Silicone Sealants for Portland Cement Concrete Pavement Joints,
- Approval Sheet 9 – Waterproofing Membrane Under Asphalt Overlay for Concrete Pavement Joints,
- Approval Sheet 33 – Curing Compound for Concrete Structures, and
- Approval Sheet 36 – Approved Monomolecular Polymer Film Products.

702.2.5.2 Portland Cement Concrete

Verify that the Contractor has obtained a Mix Design for the class of concrete to be used for the structure. Verify that truck mixers and other production and hauling equipment have been certified for use on the project. Upon delivery, verify that the Concrete Technician's concrete batch documentation on SCDOT Form 700.04 – Ready Mix Concrete Report indicates compliance with the Mix Design and contains the required information. Ensure that the required samples have been tested and approved. Check and record the discharge time, mix temperature, water-cement ratio, air content, slump and drum revolutions at mixing speed. See Section 701 for additional information.

702.2.5.3 Reinforcing Steel

Verify compliance of the type, size and condition of reinforcing steel. Do not allow the pour to begin without notification of material test approval. Verify that reinforcing steel is properly stored off the ground to prevent rusting and damage. Check compliance of placement, location, size, clearance, cover, ties, dowels and support. See Section 703 for additional information.

702.2.5.4 Expansion and Joint Sealant Materials

Verify compliance of the expansion materials required with respect to type, dimension, length, thickness, weight and condition. Consider the following:

1. Preformed Joint Filler. Fiber / asphalt and fused rubber materials meeting the Contract Specifications will be sampled at the job site and submitted to the Research and Materials Laboratory for compliance testing. Each sample will consist of a strip or section at least 24 inches long by 6 inches wide. If a material Lot has been pretested, it will be so marked and the Resident Construction Engineer will notify the Research and

Materials Engineer of the brand and Lot Number to obtain the Test Reports for the material.

2. Hot-Poured Elastic Filler. Hot-poured elastic filler is primarily used in cracks and expansion joints. Verify that the material meets the Contract Specifications and submit a copy of the manufacturer's certification to the Research and Materials Engineer. Verify compliance of the kettles used for placing hot-poured elastic filler. Excessive smoke is an indication of overheating, which is prohibited. The joint should be filled as shown in the Plans.

3. Elastomeric Compression Seals. Verify compliance of the elastomeric compression seals and the lubricated adhesive for bridge deck and pavement joints. Obtain a copy of the manufacturer's certification and certified test results. Forward a copy to the Research and Materials Engineer. Verify that installation is in accordance with the manufacturer's recommendations.

4. Silicone Sealant. Silicone sealant is a cold placed sealant typically used to fill sawed transverse and longitudinal joints in concrete pavements. It is accepted on the basis of certification and the product must be listed on SCDOT Approval Sheet 8. It is not necessary to submit a sample to the Research and Materials Laboratory. The supplier is required to furnish the following with each shipment:

    - manufacturer's certification showing brand name, shipping date, recipient, quantity and a statement indicating that the material meets SCDOT specifications;
    - container label plainly indicating the manufacturer's name, Lot Number, trademark, type of silicone and end-of-shelf-life date; and
    - a Material Safety Data Sheet (MSDS) and installation instructions.

    Silicone sealant must be installed over a backer rod to prevent the sealant from bonding to the bottom of the joint. A manufacturer's certification is also required for the backer rod or other bond breaking material.

5. Bridge Deck Joint Strip Seals. Verify compliance of bridge deck joint strip seals. See Section 723 for additional information on bridge deck joint strip seals.

702.2.5.5 Curing Materials

Curing materials are used on green concrete to prevent moisture evaporation. The materials most commonly used include burlap cloth, sheet material (e.g., waterproof paper, polyethylene film, white burlap-polyethylene sheeting) and liquid membrane-forming compounds. Verify that curing materials are supplied from a source listed on SCDOT Approval Sheet 7 or Approval Sheet 33, as appropriate. Ensure that each shipment is furnished with a proper manufacturer's certification, Materials Safety Data Sheet and application instructions and that the containers show the manufacturer's name, trademark, batch number, type and class of material and date of manufacture. Retain the manufacturer's certification for final materials certification. Note that liquid curing compounds are usually pressure-sprayed on the surface of the green concrete and usually arrive in 55-gallon drums, which can settle during storage. Verify that the material is properly stirred prior to application. Verify that the material is applied at the specified rate.

702.2.5.6 Surface Coatings for Concrete Finish

Ensure that suppliers of spray-on or brush-on surface coatings for concrete finish are listed on SCDOT Approval Sheet 7. Obtain the manufacturer’s certification, certified test results, Product Data Sheets and Material Safety Data Sheets. The letter of certification must contain a statement that the material meets SCDOT specifications. Verify that the containers are marked with the manufacturer's name, trademark, production Lot number, date of manufacture, shelf life and application procedure. Only unopened original containers will be acceptable. Verify that the surface coatings are applied in accordance with the manufacturer’s recommendations (e.g., coverage rate, equipment, temperature). No additives will be allowed at the site (e.g., gasoline, kerosene, diesel fuel).

702.2.6 Falsework and Forms

Verify that Working Drawings for falsework and forms have been submitted and reviewed by the Bridge Construction Engineer (see Section 725). Verify that the Contractor’s falsework and forming operations comply with the details of the Working Drawings. Use telltales, as needed, to monitor unacceptable movement during erection, fastening and when the concrete is poured. Immediately notify the Contractor of any non-compliance or safety concerns. Contact the Resident Construction Engineer or Bridge Construction Engineer, as needed, for assistance. See Section 702.10 of the *Standard Specifications*. Consider the following:

1. Forms. Check compliance of the type, size and condition of the forms prior to erection and ensure that unsuitable form materials are rejected and removed from the job site. Check that the forms are of adequate thickness and design to remain true to shape and that they present a smooth surface finish.

2. Falsework and Form Erection. Verify that falsework is erected in conformance with the Working Drawings. Ensure that the Contractor, a certified Inspector or registered professional engineer inspects and certifies the erection of falsework and forms, as specified. Deviations from the Working Drawings are not allowed without written approval by the Contractor’s professional engineer. Verify that form joints align properly. Verify acceptability of the form ties being used. Forms should be mortar tight and sufficiently rigid to prevent excessive deflection during the pour. Check that forms are properly located with respect to grade and alignment.

3. Form Preparation. Verify that all embedded materials (e.g., conduits, drains, utility blockouts, anchoring devices) are placed and adequately secured and that all required chamfer strips are in place. Verify that the inside surfaces and cavities are cleaned of all dirt, mortar, chips, sawdust and other foreign materials and that an acceptable form oil is being used. The form release agent must be compatible with the finish coating to be applied once the forms are removed. Ensure that forms are wetted down and thoroughly moistened prior to the pour.

4. Stay-in-Place Forms. Where stay-in-place steel bridge deck forms are used, closely inspect the forms for compliance. Verify that the erection and installation of the forms are in accordance with the details of the Contract Plans and Working Drawings and that tack welds, screws and other attachments are made by approved methods. Check to ensure that the Contractor has prevented any welding from contacting steel girders. No welding is allowed on permanent steel members for falsework erection (see Section 702.11(c) of the *Standard Specifications*).

5. Traffic and Safety Issues. Verify that provisions with respect to protecting vehicular and pedestrian traffic have been adequately addressed and that all safety items, including hand rails and toe rails, have been installed to protect workers and the traveling public. Ensure that the Contractor's competent safety person verifies that all OSHA requirements are met.

702.2.7 Joints and Other Embedded Features

Check that open joints, sliding joints (e.g., roofing felt, metal plates, mortis), fixed joints, elastomeric bearing pads (see Section 724), expansion joints and deck joint strip seals (see Section 723) are installed in accordance with the Contract Plans and Specifications and Shop Drawings. No construction joints will be permitted except those shown on the Contract Plans or approved by the Bridge Construction Engineer. Ensure that the Contractor has materials on hand for emergency bulkheads during bridge deck placements. Verify that construction joints are adequately cleaned and that any loose concrete has been removed. Ensure that construction joints are made only at approved locations. Verify compliance of the location, elevation, size and installation of pipes, conduits and drains to be encased in the concrete.

702.2.8 Dry-Run Check for Bridge Deck Pours

For bridge deck pours, require a dry run to check that the support for the screed is rigid and unyielding. Take depth measurements in all bays between beams at quarter points and near the ends of the span. For long spans, it may be necessary to take additional depth checks. The maximum distance between depth checks will not exceed 25 feet. Check reinforcing bar clearance at the same time depth measurements are taken and check the slab depth and clearance along all longitudinal and transverse construction joints. Notify the Bridge Construction Engineer of any variance greater than ±0.5 inch from Plan dimension. Measurements taken should be recorded on SCDOT Form 700.05 – Dry Run Depth Checks for Bridge Deck Pours. Any adjustments should be made prior to concrete placement.

702.3 INSPECTION DURING CONSTRUCTION

702.3.1 Concrete Placement

Do not permit the concrete pour to begin until the Resident Construction Engineer has approved preliminary items such as depth, character and water conditions of foundations, adequacy of falsework and forms, absence of debris in forms, alignment and grade of forms, conditions of construction joints and condition and spacing of reinforcing steel. Verify that the concrete is placed in accordance with the approved placement sequence and Cold and Hot Weather Batching and Mixing Plan. Verify that the concrete is placed to avoid segregating the mix or displacing the reinforcing steel or embedded items. Verify that the concrete is not dropped into forms from a height in excess of that specified. Do not allow the use of concrete that will not reach its final position in the forms within the specified time limit. The Inspector should monitor specified pouring rates. If mass concrete placement will be performed, as defined in the Contract, ensure that the Contractor operates within the requirements of the approved Mass Concrete Placement Plan. Carefully monitor the temperature of the concrete during mass concrete placement. Where concrete will be placed under water, Class 4000DS (see Section 712) and Class 4000S concrete will typically be used with special requirements for slump and water-reducing retarders. Verify compliance of the tremie used for underwater placement with respect to type, size and condition. Where the concrete will be poured in tidal water, verify compliance of placement with respect to high and low tide elevations.

702.3.2 Concrete Vibration

All classes of concrete, except Class 4000DS and 4000S for underwater pours, will be vibrated. Ensure that an adequate number of vibrators is available. This will depend on the scope of the pour. At least two are required to ensure backup in case of breakdown. Verify condition, frequency and amplitude for compliance. Vibration will be applied at the point of deposit. Verify that the vibrators are inserted and withdrawn from the concrete slowly. The vibration should be of sufficient duration and intensity to thoroughly compact the concrete without segregating the mix. Points of insertion should be uniformly spaced no farther than twice the radius over which the vibration is visibly effective. Do not allow vibrators to come into contact with forms, ties or reinforcing steel. Spading may be necessary along form surfaces and in corners. Do not allow the use of vibrators to move concrete from one place to another.

702.3.3 Wet Depth Checks

Require a wet depth check to verify slab thickness and reinforcing steel clearance for bridge deck pours. Measurements will be taken in all bays using the longitudinal screed and SCDOT Form 700.07 – Wet Depth Checks for Bridge Decks – Longitudinal. Measurements will be taken for the transverse screed if required by the Resident Construction Engineer and recorded on SCDOT Form 700.06 – Wet Depth Checks for Bridge Decks – Transverse. These forms may be modified to accommodate all bridge configurations. Notify the Bridge Construction Engineer of any variance greater than ±0.5 inch from Plan dimension.

702.3.4 Removal of Falsework and Forms

The falsework and forms should not be removed until the concrete has set in the forms for the minimum specified period and has attained the minimum specified strength. The falsework and forms will be removed as soon as practicable without damaging the structure (e.g., camber) or the concrete surface in accordance with Section 702.21 of the *Standard Specifications*. Watch for damage to the structure and to concrete surfaces during removal of the falsework and forms.

702.3.5 Initial Surface Finish

After the forms are removed from structural elements, verify that fins are removed and depressions, holes and rough surfaces are filled and pointed as specified. Inspect the surface for cracks, defects and damage and require repairs based on the provisions of the Contract. Verify compliance of the screed and burlap or broom drag finish during bridge deck pours. Limit the use of bull floats and do not permit the Contractor to sprinkle or spray water on the deck for the purpose of finishing. Check that the crown and longitudinal profile are within specified tolerances and are verified using a rolling straightedge as specified.

702.3.6 Concrete Curing

The purpose of the curing operation is to prevent rapid drying and uncontrolled cracking, especially during dry, hot weather. Ensure the Contractor's method of curing has been accepted. Immediately following the final screeding operation of bridge decks, verify the proper use of fog spray to increase the humidity directly above the fresh concrete until the curing material is in place. Do not permit the fogger to spray directly onto the concrete surface. This will weaken the surface and cause premature failure. Ensure that the proper curing compound is applied at the specified rate to all surfaces and edges. Verify the installation and acceptability of other protective measures, such as windbreaks. Such measures must be in conformance with the accepted Cold and Hot Weather Batching and Mixing Plan. Pay particular attention to any gaps in the coverage of curing material and require correction, as necessary. Ensure that each structural item is cured as specified. If unsatisfactory results are obtained, the Contractor will submit modified procedures to the Resident Construction Engineer before the next pour.

702.3.7 Final Non-Wearing Surface Finish Coat

The final exposed concrete surface of structural elements, except for bridge decks, will be given a final sprayed or brushed surface finish coat in accordance with the Contract Specifications. Generally, this treatment will be applied as the final operation prior to final inspection. Verify that the specified period has elapsed and that the concrete surface is dry, clean and at the proper temperature prior to application of the coating. Verify compliance of the color, coverage, coats, texture, thickness and rate of application. The material will be applied in strict accordance with the written instructions of the product manufacturer.

702.3.8 Sidewalks and Curbs

Carefully inspect the line, grade and texture of sidewalks and curbs. They must meet the requirements of the Contract Plans and Specifications.

702.4 POST-CONSTRUCTION CONSIDERATIONS

Where stay-in-place forms for bridge decks are installed, test the concrete soundness and bonding of the forms by sounding with a hammer and inspect the underside of the deck by requesting removal of form sections, as needed to ensure quality. Examine the concrete surface for cavities, honeycombing and other defects. Require repair work to be performed in accordance with the provisions of the Contract. Do not permit traffic on wearing surfaces until the specified design strength has been achieved, as indicated from testing cylinders or other approved testing methods. Verify that bridge decks are tested for smoothness in accordance with the Contract Specifications. Check compliance of specified tolerance and, as needed, required the surface to be corrected. All rideability corrections must be performed prior to grooving the bridge deck. The Contractor is responsible for notifying the Resident Construction Engineer when ready for this testing. The Resident Construction Engineer is responsible for notifying the Pavement Evaluation Unit to schedule the testing. After curing and all grinding of the deck surface has been completed to meet rideability requirements, check that the surface of the deck slab is grooved as specified. Pay particular attention to the limits of grooving, joints and the depth, width and spacing of the grooves. Ensure that all residue is properly cleaned up and removed from the site prior to final acceptance. No residue will be allowed to fall into open water.

702.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measurement and payment for concrete structures will not be specially made under Section 702 of the Standard Specifications. Measurement and payment will be made in accordance with other Sections, as defined in the Contract Specifications. Document all field notes in the Daily Work Report. Retain all materials certifications, invoices and similar documentation.

Section 703
Reinforcing Steel

703.1 DESCRIPTION OF WORK

The design strength of reinforced concrete structures cannot be fully realized unless the specified reinforcing steel is placed as designated on the Contract Plans. The type and size of reinforcing steel; bar location, spacing, and clearance; and the bond developed between the concrete and the bar surface are critical factors to consider during inspection. Section 703 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the work and materials related to reinforcing steel that is used on concrete pavements and structures, including deformed bars, wire, wire mesh, bar supports, dowels and tie bars. The Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying compliance of the material furnished and placed on the project.

703.2 PRECONSTRUCTION CONSIDERATIONS

Upon delivery, compare bar bundle tags with Mill Test Reports to ensure that bar size, material grade, and coating meet specified requirements. Spot check bar identification markings for proper steel grade. Check compliance of the reinforcing steel furnished with respect to size, grade and coating, if specified. Ensure that the material has been sampled, tested and approved for use prior to the concrete being poured. Ensure that reinforcing steel is stored on blocks, dunnage, etc. above ground to prevent rusting from standing water. Consider the following:

1. Deformed Rebars. The Research and Materials Engineer does not pre-approve sources or pretest shipments of reinforcing steel bars. Acceptance or rejection will be based on testing 40 inch long samples (30 inch long samples when shipped to SCDOT's Charleston Laboratory) taken in the field upon delivery. Samples of each size bar are to be taken in a random manner and submitted to the Research and Materials Laboratory. The supplier usually furnishes a short piece of each size bar to repair the bar from which the sample is taken. Do not submit this short piece as a sample. If a sample fails to meet specified requirements, obtain and submit a check sample as discussed in Section 106. When check samples are required, the samples should be from the same manufacturer and heat.

2. Galvanized Reinforcing Bars. When specified for use in concrete structures, verify that galvanized reinforcing bars are of the size and grade required. Pay particular attention to the method of bundling, lifting and handling this material to prevent damage to the coating. Tie wires must have a plastic coating to prevent damage to the galvanization. Pay particular attention to damage to the galvanization and require replacement or repair in accordance with the provisions of the Contract.

3. Wire and Wire Fabric. Where designated, verify that the wire and wire fabric reinforcement complies with the requirements of the Contract Plans and Specifications.

4. Mechanical Couplers. Where mechanical couplers are used, verify that the Contractor has furnished the manufacturer's assembly instructions. Acceptance testing will be based on a minimum of one rebar/coupler sample for each size. Test assemblies will be at least 40 inches in length with components being randomly selected from the materials delivered to the project. Witness the assembly of the rebar and coupler test sample and submit the sample to the Research and Materials Laboratory for testing. Ensure that threads and open couplers are protected from damage, debris and weather.

5. Bar Supports. Bar supports and ties are typically used to seat and secure the steel reinforcement within PCC structures. Verify that the wire supports, plastic bar supports and concrete blocks meet specified requirements. Plastic or coated chair supports are typically required to prevent rusting and to meet specified rebar clearances.

703.3 INSPECTION DURING CONSTRUCTION

Consider the following during inspection of reinforcing steel for concrete structures:

1. Bar List. Verify that the Contractor's bar list conforms to the Contract Plans with respect to bar size, quantity and bending details.

2. Bar Condition. Check that reinforcing bars are free of foreign materials. Concrete will only bond with a clean bar surface. In addition, check bars for straightness, and ensure that they are protected from damage. Ensure that any damage to bar coating is adequately repaired.

3. Bar Bending. Become familiar with the bar bending details. Where field bending is required, ensure that the proper procedures are being followed, and verify whether the application of heat is permissible.

4. Bar Alignment and Spacing. Check that bar alignment and spacing conforms with the Contract Plans. Verify that all bars and other embedded items are correctly placed so that the concrete can be adequately consolidated.

5. Handling of Rebar Cages. Verify that the Contractor has an accepted method for lifting large rebar cages for drilled shafts and columns and caps to prevent racking or loosening of the rebar ties.

6. Bar Clearance. Check bar clearance and depth of concrete cover for compliance. Ensure that the proper minimum clearance is obtained between the top mat of deck bars and the surface of the concrete.

7. Bar Splicing. Check bar splices to ensure that they are the proper length for the type and size of bar placed. Verify that bar splices are correctly staggered, if specified.

8. Bar Supports. The type, number and spacing of supports must be adequate to minimize sagging, displacement and damage of reinforcing bars. Plastic or coated supports are required for coated bars. Any damaged bar supports will be replaced or repaired.

9. Securing of Bars. To minimize displacement, bars must be securely tied. Verify that the bars are tied at all intersections or as otherwise designated in the Contract Specifications. Do not permit welding of bars except as noted on the Contract Plans. Note that the use of coated ties are required for coated bars.

10. Post-Tensioned Concrete. Adjustments made to reinforcement in post-tensioned concrete require approval by the Bridge Construction Engineer.

703.4 POST-CONSTRUCTION CONSIDERATIONS

Final approval of the type, placement and condition of the reinforcing steel for concrete structures must be obtained from the Resident Construction Engineer prior to the concrete pour. See Form 700.01 – Concrete Pour Inspector's Checklist.

703.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Reinforcing steel for structures will be measured by the weight of reinforcement placed and accepted. Payment for the quantity of each class of reinforcing steel shown in the plans will be made at the Contract unit price for the appropriate item. Document all measurements, calculations and field notes in the Daily Work Report and appropriate SCDOT Construction Forms. Retain all materials certifications, delivery tickets and similar documentation.

Section 704
Prestressed Concrete

704.1 DESCRIPTION OF WORK

Prestressed concrete differs from conventionally reinforced concrete in that the member is stressed prior to structural loading. Pre-compression is achieved by tensioning high-strength steel bars or stranded wires placed within the member. The prestressing force will be applied before the concrete is placed or after it has cured. Pre-tensioning is the method of applying the force before the concrete is placed, where the bars or wire strands will develop a continuous bond with the concrete. Post-tensioning is the method of applying the force after the concrete has cured, where the bars or wire strands will be mechanically anchored at each end of the member. Once prestressed, the member will undergo creep and camber. Creep is the shortening of the member after it has been prestressed. The actual shortening is slight and will taper off after a couple of months. Because the prestressing force is applied eccentrically, a noticeable uplift, or camber, will occur, which is anticipated during design. If a member cambers beyond tolerable limits, corrective action will be necessary. Precast girders are typically fabricated and prestressed at a precast yard and shipped to the project site for erection. Be aware that girder age and mishandling can produce additional camber that may render the girder unacceptable. When prestressed concrete beams, piling or other structural members are specified in the Contract, the Research and Materials Engineer will be responsible for verifying that the work and materials are in compliance with the Contract Plans and Specifications, including Shop Plans and Working Drawings.

704.2 PRECONSTRUCTION CONSIDERATIONS

704.2.1 <u>Shop Plans and Working Drawings</u>

The Contractor will submit the required Shop Plans and Working Drawings for fabrication, handling and erecting the prestressed concrete members, which should be clearly understood prior starting work. See Section 725 for additional information.

704.2.2 <u>Materials and Fabrication Considerations</u>

Once the Research and Materials Laboratory Inspector has inspected and approved the structural member, it will be marked with permanent paint in an unobscured location with the following information:

- date cast and manufacturer name or symbol;
- structural member identification number;
- directional arrow of member orientation, if applicable, and;
- SCDOT File Number and approval stamp.

704.3 INSPECTION DURING CONSTRUCTION

Prior to accepting delivery of prestressed members, pay particular attention to any damage that may have occurred to the members during storage, handling and transport. Check that each member complies with the dimensional tolerances shown on the standard details in the Contract Plans. This is especially important for cambered members. Excessive camber may cause a girder to project into the deck slab, interfering with the concrete deck panel or placement of reinforcing steel. Notify the Bridge Construction Engineer in such situations. Ensure that prestressed members are stamped for approval (see Section 704.2.2). During erection, verify that the members are lifted by the attachments provided for such purpose. Temporary lateral bracing may be required to avoid buckling during storage and once placed. Beams must be stored on level supports to prevent warping. Check that members are placed at the proper line and grade as they are erected. Take checkpoint elevations, as needed, to monitor compliance.

704.4 POST-CONSTRUCTION CONSIDERATIONS

Inspect the final structure to verify that all temporary supports have been removed, all chipped corners, tie rod holes, etc., have been patched and that bearings and expansion devices are properly installed.

704.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Prestressed concrete beams and girders will be measured by the unit length of the type and size specified, erected and accepted in place. See Section 711 for information on prestressed concrete piling. Partial and final payments will be made at the Contract unit price, in accordance with the provisions of the Contract. Document all measurements, calculations and field notes in the Daily Work Report. Retain all materials certifications and similar documentation.

Section 705
Bridge Railing

705.1 DESCRIPTION OF WORK

Bridge railing is generally constructed along bridge decks, curbs, sidewalks and retaining walls for the protection of pedestrian and vehicular traffic and may consist of cast-in-place or precast concrete, aluminum, steel or a combination of these materials. The Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring that the work and materials comply with the Contract Plans and Specifications, including Shop Plans and Working Drawings, when required.

705.2 PRECONSTRUCTION CONSIDERATIONS

Verify that the Contractor has an approved set of Shop Plans and Working Drawings (see Section 725). Ensure that the method of concrete placement has been determined (e.g., fixed form, slip form). Verify compliance of form location, height, dimension, connection, cleanliness and release agent. Verify that the Contractor has a Mix Design for the concrete class required (see Section 701). Verify compliance of the type, grade, size and placement of reinforcing steel (see Section 703). Verify that metal posts and rails are as required by the Shop Plans with respect to type, size, grade, dimension and coating. Require repair or replacement of any rails with damaged coating. Check all fastener hardware for compliance with respect to type, grade, dimension and coating. Obtain Mill Test Reports and material certification for all metal posts, rails and fasteners.

705.3 INSPECTION DURING CONSTRUCTION

Do not permit the construction of railing to begin until the falsework for the span has been released. Pay particular attention to compliance with the details of rail construction across expansion joints. The section of deck under the bridge railing must be finished smooth. Check compliance of concrete railing with respect to height, alignment, grade, camber, lifting and fastening details. Forms and reinforcing steel must be approved by the Resident Construction Engineer prior to placing concrete. Check concrete curing and finishing for compliance. Ensure that the lifting holes of precast sections are properly filled with approved material. Pay attention to the connection details of different types of barrier rail. Where metal railing is installed, verify the spacing of posts and that rails are properly connected without bending or kinking. Watch for proper splicing of metal rails and that they are handled without damaging the coating. Ensure that rail anchor bolts are placed using a template. Require repair to damaged coating based on the provisions of the Contract. Where aluminum rail is installed, verify the proper installation of elastomeric separation sheet. When welding is required, ensure that it is performed by an SCDOT-certified welder as indicated on SCDOT Approval Sheet 41.

705.4 POST-CONSTRUCTION CONSIDERATIONS

Check the grade and height of the rail for compliance. The alignment of the barrier should be checked for compliance using a 10-foot straightedge.

705.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Bridge railing will be measured by the unit length of the type installed and accepted in place. See Section 703 for information on measuring reinforcing steel. Payment will be made at the Contract unit price for the type specified. Document all measurements, calculations and field notes in the Daily Work Report. Retain all materials certifications and similar documentation.

Section 706
Wood Products for Use in Highway Construction

Section 706 and Section 707 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the requirements of treated and untreated wood products used in highway construction that will become a permanent part of the completed work, including structural lumber for wood bridge caps, stringers and flooring; dimensional lumber for wood bridge components and other miscellaneous uses; guardrail posts and offset blocks; fence posts and bracing; and timber piles. Section 706 of the *Standard Specifications* covers the type, grading, workmanship, quality, dimensional tolerance and other similar specifications. Section 706 of the *Standard Specifications* specifically covers the preservative treatment of such wood products. Wood products are pre-inspected by an SCDOT-approved Independent Inspection Agency. Ensure that wood products bear the Agency's hammer mark of approval. Obtain and forward to the Research and Materials Engineer a copy of the Agency's Inspection Report and Supplier's Certification. Ensure that wood products are stored and handled to prevent damage. Measurement and payment for wood products will not be performed separately, but will be included in other pay items in the Contract.

Section 707
Preservative Treatment of Wood Products

See Section 706 for information on treated and untreated wood products used in highway construction.

Section 708
Hardware

Section 708 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material and construction requirements of rolled steel, castings and miscellaneous hardware used in the construction of timber structures, including bolts, lag screws, nuts, nails, washers and turnbuckles. Hardware under this section will either be paid for based on lump sum or weight, as specified in the Contract. If based on weight, the weight designated on the Contract Plans will be that used for payment at the Contract unit price.

Section 709
Structural Steel

709.1 DESCRIPTION OF WORK

Section 709 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, fabrication, assembly and erection requirements for steel structures. The inspection of steel structures requires a great deal of coordination, attention to detail and a thorough working knowledge of the Contract documents. Prior to the start of work, review appropriate documentation to become familiar with the responsibilities of SCDOT and Contractor personnel; QC/QA sampling and testing requirements; fabrication, assembly and erection details; welding and painting requirements; dimensional tolerances; acceptance criteria and safety requirements.

709.2 PRECONSTRUCTION CONSIDERATIONS

709.2.1 Shop Plans and Working Drawings

The appropriate design office should distribute stamped Workings Drawings and Shop Plans to the Resident Construction Engineer. Consider the following:

1. Shop Plans. These Plans will include the State project number, Federal project number, bridge name and number, Contractor's name, fabricator's name and the detail of all structural components and miscellaneous parts, including: material identification, dimensions, sizes and plate rolling direction.

2. Working Drawings. These Drawings will include the proposed method of erection, including: details of all falsework bents, bracings, guys, dead-men, lifting devices and attachments to bridge members; sequence of erection; location of cranes and barges, crane capacities, location of lifting points and weights of members. Working Drawings must be sealed by a South Carolina registered professional engineer. See Section 702.2.4 for information on Crane Safety Considerations. See Section 725 for additional information.

709.2.2 Materials and Fabrication Considerations

709.2.2.1 Structural Steel Members

Structural steel is primarily used in bridge and sign construction. Steel "H" piles, pipe piles and sway bracing is generally shipped to the job without prior inspection. Other structural members, including hand railing, is usually fabricated off-site, inspected by SCDOT personnel or an SCDOT-approved Inspection Agency, delivered to the job, erected and field bolted. Check compliance of structural steel materials with respect to type, member, grade, marking, dimension, weight, lubrication, coating, connection and condition, as applicable. Each piece will be marked with the heat number, piece mark and SCDOT File Number. Consider the following:

1. <u>Not Inspected at Shop</u>. For structural steel materials that are not inspected prior to delivery to the job site, the Resident Construction Engineer will obtain from the Contractor the required Mill Test Reports and certified test results furnished by the manufacturer or distributor, as appropriate, and furnish a copy of this documentation to the Research and Materials Engineer. It will not be necessary to obtain samples of these materials; however, it is important to visually inspect the materials for signs of damage and evidence of non-compliance.

2. <u>Pre-Inspected at Shop</u>. For structural steel materials that are inspected and approved by an SCDOT Inspector or SCDOT-approved Inspection Agency at the fabrication facility, verify that each member is properly stenciled and undamaged upon delivery. For inspection performed by an SCDOT-approved Inspection Agency, the inspection work will be continuously monitored by the Research and Materials Engineer. The Research and Materials Engineer will receive Inspection Reports for all fabricated members that have been inspected and approved, which will contain all necessary compliance documentation. Therefore, it will not be necessary for the Resident Construction Engineer to obtain this documentation from the Contractor. The Inspection Reports will be forwarded to the Resident Construction Engineer as they are received by the Research and Materials Engineer.

709.2.2.2 Structural Steel Fasteners

Structural bolts are shipped to the field a short time before steel erection begins. The manufacturer's certifications for the fasteners should be received with the fasteners. The certifications include the test results for the rotational capacity tests performed by the fastener manufacturer or distributor, whoever combines the fastener assemblies. Upon receipt of the fasteners, the certifications should be checked with the containers of fasteners to ensure the correct assemblies and the correct number of fasteners was shipped. Samples of the fastener assemblies from each production lot should be pulled and shipped to the Research and Materials Laboratory. This should be done as soon as possible after receipt of the fasteners. The fasteners must be stored in a trailer or building prior to use in the structure. During use, the fastener container should be carefully opened so that they can be resealed to protect the fasteners from deterioration prior to installation. If deterioration (e.g., oxidation, loss of lubricant, dirt accumulation) occurs prior to installation, the fasteners must be cleaned, relubricated and retested prior to installation. See Section 709.06 of the *Standard Specifications* for sampling requirements.

709.2.2.3 Miscellaneous Metal and Other Fasteners

Check compliance of miscellaneous metals and other fasteners with respect to type, size, grade, marking, dimension, weight, lubrication, coating, connection and condition, as applicable. Obtain from the Contractor the manufacturer's certification stating that the material complies with the requirements of the Contract Plans and Specifications.

709.2.2.4 Elastomeric Bearing Pads

Verify compliance of the type, size and thickness of elastomeric bearing pads and that they are supplied from a source listed on SCDOT Approval Sheet 24. See Section 724 for additional information on elastomeric bearing pads.

709.2.2.5 Electrically Welded Shear Connector Studs (Field Installed)

Verify compliance of the type, size, diameter and length of electrically welded shear connector studs and ensure they are supplied from a source listed on SCDOT Approval Sheet 25. Obtain from the Contractor and furnish a copy to the Research and Materials Engineer the following information:

- manufacturer name,
- detailed description of the stud and arc shield to be used,
- manufacturer's certification,
- certified test results, and
- welding procedure.

Pay particular attention to the visual and hammer inspection tests that are specified in the Contract once installation is complete.

709.3 INSPECTION DURING CONSTRUCTION

709.3.1 Inspection of Materials Upon Delivery

SCDOT Inspectors have the authority to reject materials and work that do not meet the requirements of the Contract. Acceptance of any material or fabricated member by an SCDOT representative at the shop does not, however, bar subsequent rejection if found defective upon delivery or when erected. Inspect compliance of materials and fabricated members, whether previously inspected or not, upon delivery and after erection and require repair or replacement within the provisions of the Contract. Consider the following:

1. Storage and Handling. Girders, beams and other structural members must be handled to prevent damage, and they must be stored above ground on level platforms or skids to keep them free from dirt and grease. Pay particular attention to how members are lifted and supported. Workers must not be permitted to fasten chains or cable hooks to girder stiffeners, diaphragm connectors or gusset plates when lifted. Long, non-cambered structural members must be laid flat on supports that are placed fairly close together. Cambered members must be stored so that the proper camber will be maintained. As practicable, like members should be stored together and lined up so that errors of length can be easily detected. Check girders and beams for deflection, cracked welds, bends, twists, kinks and dents. If such damage is found, notify the Resident Construction Engineer to ensure that the problem has been satisfactorily addressed. Verify that girders and beams are stored upright and shored and that long members are placed to

prevent damage by deflection. Do not allow bent or damaged steel members to be erected and incorporated in the work without prior approval of the Resident Construction Engineer.

2. Damaged Members. Pay attention to the approved method used for straightening members to prevent overheating or damaging the member. Sharp kinks and bends are grounds for rejection. All approved repairs are to be visually inspected. If fractures are suspected, magnetic particle and dye penetration testing may be required for verification. Contact the Research and Materials Engineer in such cases. Watch for damage to shop coating caused by mishandling, and require the Contractor to repair the work in accordance with the provisions of the Contract.

3. Match Marking. Check match marks on members to ensure that they are arranged, assembled and erected properly based on the Contractor's Shop Plans and Working Drawings.

709.3.2 Falsework

Falsework for steel structures, if necessary, is entirely the Contractor's responsibility. The Contractor is responsible for submitting Working Drawings as discussed in Section 725. These Drawings must be designed and sealed by a South Carolina registered professional engineer. The Resident Construction Engineer and SCDOT Inspectors should not discuss the acceptability of Working Drawings with the Contractor. If, however, noncompliance with the Working Drawings is noticed (e.g., temporary struts or ties that are improperly located) or that falsework is distorting flanges or webs of structural members, immediately notify the Contractor of the need for corrective action. Contact the Bridge Construction Engineer, as needed, for assistance.

709.3.3 Bearings and Expansion Devices

709.3.3.1 Bridge Expansion and Contraction

A typical bridge has a fixed end and an expansion end. At the fixed end, the superstructure cannot move. At the expansion end, the superstructure can expand and contract a limited distance along its span during fluctuations in temperature and loading. The expansion device, at the expansion end, and the bearings, on which the superstructure rests, are installed to accommodate this movement.

709.3.3.2 Bearing Devices

Many different types of bearing devices are available, including rockers, rollers and elastomeric bearings. Elastomeric bearings are generally used in structures to level the structure, support the vertical loads of structural members and isolate specific movements (i.e., longitudinal, transverse, rotational). Stringent quality control governs the manufacture of these devices. Elastomeric bearings may be classified as either laminated (i.e., reinforced with laminate sheeting) or plain (i.e., non-reinforced). Leveling pads are generally not laminated. Fabrication differs with each bearing type and includes component materials such as elastomeric materials, laminate sheeting materials, adhesives, sealing pots, pistons and anchor bolts. Note that lubricants are not used in bearing devices. Depending on the application and thickness required, some elastomeric bearings may be designated as either laminated or plain and may require a sole plate, radius plate or an upper and lower sliding element. Other elastomeric bearings are fabricated to accommodate vertical loads and horizontal movement (i.e., longitudinal, transverse, rotational) due to factors such as thermal expansion and contraction, camber changes and the creep and shrink of structural members. These devices include the following types of designs:

1. Fixed Bearings. Fixed bearing designs accommodate rotation, but not longitudinal or transverse movements.

2. Guided Expansion Bearings. Guided expansion bearings accommodate rotational and longitudinal movements, but restrict movement in the transverse direction.

3. Non-Guided Expansion Bearings. Non-guided expansion bearings accommodate rotational, longitudinal and transverse movements.

4. Pot Bearings. Pot bearings are equipped with a piston and may be designated as either guided or non-guided, based on the need to accommodate or restrict movement.

5. Disc Bearings. Disc bearings are equipped with an elastomeric rotational disc and may be designated as either guided or non-guided, based on the need to accommodate or restrict movement.

6. Isolation Bearing. A bearing that is designed to isolate part of the structure from the full intensity of the seismic forces and to dissipate a large amount of energy.

Prior to fabricating these types of elastomeric bearings, the Contractor will submit Shop Plans, design calculations and load data to the designer of record. Review these drawings to become familiar with the storage, handling and installation procedures (e.g., alignment, offset) and the method of protecting the bearings during welding and painting of the structure. If required by the Contract Plans, verify that the Contractor has notified the manufacturer of the bearing to make available a representative to guide and inspect initial installation.

709.3.3.3 Expansion Devices

Generally, the concrete back wall should not be built until all superstructure steel and the concrete deck have been placed. At the fixed end, a bearing is installed that will inhibit movement of the deck. At the expansion end, a specified space is left between the deck slab and the back wall, and a bearing is installed that will allow the end of the deck to easily slide toward or away from the back wall. For expansion devices that have been strapped as a unit, spacing must be allowed relative to temperature as specified in the Contract Plans before the concrete is placed in the back wall. Any straps across the joint must be removed as soon as the concrete is strong enough to hold the seat angle in position. If they are not removed promptly, movement of the end of the deck slab may cause failure of the anchorage in the back wall.

709.3.3.4 Installation and Adjustment

After the falsework has been removed and the superstructure is bearing its full dead load, bearings and expansion devices must be checked for proper adjustment. The method and amount of adjustment depends on the ambient temperature, the type of device and the manufacturer's recommendations. At 68ºF, the bearings should be nearly centered or vertical, and the anchor bolts of expansion devices should be nearly centered in their slotted holes. If the ambient temperature is higher or lower than 68ºF when these devices are set, they must be adjusted off-center or at an angle from vertical in the proper direction along the span. The magnitude of adjustment depends on the coefficient of expansion. This coefficient is assumed to be 0.0000067 inch of movement/inch of span/degree Fahrenheit from 68ºF. Adjustments should be made while the steel has a uniform temperature. For example, if the ambient temperature is 85ºF and the span is 90 feet, the change in span length (i.e., expansion) would be: 0.0000067 x 1080 inches x 17ºF = 0.123 inches = 1/8 inches. The steel would be 1/8 inches longer at 85ºF than it would be at 68ºF. To allow for this difference, each device would be initially set so that it is centered or vertical and then would be shifted or angled away from the span a distance of 1/8 inches. The allowable tolerance of adjustment is generally ± 1/16 inch.

709.3.3.5 Inspection Guidelines

Pay particular attention to the location and setting of bearing devices, expansion devices, rockers, rollers and anchor bolts. Verify that anchor bolts are set in either concrete or grout, as specified. Verify proper adjustment to accommodate temperature variation and lengthening of the bottom flange under dead load. Verify that movement is not hindered by anchor bolts, nuts or other obstructions. Consider the following guidelines:

1. Anchor Bolts. Verify the required anchor bolt installation procedure. Generally, anchor bolts are cast monolithically with the cap; however, under certain requirements, they will be installed after the cap is cast.

2. Concrete Surface/Bearing Seat. The concrete surface and bearing seat must be level at the required elevation. Verify that the concrete surface is clean and free of cracks. Check bearing seats for irregularities and proper elevation. If the bearing seat is not properly cleaned and prepared to match the pad surface, the edge of the pad will be loaded sufficiently to cause premature failure of the device. Do not permit elastomeric bearing pads to be used for leveling purposes.

3. Installation and Adjustment. Bearing devices must be set level at right angles to the length of the member it supports, in exact position, with full and even bearing on the masonry. The final bearing elevation and alignment must be checked for compliance. Ensure that sole plates are positioned at the correct grade and superelevation and are in full contact with the bottom flange of the girder. Verify proper adjustment for temperature, post tensioning and shrinkage. Watch for interference between anchor bolts and the upper part of the bearing device.

4. Protection of Bearings. Where welding is performed in proximity to non-metallic bearing pads, check for the proper use of heat indicators to monitor the heat generated and

prevent damage to the pads. Heat shields may be required. Where the structure is painted, verify protection from overspray and contamination.

5. Metal Railing Considerations. At a location where a rail crosses an expansion joint, provision must be made to allow free movement of the rail section as expansion and contraction of the structure occurs. When provision for this movement is made by means of metal sleeves that are fitted inside hollow rail members, the sleeves should be welded in place on the downgrade side of the joint. Any bends or dips in a railing are easily detected. Care must be taken to ensure that all posts and rails are set to a uniform line and grade.

6. Final Check. Perform a final check of the bearing devices and require corrective work based on the provisions of the Contract. Following completion of the superstructure, inspect the installation and alignment of each device in the presence of the Contractor.

709.3.4 Field Welding Considerations

SCDOT prohibits field welding of structural members for the purposes of attaching erection hardware. Absolutely no field welding will be permitted unless special circumstances arise and approval is given by the Bridge Construction Engineer.

The Contractor is responsible for submitting to the Resident Construction Engineer for review by the Research and Materials Engineer the proposed field welding procedure on SCDOT Form 700.16 – Welding Procedure. This policy must be strictly enforced. Where permitted, each weld should be inspected after the slag has been removed. The SCDOT Inspector should mark each weld that has been inspected and approved in such a manner that it can be easily identified. Consider the following:

1. Welder Certification. Field welders must be pre-approved by SCDOT for the type of field welding to be performed. Ensure that field welders are listed on SCDOT Approval Sheet 41. Certification requirements will be listed under the Contract Special Provision for field welding. In general, this Special Provision requires that the welder be tested and certified by an Independent Laboratory listed on SCDOT Approval Sheet 26.

2. Welding Procedure. Steel members to be field welded must be set in the proper position and held securely in place during welding to prevent bending or twisting. The method of securing must not interfere with the welding. The surfaces of the members to be welded should be cleaned thoroughly for a distance of not less than 1 inch beyond the edges of the weld on all sides. When two pieces of steel are to be butt-welded, the ends of the pieces must be beveled, and rough edges should be made smooth. Where joints are to be field welded, ensure that they are drawn tightly together before welding. If not, the opening may be large enough to allow the weld to pass between the members and tack to the flange under the joint. These welds appear normal on the surface, are difficult to visually detect, and may cause significant damage to the structure (e.g., fatigue cracks produced by stress risers).

3. Characteristics of Quality Welds. A finished dependable weld of good workmanship should have the following characteristics:

- a uniform cross-section with flat or slightly bulging face and smooth surface;
- a reasonably straight edge flowing into the base metal;
- a well-defined crater approximately 1/16 inches deep;
- a surface with ridges or ripples spaced closely and uniformly; and
- a bright surface of uniform color after it has been cleaned with a wire brush.

4. Common Weld Defects. Common defects in welds and their causes and remedies are as follows:

   a. Overlap. Overlap, the term used when the edge of the weld is loose and extends over the base metal, is caused by poor fusion. If the overlap is very small and if the weld need not have its full strength, the weld may be accepted. If the overlap is large or if the full strength of the weld is needed, the weld should be removed and a new weld made.

   b. Undercutting. Undercutting is evidenced by not having enough electrode metal. The weld should be thoroughly cleaned and built up to standard size with additional weld metal.

   c. Shallow Craters. Shallow craters are caused by not getting enough penetration. Unless the weld is for sealing purposes only, it should be removed and a new weld made.

   d. Pits and Pockets. Pits, porosity and gas pockets are caused by improper procedure. The weld should be removed and a new weld made.

   e. Inclusions. Slag and oxide inclusions are caused by improper procedure. Unless the weld is for sealing purposes only, it should be removed and a new weld made.

   f. Spatters. If spatters are large and scattered over a wide area, they are caused by the use of an arc that is too long or by poor fusion without enough penetration. The weld should be thoroughly checked, and if there is any doubt about the quality of the weld, the weld should be removed and a new weld made.

   g. Irregular Ridge Spacing. Irregular spacing of ridges is caused by variation in the speed of welding. The weld may be accepted unless the arc has been jumped forward so as to leave a space with not enough penetration. Such a fault may be corrected by increasing the length of the weld.

5. Size and Length. The size and length of each fillet weld must be compared with the dimensions shown on the Contract Plans. The size or length may be slightly greater than specified.

6. Stay-in-Place Forms. Where stay-in-place deck forms are installed, do not allow welding or striking of arcs on the flanges of structural steel members.

709.3.5 Assembly and Erection Considerations

709.3.5.1 Positioning Steel Members

If the steel has top coats applied prior to erection, check to ensure there is no overspray on the faying surface (i.e., area under splice plates) and that there is no paint top coat on any surface of connections where bold heads and nuts are located. Top coats of paint tend to creep out from under fasteners resulting in loose fasteners. The SCDOT Inspector should make certain that all members are placed in the proper position, and that main supporting members are in correct vertical and horizontal alignment. The marks painted on the steel for identifying pieces should agree with those shown on the Shop Plans and Working Drawings, and careful attention should be given to match marks at connections. The SCDOT Inspector should recheck the relative positions of bearing connections in the substructure and superstructure just before the steel is put in place. Bearing surfaces and other contact surfaces must be checked to see that they are clean and free from dirt, grease and rust. After the structural steel has been erected, the SCDOT Inspector should check the bearings to be sure that each bearing part makes full contact.

709.3.5.2 Drift Pins and Temporary Bolts

Before splicing is begun, the members are usually held together by drift pins and temporary erection bolts. The SCDOT Inspector must make certain that these temporary connections are made in accordance with the requirements of the *Standard Specifications*. Members to be spliced together must be held in their correct position so that the connection can be made properly. Drift pins of the proper size are usually installed first in a few sets of holes, to bring the parts into their proper relative position and to keep the holes in alignment. The required bolts are installed in the remainder of the holes in the connection, brought to snug tight and then fully tensioned. The next step is to remove the drift pins and install the remaining bolts.

709.3.5.3 Connection Adjustments

Structural steel should fit together with little distortion or strain. A slight adjustment with drift pins is to be expected. If the holes are too far out of place, a workman should not be allowed to force the parts into position with drift pins. Improper use of drift pins may damage the material around the holes and will prestress the members. Striking a member with a heavy sledge hammer should not be allowed. No reaming should be allowed in a splice in a main tension member, unless specific permission is obtained from the Bridge Construction Engineer. Any error which cannot be corrected by light drifting should be reported to the Bridge Construction Engineer. The proposed method of correcting the fault must be approved by the Bridge Construction Engineer before the method is used. Checks and any necessary corrections should be made as the work progresses. Also, before the members are connected permanently, the SCDOT Inspector should check the work again to make sure that all members are aligned properly and set to the required camber. This final checking should prevent any poor alignment from being built into the final structure.

709.3.5.4 High-Strength Bolts

After the members have been drawn together tightly by temporary bolts, the Contractor will tighten the permanent high-strength bolts to the required tension by using the method specified in the Contract. The nut on each permanent bolt will first be turned snug tight and then given additional rotation to final tension. Each connection should be checked by the SCDOT Inspector immediately upon completion, because of the tendency of the bolts to freeze. Direct Tension Indicators will be placed under the unturned element. See the *Standard Specifications* for additional information on rotational capacity and turn-of-the-nut testing.

709.4 POST-CONSTRUCTION CONSIDERATIONS

Final inspection should be performed after all falsework is removed and prior to painting. See Section 710 for information on painting structural steel. Check compliance of surface preparation of structural steel prior to painting and that all deficient or damaged areas are field coated. Check that the actual camber complies with the theoretical camber and the vertical and horizontal clearances over highways and railroads prior to casting the deck. Final acceptance is the responsibility of the Resident Construction Engineer, with any needed support being provided by the Bridge Construction Engineer and Research and Materials Engineer.

709.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Structural steel will be measured either by unit weight or lump sum, as specified. This includes all materials, fabrication, erection and painting of new structures; however, re-painting existing structures will be measured and paid for in accordance with Section 710. Partial and final payments for lump sum work will be made at the Contract unit price in accordance with the provisions of the Contract and recorded in the Daily Work Report. Retain all material certifications, invoices and similar documentation.

Section 710
Paint for Structural Steel

710.1 DESCRIPTION OF WORK

Section 710 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, equipment and work related to shop painting of new structural steel members and field painting of new and existing steel structures. When pay items under Section 710 are specified in the Contract, the Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the work, equipment and materials comply with the requirements of the Contract Plans and Specifications.

710.2 PRECONSTRUCTION CONSIDERATIONS

710.2.1 Materials and Equipment Considerations

Inspect all materials and equipment upon arrival at the job site. Verify that the primer and paint materials are supplied from a source listed on SCDOT Approval Sheet 19. The materials used for intermediate and top coats must be supplied by the same manufacturer as the primer coat. Verify that each paint container is plainly marked with the correct paint type, color, number of gallons, Lot Number, Batch Number, date of manufacture and the name and address of the manufacturer. The painting system required for the project will be defined in the Contract Specifications. Obtain from the Contractor and forward copies to the Research Materials Engineer the manufacturer's certifications, application and equipment recommendations and product safety data sheets.

710.2.2 Environmental and Safety Considerations

Prior to painting, review the specified weather limitations. Know the requirements specified for environmental protection that are defined in the Contract Specifications. This is especially important if lead-based paint removal and disposal is part of the Contract. Know the precautions that must be in place to protect the environment and workers. Ensure that the Contractor is adequately prepared to protect pedestrians and vehicular traffic on, near and underneath the structure. Obtain from the Contractor the name, telephone number and address of the person who will be responsible for processing claims.

710.3 INSPECTION DURING CONSTRUCTION

710.3.1 Cleaning Steel Surfaces

Verify that steel is cleaned and inspected just prior to painting. Only as much surface should be cleaned in one day as can be painted on that day. Ensure that only approved methods of cleaning are used. Oil, grease and lubricants will be removed using an approved cleaning agent. Pay particular attention to the required treatment of slip-critical surfaces.

710.3.2 Brushing and Rolling

Thorough mixing of the paint before it is applied is essential. A mechanical mixer should be used for stirring the paint. Paint should be spread smoothly and uniformly. Paint should be worked into all corners, joints and other hard to reach areas. A sheepskin dauber may be used to coat any surface that cannot be reached with a brush. The first field coat is started by applying paint only to such surfaces as rivet heads, bolt heads, nuts, edges of plates, angles and other rolled shapes. Then, as soon as this paint has dried thoroughly, the first coat is completed by painting all surfaces, including those covered previously.

710.3.3 Spray Painting

The paint should be applied in a uniform layer. The pattern to be followed in applying the paint should make it possible to obtain a uniform thickness of not less than the specified mil thickness. There must be some overlapping at the edges of strips covered on successive strokes of the spray gun. The spray gun should be held at right angles and at the correct distance to the surface being painted. Runs and sags must be brushed out right away, or the paint must be removed and the surface repainted.

710.4 POST-CONSTRUCTION CONSIDERATIONS

Final inspection is the responsibility of the Resident Construction Engineer. Prior to approval, ensure the acceptability of the quality of workmanship and compliance with specified criteria. Check that any overspray of paint is properly cleaned and repaired.

710.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The shop painting of structural steel and the field painting of new structures will not be measured and paid for separately, but will be included under the provisions of Section 709 of the *Standard Specifications*. Painting of existing structures will be paid on a lump sum basis. Check the Contract Specifications for documentation, measurement and payment requirements for the removal of lead-based paint. Pay quantities should be recorded in the Daily Work Report. Retain all material certifications, invoices and similar documentation and forward a copy to the Research and Materials Engineer.

Section 711
Driven Pile Foundations

711.1 DESCRIPTION OF WORK

Piles are load-bearing members made of steel, prestressed concrete or treated timber. They are generally used in locations where the upper soil is too weak or too compressible to support the structure. In such locations, piles are used to transfer loads from the structure to stronger underlying layers of soil or rock. These piles are driven within tolerance into natural ground to help support the structure and minimize settlement. Without a solid foundation, the attention given to constructing a quality structure is meaningless. The Resident Construction Engineer must thoroughly and competently inspect the foundation piling provided for structures.

Many types of piles are available for foundation designs, and each design will differ based on the specific conditions at the site. The Contract Plans and Specifications will designate criteria such as pile type, number, length, horizontal arrangement, orientation (i.e., plumb, batter) and driving specifications such as design load. Driving energy, depth and number of blows will be determined from the Contractor's proposed pile driving plan and WEAP analysis performed by the designer. Each pile that is driven to specification will provide a bearing capacity that will support a fraction of the structure's total load (i.e., design load). The pile's bearing capacity results from a combination of resistant forces, including the surface friction between the pile and natural ground and the bearing pressure of the pile tip on the substrata material (e.g., bedrock).

Although it is equally important to check items such as pile type, location and orientation, it is important to continuously inspect the driving operation with respect to the number of blows each pile receives. The decision to continue or halt the operation must be made quickly. If driving is stopped too soon, the pile will not have developed the required bearing capacity to resist the design load, and the structure may eventually settle due to a lack of support. If overdriven, the pile may incur structural damage, increasing the chance that the foundation will settle or otherwise fail at the location of the damaged pile. It is important to note that the Resident Construction Engineer is responsible for determining the acceptability of the pile with respect to its load bearing capacity. The procedures, methods and criteria by which this determination is made will be specified in the Contract.

Section 711 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, equipment and construction requirements for driving various types of piles. When a pay item under Section 711 is specified in the Contract, the Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the Contractor performs the work in accordance with the Contract Plans and Specifications.

711.2 PRECONSTRUCTION CONSIDERATIONS

711.2.1 Certification of Inspection Personnel

SCDOT requires that inspection personnel on all projects requiring inspection of driven pile foundations, drilled shafts and drilled pile foundations be certified for the work to be performed. See the SCDOT publication *Foundation Inspector's Certification Manual for Pile Driving and Drilled Shafts* for additional information.

711.2.2 Pile Installation Plan

The Contractor is responsible for submitting a Pile Installation Plan to the Bridge Geotechnical Engineer, with a copy to the Bridge Construction Engineer and the Resident Construction Engineer, which will include the following information:

- all equipment, including manufacturer's data sheets on hammers;
- schedule for index pile and production pile driving;
- Shop Plans and Working Drawings for piles, cofferdams, etc.;
- Crane Safety Requirements, as discussed in Section 702.2.4;
- Pile and Driving Equipment Data Form;
- methods of monitoring hammer energy, stroke and pile advancement;
- detailed drawings of followers and templates;
- details of load test equipment meeting pile load test specifications;
- sequence of driving footing piles for each pile layout;
- plan for protecting the integrity of existing structures; and
- plan for preventing pile displacement during placement and compaction of fills.

The Bridge Geotechnical Engineer and the Bridge Construction Engineer will evaluate the Pile Installation Plan for compliance with the Contract Plans and Specifications and, upon acceptance, will notify the Contractor to proceed. All plans accepted by the Bridge Construction Engineer are subject to proof of satisfactory field performance. Work cannot begin until this review has been completed. The Plan will be on-site during all driving operations, and the appropriate pile driving logs will be completed by the Inspector for each pile installation.

711.2.3 Index Piling and Pile Load Tests

When index piling is specified in the Contract, it will be performed to determine required lengths of production piling. Verify compliance of the types, lengths and locations of all index piles. Generally, index piles will be driven to practical refusal and will be incorporated into the final structure. Note that a follower is not permitted when driving index piles. Production piles cannot be ordered until all index piles have been driven, the data evaluated and the pile lengths approved by the Bridge Construction Engineer. In special cases, it will be desirable to load test piling to determine the relationship between the driving resistance and the actual load bearing capacity of the driven pile. If specified, the requirements for load testing will be defined in the Special Provisions of the Contract.

711.2.4 Excavation and Embankment Construction

Unless otherwise directed or shown on the Contract Plans, excavation and embankment construction must be completed and accepted prior to driving foundation piles.

711.2.5 Staking and Utilities

Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins. Check to ensure that all pile locations have been properly staked in accordance with the Contract Plans.

711.2.6 Welder Certification

Field welders must be pre-approved by SCDOT for the type of field welding to be performed. Ensure that field welders are listed on SCDOT Approval Sheet 41. Certification requirements will be listed under the Contract Specification for field welding. See Section 709.3.4 for additional information on field welding.

711.2.7 Material Considerations

711.2.7.1 Prestressed Concrete Piles

The Research and Materials Laboratory Inspectors will perform the inspection work during the casting of prestressed piles. Once approved, the piles will be marked with an SCDOT approval stencil prior to shipping to the job site. Test Reports for the materials used in the piles will be forwarded to the Resident Construction Engineer when the samples are tested. The Resident Construction Engineer will inspect the piles for damage during shipping and notify the Bridge Construction Engineer of any problems identified. See Section 701, Section 702, Section 703 and Section 704 for additional information on the materials and methods used to fabricate prestressed concrete piles. Check for damage of the piles upon delivery and during handling. Concrete piles that are cracked or broken must be rejected, unless the Bridge Construction Engineer provides written approval of repair work. Check compliance of the pile dimensions. The lengths of concrete piles will be specified in the Contract, except in cases where index piling or load test piling will be used to determine lengths prior to casting.

711.2.7.2 Steel Piling Materials

Structural “H” piles and steel pipe piles are not inspected prior to delivery to the job site. The Resident Construction Engineer will obtain from the Contractor the required Mill Test Reports and manufacturer’s certifications furnished by the manufacturer or distributor, as appropriate, and furnish a copy of this documentation to the Research and Materials Engineer. It will not be necessary to obtain samples of these materials; however, it is important to visually inspect the materials for signs of damage and evidence of non-compliance. Steel piles should be stored on skids above ground to prevent rusting and deflection. Handling holes may be used for lifting purposes. Check compliance of the type, weight and dimension of the structural steel piles.

The lengths of steel piles specified in the Contract are approximate. The Contractor will drive test piles to determine the lengths of steel piles required; otherwise, the Plan pile lengths will be ordered and driven. Payment will be made for in-place lengths. Cut offs are not to be paid for. Paint and application of paint on steel piles will be as discussed in Section 710.

711.2.7.3 Treated Timber Piles

Section 706 and Section 707 describe the type of wood and treatment for treated timber piles. Treated timber piles will be pre-inspected by an SCDOT-approved Independent Inspection Agency. The Agency will inspect the wood, treatment and final product and, upon passing, will place the Agency's hammer mark of approval on the pile with a special metal hammer. Upon delivery, ensure that the treated timber piles bear the Agency's hammer mark of approval. The mark is usually placed on the ends of the pile. Do not use unmarked treated timber piles. Obtain and forward to the Research and Materials Engineer a copy of the Agency's Inspection Report and Supplier's Certification. Ensure that wood products are stored and handled to prevent damage and handled to avoid breaking the surface of the treatment. As needed, require the treated surface to be repaired as specified. The lengths of timber piles specified in the Contract are approximate. The Contractor will drive test piles to determine the required lengths of timber piles or proposed driving lengths, which will be reviewed by the Bridge Construction Engineer prior to ordering. Full length piling will always be used. Splicing of timber piling is not permitted.

711.2.8 <u>Equipment Considerations</u>

711.2.8.1 Acceptance Inspection

Various types of drop hammers and power hammers are available for driving piles. They are generally operated by steam, diesel-oil combustion or compressed air. Power hammers may be single acting or double acting. Energy-rating data for pile drivers can be obtained from the manufacturer of the equipment. Equipment selection depends on the type and size of piles to be driven. More than one type of driver may be required for the project. Pile driving work cannot begin until the pile driving system for the types of piles to be driven has been evaluated for acceptability, as specified in the Contract with respect to wave equation results, dynamic pile analyzer (PDA), required number of blows per foot and the stresses developed during driving. Acceptance by the Bridge Geotechnical Engineer will be based on commonly accepted hammer efficiencies, component properties and soil parameters. Local soil conditions and the actual driving system may affect the driving. Other equipment also must be inspected for acceptability, including pile cushions, caps, collars, leads, templates, followers and water jets, when their use is permitted. This equipment must comply with the Contractor's accepted Pile Installation Plan.

711.2.8.2 Drop Hammers

A drop hammer may be used for driving steel or timber piles on bridges requiring load bearing capacities. However, a drop hammer should not be used for driving concrete piles, unless authorized by the Bridge Construction Engineer. Consider the following:

1. Hammer Weight. The hammer should weigh at least as much as the combined weight of the driving head and the pile. Obtain the actual hammer weight from the Contractor and make sure it meets the minimum specified requirements. As needed, use a certified scale to weigh the hammer and pile cap.

2. Hammer Drop. Hammer drop should generally not exceed 15 feet for steel and timber piles and 8 feet for concrete piles. Greater drops, especially when a relatively heavy hammer is used, may damage the pile. The use of a relatively heavy hammer and lower fall will usually result in greater pile penetration per blow with less damage to the pile, because there is a greater blow rate and less chance for the soil to compact around the pile between blows. This is especially important in hard ground.

3. Hoisting Line. The hoisting line for a drop hammer must be mounted on a rotating drum that can turn freely for the full length of the hammer drop, and the line must be slack during the fall. If there is any drag of the cable, adjustment will be necessary.

711.2.8.3 Power Hammers

Read the manufacturer's literature to understand the operating characteristics of the equipment. The equipment should be in good working order and adjusted for the specified rating (e.g., energy per blow, blows per minute). The weight of the ram must bear the proper relation to the weight of the pile, and the ram must have the proper speed when it hits the pile. The ram not only must strike the pile with enough energy to overcome the inertia of the pile and the resistance of the soil, but also must be heavy enough to avoid the loss of too much energy during the impact. There will be a great loss of energy if the ram causes damage to the top of the pile. As a general rule, piles should be driven with the heaviest available ram that can be used to obtain the greatest penetration without causing serious damage to the pile. For the first few piles, carefully watch the performance of the hammer. When adjusted properly, it should move through its full stroke for the required number of blows per minute. It is important to note that the pressure gauge on the air compressor may not indicate the pressure delivered to the ram, due to leaks in valves, rings, bushings and hoses. For this reason, compressors should be able to furnish 25% greater air pressure than that required at the ram. Nearly all manufacturer's literature specify number of blows per minute based on a mean effective air pressure of 80 psi. Once started, the driving of a pile should be continuous. If stopped for a short period of time, the soil becomes compacted and increases frictional resistance around the pile and may cause pile damage when driving is resumed.

711.2.8.4 Caps and Driving Heads

A pile cap and cushion must be used on all concrete piles. Pile caps or collars should be used on timber piles to avoid damage to the top of the pile. A driving head should be used on steel piles when driving conditions cause damage to the pile. Where a driving head is required, verify compliance with the manufacturer's recommendations. Hammer cushions and striker plates are typically used to ensure uniform driving behavior and minimize damage to the pile. Where required, verify conformance with respect to type and size. Extra pile cushions and striker plates should be on hand so that, if damaged, they can be quickly replaced.

711.2.8.5 Points and Tips

When specified for use with prestressed concrete piling, verify compliance of the size and shape of prestressed pile points. When specified for use with steel piling, verify compliance of the type, size and shape of reinforced pile tips.

711.2.8.6 Leads and Followers

Leads are required for all pile driving operations. Pile driving leads are used to guide the movement of the hammer, thus ensuring the pile receives a concentric impact with each blow. It is essential that the fall of the hammer be in line with the pile; otherwise the head of the pile may be severely damaged, the hammer may be damaged, the energy of the hammer may be reduced or the pile may change direction. Leads must be straight, true, rigid and so constructed that free movement of the hammer is provided. The lead channels should be greased to prevent the hammer from sticking. Leads must be held in position by guys or stiff bracing to ensure support of the pile during the driving operation. The stiffness of the leads is an important factor in holding the pile in line, and this requirement must not be overlooked. The leads should be long enough to accommodate, at a minimum, the pile length and the length of the hammer. It is generally good practice to use a somewhat longer length as a contingency. Where followers are permitted, verify their proper use.

711.3 INSPECTION DURING CONSTRUCTION

711.3.1 <u>Pile Preparation</u>

Before the pile is lifted to the leads, stretch a tape along the pile and place keel marks along its entire length at 1-foot intervals. At least every fifth mark should be numbered to show the distance from the pile tip.

711.3.2 <u>Pile Location and Orientation</u>

Depending on the design requirement, the pile may need to be driven on a batter or slope. The amount of batter will be designated on the Contract Plans. If a pile is to be driven on a batter, the leads and the path of the hammer must be set to the required batter. After the pile has been placed in the leads but before driving is started, the tip of the pile must be carefully placed in the correct location and orientation. A template should be used as a guide. Verify that the pile is set within tolerance of its designated location. Also, check the pile alignment for deviation from allowable tolerance. Where structural steel shapes are used, verify that flanges are oriented as designated on the Contract Plans. If a pile for a bridge pier or abutment is found to be out-of-tolerance, the Contractor may be given the option of driving an offset pile or pulling and re-driving the original pile. These situations should be referred to the Bridge Construction Engineer.

711.3.3 Water Jetting

Water jets are commonly used to aid the driving of piles in sandy soils, especially concrete piles. This method must be approved by the Bridge Construction Engineer prior to use and included in the Pile Installation Plan. The jet of water should be started as soon as the tip of the pile is set in position and before driving begins. The jet pipe should be placed close to the pile. As the soil is softened and washed away by the water, the pile should sink under the weight of the hammer. If not, light hammer taps should be used. The jet should be raised from time to time, and the hammer should be used without the jet to permit the penetration per blow to be determined. Just before the proper elevation is reached, the jet pipe should be pulled out and the pile should be driven to solid bearing by the hammer alone.

711.3.4 Pile Penetration

Know the criteria established for minimum penetration, minimum tip elevation, ultimate bearing value and the method for evaluating pile penetration acceptance. When driving first begins, the hammer should strike relatively light blows. After the pile has been driven approximately 3 feet into the ground, the alignment of the pile should be checked before driving is continued as specified. During the operation, carefully monitor the location and alignment of each pile. Piles must be driven to practical refusal into natural ground or the penetration per blow is at the specified limit. Penetration readings should be recorded often so that rate of penetration at various depths will be known. If the driving becomes difficult or if the pile begins to rebound, place 1-inch marks on the pile and carefully monitor the penetrations per blow. Complete Form 700.15 – Pile Driving Log for each pile that is driven as soon as practicable after the data is obtained.

711.3.5 Pre-Drilling for Piles

Pre-drilling for piles will not be permitted except where specifically noted in the Contract Plans or approved in writing by the Bridge Construction Engineer. Where permitted and used, verify compliance of the drilling, driving and backfilling for the type of pile being installed.

711.3.6 Precautions and Driving Difficulties

Pay particular attention to the following precautions and difficulties which are commonly encountered during the driving of piles:

1. Springing / Bouncing. Watch for pile springing and hammer bouncing. Springing can occur where spliced members are not properly aligned, the pile head is not squared properly or the pile and hammer are misaligned. Bouncing can occur where the pile has reached the point of practical refusal, a hammer of insufficient weight is used or too much steam or air pressure is used in double-acting hammers.

2. Changes in Direction. Watch the pile as it is driven for sudden changes in direction. This is a good indication that the pile has failed below the ground due to an obstacle.

Near vertical rock strata can also contribute to this problem. In such cases, contact the Bridge Construction Engineer for guidance. Corrective action may be necessary.

3. Sudden Changes in Penetration. Monitor the pile for sudden changes in penetration between blows. This usually indicates that the pile has failed or an unusually soft subsurface strata has been encountered. In such cases, contact the Bridge Construction Engineer for guidance. Corrective action may be necessary.

4. Boulders/Rock Strata. Where a pile is driven in an area known to have boulders or varying rock strata, as indicated by boring logs, carefully monitor the operation for a sudden decease in the pile's penetration per blow. Such a rapid change can cause binding and an actual break in the pile. Care must be taken to avoid overdriving the pile. Contact the Bridge Construction Engineer for guidance. Pre-drilling may be required.

5. Adjacent Piles. Where piles are driven close together into a layer of soft material below firmer soil, the driving of the piles tends to build up pressure in the soft layer. If the pressure becomes high enough, driving more piles will cause piles that have already been driven to push up. Such piles have little or no bearing value; and, if not corrected, serious settlement of a structure can occur. The elevation of the top of each pile in a footer should be determined just after the pile has been driven, and each elevation should be compared with the elevation of the corresponding pile after the driving of the whole group has been completed. Piles raised by the driving of nearby piles should be re-driven until the proper penetration per blow is obtained. No pile should be driven within 15 feet of a cast-in-place concrete pile until the concrete has gained at least 85 percent of its required strength.

6. Embankment Considerations. When an abutment is to be supported on an embankment and piles must be driven into the embankment, compaction of the embankment material to meet specified requirements can make penetration difficult. To prevent damage to the piles, pre-drilling may be necessary. In such cases, the use of water jets is not permitted.

711.3.7 Cutting and Splicing Considerations

If a pile has been driven and accepted, but its top is above the elevation shown on the Contract Plans, it may be cut off square with its longitudinal axis. Steel piles and steel reinforcing bars in cast-in-place concrete piles should be cut off. On a trestle bent where the cut-offs of the several piles in the bent are on an inclined plane, because of skew or superelevation, special care must be taken in establishing the correct elevation and slope for each cut-off. The elevation will be determined by the location of the pile with respect to the reference line and the amount of superelevation. Each pile should be cut off so that there will be full and uniform bearing between the piles and the cap and so that the top of the cap will be at the correct elevation. If a pile is found to be too short, or one has been cut off too low, it may be extended or built up, as approved by the Resident Construction Engineer. Careful inspection is particularly important in the case of a concrete pile. The SCDOT Inspector must make sure that the work is performed in accordance with the Contract Plans and Specifications.

711.3.8 <u>Encasement of Steel Piling</u>

Where steel piling is to be encased in concrete, verify that the concrete is placed and cured in accordance with the Contract Plans and Specifications. Pay particular attention to the Special Provisions of the Contract.

711.4 POST-CONSTRUCTION CONSIDERATIONS

Contact the Bridge Construction Engineer for any piles that are driven out of tolerance prior to driving any other piles. Watch for damage and out-of-tolerance piles. Verify that restriking of piles is performed, as directed. Final acceptance is the responsibility of the Resident Construction Engineer, with any needed support being provided by the Bridge Construction Engineer and Research and Materials Engineer.

711.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Driven pile foundations will be measured and paid for as defined in the Contract under Section 711 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. Maintain accurate records in the Daily Work Report and on SCDOT Form 700.15 – Pile Driving Log of the work performed and accepted. Retain all material certifications, invoices and similar documentation. SCDOT Form 700.17 – Pile Record must be submitted with the final plans.

Section 712
Drilled Shafts and Drilled Pile Foundations

712.1 DESCRIPTION OF WORK

Drilled shafts are relatively large-diameter, under-ground columns of reinforced cast-in-place concrete that are constructed in pre-drilled holes to provide foundation support for structures. They are designed to transfer and distribute structural loads to underlying support strata or bedrock. In general, the construction consists of drilling a hole at a designated location, depth and diameter; constructing and placing a cage of reinforcing steel; and placing and finishing concrete to the elevation required by the foundation details of the Contract Plans. The work for drilled pile foundations includes a drilled excavation of the proper size, with a pile section concreted or grouted in place. Reinforcing steel may or may not be required for a drilled pile foundation. Section 712 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, equipment and construction requirements for drilled shafts and drilled pile foundations. When a pay item under Section 712 is specified in the Contract, the Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the Contractor performs the work in accordance with the Contract Plans and Specifications. Review the Contract Plans and Specifications with respect to the requirements for drilling equipment, materials for reinforcing steel and concrete, and shaft location, depth, diameter and elevation. Pay particular attention to the operation sequence and dewatering requirements.

712.2 PRECONSTRUCTION CONSIDERATIONS

712.2.1 <u>Certification of Inspection Personnel</u>

The Contractor and any subcontractors directly involved in this work must meet the specified qualifications for constructing drilled shafts and drilled pile foundations. SCDOT requires that inspection personnel on all projects requiring inspection of driven pile foundations, drilled shafts and drilled pile foundations be certified for the work to be performed. See the SCDOT publication *Foundation Inspector's Certification Manual for Pile Driving and Drilled Shafts* for additional information.

712.2.2 <u>Drilled Shaft Installation Plan</u>

The Contractor is responsible for submitting a Drilled Shaft Installation Plan to the Bridge Geotechnical Engineer, with a copy to the Bridge Construction Engineer and the Resident Construction Engineer, which will include the following information:

- all equipment to be used on the project, including manufacturer's data sheets;
- sequence of construction operations;
- Shop Plans, Working Drawings and Mix Design;
- casing details, including dimensions, elevation, splicing, painting and removal;

- Crane Safety Requirements, as discussed in Section 702.2.4;
- type and frequency of sampling and testing, including personnel;
- method of determining top and bottom elevation;
- excavation, cleaning and disposal methods;
- method of using slurry;
- details of steel reinforcing cage construction, placement and support;
- details of concrete placement;
- method of checking depth and horizontal and vertical alignment; and
- method of protecting the integrity of adjacent structures.

The Geotechnical Design Engineer and the Bridge Construction Engineer will evaluate the Installation Plan for compliance with the Contract Plans and Specifications and, upon acceptance, will notify the Contractor and the Resident Construction Engineer. All plans accepted by SCDOT are subject to proof of satisfactory field performance. Work cannot begin until this review has been completed. The Plan will be on-site during all operations. The Certified Drilled Shaft Reports or Certified Drilled Pile Foundation Reports (SCDOT Form 700.09 through SCDOT Form 700.14), as appropriate, will be submitted by the Contractor for each installation.

712.2.3 Boring Log and Geological Reports

Review the boring log and geological reports. This information is provided to the Contractor for informational purposes only. The Contractor may perform pre-installation soil boring analyses to confirm actual field conditions. Become familiar with the appearance of the type of material anticipated at the depth of the bearing strata.

712.2.4 Staking and Utilities

Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins. Check to ensure that all drilled shaft locations have been properly staked in accordance with the Contract Plans.

712.2.5 Welder Certification

Field welders must be pre-approved by SCDOT for the type of field welding to be performed. Ensure that field welders are listed on SCDOT Approval Sheet 41. Certification requirements will be listed under the Contract Special Provision for field welding. See Section 709.3.4 for additional information on field welding.

712.2.6 Material Considerations

Inspect compliance of all materials upon arrival at the job site. Verify that concrete, slurry, reinforcement, casing and other required materials conform to the requirements specified in the Contract. Check that the Contractor has a Mix Design of the class designated in the Contract. See Section 701 and 702 for information on concrete and concrete structures. See Section 703 for information on reinforcing steel. See Section 711 for information on foundation piling. Where steel casing is used, verify conformance with respect to wall thickness, strength, diameter and condition. Paint and application of paint on steel casing will be as discussed in Section 710. Pay particular attention to the sampling and testing requirements for slurry.

712.2.7 Equipment and Explosives Considerations

Verify that a heavy-duty drilling rig in good operating condition is provided for the work. The rig must be capable of drilling to the required depth and penetrating the underlying bearing material or bedrock. Verify that the equipment and drilling accessories comply with the requirements of the Contractor's Drilled Shaft Installation Plan. The use of explosives is not permitted for drilled shaft construction without written approval from the Bridge Construction Engineer.

712.3 INSPECTION DURING CONSTRUCTION

712.3.1 Drilling Operation

Consider the following inspection guidelines during the drilling operation:

1. Location and Depth. Check the horizontal and vertical alignment of the shaft to ensure it is within allowable tolerances. Document the depth drilled into the target bearing strata, and compare the excavated material with geological information to ensure that adequate bearing material has been reached. If, during excavation, the rock elevation varies more than ±2 feet from the soils report, contact the Bridge Construction Engineer.

2. Diameter. Check the hole diameter and sides to ensure compliance of size, vertical orientation and allowable tolerance. Where caving is encountered, halt the operation until the situation can be evaluated and corrected. Contact the Resident Construction Engineer for assistance. Protective steel casing may be needed.

3. Excavation. Verify that excavated material is disposed of properly. Check to ensure that the hole is dewatered and cleaned of all loose material. The Inspector should verify that the bottom of the hole is clean and flat. If dewatering is not practical, the provisions of the Contract with respect to placing concrete under water will govern.

4. Protective Cover. Once the hole has been accepted, verify that protective covering is installed to prevent persons and materials from falling into the hole.

5. Slurry. Ensure that the slurry being utilized is a mixture of sodium bentonite and clean, fresh water. Tidal water is not allowed. The mineral slurry must be premixed and adequate time, as prescribed by the manufacturer, must be allotted for hydration prior to introduction into the shaft excavation. During construction, the level of slurry must be maintained at a height sufficient to prevent caving of the hole. Verify that slurry properties (e.g., density, viscosity, pH) are maintained in accordance with the Contract Specifications. Check sand content to ensure compliance with the Contract Specifications. If it is too high, desanding may be required.

712.3.2 Reinforcement Cage and Steel Casing

The concrete reinforcement generally consists of a single-unit cage of reinforcing steel. The cage must be inspected prior to being placed into the drilled hole. Consider the following:

1. Cage Construction. Inspect the cage for proper bar size, spacing and fastening. Check the cage height and diameter for conformance.

2. Steel Casing. Where designated or as directed, ensure that the proper size of steel casing is installed and oiled prior to placing the cage, support system and concrete.

3. Installation Timing. After the hole and cage have been inspected, the cage and support system must be installed in the hole just prior to pouring concrete. If the concrete is not immediately poured, require removal of the cage, re-inspect the hole for loose material and check the surface condition of the steel for acceptability.

4. Support System. A support system must be provided so that the cage does not sit on the bottom nor lean against the wall of the hole. Check bottom and side clearances. Check conformance with respect to the number and interval of spacers along the length of the cage. Verify that the support system does not rack or skew the cage, and require additional steel as needed to stiffen the cage.

712.3.3 Concrete Placement

Acceptability of the placement method used for concrete will depend on whether or not the hole is considered dry or wet. Just prior to placement, check the depth of water at the bottom of the hole. If the depth, without pumping, is less than 6 inches over a 1-hour period, the hole may be considered dry for the purpose of method approval. Otherwise, the hole should be considered wet. Consider the following guidelines:

1. Dry-Hole Placement. Where the hole is dry, the concrete may be poured continuously in a free fall from the surface with the use of an approved device. Check to ensure that the concrete does not hit the reinforcing cage nor the sides of the hole on the way down.

2. Wet-Hole Placement. Concrete should be placed immediately after installation of the reinforcing cage, provided the excavation has been checked for bottom cleanliness and meets the requirements of the Contract Specifications. Concrete placement will be placed continuously from the bottom to the top of the excavation with a tremie tube. Concrete placement will continue after the shaft excavation is filled until good quality concrete is evident at the top of the shaft. During placement, ensure that the discharge end of the tremie tube remains immersed at least 10 feet into the concrete. To prevent slurry intrusion into the shaft concrete, ensure that the level of concrete within the tremie tube is always above the level of the slurry.

3. Removal of Water-Diluted Concrete. Where water-diluted concrete has floated to the top of the concrete during the pour, verify that the minimum depth of the top surface is removed and wasted.

4. Steel Casings. See Section 712.11 of the *Standard Specifications* for information on steel casings.

5. Concrete Curing. Check that the top surface of the concrete is properly cured. Pay particular attention to compliance of the curing method and period.

6. Adjacent Construction. Where other piles or shafts are to be installed adjacent to the freshly poured concrete, check compliance with respect to minimum lateral clearance and compressive strength prior to initiating the adjacent work.

712.4 POST-CONSTRUCTION CONSIDERATIONS

Obtain from the Contractor the required Certified Drilled Shaft Reports or Certified Drilled Pile Foundation Reports, as appropriate, for each drilled shaft or drilled pile installation. These Reports will be submitted before beginning construction on the next day's shafts or piles. Check the top elevation for tolerance compliance. Verify that the projecting reinforcing steel is in the correct location and properly cleaned of mortar. When specified in the Special Provisions of the Contract, the Department's on-call geotechnical consultant will perform the crosshole sonic logging test (CSL) prior to acceptance. Final acceptance is the responsibility of the Resident Construction Engineer, with any needed support being provided by the Bridge Construction Engineer and Geotechnical Design Engineer.

712.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Drilled shafts and drilled pile foundations will be measured and paid for as defined in the Contract under Section 712 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. Maintain accurate records in the Daily Work Report and appropriate SCDOT Forms 700.09 – 700.14 of the work performed and accepted. Retain all material certifications, invoices and similar documentation.

Section 713
Mechanically Stabilized Earth Retaining Wall

713.1 DESCRIPTION OF WORK

Section 713 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, equipment and construction requirements for mechanically stabilized earth retaining walls. When specified in the Contract, the Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the Contractor performs the work in accordance with the Contract Plans and Specifications.

713.2 PRECONSTRUCTION CONSIDERATIONS

Upon delivery to the job site, check compliance of the materials required for the project, including structural geosynthetic reinforcement, precast segmental concrete facing units, concrete leveling pad, perforated pipe underdrain, free drainage aggregate and backfill material. See Section 802 for information on perforated pipe underdrain. Obtain from the Contractor the required samples, Mill Test Reports, manufacturer's certification and certified test results. Forward this documentation to the Research and Materials Engineer. Acceptance will be based on the test results meeting the specified requirements. Do not allow work to begin until notified of material acceptance. Check for damage to materials upon delivery and ensure they are properly labeled, stored and handled. Pay attention to the storage requirements for structural geosynthetic reinforcement.

713.3 INSPECTION DURING CONSTRUCTION

Check the limits, grade and elevation of the excavation. Check for proper compaction of the soil. Verify that perforated pipe underdrain is installed properly at the correct location and spacing. Check compliance of the outfalls. Verify that the proper erosion control and drainage has been installed and is functioning to minimize washouts during installation. Check the dimensions and elevations of the installation of the concrete leveling pad. Do not allow the first course of segmental blocks to be placed until the concrete has reached its compressive strength. Monitor the installation of the segmental concrete facing units. Pay attention to the first course to ensure proper alignment. If required based on the size of the wall, ensure that the manufacturer's representative is on-site during construction. Continually monitor the wall for plumbness so that corrections can be effectively made. Check connections for compliance and that the block cores are backfilled with free draining aggregate before the next course is laid. Check compliance of the lift thickness and compaction of the backfill and the installation of the structural geosynthetic reinforcement. Verify that the top course is properly capped.

713.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to final acceptance, check the quality of the workmanship and that the drainage is functioning. Final acceptance is the responsibility of the Resident Construction Engineer.

713.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure mechanically stabilized earth retaining wall by the unit area of wall surface accepted in place, as measured from the top of the leveling pad to the top of the cap. Payment will be made at the Contract unit price. Maintain accurate records in the Daily Work Report including area measurements and calculations, all materials received and materials certifications.

Section 714
Pipe Culverts

714.1 DESCRIPTION OF WORK

A highway drainage system typically includes an interconnecting system of slopes, open ditches, underdrains and culverts of various types, sizes and shapes. The drainage system is constructed to prevent water from saturating and weakening the soil, prevent water from infiltrating the base and subbase, and intercept and carry the water away from the roadway. Culverts are an important part of this system. A culvert is an opening under the roadway with a clear span of less than 20 feet. A larger span is classified as a bridge. Culverts must function both hydraulically and structurally and are designed to accommodate the water flow, the pressure of surrounding soil and the traffic load above them. Culverts are typically placed at low points in the profile of natural ground and at intervals along long grades to carry water under the roadway. They may also be installed to accommodate the passage of pedestrians and wildlife.

A culvert with a rectangular opening is called a box culvert, which typically is cast in place or precast reinforced concrete (Section 722 of the *Standard Specifications*). A culvert with a round, arch or elliptical shape is called a pipe culvert (Section 714 of the *Standard Specifications*). Pipe culverts may be made of reinforced concrete, corrugated aluminum, galvanized corrugated steel or corrugated plastic. Sometimes culverts will consist of structural plates of galvanized corrugated steel or corrugated aluminum, which must be fabricated off-site and bolted in the field (Section 715 of the *Standard Specifications*). The type, size, number and location of culverts will be designated on the Contract Plans and will depend on many factors, such as application, drainage area, soil type and acidity, overhead load, surrounding soil pressure, cost and the likelihood that the pipe will be eroded.

The cost of installing pipes for culvert and sewer applications is very expensive, and therefore, warrants close inspection. When pay items are specified for pipe installations (i.e., Section 714, Section 715, Section 716 and Section 722 of the *Standard Specifications*), the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring that the work and materials comply with the respective requirements of the Contract Plans and Specifications, including applicable Supplemental Specifications and Special Provisions.

714.2 PRECONSTRUCTION CONSIDERATIONS

714.2.1 <u>Concrete Pre-Pour Conference and Checklist</u>

As applicable for reinforced concrete work for culverts (e.g., precast operations, cast-in-place headwalls), review the minutes of the Pre-Pour Conference, if held, and use SCDOT Form 700.01 – Concrete Pour Inspector’s Checklist.

714.2.2 Safety Considerations

Do not begin construction until all necessary traffic control is in place in accordance with the *MUTCD*. See Section 601, Section 602 and Section 603 for additional information. Do not enter manholes, inlets, vaults, trenches or other confined spaces without proper safety precautions and proper equipment. Unless alternative methods, such as laybacks or trench boxes are used, the sides of trenches must be securely held by shoring and bracing where trenches are excavated in material other than rock. Shoring and bracing is especially important where heavy construction equipment will be operated near the trench or where material thrown out of the trench is piled on one side. The spoil bank formed by the soil removed from the trench should be trimmed back from the edge of the trench. The weight of the soil in the spoil bank tends to overload the sides of the trench and may cause slides or cave-ins. As specified, shoring and bracing will be designed and stamped by the Contractor's South Carolina registered professional engineer.

714.2.3 Staking and Utilities

Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins. Check to ensure that culvert alignment and grade have been properly staked. Check that the elevations, alignment and locations meet the requirements for existing field conditions. Check inlet ditches and outfall ditches to see if planned elevations will properly drain existing conditions in the field. Make adjustments, if necessary.

714.2.4 Materials Considerations

714.2.4.1 Reinforced Concrete Pipe and Clay Pipe

Precast reinforced concrete pipe and box culverts will be inspected by Research and Materials Laboratory Inspectors at the fabrication facility. Once approved, an SCDOT stencil will be placed on the pipe. Do not accept any culvert material without this stencil. Precast reinforced concrete pipe will be stenciled in black with the markings "SC-3," "SC-4" or "SC-5," depending on the class of pipe inspected. Check that pipe sections are handled properly. If the method used causes damage, caution the Contractor and enforce the provisions of the Contract with respect to repairs or replacement. Pipe sections must be lowered carefully and not dumped or dropped from the truck to the ground.

714.2.4.2 Metal Pipe and Structural Plate Pipe

The sheet gauge and the type and size of corrugations for metal pipe culverts will be specified. Also, the pipe may need to be galvanized, coated with asphalt material, lined with clay or fiber bonded. If the corrugations in only the lower part of the pipe are filled, the pipe is said to have a paved invert. If the corrugations are filled all the way around the pipe, it is said to be fully paved. Metal culvert and structural plate pipe materials are not pre-inspected by SCDOT. Obtain and forward to the Research and Materials Engineer the Mill Test Reports, manufacturer's certification and certified test results. Do not allow use of the material without notification of material acceptance. It will not be necessary to submit samples, unless a problem is suspected. Upon delivery, check compliance with respect to type, size, shape, paving, thickness, length and coating. Ensure that structural plates, nuts and bolts conform to specified requirements. Verify that structural plates are matchmarked to ensure proper position during erection. Check for damage and defects. Reject non-conforming materials.

714.2.4.3 Polyethylene Pipe

Where designated for use on the project, ensure that polyethylene pipe is of the type and size specified and is supplied from a source listed on SCDOT Approval Sheet 30. Upon delivery, visually inspect the material for damage and take samples as described in Section 106.

714.2.4.4 Other Materials

Many other types of materials also may be required, including concrete and reinforcing steel for headwalls, field paving materials, joint sealant material, joint gaskets, and bedding and backfill material. Ensure that these materials conform to the requirements of the Contract. Pay attention to compliance of the type, shape and size of end sections, reducers, increasers, wyes and bends specified for the work.

714.3 INSPECTION DURING CONSTRUCTION

714.3.1 Field Adjustment Considerations

714.3.1.1 Overview

Water flowing over the ground will follow natural drainage channels at low points along the surface. When an embankment is built across a channel, water will pond, unless it can flow through the embankment. A culvert will be placed through the embankment at every natural drainage channel. Drainage-relief culverts will be installed to intercept water on excessively long grades. Drainage plans are generally based on survey data taken long before clearing and grubbing begins. Field conditions may be encountered that will require a different culvert installation. SCDOT Inspectors must study drainage conditions throughout the project. If a modification is suspected, immediately notify the Resident Construction Engineer for assistance.

Study all proposed culvert locations carefully to ensure that the Plan location, skew angle, etc., are best suited to accommodate field conditions. If the criteria appears inadequate, take corrective action. If water needs to be diverted from its natural channel but is not designated on the Contract Plans, give careful consideration to any consequential damage SCDOT may be held accountable for. Remember, the basic purpose of a culvert is to pass surface water from one side of the roadway to the other, as directly and economically as practicable, without damage to the highway or private property. Use sound engineering judgment when assessing any needed adjustments. For example, make certain that culverts are placed at low points and that outfalls are within the right-of-way. Perform field verification of all drainage features after installation. The use of energy dissipaters may be required, especially where excessive surcharges are expected.

714.3.1.2 Small Stream Considerations

Where a culvert is to carry water from a small stream through an embankment, the centerline of the culvert will typically be placed near the centerline of the stream. In addition, the bottom elevation of the culvert should be about the same elevation as the stream bed. Natural drainage channels should be used as much as practicable. Changing the course of a stream may result in property owner claims for damages due to flooding or intercepting too much water. The size, location and grade of each culvert must be constructed as defined in the Contract Plans, unless field conditions warrant adjustment. If an adjustment in location or elevation appears warranted, immediately notify the Resident Construction Engineer.

714.3.1.3 Culvert Skew

Where a culvert is provided at a natural drainage channel or where a drainage-relief culvert is required on a minor grade, the culvert will generally be set at a right angle to the roadway centerline; otherwise, the culvert will be skewed. Culverts are skewed to allow rapidly flowing water to more readily enter the inlet. Drainage-relief culverts installed along excessive grades typically will be skewed at angles of 15° to 45° with the roadway centerline. The degree of skew will be designated on the Contract Plans. In addition, the culvert will typically be set at approximately the same grade of the ditch that feeds the inlet.

714.3.1.4 Culvert Grade

The grade of a culvert is the line along its lowest inside surface, which will be designated on the Contract Plans. The flowline elevation should be set and checked at each cross-section along the culvert's profile. The flow line grade should, in general, be the same as that of the channel on each side of the culvert; however, the minimum grade should be at least 1.0% to promote self cleaning. Where pipes are laid on a relatively flat grade under high fills or yielding ground, sufficient camber must be placed in the culvert foundation to allow for settlement to avoid sag in the grade line. Settlement under high fills is much greater between roadway shoulders than near the ends of the pipe. Consider the following guidelines with respect to culvert grade:

1. Siltation. The grade of the culvert should not be so flat as to cause pipe siltation.

2. Inlet Elevation. The elevation of the flowline at a culvert's inlet should be set low enough to carry surface water away rapidly to prevent flooding adjacent land and to drain water from underdrains without backing up when the culvert is running full.

3. Outlet Elevation. The elevation of the flowline at a culvert's outlet should be set as close as practical to the existing ground. Less excavation will then be required for the outfall ditch, and the cost of maintenance will be less. In addition, where no endwall is provided at the outlet, the culvert should extend at least 2 feet beyond the toe of the embankment; and the culvert outlet may need to be treated with slope paving, a spillway or a rock dispersion pad to prevent erosion.

714.3.1.5 Inlets and Outlets

The entrance ditch to the pipe should be dug large enough to permit full use of the pipe during heavy rains. The ditch adjacent to either end of the pipe should be such that there is no abrupt change in the direction of the flow. The inlet elevations of a pipe should be carefully considered to avoid any ponding of water on private property.

714.3.2 Marking Culvert Locations

Several techniques can be used to establish culvert locations, including batter boards and stringlines, offset grade stakes and GPS technology. A common procedure is as follows:

- Stakes should be set along the centerline of the roadway at intervals of 25 feet to 50 feet for 200 feet on each side of the proposed location of the pipe.
- From each centerline stake, the distance from the roadway centerline to the planned outer edge of the shoulder will be measured in each direction at right angles to the roadway, and long stakes will be set along these shoulder lines.
- The toe of the slope will be established at a right angle to the centerline station where the end of the pipe will be located.
- A stringline should be used to set and control flowline elevation. A mark will be made on each stake either at the elevation of the flowline or at a certain uniform distance above or below the flowline elevation. The stringline, passing through these marks, will be pulled tight and secured in position on the stakes. If the stringline is not at the elevation of the flowline, the distance above or below the flowline must be marked on the stakes.

714.3.3 Trench Excavation

A pipe culvert should never be installed by simply laying it on the ground and piling fill material against it. Every pipe culvert must be laid in a trench; because the ability of the pipe, especially corrugated metal pipe, to support the load at its top depends on the support provided by the pressure of the compacted soil along its sides. Where a pipe is laid in a trench dug in compacted ground or embankment material and the void in the trench on each side of the pipe is backfilled and compacted, the resistance of the pipe to crushing is greatly increased. A trench should only be wide enough to allow room for compacting the backfill around the lower half (i.e., haunches) of the pipe. In general, the width of the trench should not be less than that required for making proper joints and compacting the backfill, and the trench must be deep enough to permit the top of the pipe to be at least the specified depth below the top of the trench. Trench excavation should always start at the low end, and the bottom of the excavation should be maintained even and sloped so that the trench will drain during construction. Trench excavation depends primarily on the type and size of the culvert being installed. See the *Standard Specifications* and *Standard Drawings* for trench excavation requirements.

714.3.4 Foundation and Bedding

An ideal condition is to have uniformity of foundation throughout the length of the pipe culvert; however, this is often not possible unless pockets or sections of material supplying unequal bearing are removed. Ensure that any unsatisfactory foundation material (e.g., soft, spongy material, rock or hard pan) is removed and replaced with suitable backfill material to the specified width and depth. Pipe culverts should not be placed directly on rock or other unyielding material because such conditions prevent proper distribution of load. If the bottom of the trench becomes soft and muddy, it may be best to undercut (i.e., dig below the normal grade) and backfill with granular material or earth selected from excavation. Only enough granular material to make a firm bottom should be used. Otherwise, water may run beneath and undermine the pipe. The contact between a pipe and the foundation on which it rests is the pipe bedding. It has an important influence on the supporting strength of the pipe. In most instances, the type of bedding to be used will be noted on the Contract Plans. Flexible pipe should generally be bedded so that the groove formed in the bottom of the trench has a width between one-half and three-fourths of the diameter of the pipe. The bottom of the trench, for a specified distance on each side of the pipe centerline, must be shaped to fit the curve of the pipe being laid with proper camber provided for flexible pipe. Where bell-and-spigot pipe is used, check that holes are properly dug in the trench to accommodate the barrels and allow the pipe to be in full contact with the foundation. It is of utmost importance that the Contractor be required to shape and prepare the pipe bedding in accordance with specified requirements. Consider the following:

1. Concrete Cradle. Where a concrete cradle is specified, the suggested method of construction is as follows:

   - The cradle below the lowest point on the pipe should be made of a concrete mix having a very stiff, dry consistency.

   - The concrete should be placed before the pipe is placed in the trench, and the surface of the concrete should be brought accurately to the grade for the bottom of the pipe. If bell-and-spigot pipe is used, the surface of the concrete should be at the grade of the line through the bottoms of the bells. Looped wires may be placed in the concrete before it hardens and later used to tie the pipe in position.

   - After the concrete below the pipe sets hard enough to be worked on, the pipe should be laid in its correct position on the concrete.

   - Fairly wet concrete should be used to complete the cradle or to encase the pipe.

2. Natural Ground Preparation. Where pipe is to be supported by natural ground, the trench bottom must be fine-graded to the proper grade, camber and shape so that the pipe will bed properly.

714.3.5 Pipe Placement

Various methods are used for lowering pipe into the trench. Mechanical equipment must be used for large pipe sections. Rigid pipe sections are typically lifted using hairpin-shaped hooks that can be inserted into the opening of the section or in special lifting holes or eye connectors.

This allows each section to be lifted and set into proper position without damage. Note that bell-and-spigot pipe sections must be laid with the bell end upstream and the laying operation must start at the downstream end of the trench. Each section should be pointed in the proper direction before it is lowered into the trench. Where reinforced concrete oval pipe is being laid, verify that the “TOP” label is uppermost. Where flexible pipe is placed in the trench, it should be lowered carefully. If a section of pipe is dropped, it may be dented or the galvanization or paving may be knocked off. If coating is knocked off or damaged, ensure that it is repaired as specified. Reject damaged pipe when conditions warrant. Before lowering the pipe into the trench, flexible pipe should be turned so that the lengthwise lap is at one side. This lap should never be at the top or bottom. The Contractor may often use different lengths of pipe sections to place the proper length of staked pipe. Should different lengths of pipe be furnished, the longer sections should be placed at each end of the pipe.

714.3.6 Joining Pipe Sections

Bell-and-spigot joints are used for small sizes of concrete pipe, and large sizes of concrete pipe usually have tongue-and-groove joints. Because bell-and-spigot pipe is laid with the bell end upstream and laying it started at the downstream end of the trench, the spigot end of the section being set in place must be inserted in the bell of the section previously placed. The methods used in joining sections of tongue-and-groove and bell-and-spigot pipe should be such that the ends of the sections are fully entered and the inner surfaces are reasonably flush and even. Typical sealants include mortar, preformed gasket material and approved sealants as listed on SCDOT Approval Sheet 13. Verify that the methods of joining pipe comply with specified requirements.

714.3.7 Inspection Prior to Backfilling

All pipe must be inspected in place before backfilling is started. Joints in large pipes should be inspected from within the pipe to make certain that they are properly filled. Any damaged joints should be repaired. Any section of pipe that has been critically cracked or broken should be taken out and replaced. At the end of each day, the trench with no pipe in it should be blocked off by a temporary dam or tight bulkhead located a short distance beyond the end of the pipe. The end of the pipe should not be blocked, because water filling the trench would then float the pipe and break the joints. Frequent observation of concrete pipe culverts should be made following the initial placement of the structure through the completion of the roadway fill and pavement. These frequent inspections throughout the duration of the project should establish the point at which damage occurs, if any, and also the extent of the Contractor’s responsibility.

714.3.8 Backfilling and Compaction

Inspection of the backfilling around and over a pipe is one of the most important duties of the SCDOT Inspector. Proper backfilling under the lower half of the pipe helps prevent rigid pipe from being crushed under heavy loads. Also, if the trench is not properly filled and compacted, a depression will usually develop in the finished roadway surface. Pay particular attention to the quality control testing and density acceptance requirements. The use of flowable fill must be approved by the Resident Construction Engineer. Check that the granular backfill material conforms to specified requirements and is free of muck, large stones, lumps and debris so that uniform compaction can be achieved. Care should be taken so as not to disturb mortared joints during backfilling.

Contractors frequently want to shove backfill material into the trench with a dozer which almost inevitably results in the backfill being placed in lifts that are too thick, especially near the trench sidewalls. Should the Contractor elect to use this method of placing earth in the trench, the SCDOT Inspector should, after each layer is placed, mark the pipe (with crayon) or by sticking stakes into the trench sidewalls to where the next layer should be. The material shoved in by the dozer will have to be redistributed along the pipe in a uniform layer. Layer thicknesses can be controlled in this manner. Backfill should be brought up uniformly on both sides of the pipe at the same time. Failure to do so produces unequal earth pressures that have not been designed for and could result in damage to the pipe. The use of mechanical equipment with buckets is much preferred.

To obtain uniform pressure around the pipe, the backfill material must be placed in layers of the specified thickness and thoroughly compacted. Mechanical tampers are normally used. The compacted layers should not exceed the specified thickness. Water should be added as needed to bring the material to optimum moisture content for maximum consolidation. To avoid displacing or unduly stressing the pipe, verify that backfilling is performed equally on both sides of the pipe simultaneously. Special care should be given to tamping material under the haunches of the pipe. Excessive compactive effort under the haunches may raise the pipe above the intended grade.

The compacted backfill should extend at least to the top of the trench. All field personnel should be cautioned to carefully observe the few feet of fill placed directly over the pipe to prevent the incorporation of any large rocks in this area. Heavy equipment can maneuver rock into this critical area. Pipe culverts should be adequately protected from damage before heavy equipment is operated near or over them. Water can sometimes be used to facilitate the settlement of granular backfills.

714.3.9 Structural Plate Pipe Considerations

Detailed instructions for erecting structural plate pipe will be shipped with the material. Obtain a copy of these instructions from the Contractor and study them carefully. Prior to beginning the work, perform a check measurement to ensure that the design length will be sufficient to fit the designated grade and alignment.

714.3.9.1 Pipe Bedding

The width of bedding for structural plate pipe need not exceed the width of the bottom plates. The percent overall height requirements for bedding will not apply except when the pipe is first assembled and then placed in the trench. Where pipe is laid on existing ground, special care must be taken to ensure full uniform support along the barrel of the pipe.

714.3.9.2 Pipe Assembly

Assembly of structural plate pipe should be started at the upstream end. The bottom plates are lapped and offset. Bolt holes near the center should be lined up and the bolts should be inserted and nuts fastened as soon as each plate is set. The longer bolts are used at points where three plates overlap. The longest bolts are used first to draw the plates together and these bolts are then replaced with standard bolts. After enough bottom plates are connected, the side plates just above them are added and held in place with a few bolts. The additional side plates and top plates are then assembled. When all plates are in position, any missing bolts should be installed and the nuts snugged. Nuts should be tightened uniformly, those at the upstream end being adjusted first. After all nuts have been tightened, they should be retightened. This adjustment may be started at either end. Check bolt lubrication and use a torque wrench and the manufacturer's recommendations, as specified, to inspect bolts and nuts.

A structural plate pipe arch is assembled in much the same manner as a structural plate pipe. The work is begun at the upstream end. After the base angles have been placed, the lowest side plates are set on them. Some other side plates and some top plates are then fastened in place with a few bolts on which the nuts are snugged but not tightened. Next, the remaining side plates and the top plates of one complete ring of the arch should be bolted into place. At this time, just enough bolts should be used to hold the plates in place, and the nuts should not be tightened securely. Drift pins will be helpful in matching the bolt holes, and temporary props can be used to help hold the plates in place until connections can be made. After one complete arch is in place, the next set of plates is assembled. Plates should be overlapped by one corrugation. After all the arch sections are in placed, all bolts and nuts should be installed. Then the nuts should be progressively tightened and retightened, as described. If the assembly procedures are not strictly followed when field assembling structural plate pipes and arches, rotation or spiraling of the barrel of the unit will usually result. Once this condition starts, it becomes worse as succeeding sections are assembled, causing the arch and invert to rotate out of position. This condition weakens the load carrying capacity of the structural plate pipe or arch, necessitating complete removal or removal to a point where a rotation is within acceptable limits, at which point correction plates must be installed. This removal or correction results in unnecessary delays to construction of the project.

714.3.10 <u>Trenchless Pipe Method</u>

When the trenchless method (jack and bore) is designated in the Contract Specifications or approved by the Resident Construction Engineer, ensure compliance. Any departure from the directives must be approved in writing by the Resident Construction Engineer. The Contractor is responsible for ensuring that the strength of the pipe can adequately withstand the jacking force. Pay particular attention to the requirements for approach trench, pipe guides, collars, jacking equipment and the allowable tolerance of deviation from Plan alignment and grade. The jacking operation should be performed continually to prevent the pipe from "freezing" in place. Lubrication may be required. Verify that joining of sections and backfilling are performed as directed.

714.4 POST-CONSTRUCTION CONSIDERATIONS

Unless adequate cover is provided, the impact load of heavy earthmoving equipment may damage the pipe culvert installations. During the grading work, pipe culverts should be reinspected at regular intervals by the SCDOT Inspector for damage due to this cause. Also, pipes under embankments should be inspected to see if any damage has occurred due to accumulated live and dead load. The Contractor should be advised immediately when an unsatisfactory condition is found to exist so that the condition can be corrected. The pipe is to be replaced if necessary. Where a pipe has to be replaced for reasons of improper installation or due to loads applied by the Contractor's heavy equipment, the Department will not bear any of the cost of the replacement. Verify that all pipe and structures are clean prior to acceptance and ensure trenches in the roadway have been resurfaced prior to opening to traffic. Where work on sewer systems has been completed, the Resident Construction Engineer must notify the owner of the system so they can inspect the sewer system for final acceptance. Ensure pipes are flush with the inside walls of the manholes.

714.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Document the measurements for payment (e.g., length, number of units installed) in the Daily Work Report for the respective pay items under pipe culverts, structural plate pipes, sewers and precast concrete box culverts. The method of measurement and basis for payment will be defined in the Contract for the respective pay items under Section 714, Section 715, Section 717 and Section 722 of the *Standard Specifications*. All field measurements of the pipe as installed are to be documented and retained for submittal with the As-Built Plans. The notes should indicate the type of pipe, its class, size, length and other relative information. The location of the pipe should be identified by station number. Notes for cross-line pipe should include the skew angle and notes for side-line pipe should indicate the side of the roadway on which the pipe was placed. Include a field sketch, as needed, to more clearly show the pipe layout. Include on the sketch the station number, length, size and skew angle in relation to the survey centerline. Where it is necessary to remove part of a section of concrete pipe as at a connection to a drainage structure, the entire joint length of pipe should be shown for payment. Pipe will be paid for in 4-foot increments. A copy of the As-Built Plans should be provided to the Resident Maintenance Engineer.

Section 715
Structural Plate Pipe, Pipe-Arch and Arch Culverts

Structural plate pipe, pipe-arch and arch culverts are governed by the requirements of Section 715 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer will be responsible for ensuring that the work and materials are in compliance with the requirements of the Contract Plans and Specifications. See Section 714 for additional guidance on inspecting the work and materials related to structural plate pipe, pipe-arch and arch culverts.

Section 716
Sewers

Sewers are governed by the requirements of Section 716 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer will be responsible for ensuring that the work and materials are in compliance with the requirements of the Contract Plans and Specifications. See Section 714 for additional guidance on inspecting the work and materials related to sewers.

Section 717
Re-Laid Culverts

Where culverts are to be re-laid, the Contractor will be required to remove, clean, haul and re-lay the existing pipe culverts at the locations designated on the Contract Plans and as directed by the Resident Construction Engineer. Verify that existing pipe culverts are removed, handled and stockpiled in a manner that will not damage the pipe material. Enforce the provisions of the Contract with respect to replacing damaged pipe. Contact the Resident Construction Engineer for any needed assistance in assessing damaged pipe. Ensure that all mortar or preformed gasket material is removed from the joints of all pipe sections and that the joints are thoroughly cleaned and prepared for re-jointing. See Section 714 for guidance on inspecting the laying of pipe culverts. Re-laid culvert will be measured by the unit length of culvert re-laid and accepted. Payment will be based on the Contract unit price. Document all measurements and field notes in the Daily Work Report.

Section 718
Brick, Rubble and Concrete Block Masonry

718.1 DESCRIPTION OF WORK

The material and construction requirements for brick, rubble and concrete block masonry are defined in Section 718 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with the requirements of the Contract Plans and Specifications.

718.2 PRECONSTRUCTION CONSIDERATIONS

Verify that clay or shale brick, concrete brick, stone rubble, concrete block, mortar materials (e.g., Portland cement, masonry cement, hydrated lime, aggregate) and reinforcing steel have been sampled and approved prior to the work. See Section 106 for the required schedule of sampling and testing. See Section 701 for additional information on Portland cement concrete materials and Section 703 for additional information on reinforcing steel. Note that masonry cement is used in only small amounts on most projects. When it is used, Mill Test Reports, if available, should be obtained from the supplier and forwarded to the Research and Materials Engineer. The Resident Construction Engineer will inspect the cement to ensure that it has not been contaminated by moisture or otherwise. Ensure that mortar materials have been proportioned and mixed in accordance with the specified requirements. See Section 718.08 of the *Standard Specifications* for mortar requirements.

718.3 INSPECTION DURING CONSTRUCTION

For brick and concrete block work, ensure that a full bed of mortar is placed between the block or brick. Ensure that at least one course in seven is composed entirely of headers. Verify that brick in the faces of structures are in good condition and not broken or chipped. Verify that joints are finished and exposed surfaces cleaned of mortar stains, and filled and pointed satisfactorily. All joints should be visible on the inside of the catch basin. If reinforcing steel is required, ensure that the steel has been placed as required by the Contract Plans. See Section 106 for sampling requirements.

For stone work, verify compliance of the shaping and dressing of the stone before it is laid. Note that no dressing or hammering will be permitted that will loosen stone already set. Ensure that stones are being laid in a full mortar bed and being placed so as to bond firmly in all directions. Ensure that the stone is being laid to achieve substantial masonry of a neat and finished appearance. When constructing walls, the bottom course is generally composed of the larger stones. Verify that one quarter of the stone area of the face of the wall is composed of headers. Verify compliance of the joints in the face of the wall and that weep holes are provided where necessary. Verify compliance of copings with respect to class of concrete, slope for drainage and length. Verify that excavated areas are backfilled with suitable material and tamped in proper layers.

718.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to acceptance, the Resident Construction Engineer will inspect the work with respect to quality of workmanship, location and dimension.

718.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Brick, rubble and concrete block masonry will be measured by the unit volume installed and accepted. Payment will be made based on the Contract unit price. Document all measurements and field notes in the Daily Work Report. Retain all Mill Test Reports, materials certifications, and similar documentation.

Section 719
Catch Basins, Drop Inlets, Manholes & Boxes

719.1 DESCRIPTION OF WORK

The material and construction requirements for catch basins, drop inlets, manholes, junction boxes and spring boxes are defined in Section 719 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with the requirements of the Contract Plans and Specifications.

719.2 PRECONSTRUCTION CONSIDERATIONS

The location of catch basins, drop inlets and manholes shown on the Contract Plans should be studied carefully for any field adjustment that can be made to improve the drainage conditions. Consideration must be given to proposed driveways, pedestrian traffic and other factors that may influence locations. Verify that utility lines have been staked and relocated, if needed. For concrete pours, use SCDOT Form 700.03 – Concrete Pre-Pour Checklist for Non-Bridge and Non-Culvert Items. Verify that concrete is of the proper class and that the cement, aggregate and admixtures have been approved. Ensure that brick, mortar, castings, reinforcing steel, structural steel and steel tubular sections have been sampled and approved. See Section 106 for the schedule of required samples and tests. If structures are precast, ensure that they conform to the Contract Plans and Specifications and check for the SCDOT approval stencil upon delivery. Verify that precast drainage items are supplied from a source listed on SCDOT Approval Sheet 14, metal basin covers from SCDOT Approval Sheet 15, steel grates and frames for catch basin covers from SCDOT Approval Sheet 45 and surface adjustment risers from SCDOT Approval Sheet 48. Gray iron castings will be accepted on the basis of certification and visual inspection at the job site. The Contractor will furnish the Resident Construction Engineer with a certification stating that material meets specified requirements, including strength, weight, dimension and workmanship. The Resident Construction Engineer will visually inspect the delivered castings and may spot weigh units to check their conformity to the weight requirements as shown on the Contract Plans.

719.3 INSPECTION DURING CONSTRUCTION

The location and elevation of catch basins and drop inlets should be such that the intakes will function properly. Too often, when catch basins and drop inlets are not constructed in conjunction with curb and gutter, the water by-passes the intake resulting in an ineffective structure. This is to be avoided. Verify that the foundation of structures are compacted to a firm, even surface and that obstructions and unstable material have been removed. Ensure that brick and concrete masonry is constructed in accordance with Section 718 and the *Standard Drawings*. Verify that inlet and outlet pipes are placed at the proper elevation, direction and grade and that pipes are substantially and neatly placed in the masonry of the structure flush with the inner faces. Verify that castings are adequately set in mortar in accordance with the

Standard Drawings. If the grade of an existing structure is being adjusted, verify that the work is being performed to use salvaged materials where practicable and that castings have been properly replaced in mortar. Verify that excavated areas are backfilled with suitable material and compacted in specified layers. The Contractor should be required to place and compact the backfill material as required with added emphasis being placed on backfill areas which are to support the pavement structure. The Contractor should be encouraged to use a mechanical tamp, because hand tamps do not thoroughly compact unless the proper tamps and effort are utilized. For structures that exceed standard depth, ensure that the excess depth has been properly measured for payment and that steps have been placed in the structure according to the *Standard Drawings*.

719.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to acceptance, ensure that all weep holes have been plugged, where required. The Resident Construction Engineer will inspect the work with respect to quality of workmanship, location and dimension prior to final acceptance.

719.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

See Section 719 of the *Standard Specifications* for the method of measurement and basis of payment. Final field measurements of catch basins, drop inlets, manholes and similar items as constructed are to be recorded in the Daily Work Report and noted on the As-Built Plans. The notes should indicate the type and depth of structure and its location. The location of the item should be given in relation to the survey station number so that the work will be properly oriented.

Section 720
Concrete Curb, Gutter, Sidewalk, Driveway & Median

720.1 DESCRIPTION OF WORK

Incidental concrete construction includes the construction of concrete sidewalks, driveways, medians, curbs, gutters and curb and gutter. This work, like bridge structures and pavements, is viewed by the public, and the quality of workmanship and inspection is readily apparent from the lines, grades and appearance of the finishing. It is important that the work be constructed to proper line, grade and finish for appearance and proper drainage functioning. The material and construction requirements are defined in Section 720 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with the requirements of the Contract Plans and Specifications.

720.2 PRECONSTRUCTION CONSIDERATIONS

720.2.1 Review of Plans and Adjacent Property

Before beginning sidewalk, curb or curb and gutter construction, the Contract Plans should be studied carefully. The elevations shown on the Contract Plans for these items should be verified.

When concrete curb and gutter is to be constructed on flat grades and at superelevated curves, the grades should be carefully studied to prevent a sag which will not drain properly. Where the new curb and gutter and sidewalk is higher than the existing property, provisions must be made for removal of any water impounded by the new construction. It may be necessary to make a grade adjustment if no other means of correcting the situation is available. The elevations of the proposed work may also be lower than the adjacent property. Where the grade is too low, field adjustments may be required.

In urban areas, the new construction usually requires that water meters, valves and other such devices be relocated. They are often installed in the grass plot or sidewalk area. Where the relocated work is placed within the new concrete work, the proper authorities should be contacted so that all adjustments may be made with as little inconvenience to the Contractor as possible. The Contract Plans, as well as the adjacent building structures, should be studied for any downspouts from roofs that should tie into the new work. This can usually be taken care of by running a small pipe under the sidewalk and through the curb or by connecting the downspout to a storm drain.

720.2.2 Utilities and Staking

Check that the line and grade have been staked in accordance with the Contract Plans and any needed field adjustments. Pay particular attention to compliance of the location of accessible ramps for the disabled.

720.2.3 Materials and Equipment Considerations

Verify that all materials to be used (e.g., cement, aggregates, admixtures, reinforcing steel, source of water, joint material, curing compound) comply with the requirements of the Contract. See Section 701 for information on Portland cement and Portland cement concrete materials, production and delivery. See Section 703 for information on reinforcing steel. Sampling and testing is discussed in Section 106. Use SCDOT Form 700.03 – Concrete Pre-Pour Checklist for Non-Bridge and Non-Culvert Items. The concrete class for this work will generally be Class 2500. Slump and air content are required to be checked when test cylinders are made and when a problem is observed. The results of the slump and air tests should be recorded on the concrete delivery ticket. Verify that the Contractor is adequately prepared to protect the concrete from rain and extreme hot or cold temperature, when necessary.

720.2.4 Subgrade

Section 720 of the *Standard Specifications* does not always require that the subgrade be compacted to a specific density, but does state that the subgrade should be thoroughly compacted. In areas where it is impractical for rollers to operate, mechanical tampers are very helpful in obtaining thorough compaction. The subgrade should be left slightly high until the forms are placed so that the concrete will not be placed on a new layer of fill material. After placement of the forms, the subgrade can then be graded down to the required grade. Subgrade should be moist at the time of placing the concrete so as to prevent the subgrade from absorbing water from the concrete. Before placement of the concrete, check the subgrade, form widths and alignment to ensure that the area of the typical section and alignment are being complied with.

720.2.5 Forms

Verify compliance of the grade, alignment and condition of the forms. Do not allow the Contractor to use forms that will produce objectionable results. Ensure that forms are clean and are properly oiled. Prior to concrete placement, the Resident Construction Engineer is required to approve the line and grade of the forms.

720.3 INSPECTION DURING CONSTRUCTION

See Section 702 for information on concrete work. Verify that expansion joints have been properly placed and checked. Ensure that the proper number of joints and joint material are placed at the proper location, line and grade. Do not permit curb sections of less than 4 feet in length. Verify that the concrete is being placed in the forms in such a manner as not to disturb or cause the forms to be moved out of line or grade. Verify that the concrete is being discharged from the truck within the specified time limit. Verify compliance of the floating, shaping and troweling of the concrete, the proper tooling of joints and the concrete finish.

Side forms are usually removed after the concrete has set sufficiently. Verify that forms are removed at the proper time. Once removed, ensure that the Contractor patches honeycombed areas. Upon removal of the forms and completion of any rubbing or necessary pointing up, the exposed surfaces are to be immediately sprayed with curing compound. When the forms remain in place for a period exceeding 72 hours it will not be necessary to cure the sides.

The Contractor may cure the concrete in several different manners. However, curing compound is commonly used. Curing compound is applied as a liquid spray which is used as a waterproof coating on the surface and prevents moisture from evaporating from the concrete. Moisture is necessary to the curing process of Portland cement concrete. When sufficient moisture is not present, little or no improvement in strength or quality of the concrete is obtained. Section 720 of the *Standard Specifications* requires that the curing compound be white-pigmented. This serves a two-fold purpose. The white-pigmented type reflects radiant heat from the sun, which results in less of an increase in temperature within the concrete throughout the curing period. Also, with the use of the white-pigmented type, it is possible to detect non-uniform application by visual inspection provided the pigment has been uniformly mixed in the liquid at the time of application.

The SCDOT Inspector should determine the approximate area of concrete to be cured and require the Contractor to spray the required quantity of uniformly mixed curing membrane on the area. During windy conditions, it may be necessary to apply additional curing compound material. The SCDOT Inspector should become thoroughly familiar with the appearance of a properly sprayed surface as a guide for inspecting the curing requirements. The curing compound must be applied immediately after the final finishing; however, should a water sheen be on the surface, the application of the curing material should be delayed until the water has disappeared.

720.4 POST-CONSTRUCTION CONSIDERATIONS

The Resident Construction Engineer will inspect the work with respect to quality of workmanship, location and dimension prior to final acceptance.

720.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The SCDOT Inspector should keep a daily record of the incidental concrete construction items poured each day. Where possible the location of the work should always be identified by station numbers. Field measurements of the work as constructed are to be recorded in the Daily Work Report. These notes will be retained by the Resident Construction Engineer. The notes should indicate the lengths, widths, etc., and the location of the completed work so that a pay quantity can be correctly computed. The location of the item should be given in relation to the survey station number so that the work will be properly oriented. See Section 720 of the *Standard Specifications* for information on the method of measurement and basis of payment.

Section 721
Asphalt Curb

721.1 DESCRIPTION OF WORK

The material and construction requirements for asphalt curb are defined in Section 721 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with the requirements of the Contract Plans and Specifications.

721.2 PRECONSTRUCTION CONSIDERATIONS

The materials used for asphalt curb will be Surface Course as defined in Section 403 of the Standard Specifications. Verify that the proper mixture is used for the project. See Section 401 for information on materials, production, hauling, placement and compaction requirements for HMA. Verify that the location and layout have been staked according to the Contract Plans. Pay attention to compliance of drainage requirements.

721.3 INSPECTION DURING CONSTRUCTION

If specified in the Contract, verify compliance of painting and sealing. If placed directly on the subgrade, verify that the soil has been compacted and graded properly. If placed on existing pavement, ensure that the surface has been properly cleaned. Verify the proper application of asphalt tack coat. Verify that the curb is being backfilled properly without damaging the curb.

721.4 POST-CONSTRUCTION CONSIDERATIONS

The Resident Construction Engineer will inspect the work with respect to quality of workmanship, location and dimension prior to final acceptance.

721.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The method of measurement and basis of payment will be as defined in Section 721 of the Standard Specifications. Record all measurements and field notes in the Daily Work Report.

Section 722
Precast Concrete Box Culverts

Precast concrete box culverts are governed by the requirements of Section 722 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer will be responsible for ensuring that the work and materials are in compliance with the requirements of the Contract Plans and Specifications. See Section 714 for additional guidance on inspecting the work and materials related to precast concrete box culverts.

Section 723
Deck Joint Strip Seal

723.1 DESCRIPTION OF WORK

Where deck joint strip seal is designated for a bridge deck, the Resident Construction Engineer will be responsible for verifying that the Contractor furnishes and installs the expansion joint in accordance with the requirements of the approved Shop Plans and the Contract Plans and Specifications. Expansion joint devices must not allow water to seep through the deck.

723.2 PRECONSTRUCTION CONSIDERATIONS

Prior to fabrication, the Contractor will submit Shop Plans to the designer of record (see Section 725). Verify that the Shop Plans have been accepted. Review the Shop Plans, the manufacturer's brochure and the Contract Plans and Specifications. The fabricator will notify the Research and Materials Engineer prior to fabrication. Pay attention to the dimension table establishing the joint opening at variable temperatures, the treatment of direction changes, field splicing and anchoring details. Verify that the joints delivered are supplied from a manufacturer that has been pre-approved by the Research and Materials Engineer. Ensure painting requirements are met. Obtain from the Contractor and copy the Research and Materials Engineer the manufacturer's certification and certified test results, indicating compliance with specified criteria. Verify compliance of the lubricant/adhesive for bonding the seal to the steel elements, the studs used in the anchorage system and the straps used for erection purposes. Contact the Bridge Construction Engineer for any needed assistance. Verify that the Contractor has submitted any required field welding procedures for review and that the plates are welded together with the specified butt weld. Welders must be certified for the type of welding required, as listed on SCDOT Approval Sheet 41. Ensure that the Contractor has notified the manufacturer's representative 2 weeks prior to installation, if required. After the second concrete pour, any steel supports, such as bolts or straps holding the two sections together, must be cut or removed before the next day.

723.3 INSPECTION DURING CONSTRUCTION

Check the joint opening for proper alignment, grade and dimensions and that the opening has been properly cleaned and prepared. During the installation of the first expansion joint, verify that the manufacturer's representative is on-site to assist in verifying proper installation, if required. Pay attention to the manufacturer's comments and recommendations and apply the guidance received during subsequent inspections. Check for the proper installation of all steel components, studs, straps and hardware. The Contractor will set the joint opening in accordance with the temperature chart. Verify that the device is properly set, supported, and secured. Verify that steel surfaces are cleaned and painted as specified and that the lubricant/adhesive material is applied as recommended by the manufacturer. Monitor the installation of the elastomeric strip for acceptability. Protrusions above the deck surface are not permitted when the joint is closed. A clearance of 0.375 inch to 0.5 inch is recommended. Do not permit the strip to be spliced. It must be installed in one continuous length.

723.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to acceptance, check that the opening of the expansion joint has been properly set and that the elastomeric material will not protrude above the deck surface once the joint is closed. See Section 723.3 for recommended clearance criteria. Test the joint for evidence of water seepage. If the test fails, require immediate correction, and retest the joint. The joint must be watertight. Final acceptance is the responsibility of the Resident Construction Engineer. Contact the Bridge Construction Engineer for any needed assistance.

723.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Joint deck strip seal will be measured by the unit length installed and accepted. Payment will be made based on the Contract unit price. Document all measurements and field notes in the Daily Work Report. Retain all materials certifications, delivery tickets and similar documentation.

Section 724
Elastomeric Bearings

724.1 DESCRIPTION OF WORK

Elastomeric bearing devices are used in structures to allow movement (i.e., longitudinal, transverse, rotational) due to such factors as temperature change, post tensioning and girder rotation. Where installed, the Resident Construction Engineer will be responsible for verifying that the Contractor's work and materials are in compliance with the Contract Plans and Specifications.

724.2 PRECONSTRUCTION CONSIDERATIONS

Review the Contract Plans and Specifications. Elastomeric bearings will be either plain (i.e., consisting of elastomer only) or laminated (i.e., consisting of alternating individual layers of elastomer and internal steel laminates). Verify that the elastomeric bearings delivered are of type required and ensure they are supplied from a manufacturer listed on SCDOT Approval Sheet 24. For each elastomeric bearing delivered, obtain from the Contractor and copy the Research and Materials Engineer the manufacturer's certification and certified tests results, indicating compliance with specified criteria. Ensure compliance of results of the required acceptance tests.

724.3 INSPECTION DURING CONSTRUCTION

Elastomeric bearings will be placed directly on the concrete surface. Check to ensure that the concrete surface and bearing seat are within tolerance of the required elevation. Verify that the concrete surface is clean and free of cracks. Verify compliance of nut tightening and thread burring. Where sole plates are to be installed, ensure they are attached properly with respect to alignment with anchor bolts. Verify that sole plates are positioned to the correct grade and superelevation and are in full contact with the bottom flange of the girder. Check bearing alignment for compliance. Verify proper adjustment for temperature. Watch for interference between anchor bolts and the upper part of the bearing device. Pay attention to elastomer damage due to welding in the vicinity of the bearing. Field welding must be performed as shown on the Contract Plans. The welder must be certified for the type of welding to be performed, as listed on SCDOT Approval Sheet 41.

724.4 POST-CONSTRUCTION CONSIDERATIONS

Check the tolerance of the alignment of the bearing and sole plate. Final acceptance is the responsibility of the Resident Construction Engineer.

724.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Elastomeric bearings will be measured by the number of units installed and accepted. Payment will be made based on the Contract unit price. Document all measurements and field notes in the Daily Work Report. Retain all materials certifications, delivery tickets and similar documentation.

Section 725
Shop Plans and Working Drawings for Structures

Shop Plans and As-Fabricated Drawings will be required for fabricated items that will remain a permanent part of the structure, such as structural steel members, expansion joints, bearings, stay-in-place bridge deck forms, prestressed and post-tensioned concrete beams and girders and prestressed concrete piling. Working Drawings will be required for construction falsework and temporary structures, which will include allowable stresses, working loads, load capacity of support elements and design calculations and specifications. Section 725 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, will govern the requirements of Shop Plans and Working Drawings, including plan size, content, number of sets, distribution and timing of submittal. Submittal requirements and coordination will be discussed at the Preconstruction Conference. Although the designer of record will review submittals for completeness, design integrity and compliance with Contract requirements is the responsibility of the Contractor. The Resident Construction Engineer will receive copies of all submittals. During construction, verify that Contractor complies with the requirements of the Shop Plans and Working Drawings. This work associated with the preparation of Shop Plans and Working Drawings for structures will not be measured and paid for separately, but will be included in other pay items in the Contract.

Section 726
Bridge Deck Rehabilitation

726.1 DESCRIPTION OF WORK

Bridge deck rehabilitation will be governed by the provisions of Section 726 of the *Standard Specifications*. In general, the Contractor will be responsible for removing deteriorated concrete, patching (i.e., full or partial depth patching), preparing the surface and placing, curing and finishing either a low-slump or latex-modified Portland cement concrete overlay. The Resident Construction Engineer will be responsible for verifying that the work and materials comply with the requirements of the Contract Plans and Specifications.

726.2 PRECONSTRUCTION CONSIDERATIONS

Ensure that the Research and Materials Engineer has been notified and provided the Mix Design for review at least 14 days prior to the work. All materials used for the overlay must be approved prior to use. See Section 701 and 702 for information on Portland cement, Portland Cement concrete and materials and construction requirements for concrete work for structures. Verify that the epoxy cement is of the proper type and properly stored. For acceptance, obtain the letter of certification from the manufacturer indicating that the epoxy cement complies with the Contract Specifications. If suspected, obtain separate unopened, one-quart samples of each component in each Lot or shipment and forward them and the certification to the Research and Materials Laboratory for testing. Do not permit the material to be used until notified of compliance. Check compliance of the gradation of sand for the epoxy-sand slurry mixture and the sand for the grout-bond coat, as appropriate. Ensure that the latex material is supplied from a source listed on SCDOT Approval Sheet 12.

726.3 INSPECTION DURING CONSTRUCTION

For latex concrete or Portland cement concrete overlays, verify that the machine preparation of the existing deck is properly performed and that all unsound concrete is removed. Ensure that joints are rehabilitated, as specified. Ensure that areas requiring partial- or full-depth patching are properly treated. After patching, verify that the machine prepared deck is cleaned of debris. Verify the proper application of the grout bond coat and the proper mixing, placing and consolidating of the concrete overlay mixture. Check compliance of the surface finish, texture and curing method and period. Ensure that joints and cracks are properly sealed. Verify the proper application of the epoxy-sand slurry and the sawing of textured grooves, if specified.

726.4 POST-CONSTRUCTION CONSIDERATIONS

The Resident Construction Engineer will inspect the work with respect to quality of workmanship prior to final acceptance.

726.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The method of measurement and basis of payment will be as defined in Section 726 of the *Standard Specifications*. Record all measurements and field notes in the Daily Work Report. Retain Mill Test Reports, delivery tickets and other similar documentation.

DIVISION 800
Incidental Construction

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

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Section 801
Aggregate Underdrains

801.1 DESCRIPTION OF WORK

Aggregate underdrain generally serves the same purpose as pipe underdrain, except that pipe underdrain material will not be placed in the trench prior to backfilling. Aggregate underdrain is commonly used in conjunction with pipe underdrain (see Section 802). See Section 802.1 for additional information on underdrains.

801.2 PRECONSTRUCTION CONSIDERATIONS

See Section 802.2.1.1 for inspection guidance on the granular filter material used for aggregate underdrain and Section 802.2.2 for information on determining underdrain locations.

801.3 INSPECTION DURING CONSTRUCTION

Check the width, depth and grade of each trench for compliance. Verify that the aggregate meets the gradation requirements of the *Standard Specifications*, Section 801.02. Where aggregate underdrain is used as a transverse drain, the bottom of the trench should extend at a minimum to the bottom of the porous foundation material. Verify that the aggregate is placed in lifts of the specified thickness and to the total required depth. A relatively impervious earth material should be placed and compacted over the aggregate to prevent the infiltration of surface water. Outlets will be provided, as directed, and protected appropriately. If recycled material is used, verify that it is backfilled first and then covered with the specified minimum depth of aggregate and thoroughly compacted. See Section 802.3 for additional information.

801.4 POST-CONSTRUCTION CONSIDERATIONS

See Section 802.4 for post-construction considerations.

801.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Aggregate underdrain that has been placed and accepted will be measured by either unit length or unit volume, as specified. If based on unit volume, document the length, depth and width of the aggregate underdrain placed and accepted. Document these measurements in the Daily Work Report. Payment will be based on the Contract unit price. See Section 802.5 for additional information.

Section 802
Pipe Underdrain

802.1 DESCRIPTION OF WORK

A pipe underdrain system is a series of interconnected longitudinal and transverse pipes that are placed in trenches and backfilled with granular filter material for the purpose of intercepting and draining subsurface water that infiltrates the subgrade and pavement structure. If excess water is not drained at locations such as seeps and springs, the load carrying capacity of the subgrade and pavement structure may decrease and become unstable, causing premature failure of the structure. Aggregate underdrains (see Section 801) are commonly used in conjunction with pipe underdrains. These subsurface drainage features are typically installed at project locations to:

- intercept springs and lower the elevation of the groundwater table below the subgrade;
- intercept subsurface water from the backslope before it seeps into the subgrade;
- intercept subsurface water that may cause slides on the side slope of a cut; and
- correct base failures due to seepage of subsurface water.

Once intercepted, the subsurface water will be carried away from the pavement structure to outfalls and into the roadway's surface water drainage system (e.g., ditches, culverts). Although the Contract Plans will designate a total underdrain quantity anticipated for use on the project, the Contract Plans usually will not designate particular installation locations, unless a location is known to be problematic from previous investigations. Care should be taken to ensure that outfalls occur at sags and the outlet elevation is below the drain but higher than the ditch line. The Resident Construction Engineer will be responsible for monitoring earthwork operations for obvious problem locations, such as seeps and springs, and for using sound engineering judgment to determine where underdrains should be installed. If there is any doubt in assessing the need for underdrains, contact the District Construction Engineer for assistance. The Roadway Inspector will be responsible for inspecting the work and materials to verify compliance with the Contract Plans and Specifications and the directives of the Resident Construction Engineer.

802.2 PRECONSTRUCTION CONSIDERATIONS

802.2.1 Materials Considerations

802.2.1.1 Granular Filter Material

Consider the following when inspecting the aggregate materials that will be used as the granular filter material in underdrains:

1. Coarse Aggregate. The coarse aggregate used for granular filter material in underdrains will be supplied from a source listed on SCDOT Approval Sheet 2. A sample must be obtained prior to use and submitted to the Research and Materials Laboratory for

testing. Check the test results to verify compliance. Quality Control Sampling and Testing will be performed as discussed in Section 106.

2. Fine Aggregate. Suppliers should be listed on SCDOT Approval Sheet 1. When its use is specified for granular filter material, fine aggregate will be sampled and tested in accordance with the Quality Control Samples and Tests presented in Section 106. Visually inspect fine aggregate for excessive lumps, organics, trash and debris, and check the test results to verify compliance.

3. Recycled Materials. When allowable recycled materials are being used, pay particular attention to the limits of application and obtain the certified test results demonstrating that the material complies with the requirements of SCDHEC and the Environmental Protection Agency. Additionally, collect samples to ensure that the material meets other applicable requirements

802.2.1.2 Underdrain Pipe Material

Consider the following when inspecting underdrain pipe materials:

1. Corrugated Metal and Corrugated Aluminum Alloy Pipe. It will not be necessary to submit samples of corrugated metal or corrugated aluminum alloy underdrain pipe to the Research and Materials Laboratory for testing, unless the material is suspected of being defective. However, the Resident Construction Engineer will be responsible for obtaining and forwarding Mill Test Reports for these products to the Research and Materials Engineer.

2. Other Pipe Materials. If corrugated polyethylene pipe is used, ensure that the supplier of the material is listed on SCDOT Approval Sheet 30. Polyvinyl chloride, concrete and asphalt-fiber underdrain pipe materials are not pre-approved by SCDOT. The Resident Construction Engineer is responsible for obtaining and submitting samples to the Research and Materials Laboratory for testing before allowing the material to be incorporated. See Section 106 for the required Quality Control Samples and Tests. When polyvinyl chloride pipe is specified, polyethylene pipe meeting the special requirements of subsection 802.07 of the *Standard Specifications* may be substituted.

802.2.1.3 Geotextile Fabric

Geotextile fabric is commonly used in conjunction with pavement edge drains, interceptor drains and wall drains. The fabric will allow water to pass into the drainage structure while retaining the in-situ soil material. Prior to installation, obtain material certifications and forward a copy to the Research and Materials Engineer.

802.2.2 Determination of Underdrain Locations

802.2.2.1 Field Review

Areas suspected of requiring subsurface drainage may have been previously identified prior to plan preparation through test boring and a soils investigation. In such cases, any problematic areas that have been found will be designated on the Contract Plans by stationing and a quantity will be specified with a notation that the underdrain material will be used as directed by the Resident Construction Engineer.

802.2.2.2 Test Boring and Observation

During earthwork operations, the Resident Construction Engineer will inspect the project to determine the exact locations where underdrains will be required. Earthwork and grading often take place during periods of dry weather, which makes it difficult to observe potentially problematic areas. Contact the District Construction Engineer for any needed assistance in making this determination.

802.2.2.3 Fill Sections

Special attention is required in assessing the need and location of underdrains under embankments. The height of fill, the type of fill material and the anticipated traffic load must be considered. Where the fill consists of a granular material, underdrains may not be needed at all. Prior to placing fill material, inspect the area for moist or saturated conditions. Where a clearly defined spring is found, it will usually be necessary to construct a spring box, using a non-perforated pipe to drain the water from the box to a suitable outfall.

802.2.2.4 Cut Sections

During excavation of a cut section, inspect the side cuts and ditches for any unusual moisture conditions. Watch for any abnormal displacement of the ground by earthmoving equipment. This often indicates that the material contains excessive moisture or is of an unstable nature. Where water is found to be seeping through a side cut, it is usually best to run a pipe underdrain parallel to the roadway under the shoulder below the seepage zone. See the *Standard Drawings* for details on installation. Water coming in from a side cut may also be controlled by deepening and widening the ditch. The feasibility of this method will depend upon the anticipated traffic load, the right-of-way available and the cost of the additional excavation. In light cut sections, the cost of additional excavation is typically less than the cost of the underdrain.

802.2.2.5 High Water Table

If an excessively high water table is encountered, the Resident Construction Engineer should contact the District Construction Engineer for assistance.

802.2.2.6 Staking

The Resident Construction Engineer will be responsible for ensuring that underdrain locations are staked and that the requirements for underdrains are clearly communicated to the Contractor. Verify that underdrain staking has been established as directed by the Resident Construction Engineer and that the stakes are properly protected during earthwork operations.

802.3 INSPECTION DURING CONSTRUCTION

802.3.1 Trench Construction

Check for compliance of the width, depth and grade of underdrain trenches. Where underdrains are placed in cut sections, the bottom of the trench must be of a sufficient depth below the side or median ditch to adequately intercept subsurface water. Ensure that the specified type of coarse aggregate material is placed in the proper lift thickness. Prior to placing the pipe, ensure that the specified coarse aggregate is placed in the bottom of the trench to a depth of 4 inches.

802.3.2 Pipe Placement

Verify that the pipe is placed in the center of the trench and firmly bedded in the bottom course of aggregate. Check the pipe grade to ensure that no low areas exist that will hinder proper drainage. Perforated pipe will be laid with the perforations on the underside of the pipe. Ensure that pipe sections are properly joined. The method of joining will differ based on the type of underdrain pipe used. Where bell and spigot type connections are used, the bell end will be laid in the upgrade direction. The intent of joining underdrain pipe is not to create a watertight seal, but to prevent the aggregate material from infiltrating the pipe. Verify that the upgrade terminal end of the underdrain pipe is capped. After placement, inspect the underdrain pipe for approval prior to allowing backfilling to begin.

802.3.3 Backfilling

Verify that coarse aggregate for pipe underdrain or aggregate underdrain (see Section 801), as directed, is placed equally on each side of the pipe in lifts of the proper thickness and to the required depth above the bottom of the pipe. Check for compliance of minimum aggregate cover over large diameter pipe. Watch for pipe displacement during backfilling. Ensure that the top compacted layer of backfill over the aggregate is of an impervious earth material to prevent the infiltration of surface water.

802.3.4 Pipe Outlets

Where perforated pipe is used for outlet sections, the pipe will be laid with the perforations on the top of the pipe. Ensure that pipe outlets are constructed and protected by concrete endwalls, as directed by the Resident Construction Engineer. Joints for outlet pipe must be sealed to provide a watertight connection and the trench backfilled in compacted layers of impervious earth material, not aggregate.

802.4 POST-CONSTRUCTION CONSIDERATIONS

To facilitate SCDOT maintenance forces locating pipe underdrain outlets, the Roadway Inspector should note the location of outlets on the As-Built Plans and ensure that the locations are marked in the field as shown in the *Standard Drawings*. During earthwork operations, make certain that underdrain pipe is protected from being crushed by heavy construction equipment traversing the area. This is a common problem that should be continually monitored. The Resident Construction Engineer may request the Research and Materials Engineer to perform an inspection of the pipe using an underdrain camera. Periodically check underdrain outlets for proper operation, and require repair work, if needed, in accordance with the provisions of the Contract.

802.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The Roadway Inspector will be responsible for providing a sketch illustrating the pipe underdrain system, as constructed in the field. The sketch does not need to be to scale, but should accurately document station numbers, distance from roadway centerline, pipe orientation and length of pipe outlets, so that the underdrain system can be accurately drawn on the As-Built Plans. A summary of the total quantity of pipe underdrain should also be noted on the sketch. This information is critical to SCDOT Maintenance Forces. Pipe underdrains and outlets will be measured by unit length of the type and size of pipe underdrain placed and accepted. Document the measurements in the Daily Work Report. Payment will be made at the Contract unit price for the type and size of pipe underdrain specified. Note that concrete for endwalls, where required, will be measured and paid for separately. Pay particular attention to the depth and limits of excavation to properly apply the provisions for unclassified excavation.

Section 803
Pipe Slope Drains

803.1 DESCRIPTION OF WORK

The construction of pipe slope drain generally consists of installing an intake spillway assembly and pipe material along the shoulder, slope and other locations as designated by the Resident Construction Engineer.

803.2 PRECONSTRUCTION CONSIDERATIONS

Check for compliance of the intake assemblies and pipe materials. The size of the intake and pipe should be commensurate with the needs of the drainage area. Contact the Resident Construction Engineer if there is any question regarding the size of intake and pipe. See Section 802.2.1.2 for additional information on pipe material and Section 802.2.2 for information on determining underdrain locations.

803.3 INSPECTION DURING CONSTRUCTION

Ensure that all pipe joints are tightly clamped to provide a watertight connection. Verify that intake assemblies are properly installed and that water will not erode or undermine the pipe. Where an intake assembly is not used, ensure that asphalt paving or other suitable means of erosion protection is provided. In addition, ensure that the outfall of the slope drain does not promote erosion. Rip rap or other slope protection may be necessary.

803.4 POST-CONSTRUCTION CONSIDERATIONS

See Section 802.4 for post-construction considerations.

803.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Pipe slope drain will be measured by the unit length of pipe placed and accepted. Intake assemblies will be measured by the number of assemblies installed and accepted. Document the measurements in the Daily Work Report. Payment will be made based on the Contract unit price for the type and size of pipe slope drain and assembly installed. See Section 802.5 for additional information.

Section 804
Rip Rap and Slope Protection

804.1 DESCRIPTION OF WORK

Rip rap and slope protection are generally specified to protect highly erodible areas along the roadside and beneath and adjacent to structures. The primary responsibility of the Roadway Inspector will be to ensure that the Contractor performs the work in accordance with the requirements of the Contract Plans and Specifications and as directed by the Resident Construction Engineer.

804.2 PRECONSTRUCTION CONSIDERATIONS

804.2.1 Geotextile Fabric and Granular Filter Materials

The use of geotextile fabric under rip rap as a permanent measure to control the erosion of embankment side slopes and stream banks is common on SCDOT projects. This treatment is also used under and around submerged structures to prevent scour by the action of moving water. The class and type of geotextile for use under rip rap will be designated on the Contract Plans. Where designated, or as otherwise directed by the Resident Construction Engineer, the placement of the geotextile fabric and rip rap material will be in accordance with the Contract Specifications. The geotextile fabric must be supplied from a source listed on SCDOT Approval Sheet 44. Obtain the manufacturer's certification. Where granular filter material is specified, ensure that the material is of the proper type and gradation. Pay particular attention to the gradation requirements for each layer of granular filter material applied.

804.2.2 Rip Rap Materials

Stone used for rip rap must be supplied from a source listed on SCDOT Approval Sheet 2. Recycled concrete may be used in some rip rap applications, with written approval of the Resident Construction Engineer. Where used, ensure that no reinforcing steel protrudes from the concrete pieces, because it can be a hazard, tear geotextile fabric and accumulate debris in place. Where bagged sand-cement is specified, check for compliance of the burlap bags, sand and Portland cement materials. Where grout is designated, check the class of stone and the type of grout material for compliance. Consistency should allow the grout to flow between the stone with limited spading. Where precast concrete units are used, check for compliance of the dimensions of the units with the details shown on the Contract Plans. Precast units are not reinforced. Use the following guidelines to correlate Pay Item and Class for rip rap, as designated in the Contract:

1. Hand Placed Rip Rap. Unless otherwise designated on the Contract Plans, hand placed rip rap will be Class B. Where designated, Class A may be placed by hand.

2. Dumped Rip Rap. Dumped rip rap may be Class A, B, C, D, E or F and is typically designated on the Contract Plans. If not designated, Class C will be used.

3. Surge Stone. The class for surge stone will be designated on the Contract Plans. Dumping is permitted, unless otherwise specified.

804.2.3 Gabion Materials

Where gabions are designated, the units will be either galvanized or PVC coated wire baskets, which will be filled with stone, connected together and anchored in place. Check the galvanized or PVC coated wire, fill stone, tie wire and stiffeners for compliance.

804.2.4 Concrete Slope Protection Materials

Where concrete or fiber-reinforced concrete will be used for slope protection, check for compliance of the concrete, wire reinforcement and fiber-reinforced concrete materials prior to use. Obtain the required manufacturer's certifications. Concrete and wire reinforcement must be sampled and tested in accordance with the Quality Control Samples and Tests presented in Section 106.

804.3 INSPECTION DURING CONSTRUCTION

804.3.1 Preparation of Slope

Verify that the slope is properly graded and compacted. Check for compliance of the trench constructed below the toe of the slope; however, not all treatments will require such a trench. Where granular filter material is specified, ensure that it is placed in the proper lifts of graded material. Where geotextile fabric will be placed, inspect the slope for any residual material that may puncture the fabric when laid. Check the placement of the fabric for compliance with respect to orientation and direction of lapping. Verify that the fabric is fastened at the locations and intervals specified. The fabric should lay smooth and be fastened with metal fasteners to prevent shifting when the rip rap material is placed. For placement of large rip rap, additional care may be needed to prevent puncture of the fabric. Once laid, construction equipment should not be permitted to operate directly on the fabric. Note that geotextile fabric deteriorates under prolonged exposure to sunlight. Pay particular attention to the length of time the fabric is exposed without cover, and enforce the provisions of the Contract with respect to the allowable length of time without cover and replacement of damaged fabric.

804.3.2 Placement of Rip Rap Materials

Stone may be dumped or placed by hand, as designated. Ensure that stone is properly seated at the required thickness. Placement will begin at the toe of the slope and proceed upward. Hand rearrangement may be necessary. The height of drop should be limited to prevent damage to geotextile fabric. As needed, require patching or replacement of damaged fabric. Where stone is to be grouted, ensure that it is wetted prior to application and that the grout fills the voids to the specified depth. The faces of stones should be maintained relatively free of grout. Ensure that the ends of treatment are properly embedded to prevent undermining. Where sand-cement bags are placed, check the sand-cement mixture for compliance and ensure that the bags are properly placed. Pay particular attention to any delays in placing succeeding layers, and inspect the terminal cutoff walls at each end of the treatment. Where precast concrete units are placed, verify that they are placed tightly against one another, starting in a trench below the toe of the slope and proceeding upward. Pay particular attention to the acceptability of the top course.

804.3.3 Placement of Gabions

Verify that empty gabion baskets are placed, anchored and fastened together in the proper alignment. Pay particular attention to any damage to geotextile fabric. Ensure that the stone is placed in the baskets to promote keying and minimize voids and damage to the galvanized or PVC wire, or geotextile fabric. After filling, verify that the baskets are properly closed and secured.

804.3.4 Placement of Concrete Slope Protection

Prior to concrete placement, check forms for proper alignment and thickness. Concrete test cylinders and wire reinforcement samples should be obtained and submitted to the Research and Materials Laboratory in accordance with the Quality Control Samples and Tests presented in Section 106. Verify that wire reinforcement is placed approximately mid-depth of the concrete. Ensure that the surface of the concrete is finished, textured and cured in accordance with the Contract Specifications.

804.4 POST-CONSTRUCTION CONSIDERATIONS

Upon completion of the rip rap or slope protection treatment, inspect the treatment for any obvious signs of defects, especially during high water or rainy conditions. Require rework, if needed, in accordance with the provisions of the Contract.

804.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Rip rap placed and accepted will be measured either by unit weight, unit volume or unit area, depending on the type of treatment specified in the Contract for the class of rip rap designated on the Contract Plans. Slope protection and geotextile fabric will be measured by unit area placed and accepted. Document measurements for payment in the Daily Work Report. Payment will be made at the Contact unit price for the type of treatment placed and accepted. Payment for grouted rip rap is measured and paid for by the square yard. Check material delivery tickets for accuracy (i.e., project, material, date, quantity). Delivery tickets will be retained by the Resident Construction Engineer.

Section 805
Guardrail, Barriers and Impact Attenuators

805.1 DESCRIPTION OF WORK

Where these systems are warranted, they will be designated at specific locations on the Contract Plans and installed to prevent errant vehicles from leaving the traveled way and moving into fixed objects, steep slide slopes and opposing traffic. Different types of designs exist to address specific conditions, including:

- steel beam guardrail (W-beam),
- adjustable guardrail,
- steel beam guardrail (double layer),
- steel beam guardrail (thrie-beam),
- steel beam guardrail (thrie-beam, double layer),
- box beam median barrier,
- median cable barrier and anchors,
- tubular beam guardrail (bridge railing),
- temporary guardrail,
- concrete median barrier,
- temporary concrete median barrier,
- end terminals, and
- crash-cushion/attenuating terminal systems.

It is critical that the Resident Construction Engineer and Roadway Inspectors understand the materials and construction details necessary to properly install the systems required for the project. The proper installation of these devices is critical. Section 805 of the *Standard Specifications*, Special Provisions, *Standard Drawings* and the manufacturer's installation recommendations, will govern the requirements for these systems. When guardrail pay items are specified in the Contract, the Roadway Inspector will be responsible for verifying that the Contractor sets, resets, adjusts or removes and stores guardrail systems in accordance with the Contract Plans and Specifications.

805.2 PRECONSTRUCTION CONSIDERATIONS

805.2.1 <u>Field Test Notification</u>

The Resident Construction Engineer will be responsible for notifying the Research and Materials Engineer sufficiently in advance of the start of work to perform the required field tests on guardrail materials. Upon notification, a Research and Materials Laboratory Inspector will be sent to the job site to perform field testing of component materials.

805.2.2 Rail sections

Check for visual defects (e.g., burrs, drips, uncoated areas) and that the rail sections are of the proper type, shape, length and curvature for the guardrail system to be installed. Verify that the rail sections are supplied from a manufacturer listed on SCDOT Approval Sheet 29. If a Contractor wishes to use rail sections from a source not listed on SCDOT Approval Sheet 29, contact the Research and Materials Engineer for approval prior to incorporating these sections into the work. In all cases, obtain and forward the Mill Test Report for these sections to the Research and Materials Engineer. A Research and Materials Laboratory inspector will perform one field test for each 500 pieces of 12.5-foot rail sections. If the rail sections are furnished in 25-foot lengths, one field test will be performed for each 250 pieces.

805.2.3 Cable

Cable for median cable barrier is not usually sampled and will be accepted based on Mill Test Reports. Check for visual defects and obtain and forward the Mill Test Report to the Research and Materials Engineer for evaluation. The Research and Materials Engineer may elect to sample and test cable to confirm the manufacturer's test results.

805.2.4 Posts

Check for visual defects and verify that posts are of the proper type and material for the guardrail to be installed. Check the length, dimensions and holes for compliance. During each field test of rail sections, one field test of steel posts also will be performed by the Research and Materials Laboratory Inspector. Treated wood posts are pre-inspected by an approved Independent Inspection Agency. Ensure that each treated wood post bears the Testing Agency's hammer mark of approval. Obtain and forward to the Research and Materials Engineer a copy of the Agency's Inspection Report and Certificate of Compliance.

805.2.5 Blockouts

Check for visual defects and verify that blockouts are of the proper type and material for the guardrail system to be installed. For example, wood blockouts are not permitted in thrie-beam systems, steel blockouts are not permitted in W-beam systems and adjustable blockouts, where designated, will have additional holes for rail-height adjustment. Check the length, dimensions and holes for compliance. Treated wood blockouts will be pre-inspected by an approved Independent Inspection Agency. Ensure that each treated wood blockout bears the Agency's hammer mark of approval. Composite blocks will not be sampled, but will be supplied by a manufacturer listed on SCDOT Approval Sheet 49.

805.2.6 Fastener Hardware

Check for compliance of the type, diameter and length of fastener hardware for the type of guardrail system to be installed. Post bolts should not extend beyond the specified distance beyond the nut and washers; however, cutting of bolts is not permitted. One sample consisting of a post bolt, splice bolt, nut, rectangular washer, round washer and other similar hardware will be obtained by the Resident Construction Engineer for testing.

805.2.7 End Terminals and Anchors

Ensure that end terminals and anchors are of the proper type for the location designated on the Contract Plans. Check for visual defects and that system components are carefully stockpiled. These systems must meet NCHRP Report 350 requirements and be supplied from a manufacturer listed on SCDOT Approval Sheet 46.

805.2.8 Concrete and Reinforcing Steel

Check for compliance of the class of concrete used for concrete median barrier, anchors and posts, where use is permitted with guardrail posts. See Section 701 and Section 702 for additional information on structural concrete. The Research and Materials Laboratory does not pre-approve sources or pretest shipments of reinforcing steel. Acceptance or rejection will be based on testing samples from the field. Concrete and reinforcing steel will be sampled and tested in accordance with the Quality Control Samples and Tests presented in Section 106.

805.2.9 Galvanization

Check steel rail sections, posts and blockouts for damage to the galvanization and require repairs to be made as specified in the Contract. Where cut or drilled in the field, ensure that the coating is repaired, as specified. For the purpose of verifying galvanization, the Resident Construction Engineer will notify the Quality Assurance Manager of the Research and Materials Laboratory when galvanized steel guardrail components have been delivered to the project. If the guardrail will be stockpiled, the Resident Construction Engineer should provide sufficient advance notification so that the galvanization may be checked while the material is stockpiled.

805.3 INSPECTION DURING CONSTRUCTION

805.3.1 New Installations

805.3.1.1 Slopes and Staking

Check approach slopes for compliance and verify stake locations. Check lateral offset, longitudinal length, termini location, post spacing, and curvature for conformance with the dimensions on the Contract Plans.

805.3.1.2 Post Installation

Guardrail posts may be driven in place, set in dug holes or set on a concrete base, as specified. Check post spacing, elevation and alignment regularly. Where posts are driven, watch for irregular movement, possibly indicating an underground obstruction. Check driven posts for damage (e.g., distortion, burring). Where posts are set in dug holes, watch for overdrilling and require backfilling and compaction as needed to adjust depth and provide a firm foundation. After setting, verify that backfill material is placed and compacted in layers around posts. Verify that all posts are set firm and plumb and that they are within tolerance of the required alignment and elevation. Where posts are placed within a paved area, ensure that the pavement is restored as specified. Do not allow the sawing of treated wood posts.

805.3.1.3 Installation of Rail Sections

Verify that all fittings and metal plates are securely placed in the correct position. Lap splices of rail sections should occur at posts, not mid section. Verify that rail sections are lapped in the direction of adjacent traffic. The transition at the lap should be smooth. Verify that bolts are drawn tight; however, bolts at expansion joints should only be snugged so that the rail sections are permitted to slide during expansion and contraction. Verify that the expansion splice is located in the proper place, especially where Thrie beam is installed on old bridges. Verify that the top of rail is set at the proper height and is smooth without undulation. Check the face of rail sections with respect to lateral offset and alignment for compliance and any needed adjustment. Where cable barrier is installed, check the cable for tightness.

805.3.1.4 End Terminals, Transitions, Anchors and Delineation

Pay particular attention to the construction details on the *Standard Drawings* and the manufacturer's installation drawings for end terminals, median terminals, bridge rail transitions and anchors. Verify compliance of the post type, post spacing, type and length of rail sections, lapping direction, splices, method of connection, fastener type and application of terminal end reflective sheeting. Specialized designs and hardware are commonly used at these locations and require close inspection prior to acceptance. Check the location of end anchors to verify that the shoulder is wide enough for the anchor. Where designated, verify that the proper type and color of delineators are installed at the proper spacing for the guardrail system.

805.3.1.5 Traffic Considerations

Where the facility will be maintained open to traffic, it is good construction practice for the installation of rail sections to closely follow the installation of guardrail posts. At the end of the workday, check to ensure that the termini of exposed rail sections are treated as specified. Where required due to project phasing, check for compliance of the installation of temporary guardrail. Pay particular attention to the type of system and end treatments required and the timing of installation and removal as the project progresses. If temporary guardrail components will be used in a permanent installation, the materials must be inspected and approved by the Resident Construction Engineer prior to use.

805.3.2 <u>Removal, Resetting, Replacement and Adjustment</u>

SCDOT Contracts frequently specify work involving the removal, resetting, replacement and adjustment of guardrail. When such work is specified, ensure that the guardrail components are handled and, as specified, stored without damage. Storage of materials must be on dunnage behind an existing roadside barrier or beyond the clear zone. Check the Special Provisions for the disposition of the guardrail with respect to ownership of salvageable materials. Pay particular attention to damage and require galvanization to be repaired as specified. Such work should be completed on a day-to-day basis so that areas requiring guardrail will not be left exposed overnight. Where guardrail adjustment is specified, verify that the rail sections are removed and the blockout assembly adjusted to raise the rail sections to the proper height. Pay particular attention to adjustment requirements at bridge rail transitions. Verify that the area underneath the adjusted guardrail is properly backfilled, graded and compacted.

805.3.3 Temporary Concrete Barrier

Temporary concrete barrier will be precast units placed as designated or directed for roadside and median applications. At transitions, check the installation of connection hardware for compliance. Check the face of the barrier in the longitudinal direction and have sections corrected that are out of tolerance. If temporary concrete median is used on existing bridge deck and the parapet wall is not in place, then the temporary barrier must be bolted to the bridge deck. See the *Standard Drawings* for details. Ensure proper placement of delineators and reflectors as per the *Standard Drawings*. This barrier must meet NCHRP Report 350 requirements and be supplied from a manufacturer listed on SCDOT Approval Sheet 54.

805.3.4 Permanent Concrete Barrier

If permanent concrete median barrier is to be precast, it will be specified. If precast is not specified, the Contractor has the option of using either the slip-form or cast-in-place method. See Section 701, Section 702 and the *Standard Drawings* for inspection guidance on forming methods, placement of reinforcing steel and placement and finishing of concrete using slip-form and cast-in-place methods. Prior to concrete placement, perform survey spot checks on the alignment and height of barrier as discussed in Section 105.8. Where concrete median barrier will be placed directly on the pavement, check drill holes and grouting and placement of dowels for compliance.

805.4 POST-CONSTRUCTION CONSIDERATIONS

At the end of each work day, check the site to ensure that guardrail sections and termini are not left exposed and are treated as specified in the Contract. Materials stored on site must be placed on dunnage behind protective barrier or beyond the clear zone. Final approval of guardrail systems, end treatments and concrete barrier is the responsibility of the Resident Construction Engineer.

805.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

New installation, removal, resetting and adjustment of permanent and temporary guardrail and barrier wall, as accepted by the Resident Construction Engineer, will be measured by length, including transitions and terminal sections, for the type of work and system designated in the Contract. End anchors and bridge end connections will be measured by the number actually placed and accepted. Pay particular attention to documenting measurements for additional lengths of posts. Document measurements for payment in the Daily Work Report. The locations of the systems installed should be noted in relation to the survey station number. Payment will be made at the Contact unit price for the type of system placed and accepted. As needed, check material delivery tickets for accuracy (i.e., project, material, date, quantity). Field notes, a copy of all certifications and delivery tickets will be retained by the Resident Construction Engineer. A copy of certifications will be forwarded to the Research and Materials Engineer.

Section 806
Fence

806.1 DESCRIPTION OF WORK

It is SCDOT policy to reset existing fence that is within the Construction Lines on the Contract Plans. As such, new fence is not normally constructed, unless otherwise directed or specified in the Right-of-Way Special Provisions. It may be necessary, however, to erect new fence before existing fence is removed. Fence that is constructed for the purpose of controlling highway access will be placed on SCDOT right-of-way. Fence used for other applications will be placed off right-of-way on adjacent property, after which it will become the property of the landowner. The types of fence typically installed or reset include woven wire, barbed wire and chain-link fence. Strands of barbed wire are often used in conjunction with woven wire and chain-link fences. Where designated, the Roadway Inspector will be responsible for verifying that the work and materials conform to the requirements specified in the Contract Plans and Specifications.

806.2 PRECONSTRUCTION CONSIDERATIONS

Review the Contract Plans and Specifications to understand the location, extent and the type of fences and gates required for the project. Treated wood posts and braces used in fencing applications are pre-inspected by an approved Independent Inspection Agency. Verify that each treated wood member bears the Agency's hammer mark of approval; accept no members without this mark. Additionally, when using more than 300 posts, obtain and forward to the Research and Materials Engineer a copy of the Agency's Inspection Report and Certificate of Compliance. Check lengths and dimensions for compliance. Do not permit field cutting of treated wood, unless pre-approved by the Resident Construction Engineer. Check compliance of steel posts, braces and miscellaneous hardware with respect to size, shape, dimension and weight per unit length, as appropriate. Check woven wire, barbed wire and chain-link fabric for compliance with respect to type, coating, wire gage and mesh dimensions, as appropriate. Pay particular attention to any coating damage and require repairs in accordance with the provisions of the Contract. Ensure that the required samples of wire, fabric, hardware and concrete are sampled and tested for compliance in accordance with the Quality Control Samples and Tests presented in Section 106.

806.3 INSPECTION DURING CONSTRUCTION

Check staking to ensure that the fence is properly located with respect to the right-of-way. Verify that the area where the fence is to be placed has been properly cleared and grubbed and that obstructions have been removed and properly disposed of. The grade at the bottom of the fence should follow the contour of the ground without touching or creating excessive gaps. Verify compliance with minimum requirements for depth of post holes and spacing of posts. Where posts are hand placed and backfilled with earth material, the hole should be of adequate size to allow compaction of the backfill material. Proper hand tamps should be used. Use of makeshift tamps should be discouraged. Pay attention to fence crossing low, swampy areas. Extra-length posts may be required by the Resident Construction Engineer. Where concrete is used to set posts, do not allow the fabric to be attached to the posts until the specified curing period has elapsed. Verify that the fabric is placed on the side of the post facing the pavement, stretched taut and securely fastened. Splicing between posts is undesirable and should be avoided. Check for compliance of the installation of any gates that may be designated on the Contract Plans.

806.4 POST-CONSTRUCTION CONSIDERATIONS

Inspect the completed fence by walking along the fence and checking compliance of post size and stability, bracing, tautness and fastening of fabric. Pay attention to the number of fasteners used to attach the fabric to the posts. The finished fence should present a good appearance with the tops of the posts being on a smooth grade or curve and of uniform height above the top wire. Ensure that electrical grounds are installed where specified.

806.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The Contractor is to obtain a release from the property owner on SCDOT Form 800.01 – Agreement for Moving Items Release. Resetting and new installation of fence, as accepted by the Resident Construction Engineer, will be measured by length of the type of fence designated in the Contract. Gates will be measured by the number actually placed and accepted. Pay attention to documenting measurements for additional lengths of posts. Document measurements for payment in the Daily Work Report. The locations of fence reset or installed should be noted in relation to the survey station number. Payment will be made at the Contract unit price for the type of fence placed and accepted. Field notes and copies of certifications will be retained by the Resident Construction Engineer. Copies of certifications will be forwarded to the Research and Materials Engineer.

Section 807
Reset Fence

The Contractor is to obtain a release from the property owner on SCDOT Form 800.01 – Agreement for Moving Items Release. Where reset fence is specified, the Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the fence is reset in accordance with the Contract Plans and Specifications. Pay attention to the disposition and ownership of the material, as specified in the Special Provisions of the Contract, and ensure that the material is properly stored for reuse without damage. See Section 806 for additional guidance.

Section 808
Relocation of Structures and Other Items
(Moving Items)

808.1 DESCRIPTION OF WORK

Where pay items under Section 808 of the *Standard Specifications* are specified in the Contract, they will be specified for the purpose of relocating miscellaneous structures and other items that will be affected by the project but are required by the property owner to be carefully salvaged and relocated by the Contractor. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the work and any new materials required are in conformance with the requirements of the Contract Plans and Specifications.

808.2 PRECONSTRUCTION CONSIDERATIONS

Carefully review the Contract Plans and Specifications, including the Right-of-Way Special Provisions, to ensure a complete understanding of the work to be performed. The Resident Construction Engineer should meet with the Contractor and the property owner prior to the work to ensure that all requirements of the work and the new location for the items to be moved are fully understood by all parties. The Resident Construction Engineer will be responsible for assessing damage and suitability of the materials salvaged during the work. See Section 720 where concrete driveways and walkways need to be constructed to replace existing drives and walkways. Any new materials such as brick or block will be sampled and tested in accordance with the Quality Control Samples and Tests presented in Section 106. The Research and Materials Engineer will verify that the proper type of masonry cement is being used. Inspect masonry cement to ensure that it has not been contaminated by moisture.

808.3 INSPECTION DURING CONSTRUCTION

During dismantling, removal and relocation ensure that the work is performed in accordance with the requirements of Section 808 of the *Standard Specifications* and any applicable Special Provisions of the Contract.

808.4 POST-CONSTRUCTION CONSIDERATIONS

Inspect the relocated items with the property owner to ensure completeness and satisfaction, and obtain a signed release from the property owner on SCDOT Form 800.01 – Agreement for Moving Items Release. The release should be signed by the property owner, two witnesses and the Resident Construction Engineer. The Contractor is responsible for obtaining this release.

808.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The work for dismantling, removing and relocating items will be measured and paid for on a lump sum basis for each item scheduled in the Contract. Field notes should be documented in the Daily Work Report. Payment should not be made for a relocated item until the signed release has been obtained from the Contractor.

Section 809
Right-of-Way Markers

809.1 DESCRIPTION OF WORK

Right-of-way markers are intended primarily to serve as a means of establishing or reestablishing SCDOT right-of-way lines and will be installed or reset on rural and controlled access facilities at the following locations:

- at break points in right-of-way lines;
- at points on the right-of-way line opposite points of curvature control (e.g., PC, PT);
- at points along the right-of-way line that maintain forward and back line-of-sight;
- in rural areas at a maximum spacing along a continuous right-of-way line of 1400 feet on tangents and 700 feet on curves; and
- in urban areas at a maximum spacing along a continuous right of way line of 500 feet on both tangents and curves.

Ideally, right-of-way markers should not be placed at points that are common to property lines or corners.

809.2 PRECONSTRUCTION CONSIDERATIONS

Ensure that reinforced concrete right-of-way markers are provided by a supplier listed on SCDOT Approval Sheet 16. Rebar cap right-of-way markers must meet the requirements of the *Standard Specifications*.

809.3 INSPECTION DURING CONSTRUCTION

Verify that right-of-way markers are installed in accordance with the construction and installation details provided in the Contract Plans and Specifications. Check to ensure the Contractor is set up to place the right-of-way marker in the correct position when the tack point is removed. Right-of-way markers should be installed plumb with the center of the marker placed on the right-of-way line and the hole well compacted.

809.4 POST-CONSTRUCTION CONSIDERATIONS

The Resident Construction Engineer is responsible for final approval of the location and installation of all right-of-way markers.

809.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The installation or resetting of right-of-way markers will be measured and paid for by the number of markers installed or reset and accepted. Document the measurements in the Daily Work Report. The field notes should indicate the survey station number at which the marker is located, location in relation to the left or right of centerline and the distance from the centerline to the right-of-way markers. Payment will be made at the Contract unit price.

Section 810
Seeding

810.1 DESCRIPTION OF WORK

When pay items under Section 810 of the *Standard Specifications* are specified in the Contract, the seeding will be for the purpose of establishing a vegetative root system to prevent erosion on a temporary or permanent basis. This work must be carefully coordinated with earthwork operations on cut and fill slopes and generally consists of preparing the seedbed and applying seed, fertilizer, lime, mulch and nitrogen, as specified. Note that the type of seed and the application of materials differ based on the location within the State and the type of seeding to be performed (i.e., temporary or permanent). The Resident Construction Engineer and the Roadway Inspectors will be responsible for ensuring that the work and materials are in conformance with the requirements specified in the Contract.

810.2 PRECONSTRUCTION CONSIDERATIONS

810.2.1 Contract Plans and Specifications

Carefully review the Contract Plans and Specifications, including Special Provisions, for the areas requiring temporary and permanent seeding, the type of seed required, the application rate of materials and the allowable time of placement, as specified in the seeding schedule. Measure the areas to be seeded prior to treatment for use in checking compliance of the application rate of lime, fertilizer, seed and other materials.

810.2.2 Agricultural Soil Testing

During construction, isolated areas of problematic soil conditions may be encountered. This may become visually evident after rough grading operations are completed, where the soil types in the area will be exposed and can be identified by color and texture. If a soil type is suspected to be problematic in developing seed growth using the specified seeding schedule, based on previous experience, the Contractor may desire to have the soil tested to determine if the seeding schedule needs to be adjusted.

If the recommendations of the Soil Testing Program indicate a change is required to the specified seeding schedule, the Resident Construction Engineer will be responsible for assessing SCDOT concurrence, approval and the need for a Change Order. In addition, the application of organic topsoil may be required.

810.2.3 Materials Considerations

810.2.3.1 Seed

Seed is controlled statewide by the South Carolina Department of Agriculture, as described in the publication *South Carolina Seed Law and Noxious Weeds and Plants - Rules and Regulations*. As such, with respect to use on SCDOT projects, seed is considered pre-tested and will be accepted based on the official approval tag attached to the seed bag, which shows seed name, net weight, origin, laboratory number of testing agency, date of testing, Lot Number, percent germination and purity (i.e., inert matter, weed seed, crop seed) and the name and number per one hundred of noxious weed seed. For each bag of seed delivered to the project, verify the data on the tag for compliance.

810.2.3.2 Fertilizer, Agricultural Lime and Nitrogen

Fertilizer and agricultural lime are controlled through testing by other State agencies. Mixed fertilizer is designated by percent nitrogen-percent phosphoric acid-percent potash, such as 10-10-10. It will not be necessary to obtain samples of fertilizer or agricultural lime; however, the Resident Construction Engineer should inspect shipments received at the project site to ensure that the specified type of fertilizer is being used, that the lime has the required tags or labels affixed and that the material is not damaged or contaminated. Where lime is delivered in bulk, obtain the delivery tickets. Lime and nitrogen are generally not required for temporary seeding.

810.2.3.3 Mulch and Tackifiers

Ensure that the tackifier material (e.g., emulsified asphalt, chemical tackifier) complies with the Contract Specifications or subsection 810.08 of the *Standard Specifications*, as appropriate, and is approved for use by the Resident Construction Engineer. Check compliance of straw mulch where used on the project. Straw mulch must comply with all State and Federal domestic plant quarantine regulations. Wood and cellulose fiber hydroseeding mulch and mulch mixtures are specifically manufactured to be dispersed by hydraulic methods. Mulch and tackifiers are generally not required for temporary seeding.

810.3 INSPECTION DURING CONSTRUCTION

810.3.1 Preparation of Seedbed

The preparation of a good seedbed is the most important factor in the development of vegetative cover. The seedbed is the place where seeds germinate and the medium from which the resulting plants, through their roots, secure moisture and mineral nutrients. It is desirable, therefore that the seedbed be in such condition as to furnish an abundance of moisture, nutrients, air and allow full penetration of plant roots. A well-prepared seedbed is firm beneath, loose and open on the surface and free from clods. Soil in this condition warms readily, holds more water and nutrients in an available form, allows free water and air movement, is favorable for the activity of soil organisms and thereby produces better growth. Where hard and compacted soil exists, the soil should be loosened to promote root growth. The Contractor should be encouraged to prepare the seedbed deeper than the specified minimum 3-inch depth on flat areas and gentle slopes. On high steep slopes (i.e., 2:1 or steeper), seedbed preparation is critical; and, under these conditions, the surface must be broken and small pockets, trenches or ridges and serrations provided to lodge the seed. Enforce these provisions, because some contractors attempt to avoid such treatment on steep cut slopes. It is important that the soil be worked when moisture conditions are normal. If the soil is saturated, any attempt to prepare a seedbed will cause the seedbed to become very cloddy. Also, verify that the Contractor removes rocks and debris from the seedbed, as specified. After the seedbed has been prepared, vehicular traffic on the seedbed should be minimal to prevent recompaction. This can be accomplished by tracking the slope vertically.

810.3.2 Placement of Select Material on Slopes

The Contract Plans may require that select material be placed on cut and fill slopes. Where select material is to be placed on such areas, cut slopes should be scarified so that the material will have something to bond with. If select material is placed on the slope without proper scarification, much of the select material could be lost due to erosion during periods of even moderate rainfall. As soon as practicable after the select material has been placed on the slopes, seeding should begin.

810.3.3 Application of Lime and Fertilizer

Soils in South Carolina are generally acidic and lime is added to improve this condition. Lime corrects soil acidity, increases the availability of minerals in the soil, improves the physical condition of the soil and increases the efficiency of fertilizer materials. To achieve the most efficient use of lime, it must be applied at the specified rate during preparation of the seedbed. The rate may be adjusted based on the results of soil testing. The lime should be thoroughly mixed and incorporated into the seedbed to the depth of seedbed preparation. Check the application rate of lime and fertilizer for compliance.

810.3.4 Application of Seed

Seeding schedules typically require the use of more than one type of seed. The quantity of each type of seed should be weighed and mixed in the presence of the Roadway Inspector. The seed should be thoroughly mixed before it is placed into mechanical spreaders. However, where hydroseeders are used, the seed proportions may be separately introduced and continuously mixed by the mixing blades throughout the hydroseeding operation. Where hydroseeders are used, the seed should be mixed only for the quantity necessary to treat 1 to 2 acres at a time. Caution should be exercised to avoid using hydroseeders during high wind conditions, which may cause a concentration of seed on lower areas and poor distribution on the top of slopes. Seed should not remain in the fertilizer slurry for a period over 30 minutes, because the fertilizer may decrease the percent germination. In flat areas, such as median strips, shoulders and interchanges, drills or cultipackers must be used, because these methods provide superior results on level terrain. Seed that is allowed to germinate on top of the ground or in air pockets under the ground will result in poor root development or death of the young seedlings. Therefore, after seeding, ensure that the seed is covered and lightly compacted into the soil. Compaction can be achieved using cultipackers, light rollers and soil pulverizers.

Covering seed to the proper depth (approximately 0.25 inch) will greatly aid in seedling emergence and will provide quick erosion control.

810.3.5 Application of Mulch and Tackifier

Know the methods of seeding with and without mulch and verify that the application of these treatments are performed as specified and in the locations requiring such treatments. The use of mulch, when applied at the proper rate, helps to prevent erosion, conserves moisture and regulates soil temperature. If the mulch is applied too light, excess soil erosion or drying may occur under abnormally wet or dry weather conditions. If applied too heavily, the blanket of mulch will prevent sunlight from reaching the seedlings, which may weaken or kill the seedlings. A tackifier, which is sprayed over the mulch, is used to bond the mulch together to prevent it from being blown away by wind or eroded by water. Where tackifier is applied, with or without mulch, care should be taken to avoid heavy application. Doing so will likely kill the seed and prevent additional fertilizer from reaching the seed. Verify that the tackifier is applied at the specified rate and is not oversprayed on private property, bridges, curbs, sidewalks ends of box culverts and other areas. Require the Contractor to clean such areas.

810.3.6 Application of Additional Fertilizer and Nitrogen

Small frequent applications of fertilizer are superior to a large bulk application and greatly assists in establishing seed growth. Complete fertilizers or nitrogen top-dressing should never be applied when plants are going into a dormant stage. A good rule is to apply fertilizer or nitrogen while the grass or plants are coming out of winter dormancy or while actively growing. The Roadway Inspector should be on site to ascertain the application rate and to ensure that a uniform rate of coverage is obtained.

810.4 POST-CONSTRUCTION CONSIDERATIONS

The Roadway Inspector should monitor seeded areas to ensure that the grass is growing and to identify any areas that are in need of fertilizer, nitrogen, additional mulch or overseeding. Verify that mowing is being performed as specified. The Resident Construction Engineer will be responsible for assessing the acceptability of the stand of grass (i.e., 70% density). 70% density is defined as looking at a square yard of coverage, in which 70% of that square yard is covered with vegetation.

810.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Seeding and each mowing operation will be measured by the surface area actually treated and accepted. Fertilizer, lime and nitrogen will be measured by the weight of material actually placed and accepted, based on certified delivery tickets or manufacturer’s tags. Acceptance is based on the application rates, as approved by the Resident Construction Engineer. Payment will be based on the Contract unit price. Retain the Contractor’s invoices, delivery tickets and manufacturer’s tags of materials received on the project, and document all area and application rate calculations in the Daily Work Report. This information will be retained by the Resident Construction Engineer.

Section 811
Planting Trees, Shrubs, Vines and Groundcover

811.1 DESCRIPTION OF WORK

To establish or re-establish vegetation for the purpose of erosion control or highway beautification, pay items under Section 811 of the *Standard Specifications* are frequently specified on SCDOT construction projects. In general, the work will consist of furnishing, delivering and planting trees, shrubs, vines and groundcover of the type and size indicated on the Contract Plans or as stated in the Special Provisions. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the work and material are in compliance with the requirements of the Contract Plans and Specifications.

811.2 PRECONSTRUCTION CONSIDERATIONS

Review the Contract Plans and Specifications to understand the types, sizes and locations of vegetation to be provided. Plants delivered for this work will be accepted based on the Certificates of Compliance from the supply source. Check and retain these Certificates of Compliance and ensure that the plants are of the type, size and diameter required by the Contract Plans. Inspect root balls and the condition of the plants for acceptability upon delivery, just before planting, during planting and after planting. The plants must be free from disease, pests and damage and must be maintained in a moist and lively condition. Substitutions will require approval by the Resident Construction Engineer and may require a Change Order. Many other materials will be required for this type of work, including topsoil, fertilizer, lime, superphosphate, mulch, water, stakes for bracing and anchoring, weed control cloth, porous material for tree root protection and pipe for underdrains. Ensure that these materials comply with specified requirements. See Section 810.2.3.2 and 810.2.3.3 for additional information on fertilizer, lime and mulch materials. Verify that the planting will occur within the specified planting season specified.

811.3 INSPECTION DURING CONSTRUCTION

Prior to allowing holes to be dug, check for proper clearing, grubbing and grading and that the Contractor's stakes are in the correct locations for the plants to be installed. Pay particular attention to any locations that may encroach the right-of-way line or the roadway. Check the root balls of the plants for acceptability. Verify that the holes are dug to specified dimensions and properly prepared. Verify the proper preparation of backfill soil and that the roots are spread prior to backfilling. Verify the planting procedure used for the type of plant being installed. Ensure that trees are planted straight, properly braced and guyed and wrapped, as specified. Top pruning may be required. Where designated or directed, check compliance of retaining walls, tree-wells and pipe underdrains. Check for proper mulching. Verify that trees and shrubs are properly transplanted, where designated.

811.4 POST-CONSTRUCTION CONSIDERATIONS

Inspect the Contractor's workmanship within 15 days after final cleanup. Perform the final inspection at the end of the specified establishment period to determine the plants, if any, that need to be rejected or replaced. Ensure that rejected plants are properly replaced and enforce the provisions of the Contract with respect to maintenance.

811.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Plants and trees will be measured by the number installed and accepted, as designated on the Contract Plans excluding replacements, and paid for based on the progress schedule specified in the Contract. Porous material for root protection will be measured by weight and drain tile and underdrain pipe will be measured by length of material placed and accepted. All other related work and materials will be included in the Contract unit price for the pay item. Document the measurements on the Daily Work Report. The Resident Construction Engineer will retain all invoices, delivery tickets, tags, labels, Certificates of Compliance and other related documents.

Section 812
Sprigging

812.1 DESCRIPTION OF WORK

To establish or re-establish vegetation for the purpose of erosion control or highway beautification, pay items under Section 812 of the *Standard Specifications* are frequently specified on SCDOT construction projects. In general, the work will consist of furnishing and planting sprigs of live grass on slopes and shoulders and other areas where designated on the Contract Plans or as stated in the Special Provisions. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the work and material are in compliance with the requirements of the Contract Plans and Specifications.

812.2 PRECONSTRUCTION CONSIDERATIONS

812.2.1 Contract Plans and Specifications

Carefully review the Contract Plans and Specifications, including Special Provisions, for the areas requiring sprigging, the application rate of materials and the allowable time of placement. Measure the areas to be sprigged prior to treatment for use in checking compliance of the application rate of lime and fertilizer.

812.2.2 Soils Testing

See Section 810.2.2 for information on soils testing. Topsoil may be required.

812.2.3 Materials Considerations

Check for compliance of the sprig harvesting operation and the sprigs that are delivered to the project. Reject those that do not comply with specified requirements. See Section 810.2.3.2 for information on fertilizer and lime.

812.3 INSPECTION DURING CONSTRUCTION

Verify compliance of the preparation of the areas to be sprigged (see Section 810.3.1). Ensure that the application rate of fertilizer and lime meets specified requirements. Ensure the sprigs are maintained in a healthy condition during the operation. Check for the proper planting of sprigs.

812.4 POST-CONSTRUCTION CONSIDERATIONS

The Roadway Inspector should monitor sprigged areas to ensure that the grass is growing and to identify any areas that are in need of fertilizer, nitrogen or re-sprigging. Verify that mowing is being performed as specified. The Resident Construction Engineer will be responsible for assessing the acceptability of the stand of grass (i.e., 70% density of each square yard).

812.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Sprigging and each mowing operation will be measured by the surface area actually treated and accepted. Fertilizer, lime and nitrogen will be measured by the weight of material actually placed and accepted, based on certified delivery tickets or manufacturer's tags. Topsoil will be measured by the volume of material delivered, placed and accepted. Acceptance is based on the application rates, as approved by the Resident Construction Engineer. Payment will be based on the Contract unit price. Retain the Contractor's invoices, delivery tickets and manufacturer's tags of materials received on the project, and document all area and application rate calculations in the Daily Work Report. This information will be retained by the Resident Construction Engineer.

Section 813
Sodding

813.1 DESCRIPTION OF WORK

To establish or re-establish vegetation for the purpose of erosion control or highway beautification, pay items under Section 813 of the *Standard Specifications* are frequently specified on SCDOT construction projects. In general, the work will consist of furnishing and laying sod on slopes and shoulders and other areas where designated on the Contract Plans or as stated in the Special Provisions. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the work and material are in compliance with the requirements of the Contract Plans and Specifications.

813.2 PRECONSTRUCTION CONSIDERATIONS

813.2.1 Contract Plans and Specifications

Carefully review the Contract Plans and Specifications, including Special Provisions, for the areas requiring sodding, the application rate of materials and the allowable time of placement. Measure the areas to be sodded prior to treatment for use in checking compliance of the application rate of lime and fertilizer.

813.2.2 Agricultural Soils Testing

See Section 810.2.2 for information on soils testing. Topsoil may be required.

813.2.3 Materials Considerations

Check for compliance of the sod that is delivered to the project. Reject sod that does not comply with specified requirements. See Section 810.2.3.2 for information on fertilizer and lime.

813.3 INSPECTION DURING CONSTRUCTION

Verify compliance of the preparation of the areas to be sodded (see Section 810.3.1). Ensure that the application rate of fertilizer and lime meets specified requirements. Ensure that the sod is maintained in a healthy condition during the operation. Check for the proper placement of sod. After sodding, verify the proper rolling of the sod.

813.4 POST-CONSTRUCTION CONSIDERATIONS

The Roadway Inspector should monitor sodded areas to ensure that the grass is growing and to identify any areas that are in need of fertilizer, nitrogen or re-sodding. Verify that mowing is being performed as specified. The Resident Construction Engineer will be responsible for assessing the acceptability of the stand of grass (i.e., 70% density of each square yard).

813.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Sodding and each mowing operation will be measured by the surface area actually treated and accepted. Fertilizer, lime and nitrogen will be measured by the weight of material actually placed and accepted, based on certified delivery tickets or manufacturer's tags. Topsoil will be measured by the volume of material delivered, placed and accepted. Acceptance is based on the application rates, as approved by the Resident Construction Engineer. Payment will be based on the Contract unit price. Retain the Contractor's invoices, delivery tickets and manufacturer's tags of materials received on the project, and document all area and application rate calculations in the Daily Work Report. This information will be retained by the Resident Construction Engineer.

Section 814
Waterproofing

814.1 DESCRIPTION OF WORK

Waterproofing is typically specified for the waterproofing or dampproofing of concrete surfaces. Two methods of substructure waterproofing are generally used. The first is used to protect bents, piers, abutments and other structures constructed in salt water, excluding prestressed concrete piles. The second is used to protect the inside of spandrel-filled arches, backs of abutments and retaining walls. Bridge deck waterproofing is sometimes used before placing an HMA overlay to serve as a barrier against penetration of water, salt solution and other contaminants that can deteriorate bridge deck concrete. When specified, the Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring compliance with the requirements of the Contract Plans and Specifications.

814.2 PRECONSTRUCTION CONSIDERATIONS

For substructure waterproofing, acceptance of the materials will be based on the manufacturer's certification, so no samples will be necessary. Refer to Section 814 of the *Standard Specifications* for the applicable AASHTO or ASTM standards for which the material must be certified. Verify proper storage of fabric. Inspection upon delivery of materials may require representative check samples to be tested. For bridge deck or pavement waterproofing, approved materials suppliers are listed on SCDOT Approval Sheet 9 and SCDOT Approval Sheet 10 for pavement and bridge decks, respectively. The Contractor should provide manufacturer certifications indicating that these materials are approved for SCDOT work and the Resident Construction Engineer should check to ensure that the materials provided are the same as those listed on the applicable Approval Sheets.

814.3 INSPECTION DURING CONSTRUCTION

During waterproofing, check the application rate and number of coats for compliance. In the first method described in Section 814 of the *Standard Specifications*, the concrete surfaces to be waterproofed must be water-cured for the specified period. The use of curing compound is not permitted. The surface will be allowed to dry for the specified period. The surface then will receive a number of coats of tar primer, as specified, and allowed to absorb. A tar seal coat will then be applied, as specified, and allowed to dry for the specified period. Water or earth will then be allowed to come into contact with the treated surface. In the second method, the surface must be dry and free of irregularities that could puncture the membrane. The surface then will be cleaned of dust and loose materials. A thorough coat of asphalt primer will be applied and allow to set. Then, three asphalt mop coats and two layers of fabric will be applied, alternating mop coat and fabric. Check for proper lapping when specified.

814.4 POST-CONSTRUCTION CONSIDERATIONS

Check for damage to the waterproofing and enforce the provisions of the Contract with respect to any needed repairs. Acceptance will be based on final approval of the Resident Construction Engineer.

814.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The first method specified for substructure waterproofing will not be measured separately for payment. Otherwise, waterproofing will be measured by the area actually treated and accepted. Document area measurements in the Daily Work Report. Payment will be based on the Contract unit price for the type of waterproofing specified. The Resident Construction Engineer will retain copies of all manufacturer certifications. Copies of certifications should be sent to the Research and Materials Engineer.

Section 815
Erosion Control

815.1 DESCRIPTION OF WORK

Erosion is a natural process whereby soil materials are detached, transported and then deposited from one location to another by the action of water, wind, ice and gravity. Erosion can take the form of sheet erosion, rill erosion, gully erosion and channel erosion. The erosion potential of any area is determined by interrelated factors, including soil characteristics, vegetative cover, topography and climate. Highway construction projects disturb large areas of natural vegetation that can accelerate the rate of erosion and cause unwanted sediment to be deposited into adjacent waterways. As such, erosion and sediment control is required on all SCDOT construction projects. All projects with 1 acre or more disturbed area are governed under the provisions of the NPDES permit. The primary legal reference is the Erosion and Sediment Reduction Act of 1983 (SC Code Annotated, Section 48-18-10, et. seq.). In compliance with this Act, SCDOT requires that all land disturbing activities under the jurisdiction of SCDOT will be performed in such a manner that erosion is controlled and sediment is retained on-site to the maximum extent feasible, and stormwater is managed in such a manner that neither any significant on-site nor off-site damage or problem will be caused or increased.

Stormwater run-off, erosion and sediment will be controlled so that off-site run-off will pass directly across the construction site through appropriate drainage structures and on-site drainage will be retained on-site until it has been properly treated before it is released. If run-off will be released from any disturbed areas in a concentrated form, such as at the outlet from a median drain or ditch, the area downstream will be assessed during project development for environmental sensitivity. Environmentally sensitive areas are defined as regulated wetlands and areas where the deposition of sediment would deprive a property owner of the intended use of the land or cause significant financial loss to the property. If the downstream area is environmentally sensitive, the Contract will specify the need for mitigation. See Section 107.26 for additional information on environmental protection and water pollution control.

815.2 PRECONSTRUCTION CONSIDERATIONS

815.2.1 Stormwater Pollution Prevention Plan (BMPs for Water Quality Control)

At the Preconstruction Conference, the Contractor is required to submit SCDOT Form 100.15 – Stormwater and Pollution Prevention Plan for Highway Construction. This plan will include detailed half-size plans that define the Best Management Practices (BMPs) required for water quality control by type and project survey station. BMPs are schedules of activities, prohibitions and practices that are employed to control erosion and sediment and to minimize pollution of stormwater run-off and receiving waters both during and after construction. BMPs may be categorized as follows:

1. Soil Stabilization Practices. Soil stabilization practices (e.g., seeding, mulching, sodding) are temporary or permanent treatments that stabilize and protect exposed earthen surfaces from erosion due to rainfall, overland flow and runoff.

2. Structural Practices. Structural practices (e.g., silt fences, check dams, silt basins) are temporary or permanent treatments that protect soil surfaces from erosion by interrupting, diverting and storing water runoff.

3. Pollution Mitigation Practices. Pollution mitigation practices are used to protect receiving waters from pollutants other than sediments due to erosion (e.g., material spill prevention, waste disposal practices).

If the affected area is less than 1 acre, the Stormwater Pollution Prevention Plan (SWPPP) will be reviewed by the Resident Construction Engineer and forwarded to the District Engineering Administrator for signature approval. If the affected area is 1 acre or greater, the SWPPP will be reviewed by the Resident Construction Engineer and forwarded to the Director of Construction, through the District Engineering Administrator, for signature approval. The importance of verifying the proper installation of BMPs and inspecting these facilities for operational compliance cannot be overemphasized. The governing provisions of the NPDES permit require the scheduled inspection of these facilities. Check the Special Provisions of the Contract. A copy of the SWPPP needs to be maintained at the Resident Construction Engineer's office. If the project warrants a construction trailer, the SWPPP must be maintained at the project site. The SWPPP needs to be updated as erosion control measures are changed.

815.2.2 Notice of Intent (NOI)

SCDOT Form 100.16 – Notice of Intent must be completed for any project in which 1 acre of land or greater will be disturbed. The Notice of Intent will be completed by the Resident Construction Engineer and submitted to the District Engineering Administrator for signature approval. Once signed by the District Engineering Administrator, a signed copy will be returned to the Resident Construction Engineer for filing. The District Engineering Administrator will forward the Notice of Intent to SCDHEC at least 48 hours prior to the start of work. A signed copy of the Notice of Intent should be kept at the Resident Construction Engineer's office. If the project warrants a construction trailer, the Notice of Intent must be maintained at the project site.

815.2.3 Notice of Termination

SCDOT Form 100.17 – Notice of Termination must be prepared at the completion and acceptance of any project in which 1 acre of land or greater was disturbed. The Notice of Termination will be completed by the Resident Construction Engineer and submitted to the District Engineering Administrator for signature approval. Once signed by the District Engineering Administrator, a signed copy will be returned to the Resident Construction Engineer for filing. The District Engineering Administrator will forward the Notice of Termination to SCDHEC.

815.2.4 NPDES Areas

815.2.4.1 Purpose and Location of NPDES Areas

NPDES areas on the Contract Plans are designated for the construction and maintenance of erosion and sediment control and stormwater run-off management features. NPDES areas can and frequently extend not only beyond the construction lines but also the project right-of-way lines. Where warranted, NPDES areas for temporary features may be located off project right-of-way on adjacent property, as permitted through a landowner agreement. NPDES areas for permanent features must be maintained after completion of the project and will be located on project right-of-way. Project right-of-way will also be used for both temporary and permanent sediment control basins.

815.2.4.2 NPDES Lines

The NPDES lines on the Contract Plans will designate the NPDES areas extending outside the construction lines (i.e., beyond the cut/fill slope line) on the Contract Plans. The Contract Plans will also include offset distances at each station from the construction centerline to the NPDES line, as measured at right angles from the centerline. NPDES lines will be designated on the Contract Plans as shown in Figure 815A.

– – – – – NPDES – – – – – NPDES – – – – – NPDES – – – – –

SYMBOL FOR NPDES LINES ON CONTRACT PLANS
Figure 815A

815.2.4.3 Treatment of NPDES Areas

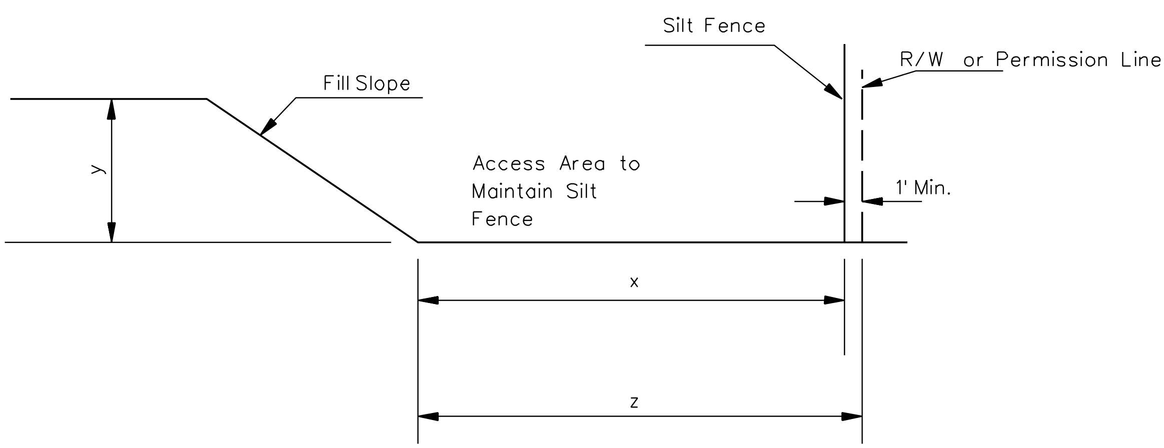
During construction, treatment of NPDES areas will be as follows:

1. Clearing and Grubbing. All NPDES areas require clearing and grubbing. See Section 201 for additional information on clearing and grubbing.

2. Seeding. All NPDES areas require seeding during construction. Use the normal seeding schedule for all permanent NPDES features. For seeding of NPDES areas on adjacent properties, use the temporary seeding schedule at the time of installation and the permanent seeding schedule during land reclamation. Measure and pay for this work based on the seeding schedules specified in the Contract. See Section 810 for additional information on seeding.

3. Reclamation. The quantity of soil for regrading NPDES areas to be reclaimed will be included in the total quantity for silt basins. The work for removing and disposing of appurtenances for temporary sediment control basins (e.g., rip rap, pipe, anti-seep collars, fence, gate) will be included in its respective pay item.

FILL HEIGHT (y – feet)	FILL SLOPE	MINIMUM OFFSET FROM TOE OF FILL SLOPE	
		Silt Fence (x – feet)	**Right-of-Way (z – feet)**
<6	2:1 4:1 6:1	2	3
6-10	2:1	12	13
	4:1 6:1	3	4
>10	2:1	12	13
	4:1 6:1	4	5



MINIMUM OFFSET OF SILT FENCE FROM TOE OF FILL SLOPE
Figure 815B

4. Silt Fence. Verify that all required silt fence is installed beyond the toe of fill slopes as shown in Figure 815B. The area between the NPDES line and the toe will be cleared and grubbed and seeded using the temporary seeding schedule. The area between the toe and the silt fence is needed to accommodate equipment necessary to remove sediment collected by the silt fence and basins. Where this area cannot be obtained, maintenance will be performed using some other practical means. Ensure that silt fence is cleaned or replaced as needed and silt basins are cleaned when they are half full.

815.2.5 Materials Considerations

815.2.5.1 Geotextile Fabric for Silt Fence and Filter Fabric

The geotextile fabric used for silt fence and filter fabric must be supplied from a source listed on SCDOT Approval Sheet 34. Obtain from the Contractor and submit to the Research and Materials Engineer for approval the manufacturer's certification for the geosynthetic material, which should include the manufacturer's name, fabric type or trade name, the project, the intended application on the project and the required test results (e.g., Minimum Average Roll Value). Verify that the material delivered to the project is labeled with the manufacturer's name, fabric type or trade name, Lot Number and the quantity of shipment. Retain these labels in the project file, referencing the information in SCDOT Form 100.10 – Materials Certification Log.

815.2.5.2 Corrugated Metal Pipe and Pipe Underdrain

The Research and Materials Laboratory does not inspect or pre-approve metal pipe culverts used for sediment dams and other types of facilities. The Resident Construction Engineer will require the Contractor to furnish Mill Test Reports, which will be forwarded to the Research and Materials Engineer for evaluation. It will not be necessary to submit samples for testing, unless the Resident Construction Engineer feels that a problem exists. See Section 802.2.1.2 for information on pipe underdrain materials used in erosion and sediment control facilities.

815.2.5.3 Seed, Fertilizer and Lime

See Section 810.2.3 for information on seed, fertilizer and lime materials used for temporary seeding.

815.2.5.4 Other Erosion and Sediment Control Materials

Many other types of materials may be specified in the Contract for use in erosion and sediment control facilities, including fiberglass and polymer roving, erosion control mats and blankets and floating turbidity barrier. Verify compliance of these materials and submit to the Research and Materials Engineer the manufacturer's certification for the materials.

815.3 INSPECTION DURING CONSTRUCTION

815.3.1 <u>Responsibilities</u>

The Resident Construction Engineer will be responsible for ensuring that the provisions of the NPDES permit are adhered to throughout the life of the project. The requirements are documented in the NPDES permit, which is a part of the Contract for each individual project. The following summarizes the key points of inspection:

- check the Contract Plans and Special Provisions for the types of control required;
- verify that all materials are certified or sampled, as required;
- determine the on-site location of each control measure;
- ensure compliance of the installation of all controls;
- use SCDOT Form 800.02 – Sediment and Erosion Control Site Inspection Report on all projects for which SWPPP is required;
- inspect the controls weekly and after each 0.5-inch rainfall event;
- perform follow-up inspections to verify compliance of deficiency corrections;
- update the half-size plans with the locations of all erosion control measures in place;
- maintain the half-size plans in the Resident Construction Engineer's office. If the project warrants a construction trailer, the plans must be maintained at the project site.

815.3.2 <u>Primary References</u>

The following sections (i.e., both this *Manual* and the *Standard Specifications*) apply to the inspection of temporary and permanent erosion and sediment controls on the project:

- Section 107.26 – Environmental Protection and Water Pollution Control,
- Section 804 – Rip Rap and Slope Protection,
- Section 810 – Seeding,
- Section 811 – Planting Trees, Shrubs, Vines and Groundcover,
- Section 812 – Sprigging,
- Section 813 – Sodding, and
- Section 816 – Sediment Control Basins and Stormwater Detention Ponds.

815.3.3 <u>Types of Erosion and Sediment Control Facilities</u>

The following provides a brief description of the most common types of facilities that are installed for the purpose of erosion and sediment control:

1. Brush Barriers. Brush barriers are occasionally used during the clearing and grubbing operation, which makes good use of the spoils of the operation.

2. Permanent Erosion Control Mats. Permanent erosion control mats consist of non-biodegradable synthetic fibers. They provide permanent reinforcement of erodible soil areas and promote the root system of grasses and vegetation. Permanent erosion control mats are used primarily on steeper slopes and ditches and in areas where germination is slow.

3. Erosion Control Blankets. Erosion control blankets generally consist of biodegradable materials such as curled wood cellulose, straw, coconut fibers or a combination of these materials. They provide temporary reinforcement of erodible soil areas prior to the establishment of vegetation. They are commonly used on cut and fill slopes.

4. Sediment Tube. The purpose of a sediment tube is to provide a flexible, lightweight and porous sediment control device that conforms to the terrain and dissipates water velocity in concentrated flow areas. The sediment tube is typically installed immediately after ditch grading and construction of catch basin boxes.

5. Silt Fence. The use of geotextile fabric for silt fence, which is a temporary erosion and sediment control measure, is common on SCDOT projects. Where designated in the Contract Plans, or as otherwise directed by the Resident Construction Engineer, the geotextile fabric will be installed in accordance with the Contract Specifications. The function of the silt fence is to remove suspended particles from surface run-off as the water passes through the geotextile fabric. The area provided between the silt fence and the toe of the slope must be wide enough to accommodate the collection and removal of the trapped sediment. Periodic removal of the trapped sediment is required and must be closely monitored during construction. See Section 815.2.4.3 and Figure 815B for additional information.

6. Silt Basins / Silt Ditches. Silt basins and silt ditches are provided to trap and retain silt on the project for later removal. Ensure that basins are cleaned when they become half full.

7. Sediment Dams / Sediment Control Basins / Stormwater Detention Ponds. These facilities are provided on a temporary or permanent basis. The primary purpose of these facilities is to intercept, trap and retain on-site water until sediment has sufficient time to settle to the bottom of the facility. These facilities require monitoring and maintenance during and, in the case of permanent facilities, after construction. Sediment control basins and stormwater detention ponds will be constructed in accordance with the requirements of Section 816 of the *Standard Specifications*.

8. Temporary Seeding. Temporary seeding is provided to establish a root system to hold the soil in place and minimize erosion. See Section 810 for additional information on temporary seeding for erosion control.

9. Wood Chips. The creation and stockpiling of wood chips from material that has been cleared and grubbed on the project is sometimes included in the Special Provisions.

The wood chips are used as an erosion control measure by spreading the material over disturbed areas.

10. Anionic Polyacrylamides (PAM). Anionic polyacrylamides are non-toxic chemicals used for controlling soil erosion and sedimentation on construction sites by acting as temporary soil binding agents. This temporary practice is intended for direct soil surface application in sites where the establishment of vegetation may not be feasible or where vegetative cover is absent or inadequate. Anionic PAM are available in emulsions, powders, gel bars or logs. The use of seed and mulch for additional erosion protection beyond the life of the anionic PAM is required.

11. Energy Dissipaters. Energy dissipaters may be used at culverts or bridges and in roadway / outfall ditches. They may be temporary or permanent and will require maintenance.

815.3.4 Temporary Facilities

Verify that the temporary facilities required by the Contract (e.g., berms, dikes, slope drains, terraces, earth rolls, sediment basins, seeding) are properly installed at the correct location and that they are operational as soon as practical. Ensure that these temporary facilities are maintained operational until the required permanent facilities are installed. Unless otherwise specified in the Contract, temporary facilities, excluding sediment control basins, fiberglass roving, silt fence, fabric for slope protection, terraces and temporary seeding, will not be measured and paid for separately, but will be included in other pay items.

815.3.5 Permanent Facilities

Verify that the permanent facilities required by the Contract (e.g., culvert pipes, terraces, gutters, asphalt curbs, permanent slope drains, rip rap, vegetation) are properly installed at the correct location and that they are installed as soon as practical without delay.

815.3.6 Additional Facilities (Unscheduled)

Watch for areas that may require installation of additional facilities, such as those with highly erodible soils. The Resident Construction Engineer may require that additional facilities be installed if the scheduled facilities are not sufficient to control erosion and sediment and manage stormwater run-off.

815.3.7 Weekly Inspections

On a weekly basis and after every 0.5-inch rainfall event, inspect each facility with a Contractor representative to ensure that it is operating and being properly maintained. Note that this is a provision of the NPDES permit. Use SCDOT Form 800.02 – Sediment and Erosion Control Site Inspection to perform this task. Note the condition of each facility, including any deficiencies and the corrective actions needed. Obtain Contractor concurrence. The Contractor is responsible for implementing corrective action for all noted deficiencies as designated on

SCDOT Form 800.02 – Sediment and Erosion Control Site Inspection. Failure to comply will be cause for the Resident Construction Engineer to issue a stop-work order until the deficiencies have been corrected, reinspected and approved.

815.3.8 Borrow Pit Excavation

When material is excavated from pits, verify that temporary and permanent erosion, sediment and stormwater run-off control facilities are installed and maintained so that sediment run-off does not enter streams, wetlands or other bodies of water. This provision applies during excavation and when the land is reclaimed. See Section 106.11 for additional information.

815.3.9 Haul Roads

Where haul roads are constructed, ensure that they are located and treated to prevent sediment from entering streams or other adjacent bodies of water. If any sediment is observed, notify the Contractor immediately. See Section 104.6 for additional information on haul roads.

815.3.10 Cut and Fill Sections

Verify that cut and fill sections are graded to the typical section without delay and that the required erosion and sediment control measures are promptly installed.

815.3.11 Drainage Profiles

Check existing and proposed drainage profiles to ensure existing drainage has not changed, proposed drainage will not flow onto adjacent property and natural drainage has not been altered to impact landowners or structures. Impacts can extend a considerable distance from the point of soil disturbance.

815.3.12 Clearing and Grubbing

Sediment basins should be used in areas of concentrated flow to capture and retain drainage before it exits the project right-of-way. To reduce the size of the basin, off-project water should not be allowed to enter the basin. Ensure that the Contractor clears areas and constructs sediment basins prior to initiating other work. Verify that silt fences are installed in areas of fill as the clearing progresses and that access is provided to maintain the fence. Ensure that a sufficient buffer is placed between the fence and the toe of the fill to retain the silt. Because silt will migrate along the fence to low areas and areas with a flat slope, ensure that silt basins are provided at these locations. Allow the Contractor to clear only a limited area. The provisions of the Contract (see Section 107.26) permit only 750,000 square feet (i.e., approximately 17 acres) to be disturbed at a time. Consider the location of the project, nature of the soil, topographic features and proximity to watercourses when imposing this restriction. Verify that steep slopes that will not be immediately graded are temporarily seeded. See Section 201 for additional information on clearing and grubbing.

815.3.13 Grading and Drainage

Ensure that the Contractor properly places and extends temporary slope drains as the construction of the embankment fill section progresses. Verify that filter structures are provided at basins located in ditches (i.e., Type 12 and 14 catch basins, drop inlets). Verify that the drainage features are efficient enough to keep the water from bypassing the basin causing erosion downstream or water to back up onto the roadway (e.g., inlet sediment filters, inlet filter pads, basin box acting as a standpipe). The Contractor should construct asphalt and concrete ditch paving as soon as practicable. Verify that permanent seeding is provided as the grading operation progresses, scheduling at regular intervals on large projects. Ensure that temporary seeding is used where needed.

815.3.14 Curb and Gutter / Valley Gutter Construction

The most effective way to mitigate sediment is by locating sediment basins at the storm drain outlets. Inlet filters should be used at the inlet of catch basins, but they must not cause water to back up into the traveled roadway. Verify that a 12-square inch opening is provided in the face of box masonry to allow the water to flow into the storm drain system as soon as practicable. Check that earth rolls are provided where necessary to direct water into the opening. Continually monitor the operation to ensure that the Contractor maintains other erosion and sediment control measures, as needed (e.g., sediment basins, silt fence, permanent and temporary seeding, filter structures). See Section 720 and Section 721 for additional information on curb and gutter construction.

815.3.15 Subbase and Base Course Construction

Verify that the Contractor maintains the 12-square inch openings provided in the faces of box masonry in curb and gutter and valley gutter sections and that the water is properly diverted into the openings with sand bags, asphalt rolls, etc. Ensure that slope drains in shoulder-ditch sections are properly maintained. Continually monitor the operation to ensure the Contractor maintains other erosion and sediment control measures, as needed (e.g., sediment basins, silt fence, permanent and temporary seeding, filter structures). See Division 300 for additional information on subbase and base courses.

815.3.16 Surface Course Construction

Check to make sure the Contractor closes up the 12-square inch openings in the curb and gutter and valley gutter sections and removes the slope drains provided in the shoulder-ditch sections. See Division 400 and Division 500 for additional information on surface course construction.

815.4 POST-CONSTRUCTION CONSIDERATIONS

After the seeding has been established and all permanent control devices are in place, verify the proper removal of silt fence and the reclamation of sediment basins. After the project has been completed and accepted, SCDOT maintenance forces will maintain the NPDES areas with top priority to the continuance of proper erosion and sediment control and stormwater management measures to prevent on-site and off-site damage or contamination of water courses and impoundments. The As-Built Plans will note all permanent erosion control measures and a copy will be provided to the Resident Maintenance Engineer.

815.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

See Section 815 of the *Standard Specifications* for the method of measurement and basis of payment for erosion and sediment control. Document measurements in the Daily Work Report. Payment will be based on acceptance and the Contract unit price.

Section 816
Sediment Control Basins/Stormwater Detention Ponds

When pay items under Section 816 of the *Standard Specifications* are specified in the Contract, the Contractor will be responsible for constructing detention ponds for temporary and permanent sediment control basins and stormwater detention ponds, including the dam, primary spillway, emergency spillway, excavation for storage, fencing, seeding, erosion protection of outlet, removal and disposal of sediment and removal of and site restoration for temporary ponds. The Resident Construction Engineer and Roadway Inspectors will be responsible for ensuring that the work and materials comply with requirements of the Contract and constructed in accordance with Section 816 of the *Standard Specifications* and the applicable *Standard Drawings*. See Section 815 for additional information on erosion and sediment control.

DIVISION 900
Reserved

SOUTH CAROLINA
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Section 901
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APPENDIX A
Construction Forms

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Section **Page**

Appendix A
Construction Forms

Figure A-1A presents a descriptive list of the most common SCDOT Construction Forms that will be used to administer SCDOT construction contracts and inspect typical pay items. The forms listed in Appendix A are available in electronic format on the SCDOT Intranet Web Site.

New No.	Old No	Name	Section	Description	Responsibility	Who Fills Out the Form?	Who Signs Forms?	Distribution
100.01		RCE Pre-Construction Checklist		general	SCDOT	RCE	RCE	RCE
100.02	LAB-291	Preliminary Letter of Certification		materials	SCDOT	RCE	RCE/DEA	RCE, Lab
100.03	3099	Report Recommending Roads for State Maintenance		final inspection	SCDOT	RCE	RCE, DEA, Road/Bridge Engr.	RCE, DEA, Dir. of Const.
100.04	616	Contractor Notice of Claim		claim	Contractor	Contractor	RCE, Contractor	RCE, Dir. of Const.
100.05		Contractor Concurrence and Prompt Payment		concurrence	SCDOT	RCE	Contractor	RCE, Contractor
100.06	608	Distribution of Payment	100	payment	SCDOT	RCE	RCE,DEA	Accounting
100.07	659	Wage Regulation Report	100	general	SCDOT	Inspector	RCE	RCE
100.08	LAB-232	Monthly Report of Testing Activities with Nuclear Gauge		equipment	SCDOT	Inspector	RCE	RCE, Lab
100.09	LAB-919	Report of Disposition of Materials Failing to meet Specifications	105	materials	SCDOT	RCE	RCE, DEA, DOC	DEA, Dir. of Const., Lab, RCE
100.10		Material Certification Log	100	materials	SCDOT	RCE	N/A	RCE
100.11		Materials Sampling and Testing Log	100	materials	SCDOT	RCE	N/A	RCE
100.12	3068-A	Utility Agreement	100	utility	Utility Company	Utility Company	Utility Mgr, Utility Company	RCE, Utility Office
100.13	3068Z	Utility Field Daily Diary	100	utility	SCDOT	Inspector	RCE	RCE
100.14	803	Slope Permission		R/W	SCDOT	Inspector	Property owner, RCE	RCE, Dir. of Const.
100.15		Stormwater and Pollution Prevention Plan for Highway Construction	800	NPDES	Contractor	Contractor	Contractor, RCE, DEA, DOC	SCDOT, Contractor
100.16	DHEC 2612	Notice of Intent - Stormwater	800	stormwater	SCDOT	RCE	DEA	RCE, District office, DHEC
100.17	DHEC 2610	Notice of Termination - Stormwater	800	stormwater	SCDOT	RCE	DEA	RCE, District office, DHEC
100.18	PR-1391	Annual EEO Report - Contractors	100	EEO	Contractor	Subs, Prime	Subs, Prime, RCE	DBE office, RCE

SCDOT CONSTRUCTION FORM DESCRIPTION TABLE
Figure A-1A

New No.	Old No.	Name	Section	Description	Responsibility	Who Fills Out the Form?	Who Signs Forms?	Distribution
100.19		DBE Quarterly Report	100	EEO	Contractor	Contractor	Subs, Prime, RCE	DBE office, RCE
100.20		Equal Employment Opportunity Stage Type Inspection	100	EEO	SCDOT	EEO	EEO, Contractor, RCE	EEO, Contractor
100.21		Request for DBE Summary	100	DBE	SCDOT	RCE	RCE	DBE office, RCE
100.22		Monthly Training Status Report	100	general	Contractor	Contractor	RCE	SCDOT, Contractor
100.23		Trainee Termination Report	100	general	Contractor	Contractor	RCE	Compliance Office
100.24		Final Inspection Acceptance Report Railroad Grade Crossing Signal Project		railroad	SCDOT	RCE	RCE, DEA & Utilities Mgr.	RCE, DEA & Utilities Mgr.
100.25		Report of Acceptance of Small Quantity Materials	100					
200.01	LAB-932	Field Density Test Report (Nuclear Gauge)	200/300	subgrade, base, embankment	SCDOT	Inspector	RCE	RCE, Lab
200.02	229A	Percent Compaction by Nuclear Gauge	200/300	subgrade, base, embankment	SCDOT	Inspector	RCE	RCE
200.03	229B	Percent Compaction by Nuclear Gauge - Direct Read Gauge	200/300	subgrade, base, embankment	SCDOT	Inspector	RCE	RCE
200.04	3078	Agreement for Placing Debris on Private Property	200	clearing/grub	Contractor	Contractor	Landowner	Landowner, Contractor
200.05	DHEC 3428	Notification of Demolition	700	structure	DHEC	Contractor, RCE	DEA	RCE, District office, DHEC
200.06	7	SCDOT Blasting Notice		public notice	Contractor	Contractor	N/A	Communications Office
300.01		Depth Check Records	300	base	SCDOT	Inspector	Inspector	RCE
300.02	LAB-935	Density Test Report (Nuclear Gauge)	300	stone base	SCDOT	Inspector	RCE	RCE, Lab
300.03	LAB-935B	Density Test Report (Nuclear Gauge) - Direct Read Gauge	300	stone base	SCDOT	Inspector	RCE	RCE, Lab
400.01	910W	Ignition Oven Worksheet	300	asphalt	Contractor	Inspector	N/A	RCE, Lab
400.02	LAB-266	Determination of Target Density for Asphalt Concrete Materials	400	asphalt	Contractor	Contractor	Contractor	Lab

SCDOT CONSTRUCTION FORM DESCRIPTION TABLE
Figure A-1A
(Continued)

New No.	Old No	Name	Section	Description	Responsibility	Who Fills Out the Form?	Who Signs Forms?	Distribution
400.03	969	Daily Report of Asphalt Plant Inspection	400	asphalt	SCDOT	Plant Inspector	Plant Inspector, RCE	RCE, Lab
400.04	944	Daily Report of Asphalt Roadway Inspection	400	asphalt	SCDOT	Roadway Inspector	Roadway Inspector, RCE	RCE, Lab
400.05	944	Daily Report of Asphalt Roadway Inspection Contractor QC/QA - Placed	400	asphalt	Contractor	Inspector	Inspector, District Asphalt Manager	RCE, Lab
400.06	LAB-966	Asphalt Ignition Oven Mixture Calibration Worksheet	400	asphalt	Contractor	Contractor	Contractor	Lab
400.07	LAB-967	Asphalt Ignition Oven Mixture Calibration Verification Worksheet	400	asphalt	Contractor	Contractor	Contractor	Lab
400.08	LAB-988	Silo Approval Overnight Storage	400	asphalt	Contractor	Contractor	Contractor	Lab
400.09	PWL-1	Lot Pay Factor Calculations	400	asphalt	Contractor	Inspector	Inspector, District Asphalt Manager	RCE, Lab
400.10	PWL-1	Lot Pay Factor Calculations - Thin Lift	400	asphalt	Contractor	Inspector	Inspector, District Asphalt Manager	RCE, Lab
400.11	PWL-2	In-Place Density Contractor QC/QA - Nuclear Gauge	400	asphalt	Contractor	Inspector	Inspector, District Asphalt Manager	RCE, Lab
400.12	PWL-2	In-Place Density Contractor QC/QA - Roadway Cores	400	asphalt	Contractor	Inspector	Inspector, District Asphalt Manager	RCE, Lab
400.13	283	Weekly Lime Anti-Stripping Additive Report	400	asphalt	Contractor	Inspector	Inspector, District Asphalt Manager	RCE, Lab
400.14	LAB-979	Verification of Hydrated Lime Weighing Systems for Hot Mix Asphalt	400	asphalt	SCDOT	Plant Inspector	Plant Inspector, RCE, Contractor	Field Lab
400.15		Maximum and Effective Specific Gravity Worksheet	400	asphalt	Contractor	Inspector	N/A	RCE, Lab
400.16		In-Place Density Contractor QA	400	asphalt	SCDOT	Contractor	Contractor, RCE	RCE
400.17		In-Place Density Contractor QC/QA PWL	400	asphalt	SCDOT	Contractor	Contractor, RCE	RCE
600.01		Traffic Control Plan	600	traffic	Contractor	Contractor	Contractor, RCE, DEA	DEA
600.02		Workzone Traffic Control Inspection	600	traffic	SCDOT	Inspector	Inspector, Contractor	RCE

SCDOT CONSTRUCTION FORM DESCRIPTION TABLE
Figure A-1A
(Continued)

New No.	Old No	Name	Section	Description	Responsibility	Who Fills Out the Form?	Who Signs Forms?	Distribution
700.01	BR-1	Concrete Pour Inspector's Checklist	500	concrete	SCDOT	Inspector	Inspector	RCE
700.02	BR-2	Concrete Pour Inspector's Checklist - Contractor's QC	500	concrete	SCDOT	Inspector	Inspector	RCE
700.03	BR-3	Concrete Pre-Pour Checklist for Non-Bridge and Non-Culvert Items	500	concrete	SCDOT	Inspector	Inspector	RCE
700.04	LAB-660	Ready Mix Concrete Report	500	concrete	SCDOT	Plant Inspector/ field inspector	Plant Inspector/ field inspector	RCE
700.05		Dry Run Depth Checks for Bridge Deck Pours	700	structure	SCDOT	Inspector	Inspector	RCE
700.06		Wet Depth Checks for Bridge Decks - Transverse	700	structure	SCDOT	Inspector	Inspector	RCE
700.07		Wet Depth Checks for Bridge Decks - Longitudinal	700	structure	SCDOT	Inspector	Inspector	RCE
700.08	PIT.VERIFI	CSL/PDA/PIT Testing Verification	700	foundations	SCDOT	RCE	RCE	RCE, Bridge, Construction
700.09		Slurry Inspection Log	700	foundations	Contractor	Contractor	Contractor, Inspector	RCE
700.10		Drilled Shaft Concrete Placement Log	700	foundations	Contractor	Contractor	Contractor, Inspector	RCE
700.11		Drilled Shaft Concrete Volumes Log	700	foundations	Contractor	Contractor	Contractor, Inspector	RCE
700.12		Drilled Shaft Excavation Log	700	foundations	Contractor	Contractor	Contractor, Inspector	RCE
700.13		Drilled Shaft Inspection Log	700	foundations	Contractor	Contractor	Contractor, Inspector	RCE
700.14		Drilled Shaft Log	700	foundations	Contractor	Contractor	Contractor, Inspector	RCE
700.15		Pile Driving Log	700	foundations	SCDOT	Inspector	Contractor, Inspector	RCE
700.16		Welding Procedure	700	structure	Contractor	Contractor	Contractor	RCE, Lab
700.17		Pile Record	700	foundations	SCDOT	Inspector	N/A	Submit w/ Final Plans

SCDOT CONSTRUCTION FORM DESCRIPTION TABLE
Figure A-1A
(Continued)

New No.	Old No	Name	Section	Description	Responsibility	Who Fills Out the Form?	Who Signs Forms?	Distribution
700.18		Swiss Hammer Readings	700	structure	SCDOT	Inspector	Inspector	RCE, Bridge, Construction
800.01	2091	Agreement for Moving Items Release		R/W	Contractor	Contractor	Landowner, 2 witnesses, RCE	RCE
800.02		Sediment and Erosion Control Site Inspection Report	800	NPDES	SCDOT	Inspector	CEI	RCE, CEI office

SCDOT CONSTRUCTION FORM DESCRIPTION TABLE
Figure A-1A
(Continued)

APPENDIX B
Sample Identification Cards

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Appendix B
Sample Identification Cards

B.1 INSPECTOR DUTIES

SCDOT requires the use of sample identification cards to properly identify project material samples. The Inspector in the field is responsible for completing and attaching the proper identification card to each material sample that is shipped to the Research and Materials Laboratory for analysis. Consider the following:

1. Form 907. Use Form 907, see Section B.1.1 and Figure B-1A, for concrete test specimens only. Figure B-3C in Section B.3 illustrates a completed example.

2. Form 907-A. Use Form 907-A, see Section B.1.2 and Figure B-1B, for all materials other than concrete test specimens. Figure B-3D through Figure B-3G in Section B.3 illustrates completed examples. Form 907-A is applicable to materials such as:

    - soil,
    - water,
    - cement,
    - fine and coarse aggregates,
    - fly ash and concrete additives,
    - lime,
    - reinforcing steel,
    - asphalt binder,
    - hot mix asphalt samples (in conjunction with Form 907-B),
    - traffic paint and glass beads,
    - diesel fuel,
    - latex,
    - pipe,
    - brick, and
    - fencing.

3. Form 907-B. Use Form 907-B, see Section B.1.3 and Figure B-1C, only for asphalt mix samples and only in conjunction with Form 907-A. For completed examples of Form 907-A and Form 907-B, see Figure B-3A and Figure B-3B, respectively.

Blank cards may be obtained from the Research and Materials Laboratory. Using a pencil of sufficient hardness to produce a durable, legible card, ensure that all data fields on the card are completed accurately, including: file number; key file number, if different than file number; State and Federal project numbers; charge code for the Contract on which the material is being used; and all fields that apply to the material being submitted. If the sample is being submitted for more than one contract, complete a sample card for each project. Because the sample card is permanently attached to a Research and Materials Laboratory Form, only write on the non-addressed, pre-printed side of the card.

B.1.1 Form 907 Completion Instructions

- Line1. Provide the charge code for the project for which the sample was taken.
- Line 2. Provide the file number and key file number for the project sample (e.g., 1621.100B.1, key: 16.115B).
- Line 3. Provide the project number and the PIN for the project sample.
- Line 4. Provide the sample material type.
- Line 5. Provide the date the material was sampled.
- Line 6. Provide a sample identification (e.g., Sample #, Load #).
- Line 7. Provide information to indicate the location from which the sample was obtained.
- Line 8. Provide the technician's name who obtained the sample. Use the format: First Initial, Last Name (e.g., J. Smith).
- Line 9. Provide the quantity represented by the sample (e.g., 50 CY).
- Lines 10 and 11. Provide the manufacturer of the material along with their location.
- Lines 12 and 13. Enter the Resident Construction Engineer's name and office location.
- Line 14. Provide the construction item the material was used in.
- Lines 15 and 16. Provide the manufacturer and type of cement used in the mix.
- Lines 17 and 18. Provide the manufacturer of the fine and coarse aggregates used in the mix.
- Lines 19 and 20. Provide the rates of material used in the mix.
- Lines 21, 22 and 23. If requested, provide the 1-Bag Mix Design information.
- Line 24 and 25. Provide the slump and air content obtained just prior to the sample being taken.
- Lines 26 and 27. Enter the water added at the project in gallons and cubic yards.
- Line 28. Provide the name of the Inspector who made the cylinders.
- Line 29. Provide the date the cylinders were made.
- Line 30. Provide the age, in days, at which the cylinders should be tested.

Charge Code | For Lab Use

File No. 2

Project No. 3

Material

Sample of 4
Date sampled 5
Identification 6
Sampled from 7
Sampled by 8
Quantity 9
Supply source 10
Address 11
Submitted by 12
Address 13
To be used in 14

Concrete Specimen

Brand:
Cement 15 Type 16
Fine aggregate 17
Coarse aggregate 18
Air entraining 19 oz./bag
Admixture 20 oz./100 lbs.
Mix used 94: 21 : 22 water 23
Slump 24 inches. Air 25 %
Water added 26 gal. in 27 CY
Made by 28 Date 29
Break specimen at 30 days

FORM 907 – SAMPLE IDENTIFICATION CARD
FOR CONCRETE TEST SPECIMENS
Figure B-1A

B.1.2 Form 907-A Completion Instructions

- Line1. Provide the charge code for the project sample.
- Line 2. Provide the file number and the key file number for the project sample (e.g., 1621.100B.1, key: 16.115B).
- Line 3. Provide the PIN for the project sample.
- Line 4. Provide the project number for the project sample.
- Line 5. Provide the sample material type.
- Line 6. Provide the date the material was sampled.
- Line 7. Provide the batch number, grind date, silo, heat, lot number or other means of identification.
- Line 8. Provide the station number or other identification to indicate the location where the sample was obtained.
- Line 9. Provide the technician's name who obtained the sample. Use the format: First Initial, Last Name (e.g., J. Smith).
- Line 10. Provide the quantity of material represented by the sample (e.g., 50 CY).
- Lines 11 and 12. Provide the manufacturer of the material along with the address of the location the material was produced.
- Line 13. For asphalt mixes, provide the job mix number. Attach Form 907-B.
- Line 14. Provide the Resident Construction Engineer's name.
- Line 15. Provide the Resident Construction Engineer's office location.
- Line 16. Provide the construction item the material will be used in.
- Line 17. Provide other pertinent information as necessary (e.g., asphalt oven type and correction factor).

Charge code	1	Lab use	
File No.	2	PIN	3
Project No.	4		
Sample of	5	Job Mix No.	13
Date Sampled	6	Submitted by	14
Identification	7	Address	15
Sampled from	8	To be used in	16
Sampled by	9	Other information	17
Quantity	10		
Supply source	11		
Address	12		

FORM 907-A – SAMPLE IDENTIFICATION CARD
FOR MATERIALS OTHER THAN CONCRETE TEST SPECIMENS
Figure B-1B

B.1.3 Form 907-B Completion Instructions

- Line 1. Provide the file number and the key file number for the project sample (e.g., 1621.100B.1, key: 16.115B).
- Line 2. Provide the date the sample was obtained.
- Line 3. Provide the field test, lot number and sample numbers.
- Line 4. Provide the sample material type (e.g., AC Surface T1, AABC).
- Line 5. Provide the approved Job Mix Number.
- Lines 6 through 16. Provide the results of the field extraction in percentage passing.
- Line 17. Provide the result of the asphalt binder content.
- Line 18. Provide the dust to asphalt ratio from the field data.

FIELD RESULTS

FILE NO. 1

DATE 2

SAMPLE NO. 3

SAMPLE OF 4

JOB MIX NO. 5

2" 6

1 ½" 7

1" 8

¾" 9

½" 10

3/8" 11

4 12

8 13

30 14

100 15

200 16

AC 17

DUST TO ASPHALT RATIO 18

FORM 907-B

FORM 907-B – SUPPLEMENTAL SAMPLE IDENTIFICATION CARD FOR ASPHALT MIX SAMPLES
(Form 907-B is only to be used in conjunction with Form 907-A)
Figure B-1C

B.2 RESEARCH AND MATERIALS LABORATORY RESPONSIBILITIES

Upon receipt of the project material sample and its identification card from the Inspector, the Research and Materials Laboratory will:

- remove the card from the sample and check the card's data for completeness and accuracy;
- assign a laboratory number to the sample;
- note the laboratory number in the cell "For Lab Use" on the identification card;
- input the sample information from the identification card in the Research and Material Laboratory's database;
- affix the identification card to the appropriate Materials Worksheet, which will be a standardized hard-copy form for the particular type of material to be tested; and
- forward the sample, identification card and Materials Worksheet to the appropriate Test Unit within the Research and Materials Laboratory.

B.2.1 <u>Research and Materials Test Unit</u>

Upon receipt of the material sample, identification card and Materials Worksheet, the Research and Materials Test Unit will:

- test the material sample;
- document the test results on the Materials Worksheet;
- input the sample information and test results in a Test Report, which will be a standardized electronic MS Word or MS Excel worksheet developed and maintained by the Research and Materials Laboratory;
- upload the Test Report to MatLab on the Department's Intranet; and
- forward the original sample identification card, the Materials Worksheet and a copy of the Test Report to the Final Reporting Unit of the Research and Materials Laboratory.

B.2.2 <u>Research and Materials Final Reporting Unit</u>

Upon receipt of the original sample identification card, the Materials Worksheet and a copy of the Test Report from the Research and Materials Laboratory Test Unit, the Final Reporting Unit will check, distribute externally to manufacturers, if requested, and file these documents, which will be retained for a period of eight years.

B.3 COMPLETED EXAMPLES OF SAMPLE IDENTIFICATION CARDS

Figure B-3A through Figure B-3G illustrates completed examples of sample identification cards (i.e., Form 907, Form 907-A, Form 907-B) for typical material samples.

Charge code 32.ɸ01.IM32.002.2220.621	Lab use
File No. 32.165B KEY: SAME	PIN 027085
Project No. IM-IM32 (002)	
Sample of ASPHALT AGGREGATE BASE	Job Mix No. B0396
Date Sampled 12/3/02	Submitted by RCE COOPER
Identification LOT 2-1	Address RICHLAND CONSTRUCTION
Sampled from TRUCK	To be used in RESURFACING
Sampled by W. THOMPSON	Other information
Quantity DAYS RUN	
Supply source SLOAN CONSTR. CO.	TROXLER
Address COLUMBIA APT	CF = +0.15

SAMPLE OF ASPHALT AGGREGATE BASE COURSE
(Completed Example of Form 907-A)
Figure B-3A

FIELD RESULTS

FILE NO.	32.165B
DATE	12/3/02
SAMPLE NO.	LOT 2-1
SAMPLE OF	ASPHALT AGGREGATE BASE
JOB MIX NO.	B0396
2"	
1 ½"	100
1"	99.3
3/4"	|
½"	79.4
3/8"	|
4	51.1
8	40.1
30	
100	
200	
AC	4.59 %
DUST TO ASPHALT RATIO	

FORM 907-B

SAMPLE OF ASPHALT AGGREGATE BASE COURSE
(Completed Example of Form 907-B supplementing Form 907-A in Figure B-3A)
Figure B-3B

Charge Code 24.Q10.BR24.004.2220.621 | For Lab Use

File No. 24.100B KEY: SAME

Project No. BRT-BR24(004) PIN: 024276

Material	Concrete Specimen
Sample of CLASS 4000 CONCRETE	Brand:
Date sampled 11/27/02	Cement LAFARGE Type I
Identification C3 B3 (EARLY)	Fine aggregate CAROLINA SAND
Sampled from MIXER TRUCK	Coarse aggregate VULCAN
Sampled by T. PARKER	Air entraining 0.39 oz./bag
Quantity 50 YDS.	Admixture 7 oz./100 lbs.
Supply source METROMONT	Mix used 94: 129 : 250 water 4.5 GAL.
Address GREENWOOD	Slump 2.0 inches. Air 4.0 %
Submitted by RCE EVANS	Water added 0 gal. in 8 CY
Address GREENWOOD CONSTR.	Made by T. PARKER Date 11/27/02
To be used in COLUMN 3 BENT 3	Break specimen at 1@7 days 1@9 & 1@11

SAMPLE OF 4000D CONCRETE
(Completed Example of Form 907)
Figure B-3C

Charge code 88.001.IM21.003.2220.621 | Lab use

File No. 1621.100B.1 KEY: 16.115B PIN 025621

Project No. IM-IM21 (003)

Sample of CEMENT - T1	Job Mix No. ——
Date Sampled 12/8/02	Submitted by RCE THOMPSON
Identification TK. #8 NBL	Address DILLON CONSTRUCTION
Sampled from TANKER	To be used in CEM. MOD. Subbase
Sampled by S. JONES	Other information
Quantity 400 BBLS	SILO #9
Supply source LAFARGE	DATE OF GRIND 11/09-10/02
Address HARLEYVILLE, SC	

SAMPLE OF CEMENT – T1
(Completed Example of Form 907-A)
Figure B-3D

Charge code 32.88C.UR32.004.2220.621 |Lab use

File No. 32.146A.1 KEY: 32.146A PIN 07970

Project No. DSB-STP-UR32(004)

Sample of REINFORCING STEEL #420 Job Mix No. —

Date Sampled 11|26|02 Submitted by RCE ISGETT

Identification #5, #7, #8 Address W. COLUMBIA CONSTR.

Sampled from STOCKPILE To be used in SPAN UNIT #10

Sampled by H. RAWLS Other information

Quantity 28,293 LBS. * RUSH *

Supply source AMERISTEEL CALL TEST RESULTS

Address AIKEN, SC TO: 796-9540

SAMPLE OF REINFORCING STEEL #420
(Completed Example of Form 907-A)
Figure B-3E

Charge code 32.028.COMB.010.2220.621 |Lab use

File No. 32.225A KEY: SAME PIN 020496

Project No. BST-COMB (010)

Sample of BORROW Job Mix No. —

Date Sampled 12/03/02 Submitted by RCE STINSON

Identification #29R Address LEXINGTON CONSTR.

Sampled from ROADWAY STA.# 3+00 To be used in EMBANKMENT

Sampled by B. CRIBB Other information

Quantity DAYS RUN COMPARISON SAMPLE

Supply source RICHARDSON PIT

Address WEST COLUMBIA

SAMPLE OF BORROW MATERIAL
(Completed Example of Form 907-A)
Figure B-3F

Charge code 36.901.IM36.001.2220.621 |Lab use
File No. 36.117B KEY: 30.117B PIN 027096
Project No. IM36(001)

Sample of PG76-22	Job Mix No. C0607
Date Sampled 12\3\02	Submitted by RCE FELKER
Identification LOT #7	Address NEWBERRY CONSTR.
Sampled from STORAGE TANK	To be used in 12.5MM SUPERPAVE
Sampled by McFARLAND	Other information
Quantity 30,000 GALLONS	
Supply source AAI	
Address SALISBURY, NC	

SAMPLE OF PG 76-22
(Completed Example of Form 907-A)
Figure B-3G

APPENDIX C
Sampling and Testing Procedures

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

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Section **Page**

Appendix C
Sampling and Testing Procedures

C.1 MATERIAL SAMPLING AND TESTING

C.1.1 Purpose

The importance of accurate and representative sampling of SCDOT highway construction materials cannot be overemphasized. If a material is not properly sampled, the sample taken may not be truly representative of the material that will eventually be incorporated into the work. If testing is performed on such a non-representative sample, the test results will be meaningless with respect to assessing material quality and adherence to specified requirements. Such practice wastes time and taxpayer dollars and eventually causes construction and maintenance problems.

C.1.2 Personnel Certification

It is essential that SCDOT and Contractor personnel in responsible charge of material sampling and testing be properly certified by the Department. SCDOT does not permit non-certified personnel to sample project materials. The Resident Construction Engineer is ultimately responsible for ensuring that each Inspector assigned to the project is properly certified by SCDOT for the type of sampling and testing to be performed. Certified Inspectors assigned to the project must adhere to the sampling and testing procedures and reporting requirements that are documented in Appendix C and the administrative policies and procedures for materials control that are documented in Section 106 of this *Manual*. Contact the Research and Materials Laboratory for any needed assistance.

C.1.3 Sampling and Testing Procedures

Appendix C documents the sampling and testing procedures that are typically used on SCDOT projects. Some of the referenced procedures are national AASHTO or ASTM procedures. SCDOT employees may obtain a copy of AASHTO and ASTM procedures from the Research and Materials Laboratory. SCDOT practices are designated "SC-T-##" (e.g., SC-T-100).

C.2 SAFETY CONSIDERATIONS

The sampling and testing procedures documented in Appendix C may involve hazardous materials, operations and equipment. Appendix C does not purport to address all of the safety hazards associated with using these sampling and testing procedures. It is the responsibility of the user of each documented procedure to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

SCDOT Sampling and Testing Procedures

C.3 AGGREGATES

Standard Method of Test for

Methods of Sampling Coarse Aggregates

SCDOT Designation: SC-T-1

1. SCOPE

1.1. These methods are intended to apply to coarse aggregates of gravel and crushed stone that have been sized and processed for use in construction items of work.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. A sample of coarse aggregate is obtained by combining portions taken from a conveyor belt, storage bin, truck, rail car or stockpile.

3. SIGNIFICANCE AND USE

3.1. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent.

4. APPARATUS

4.1. Round point shovel, large sample bags, board (optional).

5. TEST SPECIMENS

5.1. The sample size shall be governed by the maximum size of the particles to be sampled. The minimum size of sample shall conform to the requirements shown in Figure SC-T-1A.

6. PROCEDURE

6.1. *Sampling from Conveyor Belts* — Conveyor belts furnish a good point for sampling. It is necessary to stop the belt before taking a portion of the sample. At least 2 feet of the belt should be scraped clean for the entire width and depth. A sample should consist of at least three (3) portions taken from the belt. The conveyor belt should make at least two (2) revolutions between the taking of each sample portion.

6.2. *Sampling from Storage Bins* — If samples are taken from a bin, they shall be taken from the entire cross-section of the flow of material as it is being discharged. At the beginning of the discharge from the bins, sufficient material should be permitted to flow to insure normal uniformity before the sample is selected.

MAXIMUM SIZE OF PARTICLES PASSING SIEVE (inches)	MINIMUM WEIGHT OF FIELD SAMPLES (pounds)
⅜	10
½	20
¾	30
1	50
1½	70
2	90
2½	100
3	125
3½	150

TABLE OF MINIMUM SAMPLES SIZES
Figure SC-T-1A

6.3. *Sampling from Railroad Cars or Trucks* — Material from railroad cars should be taken from three (3) or more trenches dug across the car at points that appear on the surface to be representative of the material. The bottom of the trench should be at least 1 foot below the surface of the aggregate at the sides of the car and approximately 1 foot wide at the bottom. The bottom of the trench should be practically level. Equal portions should be taken at seven (7) equally spaced points along the bottom of the trench by pushing a shovel downward into the material and not scraping horizontally. Two (2) of the seven (7) points should be directly against the sides of the car. All of the material from the three (3) or more trenches is combined to form a composite sample.

6.4. *Sampling from Stockpiles* — It is extremely difficult to obtain a representative sample of coarse aggregate from a stockpile and this method of sampling should be avoided whenever possible. When it is necessary to obtain samples from a stockpile, a sample should be taken by combining approximately equal portions of materials taken from ten (10) or more different locations care being taken to avoid sampling a segregated area of coarse-grained material that is likely to exist at the base of the pile. Before obtaining the material at each sampling point, remove the aggregate to a depth of 1 foot and then, with a round pointed shovel, obtain one shovel full from the bottom of the hole. Do not let pieces of aggregate fall off the shovel when transferring the material to the sample bag. To help in preventing further segregation during sampling, a board may be shoved into the pile just above the point of sampling. The separate portions of material taken from ten (10) or more different holes must be combined to form a composite sample.

Standard Method of Test for

Methods of Sampling Fine Aggregates

SCDOT Designation: SC-T-2

1. SCOPE

1.1. These methods are intended to apply to fine aggregates which have been produced for use in concrete or other construction items.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. A sample of fine aggregate is obtained by combining portions taken from a conveyor belt, truck, rail car or stockpile.

3. SIGNIFICANCE AND USE

3.1. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent.

4. APPARATUS

4.1. Depending on the location the sample is being taken: round pointed shovel, trowel, scoop, sampling tube, earth auger or other suitable device, sample bags.

5. TEST SPECIMENS

5.1. The portions obtained as described below should be large enough to make a field sample of 10 pounds when combined or mixed and reduced as outlined in SC-T-3.

6. PROCEDURE

6.1. *Sampling from Conveyor Belts* — When sampling from a conveyor belt, it is very important that the inspector communicate with the plant personnel to be assured that the conveyor will not be activated while a portion of the sample is being obtained, thus causing possible injury to the Inspector. Some conveyors may require a platform at the side to provide access for sampling. In the event a conveyor will not start again while it is loaded, some other method for obtaining a sample must be used.

6.1.1. Obtain at least three (3) approximately equal portions, selected at random, from the material being sampled. Stop the conveyor belt while each of the sample portions is being obtained. With scoop, trowel or other suitable tool, cut through the material at two (2) locations, thus separating the portion of material to be taken from the remaining material on the belt. Carefully scoop all material within the limits of the selected increment into a suitable container, making special effort to clean the belt of all the fines. After obtaining the three (3) or more portions, combine them to create a field sample as described in Section 5 of this procedure.

6.2. *Sampling from Railroad Cars or Trucks* — Fine aggregates in railroad cars or trucks are to be sampled by shoveling away the surface material and digging into the fine aggregate in at least six (6) randomly selected locations over the car or truck. Obtain approximately equal portions from each location. Combine the material from the six (6) or more locations to form a composite sample, which can be used to create a field sample as described in Section 5 of this procedure.

6.3. *Sampling from Stockpiles* — When sampling fine aggregate from a stockpile, select six (6) or more places around the stockpile to obtain the portions that will be combined to form the sample. At each sampling location, use care to shovel away the surface material to a point that moist material is exposed. With a shovel, scoop, sampling tube, earth auger or other suitable device, obtain approximately equal portions from the six (6) or more locations. Combine the portions to form a composite sample that can be used to create a field sample as described in Section 5 of this procedure.

Standard Method of Test for

Methods of Reducing Size of Aggregate Sample

SCDOT Designation: SC-T-3

1. SCOPE

1.1. These methods are intended to apply to aggregate samples that have been obtained by the procedures outlined in SC-T-1 or SC-T-2.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-1, SC-T-2.

3. SUMMARY OF TEST METHOD

3.1. A bulk sample of aggregate is reduced to the size necessary for testing by either the quartering method or the riffle splitter method.

4. SIGNIFICANCE AND USE

4.1. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent. The sample size obtained during sampling is often larger than desirable for test procedures. Samples must be reduced in a manner that retains the properties of the original sample.

5. APPARATUS

5.1. For quartering method: clean and smooth surface free from cracks, shovel, trowel or other acceptable device for mixing aggregate and dividing the material. For riffle splitter method: riffle splitter pans to distribute material over splitter and catch material coming through splitter.

6. TEST SPECIMENS

6.1. The size of the test specimen required after reduction will be given in the procedure for that particular test.

7. PROCEDURE

7.1. Quartering Method:

7.1.1. Empty sample on a hard, clean and smooth surface that is free from cracks. Mix thoroughly and pile in a cone. Materials which tend to segregate should be dampened.

7.1.2. Flatten cone with a shovel, spreading the material to a circular layer of uniform thickness. Divide into quarters by two (2) lines intersecting at right angles at the center of the pile.

7.1.3. Discard the two (2) diagonally opposite quarters. Sweep clean the space occupied by the discarded quarters.

7.1.4. The remaining quarters should be thoroughly mixed and further reduced by quartering if desired. “Quartering” may be performed any number of times to obtain the required sample size.

7.2. Riffle Splitter Method:

7.2.1. The openings in the splitter device must be wide enough to let the largest particle easily pass through yet not so wide that a non-representative separation is obtained. (In general, the opening size should be approximately 50 percent greater than the largest particle size.)

7.2.2. Thoroughly mix the aggregate sample. Spread the material evenly across a rectangular pan having the proper width to allow equal portions of the material to be fed to each individual chute.

7.2.3. Dump the aggregate into the splitter device so that the sample is uniformly and simultaneously fed over the entire length of the splitter. Discard the material caught on one side of the splitter. This method of reducing a sample size may be repeated as many times as necessary to obtain the appropriate sample size.

Standard Method of Test for

Sieve Analysis of Fine and Coarse Aggregates

SCDOT Designation: SC-T-4

1. SCOPE

1.1. This method of test covers a field procedure for the determination of particle size distribution of fine and coarse aggregates, using sieves with square openings.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-3.

3. SUMMARY OF TEST METHOD

3.1. A sample of aggregate is sieved to determine the gradation.

4. SIGNIFICANCE AND USE

4.1. The gradation of fine and coarse aggregate samples must be tested to determine compliance with the specifications for these materials.

5. APPARATUS

5.1. Sieves in a series of sizes to determine compliance with the specifications for the material in question, balance or electronic scales.

6. TEST SPECIMENS

6.1. Samples that are too large for testing should be reduced to the proper size by SC-T-3.

6.2. Samples for sieve analysis shall be dried to a saturated, surface dry condition prior to testing. Drying may be in air or by use of a method such that the temperature of the sample does not exceed 140°F.

6.2.1. Samples of fine aggregate for sieve analysis shall weigh, after drying, approximately the amount indicated in the following:

Material with at least 95% finer than a No. 8 sieve	= 100 grams
Fine Aggregate No. 10	= 200 grams
Material with at least 90% finer than a No 4 sieve and more than 5% coarser than a No. 8 sieve	= 500 grams

6.2.2. In no case, however, shall the fraction retained on any sieve at the completion of the sieving operation weigh more than 4 grams per square inch of sieving surface. This amounts to 200 grams for the usual 8-inch diameter sieve.

6.2.3. Samples of coarse aggregate for sieve analysis shall weigh, after drying, not less than the amount shown in Figure SC-T-4A.

NOMINAL MAXIMUM SIZE OF SAMPLE OPENINGS (inches)	MINIMUM DRY WEIGHT OF TEST SAMPLE	
	(pounds)	(kilograms)
3/8	2	1
½	4	2
¾	11	5
1	22	10
1½	33	15
2	44	20
2½	77	35

TABLE OF MINIMUM DRY SAMPLE WEIGHTS
Figure SC-T-4A

7. PROCEDURE

7.1. Separate into a series of sizes using such sieves as necessary to determine compliance with the specifications for the material under test.

7.2. Conduct sieving operations by means of lateral and vertical motion of the sieve, accompanied by jarring action so as to keep the sample moving continuously over the surface of the sieve. The motion of the sieve may be accomplished by mechanical shaker or by hand. Do not turn or manipulate fragments through the sieve by hand.

7.3. Continue the sieving operation until not more than 0.5 percent by weight of the total sample passes any sieve during one (1) minute of hand sieving.

7.4. Weigh the sieved material and record the weights. The total weight after sieving must check within 0.3 percent of the original dry sample weight.

8. CALCULATIONS

8.1. A sample calculation to determine the results of the sieving operations follows with the results reported in Figure SC-T-4B:

8.2. Total Weight of Sample = 17,327 grams

Passing 1½-inch Sieve $= \left(\frac{17{,}327}{17{,}327}\right) \times 100 = 100\%$

Passing 1-inch Sieve $= \left(\frac{15{,}876}{17{,}327}\right) \times 100 = 92\%$

Passing ½-inch Sieve $= \left(\frac{8{,}210}{17{,}327}\right) \times 100 = 47\%$

Passing No. 4 Sieve $= \left(\frac{1{,}678}{17{,}327}\right) \times 100 = 10\%$

Passing No. 8 Sieve $= \left(\frac{454}{17{,}327}\right) \times 100 = 3\%$

SIEVE DESIGNATION	WEIGHT PASSING (grams)	PERCENT PASSING (%)
1½-inch	17,327	100
1-inch	15,876	92
½-inch	8210	47
No. 4	1678	10
No. 8	454	3

SIEVING OPERATIONS RESULTS
Figure SC-T-4B

9. REPORT

9.1. Report the percentage of material passing each sieve to the nearest whole percent, except the No. 200 sieve shall be reported to the nearest 0.1 percent.

Standard Method of Test for

Determination of Silt and Clay

SCDOT Designation: SC-T-5

1. SCOPE

1.1. This method covers a procedure for determining the combined silt and clay (total material passing the No. 200 sieve) in a local sand passing the No. 4 sieve.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-3.

3. SUMMARY OF TEST METHOD

3.1. The total percentage of silt and clay of a sample of fine aggregate is determined by washing the sample over a No. 200 sieve.

4. SIGNIFICANCE AND USE

4.1. The total percentage of silt and clay of a sample of natural fine aggregate can be tested quickly to determine the material's suitability for use in asphalt mixes. Excess fines can be detrimental to the performance of certain asphalt mixes.

5. APPARATUS

5.1. No. 4 sieve, No. 200 sieve, pan (approximately 11 inches in diameter and 3 inches in depth), balance or electronic scales, wetting agent.

6. TEST SPECIMENS

6.1. The sample shall consist of approximately 1000 grams of material. Larger samples shall be reduced to this size by the procedures in SC-T-3.

7. PROCEDURE

7.1. The material should be screened through a No. 4 sieve and the material retained on this sieve shall be discarded.

7.2. Approximately 300 grams of the material passing the No. 4 sieve shall be weighed and placed in a pan approximately 11 inches in diameter and 3 inches deep. The sample shall be covered with water containing a sufficient amount of wetting agent to assure a thorough separation of the material finer than the No. 200 sieve from the coarser particles and allowed to stand for approximately 15 minutes.

7.3. The contents of the pan should be stirred vigorously with a trowel or spoon and allowed to settle for about a minute. The wash water shall then be poured down a No. 200 sieve. Care should be taken to avoid spilling any of the contents. The operations shall be repeated until the wash water is clear. Do not leave the material on the spoon used for stirring. Any material that is retained on the No. 200 sieve shall then be washed back into the pan and the material in the pan dried to a constant weight. This material shall then be weighed.

8. CALCULATIONS

8.1. To determine the percentage of material passing the No. 200 sieve, divide the weight of the sample lost during washing by the original dry weight of the sample as follows:

Original Dry Weight of Sample	=	427.4 grams
Dry Weight of Sample After Washing	=	401.5 grams
Total Material Lost through Washing	=	427.4 - 401.5 = 25.9 grams

Percentage Passing the No. 200 Sieve $= \left(\frac{25.9 \text{ grams}}{427.4 \text{ grams}} \right) \times 100 = 6.1\%$

9. REPORT

9.1. Report the percentage of the sample passing the No. 200 sieve to the nearest 0.1 percent.

SCDOT Sampling and Testing Procedures

C.4 SOILS

Standard Method of Test for

Methods of Sampling Soil Pits and Fields

SCDOT Designation: SC-T-21

1. SCOPE

1.1. These methods outline the procedure to be followed when sampling sand-clay pits and borrow pits to be used for base or sub-base, and for sampling pits to be used for sand asphalt construction. Test holes should be identified by assigning them a number with a guard stake being driven by the hole with the number of the hole written on the stake as well as the depth of the test hole.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. Samples of soil are obtained from soil pits and fields to test for specification compliance by use of continuous flight augers.

3. SIGNIFICANCE AND USE

3.1. Proper sampling techniques are necessary to obtain samples that are representative of the material in the pit in order to determine the suitability of the material for use in the work.

4. APPARATUS

4.1. Continuous flight auger, minimum 4 inch overall diameter, cutting head for the auger string suited for the type of soils expected to be encountered, motorized drill rig with sufficient torque and ram stroke to advance and rotate the auger at a sufficient rate to provide sample conveyance to the surface, hand trowel, 6 feet x 6 feet canvas, polyethylene sample bags (4 mil thickness, 10 inch x 18 inch).

5. TEST SPECIMENS

5.1. The objective of this test is to collect specimens of in-situ soils for laboratory analysis. Each sample will consist of not less than 10 pounds of material.

6. PROCEDURE

6.1. Sampling Sand-Clay Pits and Pits for Sand Asphalt:

6.1.1. Samples from proposed pits are obtained by boring test holes. A sufficient number of test holes must be dug so that the extent of the supply is fully established. Sand-clay pits should also be referenced to a base line so that the outline of the pit may be later located.

6.1.2. A sample is to consist of a representative portion of the entire depth of the hole unless it is desirable to obtain samples to represent various depths of the hole. A representative portion should be obtained by placing the material taken from the hole on a canvas and mixing thoroughly prior to getting the required sample. The depth limits should be written on the sample identification card. A sample for each soil type should be sent to the Research and Materials Laboratory. When it is necessary that density tests should be run on sand-clay material, note this on the sample identification card. The sample should weigh at least 25 pounds.

6.1.3. Occasionally, materials from two different pits are blended to form a sand-clay base or sub-base. When samples representing such sources are submitted to the Research and Materials Laboratory for testing, note on the sample identification card if it desired that the Research and Materials Laboratory advise the Resident Construction Engineer of their recommended proportions.

6.1.4. A sample of at least 35 pounds is required when the material is to be used in sand asphalt work.

6.2. Sampling Borrow Material:

6.2.1. Samples (minimum weight 10 pounds) of ground surface material to be used as base are to be obtained by first cleaning off any vegetative matter at the sampling spot and then removing a portion of material for the full depth of the topsoil layer. A sample must be taken for each area of the field which represents a different soil type. If it is necessary that density tests be run on this material, this must be noted on the sample identification card. The sample should weigh at least 25 pounds.

6.2.2. A minimum of at least 1 sample shall be taken for each 1 acre of material.

Standard Method of Test for

Determining Moisture Content of Soils by Carbide Gas Method

SCDOT Designation: SC-T-22

1. SCOPE

1.1. This method covers a procedure for determining in the field the amount of moisture in a soil or fine aggregate. A carefully weighed soil sample and a powder reagent are introduced into a container with the pressure of the gas evolved from the chemical reaction being measured on a gauge that is specially calibrated to read moisture content.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. The moisture content of a sample of soil is obtained by measuring the pressure created by chemical reaction between the moisture in the soil and calcium carbide reagent.

3. SIGNIFICANCE AND USE

3.1. The moisture content of a sample of soil or fine aggregate can be obtained quickly in the field.

4. APPARATUS

4.1. Speedy Moisture Tester, two 1¼-inch steel balls, calcium carbide reagent, and conversion chart for moisture content.

5. TEST SPECIMENS

5.1. A representative soil or fine aggregate sample weighing 20 grams or 26 grams, depending on the model of the Speedy Moisture Tester. Consult the manufacturer's instructions. For materials with higher moisture content than the gauge limit, use only half the standard weight of sample.

6. PROCEDURE

6.1. For the 26-gram Tester:

6.1.1. Place soil sample in the cap of the tester.

6.1.2. Place two 1¼-inch steel balls in the body of the tester.

6.1.3. With the body of the tester in the horizontal position, place the cap in place. Bring the stirrup in place and screw down to seal the instrument pressure tight. Raise the tester to the vertical position so as to empty the soil sample on top of the reagent.

6.1.4. With the instrument in the horizontal position, manually rotate the device so the steel balls are put into orbit around the inside circumference. During this shaking action, the steel balls break down the lumpy soil. Continue shaking for approximately 1 to 3 minutes until the gauge needle stops moving. With the device in the horizontal position, at eye level, read the dial and refer to the conversion chart for moisture content, which is supplied with the Speedy Moisture Tester.

6.1.5. When the sample is dumped, examine the cap to see if all the soil was removed and examine the soil for lumps. If any soil remained in the cap or remained lumpy, obtain another sample and re-run the test.

6.1.6. After each test, the instrument should be thoroughly cleaned, using the brush to clean the bomb and the cloth to clean the cap. The cap should not be beat on a hard surface. Do not use brush or air. Scales should be balanced frequently.

6.2. For 20-gram Tester:

6.2.1. Place amount of reagent required by the manufacturer's instructions in the cap of the tester.

6.2.2. Place the 20-gram soil sample in the body of the tester.

6.2.3. Run the test as described above for the 26-gram tester.

7. REPORT

7.1. Report the moisture content in the sample as read from the oven moisture conversion chart to the nearest 0.1 percent on SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge or SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge, as appropriate.

Standard Method of Test for

Determining Moisture Content of Soils by "Pan Drying" Method

SCDOT Designation: SC-T-23

1. SCOPE

1.1. This method covers a procedure for the determining in the field the amount of moisture in a soil or fine aggregate by placing the material in a pan and drying the material over a low flame. The accuracy of the method depends upon the care exercised in making the test. Too little drying will reflect a too small moisture content, while excessive drying drives out the water combined in the clay molecules and the result will be higher than the true moisture content. Too fast a drying process with a high flame will sometimes cause sample particles to pop out of the pan and the result will also be higher than the true moisture content.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. The moisture content of a sample of soil is obtained by measuring the change in the mass of a sample of the soil prior to and after drying to a saturated surface dry condition over a heat source in an open pan.

3. SIGNIFICANCE AND USE

3.1. The moisture content of a sample of soil or fine aggregate can be obtained in the field.

4. APPARATUS

4.1. Pan approximately 11 inches in diameter and 3 inches in depth, rod or spoon for stirring, heat source, balance or electronic scales.

5. TEST SPECIMENS

5.1. A representative soil or fine aggregate sample weighing approximately 200 to 300 grams.

6. PROCEDURE

6.1. Determine the weight of the sample.

6.2. Place sample in pan and place over low heat.

6.3. Stir the material with a clean spoon or clean rod occasionally as it dries. Gradually, break down lumps so that they will dry throughout. When soil particles do not stick to the spoon or rod, remove the sample from the flame and weigh the dried sample. Be very careful not to overheat.

7. CALCULATIONS

7.1. The percent moisture in the fine aggregate or soil is computed as the difference in the wet and dry weights divided by the dry weight as follows:

Weight of Sample Before Drying = 237.5 grams

Dry Weight of Sample = 222.8 grams

%Moisture in Sample $= \left(\frac{237.5 \text{ grams} - 222.8 \text{ grams}}{222.8 \text{ grams}} \right) \text{x } 100 = 6.6\%$

8. REPORT

8.1. Report the moisture content in the sample to the nearest 0.1 percent on SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge or SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge, as appropriate.

Standard Method of Test for

Field Method of Determining Moisture-Density Relations of Soils

SCDOT Designation: SC-T-25

1. SCOPE

1.1. This method of test outlines the field procedure for determining the relation between the moisture content and density of soils.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22, SC-T-23.

3. SUMMARY OF TEST METHOD

3.1. A soil sample is compacted in a mold having a capacity of 1/30 of a cubic foot and having an internal diameter of 4 inches. The soil in the mold is compacted in three layers with 25 blows per layer from a 5.5-pound rammer dropped from a height of 12 inches. The moisture content of the sample is raised and the procedure is repeated until the maximum density and optimum moisture content are determined.

4. SIGNIFICANCE AND USE

4.1. The maximum dry density and optimum moisture content of a sample of soil can be obtained quickly in the field.

5. APPARATUS

5.1. 4-inch diameter proctor mold and 5.5-pound hammer, No. 4 sieve for Method A or ¾-inch sieve for Method C, balance or electronic scales, metal straightedge.

6. TEST SPECIMENS

6.1. If the soil is damp when received, dry it until it becomes friable under a trowel. Drying may be in air or by use of a method such that the temperature does not exceed 60°C. Then, break up any lumps in such a manner as to avoid reducing the natural size of individual particles.

6.2. For Method A, screen an adequate quantity of representative pulverized soil over the No. 4 sieve. Discard the coarse material, if any, retained on the No. 4 sieve. Select a representative sample, weighing approximately 7 pounds or more.

6.3. For Method C, prepare the sample as for Method A except that the soil shall be screened over a ¾-inch sieve and the material larger than ¾ inch discarded. A 12-pound representative sample shall be selected.

7. PROCEDURE

7.1. Method A:

7.1.1. Thoroughly mix the selected representative sample with sufficient water to dampen it to approximately 4 percentage points below optimum moisture content.

7.1.2. Form a specimen by compacting the prepared soil in the 4-inch mold (with collar attached) in 3 equal layers to give a total compacted depth of about 5 inches. Compact each layer by 25 uniformly distributed blows from the hammer dropping free from a height of 12 inches above the elevation of the soil. During compaction, the mold shall rest on a uniform, rigid foundation such as provided by a cube of concrete. Following compaction, remove the extension collar, carefully trim the compacted soil even with the top of the mold by means of a straightedge and weigh. Multiply the weight of the compacted specimen and mold, minus the weight of the mold, by a constant which will be furnished by the Research and Materials Laboratory; and record the result as the wet unit weight per cubic foot of the compacted soil.

7.1.3. Remove the material from the mold and slice vertically through the center. Take a representative sample of the material from one of the cut faces, weight immediately, and then determine the moisture content of the soil by SC-T-22 or SC-T-23.

7.1.4. Thoroughly break up the remainder of the material until it will pass a No. 4 sieve as judged by eye. Add water in sufficient quantity to increase the moisture content of the sample by 1 or 2 percentage points, and repeat the above procedure for each increment of moisture added. Continue this series of determinations until the wet unit weight per cubic foot either decreases or there is no change in wet unit weight per cubic foot.

7.2. Method C:

7.2.1. The procedure is the same as that for Method A with the following exceptions:

7.2.2. Determine the moisture content by SC-T-23.

7.2.3. Thoroughly break up the soil until it will pass a ¾-inch sieve and 90% of the soil aggregations will pass the No. 4 sieve as judged by eye.

8. CALCULATIONS

8.1. Calculate the moisture content and the dry unit weight of the soil as compacted for each trial. The dry unit weight, in pounds per cubic foot of compacted soil, is computed by using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100} \right) \times 100$$

where: γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.2. After calculating the moisture content and corresponding dry unit weight (density) for each of the soil samples, plot the dry unit weights per cubic foot as ordinates and corresponding moisture contents as abscissas. Connect the plotted points so as to produce a smooth curve.

8.3. The moisture content corresponding to the peak of the curve is termed the "optimum moisture content" of the soil. The dry unit weight per cubic foot of the soil at optimum moisture content is termed the "maximum dry density" under the above compaction.

9. REPORT

9.1. Report the optimum moisture content of the soil to the nearest 0.1 percent and the maximum dry density to the nearest 0.1 pound per cubic foot. Use SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge), SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge, and SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge.

Standard Method of Test for

Field Determination of Maximum Dry Density and Optimum Moisture Content of Soils by the One-Point Method

SCDOT Designation: SC-T-29

1. SCOPE

1.1. In this method, the maximum dry density and optimum moisture content of soils is obtained by using the results of one point on a standard proctor curve to enter a family of curves from which the maximum dry density and optimum moisture content can be determined. In most instances, it will be possible and advantageous to use the one-point proctor method, but since this method is not applicable to all soils found in South Carolina, there will be times when it will be necessary to conduct the more detailed test according to SC-T-25. The decision to run either the one-point proctor test or the more detailed test will be left to the Resident Construction Engineer. In general, if the one-point proctor test is conducted with the material at or near optimum moisture content and the point does not fall in the main portion of the family of curves, this is a good indication that SC-T-25 should be used.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22, SC-T-25.

3. SUMMARY OF TEST METHOD

3.1. A soil sample is compacted in a mold having a capacity of 1/30 of a cubic foot and having an internal diameter of 4 inches. The soil in the mold is compacted in three layers with 25 blows per layer from a 5.5 pound rammer dropped from a height of 12 inches. The wet density and moisture content of the compacted specimen is plotted on a family of curves and a maximum dry density and optimum moisture content is selected from the family of curves for use in compaction calculations.

4. SIGNIFICANCE AND USE

4.1. The maximum dry density and optimum moisture content of a sample of soil can be obtained quickly in the field.

5. APPARATUS

5.1. Proctor mold and 5.5-pound hammer, No. 4 sieve, balance or electronic scales, metal straightedge.

6. TEST SPECIMENS

6.1. Obtain approximately 2500 grams of material representative of that tested for in-place density and moisture content. Break up this material and sieve through a No. 4 sieve. Discard the material retained on the No. 4 sieve. If more than 5 percent by weight of the total sample, as judged by eye, is retained as aggregate on the No. 4 sieve, note this in the comments on the field work sheet and on Research and Materials Laboratory Form 932. In the judgment of the operator, the moisture content of the material to be tested should be on the dry side of optimum and within 2 percent of the optimum moisture content. If the moisture content is not within this range, the material should be dried if it is too wet, or water added if it is too dry. If the soil is damp when received, dry it until it becomes friable under a trowel.

7. PROCEDURE

7.1. Determine the weight of a standard proctor mold.

7.2. Place the standard proctor mold (with base plate and collar attached) on a block of concrete of sufficient size to afford a uniform, rigid foundation.

7.3. Mix the 2500-gram sample so that the moisture content is as uniform as possible.

7.4. Place approximately one-third of the sample in the proctor mold.

7.5. Compact the layer using 25 uniformly distributed blows from the 5.5-pound hammer dropping free from a height of 12 inches.

7.6. Repeat Step 7.4 and Step 7.5 for the second and third layers of the specimen.

7.7. Following compaction of the third layer, remove the extension collar and carefully trim the compacted soil even with the top of the mold by means of a straightedge.

7.8. Remove the base plate from the mold and weigh the mold and specimen to the nearest gram.

7.9. Remove the material from the mold and slice vertically through the center. Take a representative sample of the material from one of the cut faces and determine the moisture content using SC-T-22.

7.10. Determine the weight of the specimen by subtracting the weight of the mold, as determined in Step 7.1, from the weight of the mold plus specimen, as determined in Step 7.8.

7.11. Determine the wet density of the soil specimen by multiplying the mold constant, which is stamped on the base plate, by the weight of the soil specimen, as determined in Step 7.10.

7.12. Using the moisture content determined in Step 7.9 and the wet density determined in Step 7.11, plot the one point on the family of curves as shown on Figure SC-T-29A.

7.13. If the point falls on one of the curves, the maximum dry density and optimum moisture content may be read directly from the table shown in the top right-hand corner of Figure SC-T-29A. If the point does not fall on one of the curves, it is necessary to interpolate between the curves and again use the table to determine the maximum dry density and optimum moisture content.

8. CALCULATIONS

8.1. Weight of Mold and Soil = 4006 grams

8.2. Weight of Mold = 2074 grams

8.3. Weight of Soil (Step 8.1 – Step 8.2) = 4006 grams – 2074 grams = 1932 grams

8.4. Wet Density of Soil = (Mold k) x (Step 8.3) = (0.06638) x (1932 grams) = 128.2 pcf

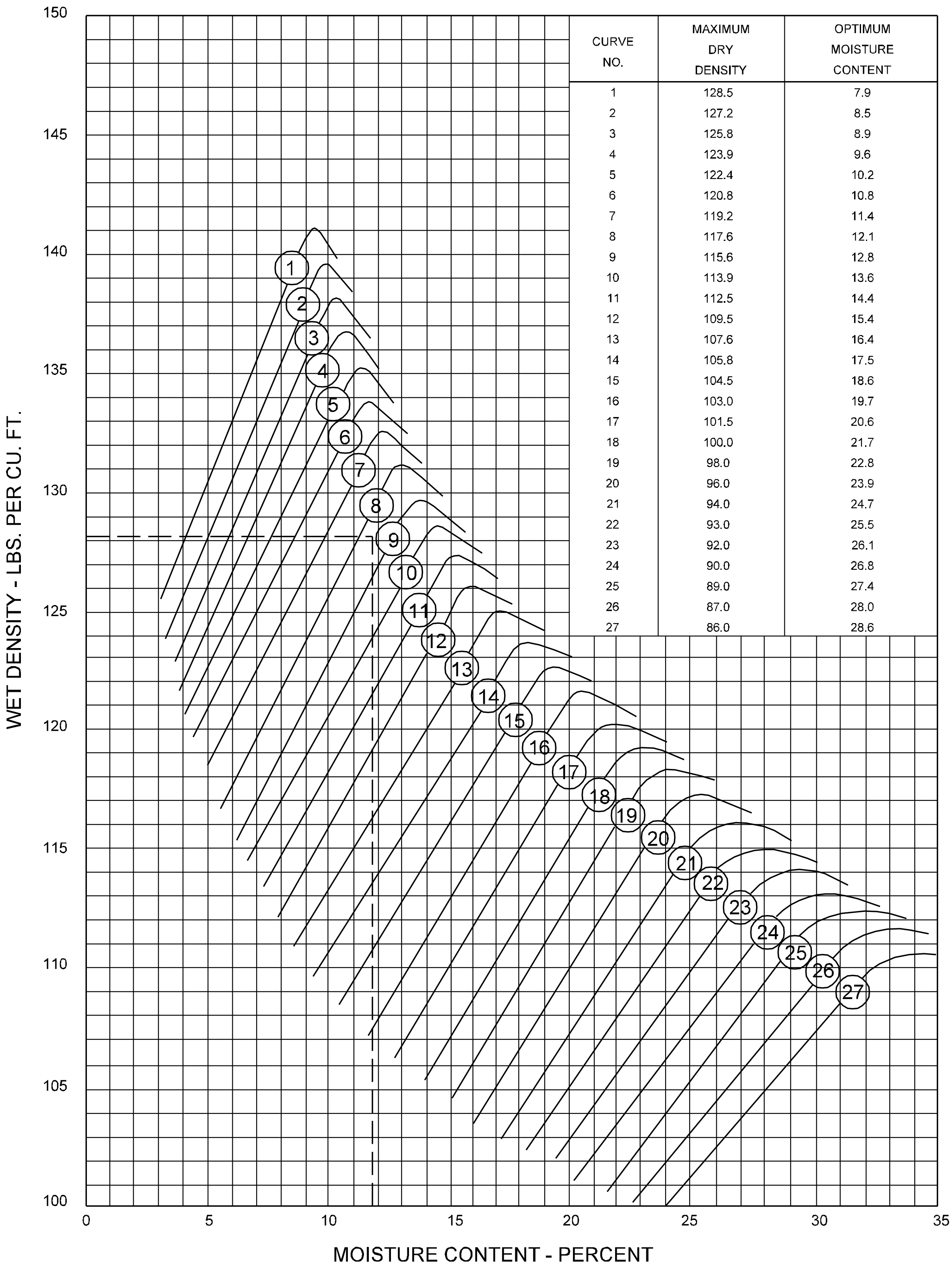
8.5. Percent Moisture (Speedy Moisture Tester) = 11.7%

8.6. Maximum Dry Density (taken from Figure SC-T-29A) = 116.6 pcf

8.7. Optimum Moisture Content (taken from Figure SC-T-29A) = 12.4%

9. REPORT

9.1. Report the optimum moisture content of the soil to the nearest 0.1 percent and the maximum dry density to the nearest 0.1 pound per cubic foot. Use SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge), SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge, and SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge.



CURVE NO.	MAXIMUM DRY DENSITY	OPTIMUM MOISTURE CONTENT
1	128.5	7.9
2	127.2	8.5
3	125.8	8.9
4	123.9	9.6
5	122.4	10.2
6	120.8	10.8
7	119.2	11.4
8	117.6	12.1
9	115.6	12.8
10	113.9	13.6
11	112.5	14.4
12	109.5	15.4
13	107.6	16.4
14	105.8	17.5
15	104.5	18.6
16	103.0	19.7
17	101.5	20.6
18	100.0	21.7
19	98.0	22.8
20	96.0	23.9
21	94.0	24.7
22	93.0	25.5
23	92.0	26.1
24	90.0	26.8
25	89.0	27.4
26	87.0	28.0
27	86.0	28.6

FAMILY OF CURVES FOR TYPICAL SOILS IN SOUTH CAROLINA
Figure SC-T-29A

Standard Method of Test for

Field Determination of Density and Moisture Content of Soils and Aggregate Bases by Use of the Troxler Model 3430 Nuclear Gauge

SCDOT Designation: SC-T- 30

1. SCOPE

1.1. This method describes procedures for determining the density and moisture content of soils and aggregate bases through the use of the nuclear equipment.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22.

3. SUMMARY OF TEST METHOD

3.1. The total or wet density of the material is determined by placing a gamma source into the material under test. The intensity of radiation detected is dependent upon the density of the material under test. The radiation intensity reading is related to measured wet density by suitable calibration curves or tables. The total water content is determined by placing a neutron source into the material under test. The quantity of fast neutrons is dependent upon the hydrogen content of the water in the material. The quantity of fast neutrons is related to the measured water content by suitable calibration curves or tables.

4. SIGNIFICANCE AND USE

4.1. The test method described is useful as a rapid, nondestructive method for the in-place determination of the wet density of soils and the wet density and moisture content of aggregate bases.

5. APPARATUS

5.1. Troxler Model 3430 Nuclear Gauge, reference standard, scraper plate, drill rod, drill rod extraction tool.

6. TEST SPECIMENS

6.1. This test is conducted on in-place soils or aggregate base material.

7. PROCEDURE

7.1. Turn the gauge on for a minimum of 10 minutes to allow the systems critical circuits to stabilize.

7.2. Take moisture and density standard counts (at least 10 feet from any large object and at least 30 feet from another gauge).

7.3. Place the standard on a dry, solid and flat surface containing not more than 15 percent moisture and at least 100 pounds per cubic foot of density.

7.4. Place the gauge on the standard, being sure scaler end of gauge is toward the raised end of the standard and seated properly on the recessed surface.

7.5. Remove the padlock that locks the source rod in the “SAFE” position.

7.6. Press the “STD” key, then the “YES” key.

7.7. Press “START” key.

7.8. After the count is complete the gauge will display DS (Density Standard) and MS (Moisture Standard).

7.9. Record both the DS (Density Standard) and MS (Moisture Standard).

7.10. Compare these standard counts to the average of the previous 4 counts. The DS should be within 1 percent and the MS within 2 percent.

7.11. Press the “ON/YES” key and the gauge will return to the “READY” screen. Return the standard to its case.

7.12. If the surface is not relatively smooth, use the scraper plate to smooth and level the test surface (all loose stone should be removed and small voids filled with native fines or sand).

7.13. Take moisture and density measurement counts.

7.14. Using the drill rod and scraper plate, put the drill rod through the extractor tool, then through the scraper plate guide. Secure the scraper plate with one foot; drive the test hole at least 2 inches deeper than the desired test depth.

7.15. Remove the drill rod by rotating and pulling straight up. Do not loosen the drill rod by tapping from side to side with a hammer.

7.16. Before moving the scrapper plate, with your foot still securing the plate, take the drill rod and mark around the corners of the scraper plate.

7.17. Place the gauge within the scrapper plate outline.

7.18. Press the “MA/PR” key and scroll up or down to select “PR” for “SOIL MODE”.

7.19. Press the "TIME" key and use up or down arrows to view count times. Press the "ENTER" key after selecting the recommended time (1 minute).

7.20. This step is only used for Aggregate Bases and Coquina Base Course. To enter Lab Proctor information, press the "MA/PR" key and follow the display instructions to select "PR". Press the "YES" key to change proctor information and scroll up or down to select correct digits. Press the "ENTER" key to return to the ready screen.

7.21. Release the trigger and lower the source rod into the hole to the desired depth of measurement.

7.22. Gently slide the gauge to the right (scaler end), placing the source rod in firm contact with the sidewall of the hole.

7.23. Press the "DEPTH" key and use the up or down arrows until the correct test depth is displayed. Press the "START/ENTER" key to begin the test count. At this time, the gauge will begin the test count.

7.24. After the count time is complete, the gauge will display %PR, DD, WD, M and %M. Record the WD (Wet Density) and the actual Density Count only. To obtain the actual Density Count, use the up or down arrows.

7.25. Pull the source rod to the top notch or "SAFE" position, and return the gauge to a safe area.

8. CALCULATIONS

8.1. Determine the moisture content and calculate the dry density, pounds per cubic foot (pcf).

8.2. For Soils:

8.2.1. Determine the percent moisture using SC-T-22.

8.2.2. Calculate the dry density using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100}\right) x\ 100$$

where:

γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.3. For Aggregate Base Materials:

8.3.1. Calculate the dry density using the following equation:

Dry Density (pcf) = Wet Density (pcf) – Moisture Content (pcf).

9. REPORT

9.1. Report the moisture content of the soil to the nearest 0.1 percent and the moisture content of aggregate base materials to the nearest 0.1 pound per cubic foot. Report the maximum dry density to the nearest 0.1 pound per cubic foot. If running the test on a soil material, report the results on SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge and SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge). If running the test on a graded aggregate base material or other material composed of large particles, use SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) – Direct Read Gauge.

Standard Method of Test for

Field Determination of Density and Moisture Content of Soils and Aggregate Bases by Use of the Troxler Model 3440 Nuclear Gauge

SCDOT Designation: SC-T- 31

1. SCOPE

1.1. This method describes procedures for determining the density and moisture content of soils and aggregate bases through the use of the nuclear equipment.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22.

3. SUMMARY OF TEST METHOD

3.1. The total or wet density of the material is determined by placing a gamma source into the material under test. The intensity of radiation detected is dependent upon the density of the material under test. The radiation intensity reading is related to measured wet density by suitable calibration curves or tables. The total water content is determined by placing a neutron source into the material under test. The quantity of fast neutrons is dependent upon the hydrogen content of the water in the material. The quantity of fast neutrons is related to the measured water content by suitable calibration curves or tables.

4. SIGNIFICANCE AND USE

4.1. The test method described is useful as a rapid, nondestructive method for the in-place determination of the wet density of soils and the wet density and moisture content of aggregate bases.

5. APPARATUS

5.1. Troxler Model 3440 Nuclear Gauge, reference standard, scraper plate, drill rod, drill rod extraction tool.

6. TEST SPECIMENS

6.1. This test is conducted on in-place soils or aggregate base material.

7. PROCEDURE

7.1. Turn the gauge on by pressing the “ON” key and the gauge will go through a short self-test. After the self-test, allow the gauge to warm-up for a minimum of 10 minutes. This will allow the systems critical circuits to stabilize.

7.2. Take moisture and density standard counts (at least 10 feet from any large object and at least 30 feet from another gauge).

7.3. Place the standard on a dry, solid and flat surface containing not more than 15 percent moisture and at least 100 pounds per cubic foot of density.

7.4. Place the gauge on the standard, being sure scaler end of gauge is toward the raised end of the standard and seated properly on the recessed surface.

7.5. Remove the padlock that locks the source rod in the “SAFE” position.

7.6. Press the “STANDARD” key and answer the prompted questions.

7.7. The gauge will prompt, “Take a new count?” Press the “YES” key.

7.8. The gauge will prompt, “Is the gauge on Standard Block & Source Rod in SAFE position?” Press the “YES” key. The gauge will display the count progress.

7.9. After the count completion, the gauge will display the Moisture Standard (MS) and the Density Standard (DS). The “P” or “F” display will indicate whether or not the counts fall within the acceptable limits. The DS should be within 1 percent and the MS within 2 percent of the average of the previous four counts.

7.10. Record both the DS (Density Standard) and MS (Moisture Standard) on the daily log.

7.11. The gauge will prompt, “Do you want to use new STD?” Press the “YES” key to accept the counts.

7.12. The gauge will return to the “READY” screen. Return the standard to its case.

7.13. If the surface is not relatively smooth, use the scraper plate to smooth and level the test surface (all loose stone should be removed and small voids filled with native fines or sand).

7.14. Take moisture and density measurement counts.

7.15. Using the drill rod and scraper plate, put the drill rod through the extractor tool, then through the scraper plate guide. Secure the scraper plate with one foot; drive the test hole at least 2 inches deeper than the desired test depth.

7.16. Remove the drill rod by rotating and pulling straight up. Do not loosen the drill rod by tapping from side to side with a hammer.

7.17. Before moving the scrapper plate, with your foot still securing the plate, take the drill rod and mark around the corners of the scraper plate.

7.18. Place the gauge within the scrapper plate outline.

7.19. Press the “SHIFT” key and “MODE” key and follow the display instructions to select the “SOIL” mode.

7.20. Press the “TIME” key and select “#2” for the recommended time (1 minute).

7.21. This step is only used for Aggregate Bases and Coquina Base Course. To enter Lab Proctor information press the “PROCTOR/MARSHALL” key and follow the display instructions to select “PROCTOR”, “STORED VALUE” or “NEW VALUE” and “LOCATION”.

7.22. Release the trigger and lower the source rod into the hole to the desired depth of measurement.

7.23. Gently slide the gauge to the right (scaler end), placing the source rod in firm contact with the sidewall of the hole.

7.24. Press the “START/ENTER” key to begin the test count. If the gauge is in the automatic depth mode, the correct depth will be displayed. If the gauge is in the manual depth mode, the gauge will prompt you to enter the depth manually. At this time, the gauge will begin the test count.

7.25. After the count time is complete, the gauge will display %PR, DD, WD, M and %M. Record the WD (Wet Density) and the actual Density Count only. To obtain the actual Density Count, press the “SHIFT” key and the “COUNTS” key.

7.26. Pull the source rod to the top notch, or “SAFE” position, and return the gauge to a safe area.

8. CALCULATIONS

8.1. Determine the moisture content and calculate the dry density pounds per cubic foot (pcf).

8.2. For Soils:

8.2.1. Determine the percent moisture using SC-T-22.

8.2.2. Calculate the dry density using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100}\right) \times 100$$

where:

γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.3. For Aggregate Base Materials:

8.3.1. Record %PR (% Compaction), DD (Dry Density), WD (Wet Density), M (Moisture) and %M (%Moisture) from the gauge display.

9. REPORT

9.1. Report the moisture content of the soil to the nearest 0.1 percent and the moisture content of aggregate base materials to the nearest 0.1 pound per cubic foot. Report the maximum dry density to the nearest 0.1 pound per cubic foot. If running the test on a soil material, report the results on SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge and SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge). If running the test on a graded aggregate base material or other material composed of large particles, use SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) Direct Read Gauge.

Standard Method of Test for

Field Determination of Density and Moisture Content of Soils and Aggregate Bases by Use of the Troxler Model 3450 Nuclear Gauge

SCDOT Designation: SC-T-32

1. SCOPE

1.1. This method describes procedures for determining the density and moisture content of soils and aggregate bases through the use of the nuclear equipment.

1.2. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22.

3. SUMMARY OF TEST METHOD

3.1. The total or wet density of the material is determined by placing a gamma source into the material under test. The intensity of radiation detected is dependent upon the density of the material under test. The radiation intensity reading is related to measured wet density by suitable calibration curves or tables. The total water content is determined by placing a neutron source into the material under test. The quantity of fast neutrons is dependent upon the hydrogen content of the water in the material. The quantity of fast neutrons is related to the measured water content by suitable calibration curves or tables.

4. SIGNIFICANCE AND USE

4.1. The test method described is useful as a rapid, nondestructive method for the in-place determination of the wet density of soils and the wet density and moisture content of aggregate bases.

5. APPARATUS

5.1. Troxler Model 3450 Nuclear Gauge, reference standard, scraper plate, drill rod, drill rod extraction tool.

6. TEST SPECIMENS

6.1. This test is conducted on in-place soils or aggregate base material.

7. PROCEDURE

7.1. Turn the gauge on by pressing the "ON" key and the gauge will go through a short self-test. After the self-test, allow the gauge to warm-up for a minimum of 10 minutes. This will allow the systems critical circuits to stabilize.

7.2. Take moisture and density standard counts (at least 10 feet from any large object and at least 30 feet from another gauge).

7.3. Place the standard on a dry, solid and flat surface containing not more than 15 percent moisture and at least 100 pounds per cubic foot of density.

7.4. Place the gauge on the standard, being sure the scaler end of the gauge is toward the raised end of the standard and seated properly on the recessed surface.

7.5. Remove the padlock that locks the source rod in the "SAFE" position.

7.6. Press the "STANDARD" key and answer the prompted questions.

7.7. The gauge display will show the last standard count and two selections ("1"-take a new count and "2"-view counts). Select "1" (take new count).

7.8. The gauge will prompt, "Put Rod In STD Pos. Place Gauge on Standard Block." Press the "ENTER" key. The gauge will display the count progress.

7.9. After the count completion, the gauge will display the Density Standard for Systems 1 (DS1), the Density Standard for Systems 2 (DS2) and the Moisture Standard (MS). The "#.#%" and "PASS" or "FAIL" display will indicate whether or not the counts fall within the acceptable limits. The DS1 and DS2 should be within 1 percent and the MS within 2 percent of the average of the previous four counts.

7.10. Record both the DS (Density Standard) and MS (Moisture Standard) on the daily log.

7.11. The gauge will prompt, "Use New Standard?" If the standard counts pass, press the "YES" key to accept the counts.

7.12. After accepting the new standard count, the gauge will prompt, "Calibrate the Depth Strip by Placing the Rod in Backscatter and Pressing Enter."

7.13. The gauge will return to the "READY" screen. Return the standard to its case.

7.14. If the surface is not relatively smooth, use the scraper plate to smooth and level the test surface (all loose stone should be removed and small voids filled with native fines or sand).

7.15. Take moisture and density measurement counts.

7.16. Using the drill rod and the scraper plate, put the drill rod through the extractor tool, then through the scraper plate guide. Secure the scraper plate with one foot; drive the test hole at least 2 inches deeper than the desired test depth.

7.17. Remove the drill rod by rotating and pulling straight up. Do not loosen the drill rod by tapping from side to side with a hammer.

7.18. Before moving the scrapper plate, with your foot still securing the plate, take the drill rod and mark around the corners of the scraper plate.

7.19. Place the gauge within the scrapper plate outline.

7.20. Press the “MODE” key and select “1” for the “SOIL” mode.

7.21. Press the “TIME” key and select “#2” for the recommended time (1 minute).

7.22. This step is only used for Aggregate Bases and Coquina Base Course. To enter Lab Proctor information, press the “TARGET” key and select “1” for “PROCTOR”. Enter either “5” for a new “TARGET VALUE” or choose an existing “STORED VALUE” and “LOCATION” from the menu. Press the “ENTER” key to return to the ready screen.

7.23. Release the trigger and lower the source rod into the hole to the desired depth of measurement.

7.24. Gently slide the gauge to the right (scaler end), placing the source rod in firm contact with the sidewall of the hole.

7.25. Press the “START” key to begin the test count. If the gauge is in the automatic depth mode, the correct depth will be displayed. If the gauge is in the manual depth mode, the gauge will prompt you to enter the depth manually. At this time, the gauge will begin the test count.

7.26. After the count time is complete, the gauge will display %PR, DD, WD, M and %M. Record the WD (Wet Density) and the actual Density Count only. To obtain the actual Density Count, press the “ARROW UP” key.

7.27. Pull the source rod to the top notch, or “SAFE” position, and return the gauge to a safe area.

8. CALCULATIONS

8.1. Determine the moisture content and calculate the dry density pounds per cubic foot (pcf).

8.2. For Soils:

8.2.1. Determine the percent moisture using SC-T-22.

8.2.2. Calculate the dry density using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100} \right) x\ 100$$

where: γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.3. For Aggregate Base Materials:

8.3.1. Record %PR (% Compaction), DD (Dry Density), WD (Wet Density), M (Moisture) and %M (% Moisture) from the gauge display.

9. REPORT

9.1. Report the moisture content of the soil to the nearest 0.1 percent and the moisture content of aggregate base materials to the nearest 0.1 pound per cubic foot. Report the maximum dry density to the nearest 0.1 pound per cubic foot. If running the test on a soil material, report the results on SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge and SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge). If running the test on a graded aggregate base material or other material composed of large particles, use SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) Direct Read Gauge.

Standard Method of Test for

Field Determination of Density and Moisture Content of Soils and Aggregate Bases by Use of the Troxler Model 3401 Nuclear Gauge

SCDOT Designation: SC-T-33

1. SCOPE

1.1. This method describes procedures for determining the density and moisture content of soils and aggregate bases through the use of the nuclear equipment.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22.

3. SUMMARY OF TEST METHOD

3.1. The total or wet density of the material is determined by placing a gamma source into the material under test. The intensity of radiation detected is dependent upon the density of the material under test. The radiation intensity reading is related to measured wet density by suitable calibration curves or tables. The total water content is determined by placing a neutron source into the material under test. The quantity of fast neutrons is dependent upon the hydrogen content of the water in the material. The quantity of fast neutrons is related to the measured water content by suitable calibration curves or tables.

4. SIGNIFICANCE AND USE

4.1. The test method described is useful as a rapid, nondestructive method for the in-place determination of the wet density of soils and the wet density and moisture content of aggregate bases.

5. APPARATUS

5.1. Troxler Model 3401 Nuclear Gauge, reference standard, scraper plate, drill rod, drill rod extraction tool.

6. TEST SPECIMENS

6.1. This test is conducted on in-place soils or aggregate base material.

7. PROCEDURE

7.1. Turn the “PWR/TIME” switch to the “SLOW” position for 10 minutes to allow critical circuits to stabilize.

7.2. Take moisture and density standard counts (at least 10 feet from any large object and at least 30 feet from another gauge).

7.3. Place the standard on a dry, solid and flat surface containing not more than 15 percent moisture and at least 100 pounds per cubic foot of density.

7.4. Place the gauge on the standard, being sure scaler end of gauge is toward the raised end of the standard and seated properly on the recessed surface.

7.5. Remove the padlock that locks the source rod in the “SAFE” position.

7.6. Place the “PWR/TIME” switch in the “SLOW” position.

7.7. Press the “START” button.

7.8. Wait 4 minutes after which time the “ERR” symbol will disappear.

7.9. Turn the display switch to “MOISTURE” and record the Moisture Standard Count.

7.10. Turn the display switch to “DENSITY” and record the Density Standard Count.

7.11. Return the standard to its case.

7.12. If the surface is not relatively smooth, use the scraper plate to smooth and level the test surface (all loose stone should be removed and small voids filled with native fines or sand).

7.13. Take moisture and density measurement counts.

7.14. Using the drill rod and the scraper plate, put the drill rod through the extractor tool, then through the scraper plate guide. Secure the scraper plate with one foot; drive the test hole at least 2 inches deeper than the desired test depth.

7.15. Remove the drill rod by rotating and pulling straight up. Do not loosen the drill rod by tapping from side to side with a hammer.

7.16. Before moving the scrapper plate, with your foot still securing the plate, take the drill rod and mark around the corners of the scraper plate.

7.17. Place the gauge within the scrapper plate outline.

7.18. Release the trigger and lower the source rod into the hole to the desired depth of measurement.

7.19. Gently slide the gauge to the right (scaler end), placing the source rod in firm contact with the sidewall of the hole.

7.20. Turn the "PWR/TIME" switch to "NORM."

7.21. Press the "START" button.

7.22. Wait one minute, after which time the "ERR" symbol will disappear.

7.23. Turn the display switch to "MOISTURE" and record the Moisture Measurement Count.

7.24. Turn the display switch to "DENSITY" and record the Density Measurement Count.

7.25. Pull the source rod to the top notch, or "SAFE" position, and return the gauge to a safe area.

8. CALCULATIONS

8.1. Calculate wet density pounds per cubic foot (pcf).

8.1.1. Divide the density measurement count by the density standard count to obtain the count ratio.

8.1.2. Turn to the proper tables provided with the nuclear gauge and record the wet density, pcf.

8.2. Determine the moisture content and calculate the dry density pounds per cubic foot (pcf).

8.3. For Soils:

8.3.1. Determine the percent moisture using SC-T-22.

8.3.2. Calculate the dry density using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100} \right) x\ 100$$

where:

γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.4. For Aggregate Base Materials:

8.4.1. Divide the moisture measurement count by the moisture standard count to obtain the count ratio.

8.4.2. Turn to the proper tables provided with the gauge and record the moisture content, pcf.

8.4.3. Calculate the dry density using the following equation:

Dry Density (pcf) = Wet Density (pcf) – Moisture Content (pcf).

9. REPORT

9.1. Report the moisture content of the soil to the nearest 0.1 percent and the moisture content of aggregate base materials to the nearest 0.1 pound per cubic foot. Report the maximum dry density to the nearest 0.1 pound per cubic foot. If running the test on a soil material, report the results on SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge and SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge). If running the test on a graded aggregate base material or other material composed of large particles, use SCDOT Form 300.02 – Density Test Report (Nuclear Gauge).

SCDOT
Sampling and Testing Procedures

C.5 CONCRETE AND CEMENT

Standard Practice for

Making and Curing Concrete Beam Specimens

SCDOT Designation: SC-T-46

1. SCOPE

1.1. This practice covers procedures for making beam specimens from representative samples of fresh concrete for a construction project. The nominal size of the beam specimen is 6 inches by 6 inches by 20 inches.

1.2. This practice is not satisfactory for making specimens from concrete not having measurable slump or requiring other shapes and sizes.

1.3. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1. None.

3. SIGNIFICANCE AND USE

3.1. This practice provides standardized requirements for making concrete beam specimens.

3.2. If the specimens are made and standard cured, as stipulated herein, the resulting strength test data when the specimens are tested are able to be used for the following purposes:

3.2.1. Acceptance testing for specified strength,

3.2.2. Checking adequacy of mixture proportions for strength,

3.2.3. Quality control.

3.3. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent.

4. APPARATUS

4.1. *Beam Molds* — Beam molds shall be of the shape and dimensions stipulated in step 5.1. The inside surfaces of the molds shall be smooth. The sides, bottom and ends shall be at right angles to each other and be straight and true and free of warpage. Maximum variation from the nominal cross section shall not exceed 1/8 inch. Molds shall produce specimens at least as long but not more than 1/16 inch shorter than the required length in step 5.1.

4.2. *Tamping Rod* — A round, straight steel rod that is 5/8 inches in diameter and 20 inches in length, having the tamping end or both ends rounded to a hemispherical tip of the same diameter as the rod.

4.3. *Vibrators* — Internal vibrators shall be used. The vibrator frequency shall be at least 7000 vibrations per minute (150 Hz) while the vibrator is operating in the concrete. The diameter of a round vibrator shall be no more than 1.5 inches. Other shaped vibrators shall have a perimeter no greater than the equivalent round vibrator (1.77 inches). The combined length of the vibrator shaft and vibrating element shall be at least 9 inches. The vibrator frequency shall be checked periodically using the vibrating reed tachometer.

4.4. *Mallet* — A mallet with a rubber or rawhide head weighing 1.25 ± 0.50 pounds shall be used.

4.5. *Small Tools* — Shovels, hand-held floats, scoops, and vibrating reed tachometer shall be provided.

4.6. *Sampling Receptacle* — The receptacle shall be a suitable heavy gage metal pan, wheelbarrow, or flat, clean, nonabsorbent board of sufficient capacity to allow easy remixing of the entire sample with a shovel or trowel.

5. TESTING REQUIREMENTS

5.1. *Beam Specimens* — Flexural strength specimens shall be beams of concrete cast and hardened in the horizontal position. The standard beam shall be 6 by 6 inches in cross section and 20 inches in length.

6. SAMPLING CONCRETE

6.1. The samples used to fabricate test specimens under this standard shall be obtained in accordance with SCDOT procedure SC-T-41, “Sampling Fresh Concrete”.

7. MOLDING SPECIMENS

7.1. *Place of Molding* — Mold specimens promptly on a level, rigid surface, free of vibration and other disturbances, at a place as near as practicable to the location where they are to be stored.

7.2. *Consolidation* — The methods of consolidation for this practice are rodding or internal vibration.

7.2.1. *Rodding* — Place the concrete in the mold, in two layers of approximately equal depth. Rod each layer with the rounded end of the rod sixty (60) times, distributing the roddings uniformly over the cross section of the mold. For the upper layer, allow the rod to penetrate through the layer being rodded into the layer below approximately 1 inch.

After each layer is rodded, tap the outsides of the mold lightly 10 to 15 times with the mallet, to close any holes left by rodding and to release any large air bubbles that may have been trapped. *(Note: Do NOT use a steel hammer for this step.)* After tapping, spade each layer of the concrete along the sides and ends of beam molds with a trowel or other suitable tool. It is recommended that the mold be slightly overfilled for the second layer prior to rodding to account for the reduction of volume caused by consolidation. Underfilled molds shall be adjusted with representative concrete during consolidation of the top layer. Overfilled molds shall have excess concrete removed.

7.2.2. *Vibration* — Maintain a uniform duration of vibration for the particular kind of concrete and vibrator involved. Fill each mold so as to avoid overfilling (after vibration) by more than ¼ inch. Only one layer of concrete is required. Vibrate once in the center of the mold and once at each end, 6 inches from the center. Vibrate long enough only to achieve proper consolidation of the concrete. Usually sufficient vibration has been applied as soon as the surface of the concrete the surface of the specimen has become relatively smooth. While vibrating the specimen, the vibrator shall not be allowed to rest on or touch the sides or bottom of the mold. Carefully withdraw the vibrator in such a manner that no air pockets are left in the specimen. After vibration, tap the outsides of the mold at least 10 times with the mallet to close holes that remain and release entrapped air voids. *(Note: Do NOT use a steel hammer for this step.)*

7.3. *Finishing* — After consolidation, finish the specimen by striking off the top with a straightedge and finishing with a hand-held float. Overfinshing shall be avoided. Care should be taken to when cutting down the specimen to avoid removal of excess depth. *(Note: This can be accomplished with a straightedge that has a sharp side corner rather than a worn or rounded side corner.)* Smooth the surface with a flat trowel.

8. CURING

8.1. *Storage* — If specimens cannot be molded at the place where they will receive initial curing, immediately after finishing move the specimens to an initial curing place for storage. The supporting surface on which specimens are stored shall be level to within 0.25 inch per foot.

8.2. *Initial Curing* — Immediately after molding and finishing, the specimens shall be stored for a period between 18 and 48 hours in a temperature range of 60°F to 80°F and in an environment preventing moisture loss from the specimens. Various procedures are capable of being used during the initial curing period to maintain the specified moisture and temperature conditions. An appropriate procedure or combination of procedures shall be used (See Note 3). Shield all specimens from direct sunlight and, if used, radiant heating devices. The storage temperature shall be controlled by the use of heating and cooling devices, as necessary. Record the temperature using a maximum-minimum thermometer. *(Note 3: A satisfactory moisture environment can be created during the initial curing by one or more of the following procedures: (1) place inside plastic bags, (2) cover with plastic sheets or non-absorbent, non-reactive plates or a sheet of tough, durable plastic. A satisfactory temperature environment can be controlled during the initial curing of the specimens by one or more of the following* *procedures: (1) use of ventilation, (2) use of ice, (3) use of thermostatically controlled heating or curing devices, or (4) use of heating methods such as stoves or light bulbs. Other suitable methods may be used provide the requirements limiting specimen storage temperature and moisture loss are met.)*

8.3. *Final Curing* — Upon completion of initial curing and within 30 minutes after removal the molds, cure specimens with free water maintained on their surfaces at all times at a temperature of 73° ± 3°F through the use of an approved moist curing room or in a continuously circulating, thermostatically temperature-controlled bath of water saturated with calcium hydroxide. Upon removal from the molds, the specimens shall be marked with a waterproof felt tip marker to minimally indicate month, day, and specimen number. Care shall be exercised in handling the beams to avoid bumping them together or dropping them. A recording thermometer shall be used to monitor air or water temperature, as appropriate, to create a permanent record of curing temperature. If a moist curing room is used, the specimens shall be stored in a calcium hydroxide-saturated water bath meeting the requirements given above for a minimum of 20 hours prior to testing. Drying of the surfaces of the beam shall be prevented between removal from water storage and completion of testing. *(Note 4: Relatively small amounts of surface drying of flexural specimens can induce tensile stresses in the extreme fibers that will markedly reduce the indicated flexural strength.)*

9. TRANSPORTATION OF SPECIMENS TO LABORATORY

9.1. If the specimens must be transported for final testing, cure and protect specimens as required in Step 8. Specimens shall not be transported until they are at least 7 days old. When transporting specimens, a truck bed covered with damp sand or several layers of dampened burlap shall be used in order to keep the surfaces damp while transporting. After placing beams in the prepared truck bed, a polyethylene cover should be used to hold moisture in the load while traveling. Under no circumstances shall the transportation time exceed 4 hours.

Standard Method of Test for

Method of Sampling Portland Cement, Slag, and Fly Ash

SCDOT Designation SC-T-47

1. SCOPE

1.1. These methods cover the procedures for sampling Portland cement, slag, and fly ash.

2. SUMMARY OF SAMPLING METHOD

2.1. A sample of Portland cement may be sampled from a bulk shipment of car or truck, or from the batch plant silo.

3. SIGNIFICANCE AND USE

3.1. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent.

4. APPARATUS

4.1. Plastic airtight gallon container and a suitable, clean shoveling device.

5. TEST SPECIMENS

5.1. *Sample Size and Sample Protection* — The size of the sample of material shall be 1 gallon. As samples are taken, it shall be placed directly in moisture-proof, airtight 1-gallon container to avoid moisture absorption and aeration of the sample. Containers shall be completely filled and sealed immediately.

6. PROCEDURE

6.1. *Sampling* — The material may be sampled as circumstances and batch plant equipment permit. In all cases, care shall be taken to prevent contaminating the sample by foreign matter. In most cases, samples may be obtained as follows:

6.2. *From Bulk Shipment of Rail Car or Truck* — The sample may be obtained from the delivery vehicle or along the conveyer route of travel from the vehicle to the batch plant storage silo. When sampling from the delivery vehicle, the sample may be obtained from the top hatch openings of a full load. The sample shall be taken at different points and should not include the surface material. When sampling from the conveyor route, be it bucket, auger or air flow, the sample shall be obtained by stopping the conveyor as many times as necessary to obtain a complete sample.

6.3. *From Batch Plant Silo* — The sample may be obtained from the scale hopper or by discharge as equipment will permit. Sampling from batch plant silos should only be done as a last resort when the identity of the material sample by mill test report is questionable.

SCDOT Sampling and Testing Procedures

C.6 ASPHALT MATERIALS

Standard Method of Test for

Methods of Sampling Bituminous Materials

SCDOT Designation SC-T-61

1. SCOPE

1.1. These methods apply to the sampling of liquid or semi-solid bituminous materials from storage tanks and tanker trucks.

2. SIGNIFICANCE AND USE

2.1. The purpose of using this procedure is to ensure that the sample of bituminous material is representative of the entire storage tank and to reduce sampling bias.

3. APPARATUS

3.1. It is essential that thoroughly clean and dry containers are used. Samples of asphalt cement are to be placed in compression top cans; cutback asphalts are to be placed in screw top cans; and emulsions are to be placed in clean plastic containers.

4. TEST SPECIMEN

4.1. Care shall be taken that the samples are not contaminated with dirt, fuel-oil or other extraneous matter and that the sample containers are perfectly clean and dry before filling.

4.2. Immediately after filling, the sample containers shall be tightly closed and properly marked for identification. Samples of emulsions shall be protected from freezing.

5. PROCEDURE

5.1. Samples shall be taken in the manner hereinafter described. They shall in no case be dipped from the surface of the material.

5.2. *Sampling from Storage Tanks* — In sampling from storage tanks (such as those located at asphalt plants), the sample is to be taken from one of the three sampling outlets provided. Some asphalt should be permitted to flow through the sampling outlet before the sample portion is taken.

5.3. *Sampling from Delivering Tankers* — In sampling from delivery tankers, the sample is to be taken by using the sampling valve after a distributor load has been removed from the tanker. The sampling valve should be flushed with at least 4 liters (1 gallon) of the asphalt to remove foreign material prior to obtaining the sample.

Standard Method of Test for

Methods of Sampling Bituminous Materials

SCDOT Designation SC-T-62

1. SCOPE

1.1. This method covers the procedures for sampling mixtures of bituminous materials with mineral aggregate as prepared for use in paving.

2. SIGNIFICANCE AND USE

2.1. The purpose of using this procedure is to ensure that the sample of bituminous mixture is representative of the entire truck or paver and to reduce sampling bias.

3. APPARATUS

3.1. Round-point shovel and sample bag or 5-gallon pail.

4. TEST SPECIMEN

4.1. Minimum size sampled should be in accordance with Figure SC-T-62A.

MAXIMUM SIZE OF PARTICLE (Passing Sieve)	MINIMUM WEIGHT OF SAMPLES (kilograms (pounds))
2.00 mm (No. 10)	1.8 (4)
4.75 mm (No. 4)	1.8 (4)
9.5 mm ($^3/_8$ inch)	3.6 (8)
12.5 mm (½ inch)	5.4 (12)
19.0 mm (¾ inch)	7.2 (16)
25.0 mm (1 inch)	9.0 (20)
37.5 mm (1½ inch)	11.3 (25)
50.0 mm (2 inch)	15.9 (30)

TABLE OF MINIMUM SAMPLE SIZES
Figure SC-T-62A

5. PROCEDURE

5.1. *Selection of Samples* — Sampling is as equally important as testing, and the sampler shall use every precaution to obtain samples that are truly representative of the bituminous mixture. Care shall be taken in sampling to avoid segregation of coarse aggregate and bituminous binder. Care shall also be taken to prevent contamination by dust or other foreign matter.

5.2. *Size of Sample* — The size of the sample shall be governed by the maximum size of particle of mineral aggregate in the mixture. The minimum size of sample shall conform to the requirements shown in Figure SC-T-62A.

5.3. Sampling Plant-Mixed Bituminous Mixtures:

5.3.1. *Truck Bed Sampling* — Sampling from the truck beds shall be accomplished by shoveling away the top part of the section to be sampled to a depth of at least 300 millimeters (12 inches). This is done so as to eliminate the possibility of segregated material. Then, with a round-point shovel, dig straight down into the material from at least two places to obtain the sample. *In no case should the plant technician step into the bed of the truck. If necessary, the truck will need to be repositioned to reach a desired location.*

5.3.2. *Paver Hopper Sampling* — Sampling from the paver hopper shall be accomplished by having the truck unload half of its load into the hopper and then having the truck pull forward. The sample should be obtained by shoveling away the top material with a round-point shovel and removing the material from at least two places in the hopper, directly above the slat conveyors. Sampling from the paver screw conveyors shall not be permitted.

Standard Method of Test for

Field Determination Of Target Density For Asphalt Concrete Materials By Use Of The Control Strip Technique

SCDOT Designation: SC-T-65

1. SCOPE

1.1 This test method demonstrates how to properly construct a control strip during the placement of Hot Mix Asphalt Pavement (HMA). Control strips are necessary to determine an optimum roller pattern and to ensure proper target density.

2. REFERENCE DOCUMENTS

2.1 SC-T-101

3. SUMMARY OF TEST METHOD

3.1 This test method determines the number of passes for each phase of rolling to achieve contract density requirements. The average of 10 random nuclear gauge readings shall be used to determine the compaction effort to be used as a target density of the hot mix asphalt.

4. SIGNIFICANCE AND USE

4.1 The established target density shall be used to monitor the compaction effort throughout the construction of the hot mix asphalt.

5. APPARATUS

5.1 The Contractor may select the equipment for rolling the asphalt concrete mixture in the control strip so long as proper density and a smooth riding pavement are obtained. The density of the asphalt concrete material is determined with a nuclear gauge operating in the backscatter mode. The nuclear gauge shall be capable of measuring the density of asphalt concrete materials and shall be operated by a trained and certified operator.

6. TEST SPECIMEN

6.1 Minimum of 300 feet of freshly paved asphalt roadway.

7. PROCEDURE

7.1 General:

7.1.1 The control strip shall be constructed at the start of the paving operation, generally between 500 and 1000 feet from the point the paving operation begins. As work progresses, additional control strips will need to be constructed if there are changes in the underlying support, the materials in the asphalt mix, the thickness of the mat, the paving or rolling equipment, any other elements that might affect the final density achieved, or when density requirements are not being met.

7.1.2 The control strip shall be a minimum of 300 feet in length, one paving width wide, and the same thickness as required in the construction documents.

7.1.3 Material used for construction of the control strip shall be representative of the asphalt concrete material in the subsequent paving operation. Delivery temperature of the material shall be within $\pm$ 20°F of the specified mixing temperature and shall be the same as the temperature expected on the remainder of the work.

7.1.4 The control strip shall be constructed using the same paving and rolling equipment that will be used for the subsequent paving operation.

7.2 Optimum Roller Pattern:

7.2.1 After the initial pass of the breakdown roller, 3 locations within the 300 ft. control strip shall be selected and marked with lumber crayon. These locations shall be at least 3 feet from the pavement edge. NOTE: A zero offset shall be used when obtaining control strip density readings.

7.2.2 Initial nuclear gauge readings shall be taken at each of the 3 selected locations. Density shall be determined from appropriate calibration curves for the nuclear gauge being used.

7.2.3 Successive nuclear gauge readings shall be taken at the exact same locations after each pass of the roller. Mix temperature will be taken and recorded at that time. Rolling shall continue until the maximum attainable density is achieved, as determined by successive readings showing not more than 1 pound of density increase, with a minimum of 2 passes of each rolling phase.

7.2.4 The procedure as outlined in 7.2.1, 7.2.2, and 7.2.3 shall be repeated for each phase of rolling. All rolling shall be completed while the mix temperature is above 175°F, unless otherwise approved in writing by Asphalt Materials Engineer.

7.2.5 The optimum roller pattern shall be established by eliminating subsequent passes of each roller that do not contribute to more than 1 pound of densification, except for the finishing rolling, which should yield the maximum compaction effort, without “breaking” the mixture. This roller pattern shall be recorded and used throughout the subsequent paving operation or until conditions require a new control strip to be constructed.

7.3 Target Density:

7.3.1 After all rolling of the control strip has been completed, twelve random nuclear gauge tests are made in the control strip area. The highest and lowest will be discarded. These readings are averaged and this average control strip density shall be the target density for subsequent paving operations.

CALCULATIONS

8.1 Example: ....

Roller & No. Passes	Site 1	Site 2	Site 3	Average	Remarks
Static 1	131.2	128.0	131.4	130.2	
Static 2	136.2	132.0	133.2	133.8	
Static 3	137.3	132.7	135.8	135.3	
~~Static 4~~	~~138.4~~	~~134.5~~	~~135.5~~	~~136.1~~	Omit
Pneumatic 1	135.4	135.1	135.9	135.5	
Pneumatic 2	135.3	136.8	138.7	136.9	
~~Pneumatic 3~~	~~137.7~~	~~136.6~~	~~135.9~~	~~136.7~~	Omit
Finish 1	138.5	136.9	137.7	137.7	
Finish 2	139.6	138.6	137.9	138.7	
Finish 3	139.5	137.8	138.4	138.6	Use

Notes: Omit these passes due to gaining less than 1 pound.

ROLLER PATTERN CALCULATIONS
Figure SC-T-65A

The above roller pattern shall be recorded as 3 Static – 2 Pneumatic – 3 Finish

8.2 The target density shall be used in the monitoring and acceptance of hot mix asphalt. Density readings taken throughout the monitored section of the roadway should compare reasonably with the target density. Compare the readings to the target density in the following manner:

Established Target Density = 135.6 psy

Average Daily Random Readings (SC-T-101) = 134.8 psy

Percentage of Target Density (% Compaction) = $\frac{134.8}{135.6} \times 100 = 99.4\%$

Results not comparing favorably should be investigated by the QC Manager and may require a new control strip and a new target value established.

8. REPORT

9.1 Record roller patterns and densities on SCDOT Form 400.02 – Determination of Target Density for Asphalt Concrete Materials.

Standard Method of Test for

Field Determination of Stability of Hot-Mix Asphalt Mixture by Marshall Method

SCDOT Designation: SC-T-66

1. SCOPE

1.1. This method covers the field procedure for determining Marshall stability of hot-mix asphalt surface, binder and sand asphalt mixes.

2. REFERENCED DOCUMENT

2.1. AASHTO T 245, AASHTO M 231.

2.2. SC-T-62, SC-T-100.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to check or verify the compressive strength of an asphalt mixture to ensure that minimum stability values meet the required specifications.

4. APPARATUS

4.1. *Compaction Assembly* — specimen mold assembly, compaction hammer, compaction pedestal, specimen mold holder and breaking head meeting specifications of AASHTO T 245.

4.2. *Thermostatically Controlled Oven* — capable of maintaining 95°C to 150°C (200°F to 300°F).

4.3. *Hot Plate* — capable of maintaining 95°C to 150°C (200°F to 300°F).

4.4. *Balance* — of sufficient capability (2-kilogram capacity and sensitive to 0.1 gram) meeting the requirements of AASHTO M 231.

4.5. *Wire Basket* — or non-absorbent string (to hang under balance).

4.6. *Water Bath* — of sufficient capacity (typically 170 liters (45 gallons)) equipped with a mechanical stirrer and capable of maintaining 60°C ± 1.0°C (140°F ± 1.8°F). Bath shall contain potable water.

4.7. *Miscellaneous Items* — calibrated dial thermometer (range of 10°C to 204°C (50°C to 400°F) and sensitive to 2.8°C (5°F) is recommended, penetrating oil (e.g. WD-40), circular paper disks (100 millimeter diameter), spade or spatula.

5. TEST SPECIMENS

5.1. Thirty to sixty minutes prior to molding the specimens, heat the mold assembly (base plate, mold and collar) to a temperature between 95°C (200°F) and 150°C (300°F) in a thermostatically controlled oven. Heat the compaction hammer to a temperature between 100°C (200°F) and 150°C (300°F) on a hot plate. The mold assembly and hammer shall be perfectly clean.

5.2. Check the temperature of the mix in the truck. If the temperature is between 146°C (295°F) and 157°C (315°F), take a large enough sample for a solvent-extraction or ignition-oven test and two Marshall specimens.

5.3. Remove the mold from the oven and coat the inside of the mold with a light application of a penetrating oil. Place a circular 100-millimeter (4-inch) diameter disc of paper in the bottom before the mixture is introduced.

5.4. Weigh approximately 1000 grams of the sample for a sand asphalt specimen, and 1200 grams for binder and surface specimens.

5.5. Introduce the hot mix into the mold and spade with a heated spatula (or spade) 15 times around the perimeter and 10 times over the interior. Remove the collar and smooth the surface of the mix with a trowel to a slightly rounded shape. Insert a dial thermometer in the mix and move the thermometer around the mold to insure an accurate reading. The mix temperature before compacting should be 146°C ± 3°C (295°F ± 5°F). If the temperature is below 143°C (290°F), discard the batch and repeat the process quickly to reduce heat loss. The mixture shall not be reheated.

5.6. Replace the collar and place the mold assembly with the mixture in the mold holder, and insert another 100-millimeter (4-inch) diameter disc of paper. Apply a light coat of the penetrating oil to base of the hammer to prevent the sticking of the hammer to the surface of the core. Then, apply the number of blows specified in the Contract (either 50 blows or 75 blows) with the compaction hammer. The face of the compaction hammer shall be parallel to the base during the application of compaction blows.

5.7. Remove the base plate and collar, reverse and reassemble the mold. Repeat the same number of blows on the reverse side.

5.8. Remove the collar and base plate. After the specimen has air cooled, place the assembly (with the extension collar up) in the testing machine; apply pressure to the collar by means of the load transfer bar and force the specimen into the extension collar. After removal, number each specimen and place them on a flat surface. Care should be exercised in handling to avoid fracture.

5.9. The specimen shall then be air cooled to room temperature.

5.10. Make an additional specimen using the same material as obtained in Step 5.2 above. Dig deep down into the bucket of mixture to secure hot material.

6. PROCEDURE

6.1. To determine the volume of the test specimen, weigh the specimen in air and then, by attaching a non-absorbent string or wire basket to a balance, weigh the specimen under water at 25°C ± 1°C (77°F ± 1.8°F). The specimen should be gently moved around before obtaining a final reading to allow all air bubbles to escape. The specimen shall then be weighed saturated surface-dry (SSD). The SSD condition is obtained by gently blotting the wet specimen with a damp towel or cloth (do not use a dry paper towel to dry the specimen) until the surface of the specimen contains no free moisture. The weight in water subtracted from the SSD weight yields the volume (cubic millimeters) of the specimen. This volume will be used later to determine the correlation ratio.

6.2. Place the specimen and testing mold in a water bath, equipped with a mechanical stirrer, at a temperature of 60°C ± 1.0°C (140°F ± 1.8°F) for a period of 35 ± 5 minutes.

6.3. Check the guide rods to see that the upper test head slides freely. Remove the specimen from the water bath and place in the lower segment of the breaking head. Place the upper segment of the breaking head on the specimen. The testing head and specimen are then placed in the Marshall machine.

6.4. Apply load to the specimen until the maximum load is reached and the load decreases as indicated by the dial. Record the maximum deflection noted on the testing machine and refer to the chart for the stability value. The elapsed time for the test from removal of the test specimen from the water bath to the maximum load determination shall not exceed 30 seconds. The corrected stability is found by multiplying the measured stability by the correlation ratio. Using the volume of the core, calculated in Step 6.1., determine the correlation ratio using Figure SC-T-66A.

7. CALCULATIONS

7.1. Volume = Air Weight – SSD Weight

Corrected Stability = Measured Stability x Correlation Ratio
(see Note 2. Figure SC-T-66A)

8. REPORT

8.1. Record the corrected stability on SCDOT Form 400.01 – Ignition Oven Worksheet and report on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection.

VOLUME OF SPECIMEN[1] (cm^3)	THICKNESS[1] OF SPECIMEN mm (inch)	CORRELATION RATIO
406 to 420	50.8 (2)	1.47
421 to 431	52.4 (2-1/16)	1.39
432 to 443	54.0 (2-1/8)	1.32
444 to 456	55.6 (2-3/16)	1.25
457 to 470	57.2 (2-1/4)	1.19
471 to 482	58.7 (2-5/16)	1.14
483 to 495	60.3 (2-3/8)	1.09
496 to 508	61.9 (2-7/16)	1.04
509 to 522	63.5 (2-1/2)	1.00
523 to 535	64.0 (2-9/16)	0.96
536 to 546	65.1 (2-5/8)	0.93
547 to 559	66.7 (2-11/16)	0.89
560 to 573	68.3 (2-3/4)	0.86
574 to 585	71.4 (2-13/16)	0.83
586 to 598	73.0 (2-7/8)	0.81
599 to 610	74.6 (2-15/16)	0.78
611 to 625	76.2 (3)	0.76

CORRELATION RATIOS FOR SPECIMENS
Figure SC-T-66A

Notes:

1. *Volume-thickness relationship is based on a specimen diameter of 100 millimeters (4 inches).*

2. *The measured stability of a specimen multiplied by the ratio for the thickness of the specimen equals the corrected stability for a 63.5-millimeter (2½-inch) specimen.*

Standard Method of Test for

Determination of Percent Air Voids and Percent Voids in Mineral Aggregate in Compacted Marshall / Gyratory Specimens

SCDOT Designation: SC-T-68

1. SCOPE

1.1. This test method outlines the procedure for determining the percent air voids and voids in mineral aggregate (VMA) in compacted Marshall / Gyratory specimens.

2. REFERENCED DOCUMENT

2.1. AASHTO M 231, AASHTO T 312.

2.2. SC-T-62, SC-T-66.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to determine the percent of air voids in an asphalt mixture to assess whether the mixture meets specifications.

4. APPARATUS

4.1. *Balance* — meeting the requirements of AASHTO M 231, 3 kilograms or greater capacity, sensitive to 0.1 gram, equipped with suitable suspension apparatus and holder to permit weighing the specimen while suspended from the center of the scale pan of balance.

4.2. *Water Bath* — for immersing the specimen in water while suspended under the balance, capable of maintaining temperature of 25°C ± 1°C.

5. TEST SPECIMENS

5.1. Obtain the asphalt sample from the truck in accordance with SC-T-62 and prepare a minimum of two (2) Marshall/Gyratory specimens according to the method outlined in SC-T-66 or AASHTO T 312.

6. PROCEDURE

6.1. Cool the specimens to room temperature (25°C ± 1°C), weigh and record the dry mass in grams (designated as A).

6.2. Immerse each specimen in water for 3 to 5 minutes on the suspended scale pan, weigh and record the immersed mass in grams (designated as C).

6.3. Remove the specimens from the water, surface dry by blotting with a damp towel, and weigh and record the saturated surface-dry (SSD) mass in grams (designated as B).

7. CALCULATIONS

7.1. Calculate the Bulk Specific Gravity (BSG) of each specimen as follows:

$$\text{Bulk Specific Gravity} = D = \frac{A}{(B - C)}$$

where:
- A = mass (grams) of specimen in air
- B = mass (grams) of specimen SSD in air
- C = mass (grams) of specimen in water

7.2. Calculate the Maximum Rice Specific Gravity (MSG) for each specimen as follows:

$$E = MSG = \frac{100}{(F/G) + ((100 - F)/ESG)}$$

where:
- F = %AC in sample (from extraction)
- G = specific gravity of AC in sample (from job mix information sheet)
- ESG = Effective Specific Gravity (from job mix information sheet)

7.3. Calculate the Percent Air Voids as follows:

$$\%\text{Air Voids} = (1 - (D/E)) \times 100$$

where:
- D = Bulk Specific Gravity
- E = Maximum Rice Specific Gravity

7.4. Calculate the %AC by volume as follows:

$$\%\text{AC by volume} = \frac{(F \times D)}{G}$$

where:
- D = Bulk Specific Gravity
- F = %AC in sample (from extraction)
- G = specific gravity of AC in sample (from job mix information sheet)

7.5. Calculate the Percent Voids in Mineral Aggregate as follows:

%VMA = %AC by volume + %Air Voids

7.6. Example Calculations:

7.6.1. Given:
- A = 1206 grams = mass of specimen in air
- B = 1210 grams = mass of specimen SSD in air
- C = 699 grams = mass of specimen in water
- F = 5.7% = %AC in sample (from extraction)
- G = 1.031 = specific gravity of AC in sample (from job mix info. sheet)
- ESG = 2.738 = Effective Specific Gravity (from job mix info. sheet)

Find: %Air Voids and %VMA

7.6.2. Calculations:

$$\text{Bulk Specific Gravity} = \frac{1206}{(1210 - 699)} = 2.360$$

$$E = MSG = \frac{100}{(5.7/1.031) + ((100 - 5.7)/2.738)} = 2.502$$

$$\%\text{Air Voids} = (1 - (2.360/2.502)) \text{ x } 100 = 5.7\%$$

$$\%\text{AC by volume} = \frac{(5.7 \text{ x } 2.360)}{1.031} = 13.0\%$$

$$\%\text{VMA} = 13.0 + 5.7 = 18.7\%$$

8. REPORT

8.1. Record BSG, MSG, %Air Voids, %AC by volume and %VMA on SCDOT Form 400.01 – Ignition Oven Worksheet and report on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection.

Standard Method of Test for

Field Determination of Percent Lime in Asphalt Mixtures

SCDOT Designation: SC-T-71

1. SCOPE

1.1. To determine the percent lime being entered into an asphalt mixture at the production site.

2. REFERENCED DOCUMENT

2.1. SC-T-2, SC-T-23.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to check the lime rate to ensure that the lime rate meets SCDOT specifications to prevent asphalt mixtures from stripping.

4. APPARATUS

4.1. Heavy-duty large plastic garbage bag, scale, timing.

5. TEST SPECIMEN

5.1. Hydrated lime.

6. PROCEDURE

6.1. The plant's cold feed production rate at the time of sampling the lime shall be obtained from the computer display in the control room. The cold feed rate shall be the rate of aggregate and moisture in tons per hour (TPH).

6.2. Determining Moisture Content:

6.2.1. The moisture content of the aggregate is determined by stopping the cold feed belt and obtaining a representative sample of aggregate from the belt. The belt sample should be obtained by following the procedure outlined in SC-T-2, "Methods of Sampling Fine Aggregates." The aggregate moisture content shall be determined in accordance with SC-T-23, "Determining Moisture Content of Soils by Pan Drying Method." To account for the presence of coarse aggregate, use a sample of 2000 to 3000 grams stated in SC-T-23.

6.3. Sampling the Lime:

6.3.1. Using a pre-weighed bag, divert the lime to flow from the silo into the bag and immediately start a timer. After reaching a predetermined time (normally 10 or 15 seconds), allow the lime flow to return to the cold feed belt and remove the bag.

6.3.2. Fasten the bag containing the lime to a scale and record the weight. Subtract the weight of the bag to determine the actual weight of the lime sampled.

7. CALCULATIONS

7.1. The calculations may be performed using either Method A, a unit analysis procedure, or Method B, a direct formula procedure used on Research and Materials Laboratory Form 283, “Weekly Lime Anti-Stripping Additive Report.” Both methods will yield the same result. Examples of each calculation are shown below:

7.1.1. Method A — Unit Analysis Procedure:

A = Cold Feed Rate (aggregate & moisture, TPH)
B = Moisture in Aggregate (%)
C = Time Length of Lime Sample (sec)
D = Weight of Sample (lbs)
E = Dry Aggregate (TPH)
F = Lime (TPH)

$$E = \frac{A}{(1 + (B/100))}$$

$$F = \frac{D}{C} \text{ x } \frac{1\text{ ton}}{2000\text{ lbs}} \text{ x } \frac{60\text{ sec}}{1\text{ min}} \text{ x } \frac{60\text{ min}}{1\text{ hr}}$$

Rate of Lime (%) = (F/E) x 100

7.1.2. Method B — Direct Formula Procedure:

A = Cold Feed Rate (aggregate & moisture, TPH)
B = Moisture in Aggregate (%)
C = Time Length of Lime Sample (sec)
D = Weight of Sample (lbs)

$$\text{Rate of Lime } (\%) = \frac{D(180 + 1.8B)}{(A)(C)}$$

8. REPORT

8.1. Record the percent lime on SCDOT Form 400.13 – Weekly Lime Anti-Stripping Additive Report.

Standard Method of Test for

Method of Quartering Bituminous Mixtures

SCDOT Designation: SC-T-72

1. SCOPE

1.1. This method is for use in obtaining the required size bituminous mixture sample for testing. In most instances, bituminous mixtures are too large in size and must be reduced to obtain the proper quantity for testing.

2. REFERENCED DOCUMENT

2.1. SC-T 62, SC-T-100.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to properly reduce asphalt mixture samples to an appropriate testing size to ensure consistency and repetition of test results.

4. APPARATUS

4.1. Clean, smooth metal table; trowel; 5-gallon pail or sample bag.

5. TEST SPECIMEN

5.1. 5-gallon pail or sample bag of asphalt mixture.

6. PROCEDURE

6.1. Obtain a sample of the bituminous mixture for a random location, as determined using SC-T-100, by following the sampling method in SC-T-62.

6.2. Invert the sample bucket (or bag) containing the mixture on a clean, smooth metal table.

6.3. Using a trowel, gently slice into the mixture so the mixture spreads into a near circular layer with uniform thickness and with as little segregation as possible. Divide the mixture into quarters by two lines intersecting at right angles at the center.

6.4. Place the diagonally opposing quarters (i.e., 2 and 3 or 1 and 4) in a sample bag immediately, or discard as required. Clean and discard all fines from the trowel.

6.5. The remaining opposing quarters should be pulled together. DO NOT remix to avoid segregation. Quarter the mixture again until the required sample size is obtained.

6.6. Once the proper sample size is obtained, clean both sides of the trowel with the edge of the table or a straight edge, and place a quarter of the fines in the sample to be tested.

Standard Method of Test for

Determination of Asphalt Binder Content for Asphalt Paving Mixtures by the Ignition Oven

SCDOT Designation: SC-T-75

1. SCOPE

1.1. This method covers the determination of asphalt binder content of hot-mix paving mixtures by ignition of the asphalt binder in a furnace.

Safety Notice: This procedure involves extremely high temperatures (650°C (1200°F)) and will require the technician to wear appropriate safety protection during portions of the testing. Some steps in the procedure, which are known to involve high temperatures, are highlighted with a notice concerning the use of proper safety equipment. The absence of a warning does not necessarily mean that all material and equipment is safe to handle. The technician should use caution during each step of the procedure.

2. REFERENCED DOCUMENT

2.1. AASHTO M 231.

2.2. SC-T-62, SC-T-72, SC-T-76.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to accurately determine the asphalt binder content from asphalt mixtures. The asphalt binder is burned in a furnace in accordance to this procedure. The asphalt binder content is calculated as the difference between the initial and ending weights, with a calibration factor for the mixture and temperature. The final asphalt content is expressed as a percentage of mass loss.

4. APPARATUS

4.1. *Furnace* — A forced air ignition furnace, capable of maintaining 650°C (1200°F), with an internal balance or load cell thermally isolated from the furnace chamber and accurate to 0.1 gram. The balance shall be capable of weighing a 3500-gram sample in addition to the sample baskets. If needed, the furnace shall calculate a temperature compensation factor for the change in weight of the sample baskets. Note that not all ovens may require the use of a temperature compensation factor. Check with the oven manufacturer to determine if this factor is necessary. The furnace shall provide a printed ticket with the initial specimen weight, specimen weight loss at one minute intervals, temperature compensation, if needed, aggregate correction factor, correct asphalt binder content (percent), test time and test temperature. The furnace chamber internal volume shall be at least 0.85 cubic feet. A method for reducing furnace emissions shall be provided. The furnace shall provide an audible alarm and indicator light when the sample weight loss does not exceed 0.2 grams for two (2) consecutive minutes. The furnace door shall be locked until the completion of the test procedure.

4.2. *Baskets* — Two (2) or three (3) tempered stainless steel 2.36-millimeter (No. 8) mesh or otherwise perforated baskets, dimensioned to properly fit in the oven. The baskets shall be nested and shall be provided with screening on the legs to confine the aggregate.

4.3. *Catch Pan* — One (1) stainless steel catch pan with dimensions slightly wider and longer than the stainless steel baskets and approximately 25 millimeter (1 inch) in height.

4.4. *Oven* — Oven capable of maintaining 125°C + 5°C (257°F + 9°F), inside volume of at least 70,800 cubic millimeters (2.5 cubic feet).

4.5. *Balance* — Balance, 8 kilogram or greater capacity, sensitive to 0.5 gram for weighing sample in baskets, meeting the requirements of AASHTO M 231.

4.6. *Miscellaneous Equipment* — Pan dimensions 380L x 380W x 50D millimeters (15L x 15W x 2D inches) minimum for transferring samples after ignition, spatulas, bowls and wire brushes.

4.7. *Safety Equipment* — Safety glasses, face shield, high temperature gloves, long sleeve jacket or apron. Additionally, a heat resistant surface capable of withstanding 650°C (1200°F) and a protective cage capable of surrounding the sample baskets shall be provided.

5. TEST SPECIMEN

5.1. The sample shall be the end result of quartering a larger sample taken in accordance with SC-T-62, except that the sample size will be determined using Figure SC-T-75A. The sample will be properly quartered to the required testing size using SC-T-72 or SC-T-93. When the mass of the test specimen exceeds the capacity of the equipment used, the test specimen may be divided into suitable increments, tested and the results appropriately combined for calculation of the asphalt binder content (weighted average). It is recommended the sample size should not be more than 400 grams greater than the minimum recommended sample mass. Large samples of fine mixes may result in incomplete ignition of the asphalt binder.

NOMINAL MAXIMUM AGGREGATE SIZE (sieve size)	MINIMUM MASS OF SAMPLE (grams)
4.75 (No. 4)	1200
9.5 (3/8 inch)	1200
12.5 (½ inch)	1500
19.0 (¾ inch)	2000
25.0 (1.0 inch)	3000
37.5 (1.5 inch)	4000

SIZE OF SAMPLE
Figure SC-T-75A

5.2. If the mixture is not sufficiently soft to separate with a spatula or trowel, place it in a large flat pan and warm it to 125°C ± 5°C (257°F ± 9°F) for 25 minutes. The sample shall not be heated for more than 1 hour.

5.3. A specimen for moisture determination may be made as deemed necessary. This specimen may not be used for asphalt binder content determination.

6. PROCEDURE

6.1. *Mixture Calibration – General*: Before testing can be performed on an asphalt mixture, the oven must be calibrated using the mixture. The mixture shall be calibrated following this procedure using the entire mixture. The use of aggregate-only calibration will not be permitted.

RAP Mixtures: For mix designs containing RAP, a sufficient quantity of RAP should be sampled such that the binder content of the RAP may be estimated and to provide for the RAP to be used in the mix calibration. The binder content of the RAP will be estimated from the average of four (4) samples (RAP only) burned in the furnace. The portions of RAP should be obtained using a sample splitter.

6.1.1. The ignition procedure may be affected by the type of aggregate in the mixture. Therefore, to optimize accuracy, a calibration factor will be established by testing a set of calibration samples for each mix. This procedure must be performed before any acceptance testing is completed.

6.1.2. A calibrated specimen conforming to the mass requirements of Figure SC-T-75A shall be prepared by a SCDOT Mix Design Technician at the design asphalt binder content and at +0.5% of the design asphalt binder content for a total of three (3) specimens. A butter mix shall be prepared at the design asphalt binder content, mixed and discarded prior to mixing any of the calibration specimens.

Aggregate, hydrated lime and asphalt binder used for the calibration specimens shall be representative of the material used in the mix. This may require the use of aggregate sampled from current stockpiles located at the plant for which the mix is, or will be, produced.

Any method may be used to combine the aggregates; however, an additional "blank" specimen with no asphalt binder shall be batched and tested according to SC-T-76. The washed gradation shall fall within the Job Mix allowable tolerances.

6.1.3. Reset the ignition furnace to 538°C + 10°C (1000°F + 18°F), and record the furnace temperature prior to the initiation of the test (set point). Although this temperature is to be used on most mixes, some mixes may have more aggregate breakdown at this high temperature than others. If it is determined during calibration that the mix is breaking down excessively, a lower ignition temperature may be used. If a lower temperature is used for calibration, this lower temperature shall be recorded and used on any future tests involving that mix. Using a lower temperature will cause the time for complete burning to increase.

6.1.4. Place the freshly mixed specimens directly into the sample baskets. If the specimens were allowed to cool, preheat them in an oven at 125°C ± 5°C (257°F ± 9°F) for 25 ± 5 minutes. Do not preheat the sample baskets.

6.1.5. Enter the correction factor of “0.0” in the ignition furnace. Weigh and record the weight of the sample baskets and batch pan (with guards in place) as W_b.

6.1.6. Place the sample basket into the catch pan. Evenly distribute the calibration specimen in the baskets taking care to keep the material away from the edges of the basket. Evenly distribute the specimen in the baskets using a spatula or trowel to level the specimen. Weigh and record the total weight of the sample, basket catch pan and basket guards (W_T). Calculate, using Equation 75-1, and record the initial weight of the sample specimen (W_i).

$$W_i = W_T - W_b \qquad \text{(Equation 75-1)}$$

6.1.7. Input the initial weight of the sample specimen (W_i) into the ignition furnace controller. Verify that the correct weight has been entered.

6.1.8. **For this next step, wear the appropriate safety gear**. Open the chamber door and place the sample baskets in the furnace. Be careful not to slide the basket on the floor of the furnace. Close the chamber door and verify that the total sample weight displayed on the furnace scale or load cell equals the total weight recorded as W_T (Equation 75-1), within ±5 grams. A difference greater than 5 grams or failure of the furnace scale to stabilize may indicate that the sample baskets are contacting the furnace wall.

Initiate the test by pressing the “START/STOP” button. At this point the chamber door will lock and will not open until the test is complete. The printer will begin recording the test results. Allow the test to continue until the stable light and audible stable indicator indicates the test is complete. The final weight of the sample will be denoted W_f.

6.1.9. **Wearing protective gear**, open the chamber door and remove the sample baskets using the proper tool and place them on a temperature resistant block. Cover the baskets with a protective cage and allow them to cool to room temperature (approximately 30 minutes).

6.1.10. Once all of the calibration specimens have been burned, use Equation 75-2 to determine the difference ($\%AC_{DIFF}$) between the actual ($\%AC_{ACT}$) and measured ($\%AC_{MEAS}$) asphalt binder contents for each sample. Use Equation 75-3 to calculate the mix correction factor (C_F), which is the average of the measured differences. The correction factor (C_F) is the number (either + or -) that will bring the tested asphalt binder content back to the original amount entered. If the oven consistently gives a higher $\%AC_{MEAS}$, the correction factor will be a negative number and will be subtracted from the final test result.

$$\%AC_{DIFF} = \%AC_{ACT} - \%AC_{MEAS} \qquad \text{(Equation 75-2)}$$

$$C_F = \frac{[\%AC_{DIFF}(1) + \%AC_{DIFF}(2) + \%AC_{DIFF}(3)]}{3} \qquad \text{(Equation 75-3)}$$

Refer to figure SC-T-75B see if the individual correction factors are within acceptable tolerances.

- 0.5 % BELOW OPTIMUM BINDER CONTENT	OPTIMUM BINDER CONTENT	+ 0.5 ABOVE OPTIMUM BINDER CONTENT	RERUN SAMPLE?
$\%AC_{DIFF} \leq C_F$			No
$\%AC_{DIFF} \geq C_F$			Yes*
$\%AC_{DIFF} \geq \pm 0.51$			Call R&M Lab

**Note: Rerun – if $\%AC_{DIFF}$ exceeds C_F (see Figure SC-T-75B) on any of the three burns, rerun two additional samples and recalculate the corrections factor using the average of correction factors by dropping the highest and lowest difference from the $\%AC_{ACT}$ and average the remaining (3) samples for the correction factor.*

CALIBRATION ALLOWABLE DIFFERENCE
Figure SC-T-75B

6.1.11. Verification and Updating of the Calibration Correction Factor:

6.1.12. The mix calibrations should be checked and updated on a routine basis, or as often as is required. The following steps indicate how to properly verify and update the mix calibration factor:

6.1.13. Prepare a specimen at the optimum asphalt binder content in the same manner in which specimens were prepared in the mixture calibration. Instead of three (3) calibration specimens, there will only be one (1).

6.1.14. Preset the ignition furnace to 538°C ± 10°C (1000°F ± 18°F). Record the furnace temperature prior to the ignition of the test (set point). If a lower oven temperature was used for calibration, record and use that temperature for verification testing as well.

6.1.15. Place the freshly mixed specimen directly into the sample baskets. If the specimen was allowed to cool, preheat it in an oven at 125°C ± 5°C (257°F ± 9°F) for 25 ± 5 minutes. Do not preheat the sample baskets.

6.1.16. Enter a correction factor of “0.0” in the ignition furnace. Weigh and record the weight of the sample baskets and catch pan (with guards in place) as W_b.

6.1.17. Follow the same steps as outlined in the mixture calibration procedure to completely burn the specimens. When the test is complete, use Equation 75-4 to calculate the %AC difference ($\%AC_{DIFF(Verify)}$).

$$\%AC_{DIFF(Verify)} = \%AC_{ACT} - \%AC_{MEAS} \qquad \text{(Equation 75-4)}$$

6.1.18. The %AC difference ($\%AC_{DIFF(Verify)}$) from Equation 75-4 is to be factored as a weighted average into the current correction factor being used for the mix design using Equation 75-5.

$$C_{F(New)} = \frac{\%AC_{DIFF(Verify)} + 3\left(C_{F(CURRENT)}\right)}{4} \quad \text{(Equation 75-5)}$$

$C_{F(New)}$, determined from Equation 75-5, becomes the new correction factor to be used for the mix design; and each time the correction factor is verified, the new correction factor should be averaged into the previous correction factor using Equation 75-5. If $C_{F(New)}$ is less than the allowable difference in Figure SC-T-75C, $C_{F\ (New)}$ can be utilized for 3 months. If the $C_{F(New)}$ is calculated and found to be outside of the allowable difference, monthly verification testing must continue monthly until is $C_{F(New)}$ is found to be within allowable tolerances.

CURRENT CORRECTION FACTOR C_F	**ALLOWABLE DIFFERENCE FROM CORRECTION FACTOR (C_F - $C_{F\ (New)}$)**	**INDIVIDUAL DIFFERENCE FROM CORRECTION FACTOR (> 0.15)**
≤ +/- 0.30	0.05	Must continue monthly verification
+/- 0.31 to 0.50	0.10	
≥ +/- 0.51	0.15	Must continue monthly verification & Contact R&M Lab

ALLOWABLE DIFFERENCE – VERIFICATION
Figure SC-T-75C

6.2. Asphalt Binder Content Determination Test Procedure:

6.2.1. Allow the ignition furnace to preheat to 538°C ± 10°C (1000°F ± 18°F). Record the furnace temperature (set point) prior to the initiation of the test. If needed, the temperature correction factor will be denoted T_{CF}. If a lower oven temperature was used for calibration, record and use that temperature for sample testing as well. At room temperature, weigh the sample baskets and catch pan (with guards in place). Record this weight as W_b.

6.2.2. Prepare the sample as described in Section 5 by heating for 25 ± 5 minutes in an oven at 125°C ± 5°C (257°F ± 9°F). Place the sample basket in the catch pan. Evenly distribute the sample in the basket taking care to keep the material away from the edges of the basket. Use a spatula or trowel to level the specimen.

6.2.3. Weigh the sample, basket, catch pan and basket guards and record the weight as W_T. Calculate and record the initial weight of the sample specimen (W_i) using Equation 75-1.

6.2.4. Input the initial weight of the sample specimen (W_i) into the ignition furnace controller. Verify that the correct weight has been entered.

6.2.5. **For this next step, wear the appropriate safety gear.** Open the chamber door and place the sample baskets in the furnace. Close the chamber door and verify that the total sample weight displayed on the furnace scale or load cell equals the total weight (W_T), as determined from Equation 75-1, within ±5 grams. A difference greater than 5 grams or failure of the furnace scale to stabilize may indicate that the sample baskets are contacting the furnace wall.

Initiate the test by pressing the "START/STOP" button. At this point, the chamber door will lock and will not open until the test is complete. The printer will begin recording the test results. Allow the test to continue until the stable light and audible stable indicator indicates that the test is complete. The final weight of the sample will be denoted W_f.

6.2.6. **Wearing protective gear**, open the chamber door and remove the sample baskets using the proper tool and place them on a temperature resistant block. Cover the baskets with a protective cage and allow them to cool to room temperature (approximately 30 minutes). If a gradation analysis is desired, empty the contents of the baskets into a flat pan (be sure all fines are removed), and perform the gradation analysis.

7. CALCULATION – ASPHALT BINDER CONTENT

7.1. The ignition oven will automatically calculate the corrected asphalt binder content of the sample based on Equation 75-6 and Equation 75-7. **Be sure to use the correct sign (+ or -) when using the correction factors.**

$$AC_{UNCORRECTED} = \frac{(W_i - W_f)}{W_i} \text{ x } 100 \qquad \text{(Equation 75-6)}$$

$$\%AC_{CORRECTED} = \%AC_{UNCORRECTED} + C_F + T_{CF} \text{ (if needed)} \qquad \text{(Equation 75-7)}$$

7.2. Example Calculation:

7.2.1. The results of an example mixture calibration for three (3) specimens is shown in Figure SC-T-75D.

DESCRIPTION	**UNIT/EQUATION**	**SAMPLE NUMBER**		
		1 (-0.5%)	**2 (Opt.)**	**3 (+0.5%)**
Test Temperature	T (°C)	1000	1000	1000
Known %AC	AC_{ACT}	5.7	6.2	6.7
Wt. Basket	W_b	3326.2	3326.1	3324.3
Wt. Basket + Sample	W_T	4718.7	4719.2	4718.4
Wt. Sample	$W_i = W_T - W_b$	1392.5	1393.1	1394.1
Measured %AC	AC_{MEAS}	5.45	6.15	6.67
Difference	$AC_{DIFF} = AC_{ACT} - AC_{MEAS}$	0.25 (Failed)	0.05	0.03
Correction Factor	C_F = [Avg. AC_{DIFF}] /3	0.11		

Note: All weights in grams.

EXAMPLE MIXTURE CALIBRATION
Figure SC-T-75B

Because the first sample was outside of allowable tolerances due to C_F (0.11), two additional samples were burned @ 5.7% AC, and the results were 5.61, and 5.60. The highest (i.e., 5.61), and the lowest (i.e., 5.45) were dropped, and the 5.60 was used to determine the C_F, as follows:

Corrected C_F = [$\%AC_{DIFF}$ (0.10) + $\%AC_{DIFF}$ (0.05) + $\%AC_{DIFF}$ (0.03)]/3 = 0.06

7.3. Example Test Procedure (Unknown Specimen):

DESCRIPTION	UNIT/EQUATION	RESULT
Calibration Factor	C_F	0.06
Test Temperature	T (°C)	1000
Temperature Compensation Factor	$T_{CF}^{(1)}$	0.01
Wt. Basket	W_b	3325.8
Wt. Basket + Sample	W_T	4716.5
Wt. Sample (Initial)	$W_i = W_T - W_b$	1390.7
Wt. Sample (Final)	W_f	1305.7
Uncorrected %AC	$\%AC_{UNCORRECTED} = [(W_i - W_f)/W_i] \times 100$	6.11
Corrected %AC	$\%AC_{CORRECTED} = \%AC_{UNCORRECTED} + C_F + T_{CF}^{(1)}$	6.18

Notes:

1. *Use T_{CF} only if needed.*
2. *All weights in grams.*

EXAMPLE TEST PROCEDURE
Figure SC-T-75C

8. REPORT

8.1. Report the following information: Corrected asphalt binder content, mix correction factor, temperature compensation factor (if needed), total percent loss, sample mass and test temperature. Attach the original ignition oven ticket showing mass loss at one-minute intervals to the report. Test results are reported on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection. Data and calculations are recorded on SCDOT Form 400.01 – Ignition Oven Worksheet. Calibration and verification data must be reported on SCDOT Form 400.06 – Asphalt Ignition Oven Mixture Calibration Worksheet and SCDOT Form 400.07 – Asphalt Ignition Oven Mixture Calibration Verification Worksheet.

Standard Method of Test for

Determination of Washed Aggregate Gradation of Hot-Mix Asphalt Extracted Aggregates

SCDOT Designation: SC-T-76

1. SCOPE

1.1. This method covers the determination of combined silt and clay material passing the 75-μm (No. 200) sieve and the mechanical analysis of hot-mix asphalt extracted aggregate.

2. REFERENCED DOCUMENT

2.1. AASHTO M 231.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to accurately determine the amount of aggregate that passes the 75-μm (No. 200) sieve to ensure that the gradation of the mixture meets job mix specifications.

4. APPARATUS

4.1. *Sieves* — standard sieves with square openings. For the washing: a 600-μm (No. 30) sieve nested on a 75-μm (No. 200).

4.2. *Balance* — of sufficient capacity and accuracy meeting the requirements of AASHTO M 231.

4.3. *Wetting/Disbursing Agent* — (e.g., Calgon).

4.4. *Container* — bowl of sufficient capacity to hold the entire sample.

4.5. *Oven* — capable of maintaining 125°C ± 5°C (257°F ± 9°F).

4.6. *Shaker* — mechanical shaker (e.g., Rotap).

4.7. *Water* — potable water.

4.8. *Miscellaneous Items* — brush, trowel or spoon.

5. TEST SPECIMEN

5.1. The sample size used for conducting this test will be based on the amount of material remaining after a solvent extraction or ignition oven test has been performed. Unless otherwise indicated, this test will use the entire sample remaining after performing one of the aforementioned tests.

6. PROCEDURE

6.1. Place the entire sample at room temperature into a container. Use a brush to be sure that all of the fine material is transferred into the container. Material which has been allowed to sit for several hours, or has been obtained through solvent extraction, shall be heated in an oven at 125°C ± 5°C (257°F ± 9°F) until it is dried to constant weight. The sample and pan shall be weighed and the weight recorded to the nearest 0.1 gram as W_{Ti}. The weight of the empty container shall be recorded as W_C.

6.2. Cover the sample completely with water. Add a sufficient amount of wetting agent to assure a thorough separation of fine material from the coarser particles. Immediately stir the contents of the container vigorously with a trowel or spoon for approximately 10 to 15 seconds. Allow the material to sit and soak for a total of 5 minutes. Stir the sample once more in the middle of this time period and again at the end of the time period for a total of 3 stirrings.

6.3. At the end of the time period, after the material has been stirred for the final time, immediately pour the wash water through a nest of sieves consisting of a 600-μm (No. 30) sieve nested on a 75-μm (No. 200) sieve. Care should be taken to avoid spilling any of the larger particles onto the sieve nest.

6.4. An additional amount of water should be added to the container to again cover the sample completely. The sample should be immediately stirred and then decanted through the same nest of sieves. The sample should not be allowed to sit and soak. Repeat this rinsing and decanting until the wash water becomes clear.

6.5. Any material which is retained on the nest of sieves shall be carefully washed back into the container. The sample and container shall be placed in an oven at 125°C ± 5°C (257°F ± 9°F) and dried to constant weight. After drying, the material will be removed from the oven and immediately weighed before any moisture can be absorbed. The total weight of the sample and pan is designated as W_{TF}.

7. CALCULATIONS

7.1. Fine Aggregate Wash:

Figure SC-T-76A shows the calculations necessary to compute the total amount of material passing through the 75-μm (No. 200) sieve.

7.2. Mechanical Analysis of Extracted Aggregate:

7.2.1. The aggregate sample shall be introduced into a nested set of sieves corresponding to the required fraction sizes. Be sure to brush all fine material from the container. The sample shall be subjected to mechanical shaking for a period of 15 ± 1 minutes. If the sample size is greater than that allowed for the nest of sieves, the sample shall be split into smaller portions and subjected to shaking separately. When complete, the weight passing a given sieve size for each sample shall be added to each corresponding sieve size. The total amount of material from all sets of sieves shall be used in determining the percent passing each individual sieve.

DESCRIPTION	EQUATION	RESULT
ORIGINAL SAMPLE		
Initial Wt. Sample & Container	W_{Ti}	1645.0
Wt. of Container	W_C	500.0
Initial Sample Wt.	$W_i = W_{Ti} - W_C$	1145.0
MATERIAL DRIED		
Wt. Sample & Container After Drying	W_{Tf}	1635.0
Wt. of Container	W_C	500.0
Final Sample Wt.	$W_f = W_{Tf} - W_C$	1135.0
Total Loss thru 75-µm (No. 200) Sieve	$W_L = W_i - W_f$	10.0

Note: All weights in grams.

AGGREGATE WASH CALCULATIONS
Figure SC-T-76A

7.2.2. Invert the nest of sieves by removing the top size sieve and using it as the bottom. Remove the individual sieves and stack them on top of each until the pan is on top. Begin weighing and recording the amount of material contained in each sieve starting with the pan and proceeding cumulatively to the largest sieve containing material. Record the cumulative weight for the entire sample.

7.3. Mechanical Analysis Calculations:

7.3.1. Add the amount of material washed through the 75-µm (No. 200) sieve (W_L) back to each individual sieve fraction as shown in Figure SC-T-76B. Calculate the percentage of material passing each individual sieve as a portion of the entire sample with the washed material added back. Figure SC-T-76B shows an example of these calculations.

SIEVE SIZE	WT. PASSING	+ W_L	= TOTAL WT. PASSING	TOTAL PASSING %
19.0 mm	1135	10	1145	100.0
12.5 mm	1079	10	1089	95.1
9.5 mm	908	10	918	80.2
4.75 mm	646	10	656	57.3
2.36 mm	443	10	453	39.6
600 µm	261	10	271	23.7
150 µm	136	10	146	12.8
75 µm	85	10	95	8.30

Note: All weight in grams.

EXAMPLE MECHANICAL ANALYSIS CALCULATIONS
Figure SC-T-76B

8. REPORT

8.1. Report the total percent passing of the required sieves. Test results are reported on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection. Data and calculations are recorded on SCDOT Form 400.01 – Ignition Oven Worksheet.

Standard Method of Test for

Method of Verification of Hydrated Lime Weighing Systems for Hot-Mix Asphalt

SCDOT Designation: SC-T-78

1. SCOPE

1.1. This method applies to the verification of hydrated lime weighing systems for hot-mix asphalt.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to check the lime rate to ensure that the lime rate meets SCDOT specifications to prevent asphalt mixtures from stripping.

3. APPARATUS

3.1. Four 50-pound test weights that are certified once a year by an authorized public official or scale servicer. Documentation of weight certifications shall be maintained in the field laboratory.

4. PROCEDURE

4.1. With the weigh pod empty, record the scale indicator reading on Laboratory Form 979.

4.2. Apply all four test weights and record the scale indicator reading. The display reading on the scale indicator is to be within ±20 pounds of the actual weight when the four 50-pound weights (200 pounds) are attached to the empty weigh pod.

4.3. The weigh pod is to be loaded approximately half full with hydrated lime with four 50-pound weights attached. Record the scale indicator reading on Laboratory Form 979 for verification.

4.4. Remove the four 50-pound weights one at a time and record the scale indicator reading on Laboratory Form 979. The scale indicator reading in the control room shall reflect the weight changes to within ±5 pounds of the actual weight on the weigh pod.

5. CALCULATIONS

5.1. When performing the procedures in Section 4, the scale weight is subtracted from the actual calculated weight and its absolute value is compared to the allowable tolerance.

6. REPORT

6.1. The actual weight difference shall be within the allowable tolerance of ±5 pounds for each 50-pound test weight removed. All data must be reported on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection and recorded on SCDOT Form 400.14 – Verification of Hydrated Lime Weighing Systems for Hot Mix Asphalt.

Standard Method of Test for

Sampling, Testing, and Approving Hot-Mix Asphalt Silos for Overnight Storage

SCDOT Designation: SC-T-79

1. SCOPE

1.1. This test method covers sampling, testing and acceptance of materials for overnight storage (up to 18 hours maximum) of hot-mix asphalt in identified silos.

2. REFERENCED DOCUMENT

2.1. AASHTO T 170, AASHTO T 202.

2.2. SC-T-62, SC-T-64, Laboratory Form 988.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to determine whether an asphalt storage silo is letting too much air into the silo allowing the asphalt mixture to oxidize prematurely.

4. APPARATUS

4.1. Round pointed shovel; cloth sample bags; insulated cooler, metal or plastic, of sufficient size for transporting 3 bagged hot-mix asphalt samples; SCDOT security seals.

5. TEST SPECIMEN

5.1. Three bagged and sealed samples of asphalt mix obtained from silo. Minimum sized sample should be in accordance with SC-T-62.

6. PROCEDURE

6.1. With a Department Inspector observing operations, the asphalt storage silo shall be filled with a virgin binder or surface type mix at the end of the production period. No mix with recycled asphalt pavement will be allowed. The asphalt plant shall not add any additional material to the silo until all of the hot mix is discharged and sampled the next day. Asphalt mix stored for testing that meets all the Department's requirements may be used on Department projects upon the discretion of the Engineer.

6.2. The next day, three samples shall be obtained as follows:

6.3. Sample No.1 will be obtained in accordance with SC-T-62 from the first full truck-load discharged from the silo. The sample shall be placed into a cloth sample bag and sealed with a SCDOT security seal by the Department Inspector. The sample bag will be marked as Sample No. 1. Place the sample in the insulated cooler to prevent oxidation.

6.4. Sample No. 2 will be obtained in accordance with SC-T-62 from the truck when the silo is approximately half empty. The sample shall be placed into a cloth sample bag and sealed with a SCDOT security seal by the Department Inspector. The sample bag will be marked as Sample No. 2. Place the sample in the insulated cooler to prevent oxidation.

6.5. Sample No. 3 will be obtained in accordance with SC-T-62 from the truck when the last full load is discharged from the silo. The sample shall be placed into a cloth sample bag and sealed with a SCDOT security seal by the Department Inspector. The sample bag will be marked as Sample No. 3. Place the sample in the insulated cooler to prevent oxidation.

Note that this procedure must be coordinated with the Central Laboratory Liquid Asphalt Testing Supervisor (803-737-6704) to assure proper arrangements have been made for testing. Samples that are not submitted for testing within 1 day of sampling will be discarded and the entire procedure repeated. Mixture information is to be recorded on Laboratory Form 988 by the Inspector and submitted with the samples to the Central Laboratory.

6.6. The sample shall be immediately transferred to the Department's Central Laboratory and tested in accordance with SC-T-64, AASHTO T 170 and AASHTO T 202. The Contractor shall be responsible for transporting samples to the Department's Central Laboratory.

7. REPORT

7.1. The recovered viscosity of any individual sample shall not be greater than 13,000 p. Test results are to be recorded on SCDOT Form 400.08 – Silo Approval Overnight Storage.

Standard Method of Test for

Preparation, Verification and Approval of Asphalt Mix Designs

SCDOT Designation: SC-T-80

1. SCOPE

1.1. This method outlines the procedure for submitting asphalt mix designs to the Research and Materials Laboratory for preparation, verification and approval.

2. REFERENCED DOCUMENT

2.1. AASHTO T 245, AASHTO T 312.

2.2. SC-T-68, SC-T-83, SC-T-82, SC-T-82B, SC-T-88, R&M Laboratory Form 269.

3. APPARATUS

3.1. See SC-T-82 and SC-T-82B for a listing of equipment needed to complete a Marshall / Superpave gyratory mix design. If performing an Open-Graded Friction Course Design, use SC-T-88 in lieu of SC-T-80.

4. TEST SPECIMEN

4.1. A SCDOT-certified HMA Design Technician (Level 2S) must submit the following items for verification of each Mix Design along with the appropriate Form 269 and all Marshall / Gyratory, moisture susceptibility and maximum gravity data. These tests must be performed in an SCDOT-certified mix design laboratory in accordance with SC-T-82 / SC-T-82B.

4.2. Two Dry Marshall / Gyratory specimens, at each point, prepared just above and below optimum binder content. Specimens must be 2.50 inch ± 0.05 inch for Marshall specimens and 115 ± 5 millimeters for gyratory specimens. (e.g., Optimum is set at 4.8%, submit specimens at 4.5% and 5.0%). If optimum binder content is determined to be the same as one of the mix points, then a set of specimens at that point, along with a set 0.5 above or 0.5 below optimum must be submitted. (e.g. Optimum is set at 5.0%, submit specimens at 5.0% and either 4.5% or 5.5%). **Must be different specimens from the Contractor's specimens.**

4.3. One Maximum Theoretical Specific Gravity sample. Usually prepared at highest binder content and made at same batch weight of Marshall cores, not to exceed 2000 grams for gyratory specimens. **Must be different from Contractor's sample.**

4.4. Three blended aggregate samples at Marshall / Gyratory batch weight, for check samples. Samples must be submitted in plastic bags, not mixed with water, or if RAP is being used, RAP must be weighed into separate plastic bags according to the calculated batch weight.

4.5. Six Gyratory 75 ± 1 millimeter specimens meeting compaction criteria of 96 ± 1% air voids (Surface T-1C, Superpave 19.0 mm, and 12.5 mm only). If a gyratory compactor is not accessible, aggregate batches must be submitted so that the Research and Materials Laboratory can make gyratory specimens.

5. PROCEDURE

5.1. These steps will be performed by the Research and Materials Laboratory.

5.2. Determine the Bulk Specific Gravities (BSG) of the Marshall / Gyratory specimens using SC-T-68. The average BSG of each set of cores must compare within 0.020 of the contractor's BSG.

5.3. Perform SC-T-83 to calculate the Maximum Theoretical Specific Gravity (MSG). The Departments test results must compare to the Contractor's MSG within 0.018.

5.4. If either sets of Marshall / Gyratory cores, or the MSG, do not compare, then the Department will use the blended aggregate samples to check specimens. If the specimens still do not compare to the Contractor's tests the contractor will be required to redesign the mix. If the check specimen compares to the Contractor's original specimen, then the original data will be used.

5.5. Moisture susceptibility, stability and other test reports will be reviewed and may be required to be verified.

5.6. Perform rutting susceptibility testing, and make sure the mixtures meet rut depth criteria. (Surface T-1C, Superpave 19.0 mm, and 12.5 mm only).

6. CALCULATIONS

6.1. Calculations will be performed in accordance with AASHTO T-245, AASHTO T-312, SC-T-68 and SC-T-83.

7. REPORT

7.1. The Department will prepare an information sheet with the Contractor's name, plant location and Marshall / Gyratory data, along with approval and expiration dates and other information. The information sheet will be kept on file at the Department and a copy will be sent to the Contractor.

Standard Method of Test for

Inspection and Approval of Asphalt Field Laboratories

SCDOT Designation: SC-T-81

1. SCOPE

1.1. This method covers the inspection and approval process for asphalt plant field laboratories that are used in testing asphalt mixtures. This method is not a safety inspection. The Contractor shall be responsible for maintaining the safety requirements for the asphalt field laboratories.

2. REFERENCED DOCUMENT

2.1. AASHTO T 245.

2.2. SC-T-66, SC-T-68, SC-T-75, SC-T-83.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to ensure Contractor field laboratories have all of the necessary equipment for testing asphalt mixtures, and the supplied equipment is properly calibrated to ensure the accuracy of testing materials.

4. APPARATUS

4.1. See Attachment SC-T-81.

5. PROCEDURE

5.1. Asphalt field laboratories must have all the required equipment listed on the asphalt field laboratory checklist (see Attachment SC-T-81) and meet all requirements as specified in the *Standard Specifications* and any Supplemental Specifications. It is the Contractor's responsibility to notify the Bituminous Engineer when their laboratory is ready for initial or annual inspection.

5.2. A representative of the Bituminous Materials Engineer will perform an inspection and verify that the laboratory complies with *Standard Specifications* and Attachment SC-T-81.

5.3. The required field laboratory equipment must be calibrated on an annual basis. All calibrations of equipment must be available upon request, and records must be kept at the field laboratory. The calibrations will require a calibrated manometer, micrometer and thermometers.

5.4. Upon meeting all requirements for approval, an annual approval decal will be placed at a suitable location inside the field laboratory. If at anytime all requirements are not met, the approval will be revoked.

6. REPORT

6.1. For reporting purposes, use Research and Materials Laboratory Form 981 (Checklist for Annual Field Lab Certification).

Attachment SC–T-81

I. CONTRACTOR INFORMATION:

Asphalt Contractor:______________________________ Plant Location:______________________

Contractor's Representative:____

Date Inspected: ________________________________ Inspected By:______________________

Next Inspection Due Date:_______________________ District:____________________________

NOTE: This checklist is used only as a guide for inspection. The requirements of the *Standard Specifications* and applicable Supplemental Specifications will govern any conflicts with the items listed.

II. LAB STRUCTURE

1. Size and Type of Structure:

   Floor Space: ________________________ Height: ______________________________

   Type of Structure:____

		Yes	No
2.	Is the plant in full view and close proximity from one of the windows of the laboratory?	☐	☐
3.	Is sufficient water available for all tests	☐	☐
4.	Is sufficient and satisfactory furniture for office work provided?	☐	☐
5.	Are satisfactory electric lighting and electric outlets provided?	☐	☐
6.	Are suitable worktables and/or benches provided?	☐	☐
7.	Are locks provided for the windows and doors?	☐	☐
8.	Is the field laboratory equipped so that the temperature inside the laboratory can be maintained between 65°F – 80°F?	☐	☐

III. EQUIPMENT

1.	Ignition oven meeting requirements of SC-T-75.	☐	☐
2	Complete Marshall Apparatus:	☐	☐
	a. automatic compaction hammer.	☐	☐
	b. four (4) compaction molds.	☐	☐
	c. compaction mold holder.	☐	☐

III.	EQUIPMENT (continued)	Yes	No
	d. Marshall compression and testing machine.	☐	☐
	e. Marshall specimen protection paper disc No. 4.	☐	☐
	f. hot plate.	☐	☐
	g. sand bath for Marshall hammer.	☐	☐
	h. garden spade minimum 2″ wide.	☐	☐
	i. flat spade ¾″ wide and 6″ in length.	☐	☐
	j. extractor jack assembly – hydraulic type to extrude Marshall specimens.	☐	☐
3.	Marshall water bath capable of maintaining a constant temperature of 140°F ± 1.8°F (60°C ± 1°C) throughout the entire volume of the bath. Water bath should meet testing standards specified in SC-T-66.	☐	☐
4.	Marshall water bath equipped with a water circulator capable of maintaining a constant temperature of 77°F ± 1.8°F (25°C ± 1°C) throughout the entire volume of the bath. Water bath should meet the testing standards specified in SC-T-68.	☐	☐
5.	Maximum Gravity Equipment (see SC-T-83):	☐	☐
	a. Vacuum pump capable of pulling a vacuum of 27 mm Hg absolute pressure continuously throughout the test.	☐	☐
	b. Metal container or a volumetric metal flask having a capacity of at least 1000 mL. The container must have a cover fitted with a rubber gasket and a hose connection. The hose opening shall be covered with a small piece of No. 200 wire mesh to minimize the possibility of loss of fine material. Gauge or manometer installed in line to monitor vacuum. Kraft brown paper for preparation of sample approximately 3′ x 3′.	☐	☐
	c. Gauge or manometer installed in line to monitor vacuum.	☐	☐
	d. Kraft brown paper for preparation of sample approximately 3′ x 3′.	☐	☐
6.	Masonry saw equipped with a diamond tip blade and water cooling system. The masonry saw shall be capable of slicing a 6″ diameter core in one pass without disturbing the structure of the core.	☐	☐
7.	Double-walled convection laboratory oven with an inside volume of at least 2.5 ft^3. This oven should be capable of maintaining a temperature of 230°F ± 9°F (110°C ± 4.4°C).	☐	☐
8.	Fax machine and telephone for use by the Inspector.	☐	☐

		Yes	No
III.	**EQUIPMENT (continued)**		
9.	Double-walled thermostatic controlled forced air laboratory oven with a minimum inside volume of 5.0 ft^3. This oven should be capable of maintaining a temperature of 295°F ± 5°F (146°C ± 2.5°C).	☐	☐
10.	Sample quartering table of minimum size 3′ x 3′ and accessible from at least two sides.	☐	☐
11.	Two (2) buckets of adequate size (approximately 5 gallons) for sampling asphalt mix from the truck	☐	☐
12.	One (1) large mason trowel.	☐	☐
13.	Sample splitter with a minimum of eight chutes 2″ wide with a minimum of three (3) splitter pans.	☐	☐
14.	Motor driven large shaker complete with screens of suitable sizes.	☐	☐
15.	Sieves required for the large shaker: 2″, 1½″, 1″, ¾″, ½″, No. 4, No. 8 and bottom pan.	☐	☐
16.	One (1) milk scale having a maximum capacity of at least 30 pounds and graduated in 0.1-pound increments, for lime rate determination, or equivalent.	☐	☐
17.	8″ sieve shaker (e.g., Ro-Tap design or approval equivalent with a tapping device).	☐	☐
18.	Sieves required for the 8′ shaker: 1″, ¾″, ½″, 3/8″, No. 4, No. 8, No, 30, No. 100 bottom pan and two (2) No. 200 sieves.	☐	☐
19.	Two (2) 12K electronic balances accurate to 0.1 grams.	☐	☐
20.	Five (5) dial thermometers (50°F to 400°F) for Plant and Road Inspectors	☐	☐
21.	One (1) 140°F (60°C) mercury thermometer (graduated to nearest 0.1 degree).	☐	☐
22.	One (1) 77°F (25°C) mercury thermometer (graduated to nearest 0.1 degree).	☐	☐
23.	Two (2) weather thermometers.	☐	☐
24.	One (1) crucible tong.	☐	☐
25.	One (1) stencil brush.	☐	☐
26.	One (1) brass wire brush.	☐	☐

III.	**EQUIPMENT (continued)**	Yes	No
27.	One (1) wash No. 200 pan (e.g., enamel pan 3″ deep x 9″ diameter).	☐	☐
28.	Wetting/disbursing agent (e.g., Calgon, but <u>not</u> Calgon with oil beads).	☐	☐
29.	Penetrating oil.	☐	☐
30.	Adequate supply of rubber gloves.	☐	☐
31.	Two (2) pairs of work gloves (one pair regular and one pair insulated for high temperatures).	☐	☐
32.	Paper towels.	☐	☐
33.	Hand lotion with lanolin.	☐	☐
34.	Cloth towel (water absorbing for Marshall specimens).	☐	☐

IV. CALIBRATION RECORDS

1.	Ignition oven calibrations for individual job mixes posted or field in the field laboratory?	☐	☐
2.	Ignition oven calibration performed on a monthly basis?	☐	☐
3.	Mercury thermometers calibrated?	☐	☐
4.	Records on other type thermometers calibrated (digital or dial)?	☐	☐
5.	Marshall hammer calibrated to handheld hammer?	☐	☐
6.	Marshall hammer calibration records available in the field laboratory?	☐	☐
7.	Manometer for verifying vacuum gauge?	☐	☐

V. REMARKS:

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Standard Method of Test for

Determination of Maximum Theoretical Specific Gravity

SCDOT Designation: SC-T-83

1. SCOPE

1.1. This method covers the determination of the maximum specific gravity of uncompacted bituminous paving mixtures.

2. REFERENCED DOCUMENT

2.1. AASHTO C 168, SC-T-80.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to determine the maximum compacted state of a loose asphalt mixture. This value is used to determine the percent air voids in compacted asphalt mixtures.

4. APPARATUS

4.1. *Balance* — 12 K electronic balance with a suitable suspension apparatus. Suspension wire should be the smallest practical size to minimize any possible effects of a variable immersed length.

4.2. *Metal Container or Volumetric Metal Flask* — having a capacity of at least 1000 mL. The container must have a cover fitted with a rubber gasket and a hose connection. The hose opening shall be covered with a small piece of No. 200 wire mesh to minimize the possibility of loss of fine material.

4.3. *Thermometer* — calibrated liquid-in-glass, total immersion type, 77°F mercury thermometer with gradations at every 0.2°F minimum.

4.4. *Vacuum Pump* — capable of pulling a vacuum of 27 mm Hg absolute pressure continuously for at least 15 minutes. The assembly shall have a calibrated gauge or a manometer to show actual pressure.

4.5. *Water Bath* — capable of maintaining a constant temperature of 77°F ± 1.8°F (25°C ± 1°C) throughout the entire area of the bath. The bath shall have a method of continuously circulating the water and controlling water temperature.

5. TEST SPECIMEN

5.1. For field testing, the sample should be obtained in accordance with AASHTO T 168, “Sampling Bituminous Paving Mixtures.” The size will be governed by the nominal maximum aggregate size of the mixture and conform to Figure SC-T-83A.

NOMINAL MAXIMUM SIZE OF AGGREGATE * (sieve size)	MINIMUM MASS OF SAMPLE (kilograms)
25.0 mm (1 inch)	2.5
19.0 mm (¾ inch)	2.0
12.5 mm (½ inch)	1.5
9.5 mm (⅜ inch)	1.0
4.75 mm (No. 4)	0.5

** Note: The Nominal Maximum Aggregate Size is defined as one sieve size larger than the first sieve to retain more than 10%.*

NOMINAL AGGREGATE SIZE
Figure SC-T-83A

For laboratory testing, weigh and mix the maximum theoretical specific gravity samples as per SC-T-80.

6. PROCEDURE

6.1. Before obtaining the sample, determine which metal container will be used and obtain a dry weight (A) to the nearest 0.1 gram. Submerge the container in the 77°F water bath for 10 minutes and record the submerged weight (D) to the nearest 0.1 gram. Thoroughly dry the container when finished weighing.

6.2. Separate the particles of the sample, taking care not to fracture the mineral particles, so that the particles of fine aggregate portion are not larger than 6.5 mm (¼ inch). If needed, slightly heat the material in a flat pan to ensure separation.

6.3. Cool the samples to room temperature and place them in the metal container. Determine the mass of the sample and the metal container (B) to the nearest 0.1 gram.

6.4. Add sufficient 77°F ± 1.8°F (25°C ± 1°C) potable water to cover the sample. To aid in the release of entrapped air, add a suitable wetting agent such as Aerosol OT in a concentration of 0.01 percent.

6.5. Remove the entrapped air by subjecting the contents to a vacuum of at least 27 mm Hg absolute pressure continuously for 15 ± 2 minutes. Agitate the container and contents by using a mechanical device or vigorous shaking manually at minimum intervals of 2 minutes.

6.6. Suspend the container and sample in water at 77°F ± 1.8°F (25°C ± 1°C) and record its mass (E) to the nearest 0.1 gram after 10 ± 1 minutes.

7. CALCULATIONS

7.1. A = weight of container
B = weight of sample and container
C = weight of sample
D = weight of sample and container in water
E = weight of container in water
F = weight of submerged sample
$MSG_{Theoretical}$ = Maximum theoretical specific gravity

7.2. C = B – A

7.3. F = D – E

7.4. $$MSG_{Theoretical} = \frac{C}{(C - F)}$$

8. REPORT

8.1. Record $MSG_{Theoretical}$ to the nearest 0.001, which will be used in the calculation of the %Air Voids after the Bulk Specific Gravity is obtained. Data and calculations are recorded on Research and Materials Laboratory Form 409 and reported on Form 416, Form 910 or Form 969 (Plant Report).

Standard Method of Test for

Determination of Temperatures During Hot-Mix Asphalt Production

SCDOT Designation: SC-T-84

1. SCOPE

1.1. This method covers the determination of hot asphalt mixture temperature in the delivery trucks, the hot mat during compaction, the existing roadway surface and the ambient air.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to ensure that asphalt mixtures meet temperature requirements in the SCDOT specifications and to eliminate any mix that is overheated or under-heated that may hinder the overall performance of the mixture.

3. APPARATUS

3.1. All thermometers must have records of calibration and shall be verified at a minimum of two (2) times a year. Calibration can be checked at the R&M Laboratory.

3.2. Calibrated dial thermometer with temperature ranges from 50°F to 400°F (10°C to 205°C).

3.3. Hand-held infrared non-contact thermometer with temperature ranges from 0°F to 1000°F (-18°C to 538°C).

3.4. Glass weather thermometers.

4. PROCEDURE

4.1. Asphalt Mixture in a Truck:

4.1.1. The temperature of asphalt mixtures in trucks shall be checked in a suitable location with a calibrated dial thermometer. The thermometer will be inserted into a hole located on each side of the truck bed. The hole should be located approximately 4 feet from the front of the truck bed and approximately 18 inches from the bottom of the truck bed. The thermometer shall be placed into the hole as deep as possible and remain there until the temperature reading stabilizes. Record this temperature reading as the mix temperature in the truck.

4.2. Existing Roadway:

4.2.1. The existing roadway temperature shall be checked with a handheld infrared non-contact thermometer in the shade (if available) at approximately 3 feet above the existing roadway in at least 5 random locations. These five random readings are to be averaged and recorded as the existing roadway temperature.

4.3. Asphalt Mat During Production:

4.3.1. The temperature of the hot mat shall be accomplished by either a handheld non-contact infrared thermometer held approximately 3 feet above the hot asphalt mat or by a calibrated dial thermometer inserted into the mat for a minimum of 5 random readings. These readings are to be averaged and recorded as the asphalt mat temperature.

4.4. Ambient Temperature:

4.4.1. The ambient temperature will be measured in the shade (if available) with a calibrated mercury thermometer. The reading will be measured until the reading stabilizes and recorded.

5. REPORT

5.1. Report the temperature of the mix inside the truck, on the roadway and the ambient temperature wherever required. Report data on SCDOT Form 400.04 – Daily Report of Asphalt Roadway Inspection.

Standard Method of Test for

Determination of Asphalt Mixture Roadway Placement Rate

SCDOT Designation: SC-T-85

1. SCOPE

1.1. This method covers the necessary calculations for calculating the rate of spread of hot-mix asphalt in pounds per square yard by using the asphalt truck delivery tickets. This method utilizes standard units of measure, however, the general procedure can be easily modified to calculate metric quantities.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to ensure that the proper amount of asphalt mixture is applied to the roadway according to project requirements.

3. APPARATUS

3.1. Calibrated tape measure capable of measuring entire width of roadway being paved

4. PROCEDURE

4.1. Determine the length of roadway being surfaced using station numbers (i.e., feet or meters).

4.2. Measure the width of pavement placed (i.e., feet or meters).

4.3. Determine the area measured (i.e., square feet or square meters).

4.4. Calculate the weight of the mix placed in a section by totaling the amount of mix used from the asphalt truck delivery tickets (i.e., pounds or kilograms).

4.5. Divide the placement area into the weight of mix placed in the roadway section.

5. CALCULATIONS

5.1. Calculate the mix rate (i.e., pounds per square yard or kilograms per square meter).

5.2. Determine the length of roadway section by calculating the distance based on the established station numbers as follows:

Ending Station	14 + 75
– <u>Beginning Station</u>	–<u>12 + 50</u>
	2 + 25

Convert the station numbers to feet or meters: 2 + 25 times 100 = 225 linear feet.

5.3. Determine the area of the roadway section. Multiply the length of the section by the width of placement and convert this value to square yards or square meters, as needed.

Example: (225 feet x 10 feet) X [1 square yard/9 square feet] = 250 square yards

5.4. Based on the delivery tickets, determine the total weight of asphalt mix applied to the section (convert to tons, tonnes or kilograms as needed).

Example: 12.5 tons = 25,000 pounds of asphalt mix placed in this test section.

5.5. Calculate the placement rate by dividing the weight of asphalt mix placed by the area of the section.

Example: 25,000 pounds ÷ 250 square yards = 100 pounds per square yard.

6. REPORT

6.1. Actual rate in pounds per square yard or kilogram per square meter on SCDOT Form 400.04 – Daily Report of Asphalt Roadway Inspection.

Standard Method of Test for

Determination of Asphalt Tack Coat Roadway Placement Rate

SCDOT Designation: SC-T-86

1. SCOPE

1.1. This method describes how to determine liquid asphalt tack rate for emulsified asphalt products and is based on the use of a temperature-volume correction. Two methods are described. One method is based on the residual asphalt content, and the other is not. Note that these two methods are mutually exclusive. Ensure that the proper method is used as specified in the Standard Specifications for the particular Contract pay item under scrutiny.

2. REFERENCED DOCUMENT

2.1. Figure SC-T-86A, Temperature-Volume Corrections for Emulsified Asphalts.

3. SUMMARY OF TEST METHOD

3.1. The road surface to be covered is measured, the flow meter on the distribution tank is checked before and after application and the temperature of the tack in the distribution tank is recorded. The rate of application is determined for the quantity of tack used based on the temperature-volume correction for emulsified asphalt and the method specified for the Contract pay item (i.e., with or without consideration of residual asphalt content).

4. SIGNIFICANCE AND USE

4.1. The asphalt tack is used to bond layers of asphalt mixture together and to prevent slippage. The purpose of this procedure is to ensure that the tack application rate is in accordance with the Contract specifications.

5. APPARATUS

5.1. Calculator.

6. TEST SPECIMEN

6.1. None.

7. PROCEDURE

7.1. *Determine Area Covered* — Measure the longitudinal length and the transverse width of the roadway surface to be treated (i.e., feet or meters). Use pavement markings, surveys, a tape measure or other measuring device, as needed, to obtain these distances. Calculate the area (i.e., either square yards or square meters) of the roadway surface to be treated (i.e., length x width).

7.2. *Determine Quantity Used* — Determine the quantity (i.e., liters or gallons) of tack used. This is performed based on initial and final readings of the flow meter attached to the tack distributor. Take a reading before the tack is sprayed and a reading after the tack is sprayed. The absolute value of the difference in the readings will be the quantity of tack sprayed over the roadway surface.

7.3. *Measure Temperature for Volume Correction* — Measure the temperature of the tack in the distributor tank at the time it was sprayed on the roadway surface. This temperature will be used in conjunction with Figure SC-T-86A to obtain a temperature-volume multiplier, which will be used to adjust the volume of the quantity of used.

8. CALCULATIONS

8.1. *Adjust Volume of Tack Used* — Prior to calculating tack rate, it is important to understand that the quantity of tack used (i.e., its volume as determined in Step 7.2.) must be adjusted based on the temperature of the tack in the distribution tank, as determined in Step 7.3. Use Figure SC-T-86A to obtain the temperature-volume correction multiplier, and adjust the volume quantity used.

8.2. *Determine Tack Rate* — Tack rate (i.e., gallons per square yard or liters per square meter) is based on the adjusted volume of tack used (see Step 8.1) and the roadway area actually treated (see Step 7.1). The method used to calculate the tack rate may or may not require consideration of the residual asphalt content (see Section 1.1).

8.3. Example Calculations:

8.4. Method A – Without Residual Asphalt Content – Example for CSS-1 Tack:

8.4.1. Determine Area Covered (See Step 7.1):

Width of Coverage (W)	=	12 feet
Length of Coverage (L)	=	4765 feet
Area of Coverage ($A_{Coverage}$)	=	L x W
	=	12 x 4765 = 57,180 ft² = 6353.3 yd²

8.4.2. Determine Quantity Used (See Step 7.2):

Beginning Flow Meter Reading (Q_B)	=	123 gallons
Ending Flow Meter Reading (Q_E)	=	478 gallons
Total Quantity Tack Used (Q_{Total})	=	$Q_E - Q_B$ = 478 – 123 = 355 gallons

8.4.3. Adjust Volume of Tack Used (See Step 8.1):

Temperature of Tack in Distributor Tank	=	150°F (determined from Step 7.3)
Temperature-Volume Multiplier (M_{TV})	=	0.97750 (see Figure SC-T-86A)
Adjusted Tack Quantity (Q_{ADJ})	=	$Q_{Total} \times M_{TV}$
	=	355 x 0.97750 = 347.0 gallons

8.4.4. Determine Tack Rate (See Step 8.2):

Tack Rate (R_{Tack}) = Q_{ADJ} / $A_{Coverage}$
= 347.0 / 6353.3 = 0.055 gal/yd²

8.5. Method B – With Residual Asphalt Content – Example using CRS-2 Tack:

8.5.1. Determine Area Covered (See Step 7.1):

Width of Coverage (W) = 10 feet
Length of Coverage (L) = 3000 feet
Area of Coverage ($A_{Coverage}$) = L x W
= 10 x 3000 = 30,000 ft² = 3333.3 yd²

8.5.2. Determine Quantity Used (See Step 7.2):

Beginning Flow Meter Reading (Q_B) = 120 gallons
Ending Flow Meter Reading (Q_E) = 500 gallons
Total Quantity Tack Used (Q_{Total}) = $Q_E – Q_B$
= 500 – 120 = 380 gallons

8.5.3. Adjust Volume of Tack Used (See Step 8.1):

Temperature of Tack in Distributor Tank = 122°F (determined from Step 7.3)
Temperature-Volume Multiplier (M_{TV}) = 0.98450 (see Figure SC-T-86A)
Adjusted Tack Quantity (Q_{ADJ}) = Q_{Total} x M_{TV}
= 380 x 0.98450 = 374.1 gallons

8.5.4. Determine Tack Rate (See Step 8.2):

Tack Rate (R_{Tack}) = Q_{ADJ} / $A_{Coverage}$
= 374.1 / 3333.3 = 0.1122 gal/yd²

8.5.5. Determine Residual Tack Rate:

Percent Residual Asphalt (P_{RA}) = 0.58 (submitted by supplier as 58%)
Residual Tack Rate ($R_{Residual}$) = R_{Tack} x P_{RA}
= 0.1122 x 0.58 = 0.065 gal/yd²

9. REPORT

9.1. Report the corrected rate of tack placed on the SCDOT Form 400.04 – Daily Report of Asphalt Roadway Inspection.

°C	°F	M	°C	°F	M	°C	°F	M
10.0	50	1.00250	35.0	95	0.99125	57.8	136	0.98100
10.6	51	1.00225	35.6	96	0.99100	58.3	137	0.98075
11.1	52	1.00200	36.1	97	0.99075	58.9	138	0.98050
11.7	53	1.00175	36.7	98	0.99050	59.4	139	0.98025
12.2	54	1.00150	37.2	99	0.99025	60.0	140	0.98000
12.8	55	1.00125	37.8	100	0.99000	60.6	141	0.97975
13.3	56	1.00100	38.3	101	0.98975	61.1	142	0.97950
13.9	57	1.00075	38.9	102	0.98950	61.7	143	0.97925
14.4	58	1.00050	39.4	103	0.98925	62.2	144	0.97900
15.0	59	1.00025	40.0	104	0.98900	62.8	145	0.97875
15.6	60	1.00000	40.6	105	0.98875	63.3	146	0.97850
16.1	61	0.99975	41.1	106	0.98850	63.9	147	0.97825
16.7	62	0.99950	41.7	107	0.98825	64.4	148	0.97800
17.2	63	0.99925	42.2	108	0.98800	65.0	149	0.97775
17.8	64	0.99900	42.8	109	0.98775	65.6	150	0.97750
18.3	65	0.99875	43.3	110	0.98750	66.1	151	0.97725
18.9	66	0.99850	43.9	111	0.98725	66.7	152	0.97700
19.4	67	0.99825	44.4	112	0.98700	67.2	153	0.97675
20.0	68	0.99800	45.0	113	0.98675	67.8	154	0.97650
20.6	69	0.99775	45.6	114	0.98650	68.3	155	0.97625
21.1	70	0.99750	46.1	115	0.98625	68.9	156	0.97600
21.7	71	0.99725	46.7	116	0.98600	69.4	157	0.97575
22.2	72	0.99700	47.2	117	0.98575	70.0	158	0.97550
22.8	73	0.99675	47.8	118	0.98550	70.6	159	0.97525
23.3	74	0.99650	48.3	119	0.98525	71.1	160	0.97500
23.9	75	0.99625	48.9	120	0.98500	71.7	161	0.97475
24.4	76	0.99600	49.4	121	0.98475	72.2	162	0.97450
25.0	77	0.99575	50.0	122	0.98450	72.8	163	0.97425
25.6	78	0.99550	50.6	123	0.98425	73.3	164	0.97400
26.1	79	0.99525	51.1	124	0.98400	73.9	165	0.97375
26.7	80	0.99500	51.7	125	0.98375	74.4	166	0.97350
27.2	81	0.99475	52.2	126	0.98350	75.0	167	0.97325
27.8	82	0.99450	52.8	127	0.98325	75.6	168	0.97300
28.3	83	0.99425	53.3	128	0.98300	76.1	169	9.97275
28.9	84	0.99400	53.9	129	0.98275	76.7	170	0.97250
29.4	85	0.99375	54.4	130	0.98250	77.2	171	0.97225
30.0	86	0.99350	55.0	131	0.98225	77.8	172	0.97200
30.6	87	0.99325	55.6	132	0.98200	78.3	173	0.97175
31.1	88	0.99300	56.1	133	0.98175	78.9	174	0.97150
31.7	89	0.99275	56.7	134	0.98150	79.4	175	0.97125
32.2	90	0.99250	57.2	135	0.98125			
32.8	91	0.99225						
33.3	92	0.99200						
33.9	93	0.99175						
34.4	94	0.99150						

Note: M = Multiplier for correcting volumes to the basis of 15.6°C (60°F).

TEMPERATURE-VOLUME CORRECTIONS FOR EMULSIFIED ASPHALTS
Figure SC-T-86A

Standard Method of Test for

Method of Determining Asphalt Pavement Compaction Using Maximum Specific Gravity

SCDOT Designation: SC-T-87

1. SCOPE

1.1. This method applies to situations where the asphalt roadway compaction is to be determined as a percentage of the asphalt mixture's daily maximum specific gravity. The Maximum Specific Gravity is often referred to as the Maximum Theoretical Specific Gravity, the Maximum Rice Specific Gravity or MSG.

2. REFERENCE DOCUMENT

2.1. SC-T-68, SC-T-100, SC-T-101.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to ensure that the proper amount of field compaction is achieved according to SCDOT specifications.

4. APPARATUS

4.1. Diamond-bit 150-millimeter (6-inch) circular drill, water cooled; circular saw to cut roadway core into layers; see equipment list in SC-T-68 for density determination.

5. TEST SPECIMEN

5.1. 150-millimeter (6-inch) diameter roadway core obtained from the freshly paved layer of asphalt. Each core will be well marked to identify the location from which it was obtained.

6. PROCEDURE

6.1. Determine the average daily maximum specific gravity (MSG) of the asphalt mixture based on the job mix effective specific gravity (ESG), the asphalt binder specific gravity from the job mix and the average daily asphalt binder content. Compare this value with the bulk specific gravity of each core to determine the percent roadway compaction. Using SC-T-100, SC-T-101, determine the random location of the roadway cores based on the day's production and number of samples required.

6.2. Obtain an undamaged(1) roadway core from each of the locations identified using SC-T-100, SC-T-101. These locations should be clearly marked for future reference. The drill is to cut into the pavement to the full depth of asphalt, and the top layer removed with a circular saw. In no case should a screwdriver or other sharp device be used to pry the top layer from the existing roadway. The use of a screwdriver may damage the core and result in inaccurate density readings. If the roadway is too hot to obtain a core, a small amount of dry ice may be placed over the location to assist with the cooling. Bagged ice may be used in lieu of dry ice, provided the ice is not removed from the bag.

(1) *Note: Any cores that are damaged shall not be used in this procedure. If it is determined that a core is damaged while drilling, then another core will be taken within a 600-millimeter (2-foot) radius of the damaged core location. The original core will be marked and discarded.*

6.3. Carefully transport the core samples to the laboratory for testing. At all times the cores are to be kept at ambient temperature and shall remain dry. In no case will the cores be submerged in ice or in water.

6.4. At the laboratory, the cores are to remain at ambient temperature until they are dried to a constant weight. A fan may be used to provide some additional air-drying. In no case will the cores be placed in an oven at a temperature outside the range of 25°C ± 1°C (77°F ± 2°F).

6.5. When the cores have reached constant weight, they shall be individually weighed in air, weighed submerged in water and weighed in a saturated surface-dry (SSD) condition. This weighing procedure shall follow the procedure listed in SC-T-68 for weighing and recording the core sample weights.

7. CALCULATIONS

7.1. Calculate the Average Daily Maximum Specific Gravity (MSG) (see SC-T-68):

$$\text{MSG} = \frac{100}{(\text{F}/\text{G}) + ((100 - \text{F})/\text{ESG})}$$

where: F = Average Daily %Asphalt Binder (from ignition oven or solvent extractions)

G = Specific Gravity of Binder (from job mix information sheet)

ESG = Effective Specific Gravity (from job mix information sheet)

7.2. Calculate the Individual Core Bulk Specific Gravity (BSG) (see SC-T-68):

$$\text{Bulk Specific Gravity} = \frac{\text{A}}{(\text{B} - \text{C})}$$

where: A = mass (grams) of specimen in air
B = mass (grams) of specimen SSD in air
C = mass (grams) of specimen in water

7.3. Determine the Individual Roadway Core Percent Compaction (%Compaction):

$$\%\text{Compation} = \left(\frac{\text{BSG}}{\text{MSG}}\right) \text{x } 100$$

where: %Compaction = individual roadway core percent compaction
BSG = individual roadway core bulk specific gravity
MSG = average daily maximum specific gravity

7.4. Calculate the average daily roadway compaction. The average daily roadway compaction shall be the average of the individual core compactions.

7.5. Example Calculations:

7.5.1. Five cores were obtained from random locations (using SC-T-100, SC-T-101) on the roadway. The cores were taken to the field laboratory and weighed in air, under water and in SSD condition (see SC-T-68). The bulk specific gravity (BSG) was computed for each core as shown in Figure SC-T-87A.

CORE	WT. AIR	WT. WATER	WT. SSD	BSG
1	632.1	366.1	633.1	2.367
2	655.3	379.4	657.2	2.359
3	648.9	376.0	650.7	2.362
4	630.2	365.3	631.4	2.368
5	650.7	375.2	651.6	2.354

Note: All weights in grams.

BULK SPECIFIC GRAVITY OF CORES
Figure SC-T-87A

7.5.2. There were 4 extraction tests performed that day with the asphalt binder content results shown in Figure SC-T-87B. The average daily binder content was also calculated.

SAMPLE	BINDER CONTENT (%)
1	4.43
2	4.32
3	4.21
4	4.38
Average	4.34

AVERAGE DAILY BINDER CONTENT
Figure SC-T-87B

7.5.3. Using mix properties from the job mix information sheet (i.e., aggregate ESG = 2.647, asphalt binder specific gravity = 1.030), the daily average MSG was calculated as follows:

$$\text{MSG} = \frac{100}{(4.34/1.030) + ((100 - 4.34)/2.647)} = 2.480$$

7.5.4. The individual and average compaction were determined for the cores as shown in Figure SC-T-87C.

Core	**BSG**	**%COMPACTION (BSG/MSG) x 100**
1	2.367	95.5
2	2.359	95.2
3	2.362	95.3
4	2.368	95.6
5	2.354	95.0
Average		95.3

INDIVIDUAL AND AVERAGE COMPACTION FOR CORES
Figure SC-T-87C

8. REPORT

8.1. Report individual roadway core percent compaction and average roadway core percent compaction on SCDOT Form 400.16 – In-Place Density Contractor QA.

Standard Method of Test for

Wash Method for Determining Gradation of HMA Mixtures

SCDOT Designation: SC-T-92

1. SCOPE

1.1. This method is used to determine the gradation of the aggregate from a hot-mix asphalt (HMA) sample when the asphalt content of the mixture has been determined by SC-T-75.

2. REFERENCED DOCUMENT

2.1. AASHTO M 231, AASHTO T 27, AASHTO R 18.

2.2. SC-T-62, SC-T-72, SC-T-75, SC-T-100.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to determine the aggregate gradation of an asphalt mixture in field applications. This procedure is often used to prevent aggregate breakdown of asphalt mixtures and to ensure that the gradations meet job mix specifications.

4. APPARATUS

4.1. *Balance* — sufficient capacity and sensitivity to 0.1 grams (see AASHTO M-231).

4.2. *Solvent* —- shall be a biodegradable, nontoxic asphaltic extracting solvent.

4.3. *Oven* — capable of maintaining 135°C ± 5°C.

4.4. *Hot Plate or Oven* — capable of maintaining 110°C ± 5°C.

4.5. *Sieves and Shaker* — to conduct gradation analysis.

4.6. *Miscellaneous Equipment* — pans with dimensions 305L x 203W x 76D millimeters (12L x 8W x 3D inches) or bowls with the capacity of approximately 9.5 liters (10 quarts), spatula for stirring sample and sieve brushes.

5. TEST SPECIMEN

5.1. Obtain a representative sample of the bituminous mixture to yield a minimum sample size after quartering as shown in Figure SC-T-92A.

6. PROCEDURE

6.1. Obtain a representative sample of the mixture using SC-T-62, and reduce the HMA sample to testing size using SC-T-72. See Figure SC-T-92A for the minimum sample size. The correct sample size is determined by the nominal maximum sieve size of the HMA mixture.

NOMINAL MAXIMUM AGGREGATE SIZE (sieve size)	MINIMUM MASS OF SAMPLE (grams)
4.75 mm (No. 4)	1000
9.5 mm ($^3/_8$ inch)	1100
12.5 mm (½ inch)	1250
19.0 mm (¾ inch)	1500
25.0 mm (1.0 inch)	3000
37.5 mm (1.5 inch)	4000

SAMPLE SIZE
Figure SC-T-92A

6.2. Dry the sample for 15 to 30 minutes in an oven at 125°C ± 5°C (257°F ± 9°F) and weigh to the nearest 0.1 gram. RAP stockpile samples shall be heated until dry, approximately 30 to 60 minutes.

6.3. Determine the percent asphalt binder being added to the mixture at the time that the sample was obtained from the results of the ignition oven using SC-T-75.

6.4. Place the mixture in the pan, pail or bowl and cover with solvent. Gently agitate the sample frequently with a spatula. Continue this process for 15 to 30 minutes for plant produced mixtures and 30 to 60 minutes for RAP stockpile samples.

6.5. Decant the solvent, pouring over a 2.36-mm (No. 8) sieve nested over a 75-μm (No. 200) sieve. Dispose of the solvent according to the products MSDS. Add water, agitate and decant over the same sieves. Continue washing with water until the wash water is clear. Material retained on either of the sieves shall be washed back into the sample. Decant off any excess water. Care should be taken to avoid the loss of particles.

6.6. Dry the sample to a constant weight in an oven or on a hot plate at 125°C ± 5°C (257°F ± 9°F). Stir occasionally to avoid excessive temperature in the drying process.

6.7. Conduct a gradation test on the aggregate in accordance with AASHTO T 27.

7. CALCULATIONS

7.1. Calculate the total dry weight of the aggregate (W_{agg}) as follows:

$$W_{agg} = (W_{mix})\ x \left[1 - \frac{\%Binder}{100}\right]$$

where: W_{agg} = total dry weight of the aggregate before wash (grams)
W_{mix} = total dry weight of the HMA mixture (grams)
%Binder = percent asphalt binder determined by SC-T-75

Calculations for the corrected %AC and aggregate wash are shown in Figure SC-T-92B and Figure SC-T-92C, respectively.

DESCRIPTION	UNIT/EQUATION	RESULT
Calibration Factor	C_F	0.11
Test Temperature	T (°C)	538
Temperature Compensation Factor	$T_{CF}^{(1)}$	0.21
Wt. Basket	W_b	3611.5
Wt. Basket + Sample	W_T	5056.8
Wt. Sample (Initial)	$W_i = W_T - W_b$	1445.3
Wt. Sample (Final)	W_f	1370.4
Uncorrected %AC	$\%AC_{UNCORR} = [(W_i - W_f)/W_i]$ x 100%	5.18
Corrected %AC	$\%AC_{CORR} = \%AC_{UNCORRECTED} + C_F + T_{CF}^{(1)}$	5.50

Notes:
1. *Use T_{CF} only if needed.*
2. *All weights in grams.*

EXAMPLE TEST PROCEDURE
Figure SC-T-92B

DESCRIPTION	EQUATION	RESULT
ORIGINAL SAMPLE		
Initial Wt. Sample & Container	W_{Ti}	1747.9
Wt. of Container	W_C	500.0
Initial Sample Wt.	$W_{mix} = W_{Ti} - W_C$	1247.9
MATERIAL DRIED		
Wt. of Binder	$W_B = W_{mix}$ x $(\%AC_{corr} / 100)$	68.6
Wt. Before Wash	$W_{agg} = W_{mix} - W_B$	1179.3
Wt. Sample & Container After Wash	W_{Tf}	1622.3
Final Sample Wt.	$W_f = W_{Tf} – W_C$	1122.3
Total Loss thru 75-µm (No. 200) Sieve	$W_L = W_{agg} - W_f$	57.0

Note: All weights in grams.

AGGREGATE WASH CALCULATIONS
Figure SC-T-92C

7.2. Calculate the gradation, as shown in Figure SC-T-92D, using the dry weight of aggregate determined in Step 7.1.

SIEVE SIZE	WT. PASSING	+ W_L	= TOTAL WT. PASSING	TOTAL PASSING (%)
19.0 mm	1122.3	57	1179.3	100.0
12.5 mm	1083.2	57	1140.2	96.7
9.5 mm	1012.0	57	1069.0	90.6
4.75 mm	766.3	57	823.3	69.8
2.36 mm	592.3	57	649.3	55.1
600 μm	353.2	57	410.2	34.8
150 μm	52.3	57	109.3	9.3
75 μm	12.1	57	69.1	5.86

Note: All weights in grams.

EXAMPLE MECHANICAL ANALYSIS CALCULATIONS
Figure SC-T-92D

8. REPORT

8.1. The results of the sieve analysis should be reported to the nearest 0.1 percent on all sieves other than the 75-μm sieve (0.01 percent). Data and calculations are recorded on SCDOT Form 400.01 – Ignition Oven Worksheet and reported on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection.

Standard Method of Test for

Utilizing a Quartering Apparatus to Reduce Hot-Mix Asphalt Field Samples

SCDOT Designation: SC-T-93

1. SCOPE

1.1. This method is used for obtaining the required sample size for testing hot-mix asphalt.

2. REFERENCED DOCUMENT

2.1. SC-T-62, SC-T-100.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to reduce asphalt mixtures in field applications to the proper testing size. This procedure is used to prevent segregation of mixtures and to ensure that all samples are divided equally, reducing technician variability in reducing samples.

4. APPARATUS

4.1. An approved quartering apparatus, similar to the Gilson's Quartermaster, with smaller pails capable of holding hot-mix asphalt.

5. TEST SPECIMEN

5.1. Bituminous material.

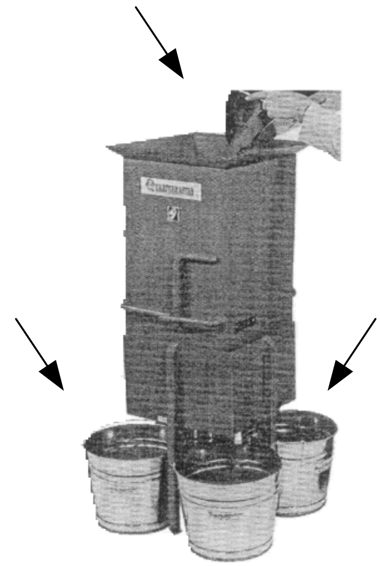
6. PROCEDURE

6.1. Obtain a representative sample of the bituminous mixture in accordance with SC-T-100, Random Method of Sampling Highway Construction Materials, and SC-T-62, Sampling of Bituminous Mixtures.

6.2. Invert the sample bucket or bag into the hopper of the quartering apparatus, as shown in Figure SC-T-93A, and level. Release the lever and allow the sample to flow into the four smaller buckets. Pour the opposing buckets into a sample bag and label accordingly. Place the other remaining buckets back into the original sample bucket or bag.

6.3. Repeat Step 6.2 using the opposite opposing buckets (see Figure SC-T-93B) until the required sample size is obtained.

INVERT SAMPLE BUCKET OR BAG
INTO HOPPER AND LEVEL
Figure SC-T-93A



USE OF OPPOSITE
OPPOSING BUCKETS
Figure SC-T-93B

SCDOT Sampling and Testing Procedures

C.7 GENERAL

Standard Method of Test for

Random Method of Sampling Highway Construction Materials

SCDOT Designation: SC-T-100

1. SCOPE

1.1. This test method outlines the procedure for randomly sampling highway construction materials at the production plant and on the roadway. A table of random numbers is used to pre-determine the sampling time and location. This method may be used in any situation requiring random selection procedures.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to obtain random material samples that are representative of the material being produced. This procedure is used in determining sample times and sample locations that are necessary for obtaining random samples that are used for acceptability of materials according to SCDOT specifications.

3. PROCEDURE

3.1. Determine Sampling Times:

3.2. Sampling Frequency: Determine the number of samples of the material that are to be obtained from each day's production. A day's run will normally constitute a lot.

3.3. Randomization:

3.3.1. At the beginning of each day, divide the anticipated period of plant operation into the required number of equal intervals.

3.3.2. Select a series of consecutive random numbers from Figure SC-T-100A.

3.3.3. To determine the sampling time, multiply the first random number in the series by the number of minutes in the first time interval and add the product to the clock time at the beginning of the interval. Sample the first load of material which leaves the plant following the computed sampling time.

3.3.4. Repeat the operation, using the other random numbers in the same order as they appear in the Figure SC-T-100A, to determine the sampling times for the three remaining time intervals. In each interval, the product of the random number and the number of minutes in that interval is added to that interval's beginning clock time to determine the sampling time.

3.3.5. Example of Calculating the Random Sampling Times:

Assume the plant is expected to begin operations at 7:00 a.m. and operate for ten hours.

0.576	0.730	0.430	0.754	0.271	0.870	0.732	0.721	0.998	0.239
0.892	0.948	0.858	0.025	0.935	0.114	0.153	0.508	0.749	0.291
0.669	0.726	0.501	0.402	0.231	0.505	0.009	0.420	0.517	0.858
0.609	0.482	0.809	0.140	0.396	0.025	0.937	0.310	0.253	0.761
0.971	0.824	0.902	0.470	0.997	0.392	0.892	0.957	0.640	0.463
0.053	0.899	0.554	0.627	0.427	0.760	0.470	0.040	0.904	0.993
0.810	0.159	0.225	0.163	0.549	0.405	0.285	0.542	0.231	0.919
0.081	0.277	0.035	0.039	0.860	0.507	0.081	0.538	0.986	0.501
0.982	0.468	0.334	0.921	0.690	0.806	0.879	0.414	0.106	0.031
0.095	0.801	0.576	0.417	0.251	0.884	0.522	0.235	0.398	0.222
0.509	0.025	0.794	0.850	0.917	0.887	0.751	0.608	0.698	0.683
0.371	0.059	0.164	0.838	0.289	0.169	0.569	0.977	0.796	0.996
0.165	0.996	0.355	0.375	0.654	0.979	0.815	0.592	0.348	0.743
0.477	0.535	0.137	0.155	0.767	0.187	0.579	0.787	0.358	0.595
0.788	0.101	0.434	0.638	0.021	0.894	0.324	0.871	0.698	0.539
0.566	0.815	0.622	0.548	0.947	0.169	0.817	0.472	0.864	0.466
0.901	0.342	0.873	0.964	0.942	0.985	0.123	0.086	0.335	0.212
0.470	0.682	0.412	0.064	0.150	0.962	0.925	0.355	0.909	0.019
0.068	0.242	0.667	0.356	0.195	0.313	0.396	0.460	0.740	0.247
0.874	0.420	0.127	0.284	0.448	0.215	0.833	0.652	0.601	0.326
0.897	0.877	0.209	0.862	0.428	0.117	0.100	0.259	0.425	0.284
0.875	0.969	0.109	0.843	0.759	0.239	0.890	0.317	0.428	0.802
0.190	0.696	0.757	0.283	0.666	0.491	0.523	0.665	0.919	0.146
0.341	0.688	0.587	0.908	0.865	0.333	0.928	0.404	0.892	0.696
0.846	0.355	0.831	0.218	0.945	0.364	0.673	0.305	0.195	0.887
0.882	0.227	0.552	0.077	0.454	0.731	0.716	0.265	0.058	0.075
0.464	0.648	0.629	0.269	0.069	0.998	0.917	0.217	0.220	0.659
0.123	0.791	0.503	0.447	0.659	0.463	0.994	0.307	0.631	0.422
0.116	0.120	0.721	0.137	0.263	0.176	0.798	0.879	0.432	0.391
0.836	0.206	0.914	0.574	0.870	0.390	0.104	0.755	0.082	0.939
0.636	0.195	0.614	0.486	0.629	0.663	0.619	0.007	0.296	0.456
0.630	0.673	0.665	0.666	0.399	0.592	0.441	0.649	0.270	0.612
0.804	0.112	0.331	0.606	0.551	0.928	0.830	0.841	0.602	0.183
0.360	0.193	0.181	0.399	0.564	0.772	0.890	0.062	0.919	0.875
0.183	0.651	0.157	0.150	0.800	0.875	0.205	0.446	0.648	0.685

TABLE OF RANDOM NUMBERS
Figure SC-T-100A

3.3.5.1 Divide the operating period into four intervals as follows:

$$I = \frac{60H}{S} = \frac{(60)(10)}{4} = 150 \text{ minutes}$$

where: I = the interval (minutes)
H = number of hours the plant operates
S = number of samples to be obtained

3.3.5.2 Select a series of random numbers from the random number table.

0.354 0.949 0.24 0.826

3.3.5.3 Compute Sampling Times:

0.354 x 150 = 53 minutes
0.949 x 150 = 142 minutes
0.241 x 150 = 36 minutes
0.826 x 150 = 124 minutes

Interval 1 = 7:00 a.m.
Interval 2 = 7:00 a.m. + 150 minutes = 9:30 a.m.
Interval 3 = 9:30 a.m. + 150 minutes = 12:00 noon
Interval 4 = 12:00 noon + 150 minutes = 2:30 p.m.

Sampling Times:

Interval 1 = 7:00 a.m. + 53 minutes = 7:53 a.m.
Interval 2 = 9:30 a.m. + 142 minutes = 11:52 a.m.
Interval 3 = 12:00 noon + 36 minutes = 12:36 p.m.
Interval 4 = 2:30 p.m. + 124 minutes = 4:34 p.m.

3.3.6. Delay of production due to plant breakdown, weather or other cause:

When it is not possible to obtain a scheduled sample because of plant breakdown, weather or other cause, disregard the sample and proceed to obtain the next scheduled sample. If plant operations are resumed before the completion of a specific interval, then a sample is to be taken as soon as it is feasible to do so before completion of that interval.

3.3.7. Examples of a Delay in Production:

Example 1: Suppose a breakdown occurs at 10:30 a.m. and operations do not resume until 12:05 p.m. No sample would be obtained during Interval 2 because no load left the plant between 11:52 a.m., the sampling time and 12:00 noon, the end of Interval 2. Interval 3 would be sampled as scheduled.

Example 2: Suppose a breakdown occurs at 7:30 a.m. and operations do not resume until 8:30 a.m., then a sample would be required from Interval 1 as soon as it is feasible to obtain one.

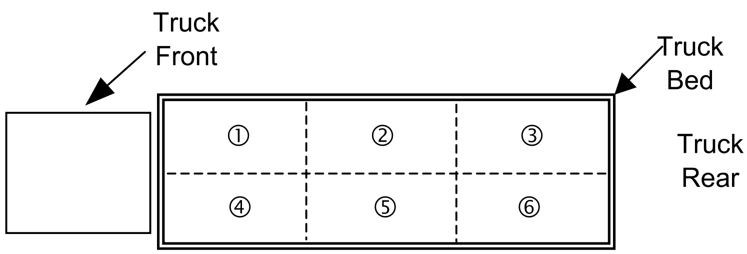
3.4. Sampling from a Truck Bed:

3.4.1. A suitable sampling platform shall be provided on which the Plant Inspector is able to stand and sample the material in the truck bed. The platform shall be constructed such that the truck is able to park on either side to prevent the Inspector from having to climb up onto the truck. If it is not possible for the platform to be constructed in this manner, then two appropriately constructed separate platforms shall be provided or the truck required to reverse direction so that the sample may be obtained.

3.4.2. Determining Sampling Locations on the Truck:

3.4.3. Divide the truck into 6 imaginary locations as shown in Figure SC-T-100B:

These locations are to remain constant and cannot be reversed.



TRUCK SAMPLING LOCATIONS
Figure SC-T-100B

3.4.4. Select a set of random numbers from Figure SC-T-100A. Because there are 6 imaginary locations on the truck, multiply each random number by 6. The sample locations are determined by the magnitude of the product (see Figure SC-T-100C):

PRODUCT	SAMPLE LOCATION
0.00-1.00	1
1.01-2.00	2
2.01-3.00	3
3.01-4.00	4
4.01-5.00	5
5.01-6.00	6

SAMPLE LOCATIONS
Figure SC-T-100C

3.4.5. Example of Computing Sampling Locations on Truck (see Figure SC-T-100D):

SAMPLE NO.	RANDOM NO.	PRODUCT (Random No. x 6)	TRUCK LOCATION
1	0.509	3.05	4
2	0.834	5.00	5
3	0.165	0.99	1

COMPUTING SAMPLING LOCATIONS
Figure SC-T-100D

3.5. Random Roadway Sampling of In-Place Highway Materials:

3.5.1. Divide the length of the day's run into the required number of equal subsections. Determine the beginning station number of each subsection.

3.5.2. Randomly select a column of random numbers from Figure SC-T-100A, which are the random number table to be used to determine the longitudinal distance from each beginning subsection station number.

3.5.3. Randomly select another column of random numbers from Figure SC-T-100A, which are to be used to determine the transverse distance from the right edge of the roadway to the sample location.

3.5.4. For the first sample, multiply the first random number of the first set by the number of feet in the subsection. Add this value to the beginning station number of that subsection. This will yield the station number of the sample location. To determine the transverse distance from the right edge of the roadway to the sample location, multiply the width of the lane available (available = width of lane - 2 ft.) by the random number from the second set and add one foot.

3.5.5. Continue this procedure for each sample location.

3.5.6. Example of Locating Samples of In-Place Highway Materials:

3.5.6.1 Suppose a day's run was 5000 feet. Determine the subsection lengths:

5000 feet = 1000 feet per subsection (5 subsections)

Recall the beginning station number for the day. Add 1000 feet to the station number to obtain the beginning station number of the next subsection. Do this for all 5 subsections.

3.5.6.2 Assume that the roadway is 12 feet wide; therefore, the available roadway width is:

12 feet - 2 feet = 10 feet

3.5.6.3 Randomly select 2 sets of random numbers from Figure SC-T-100A:

0.629	0.399	0.551	0.564	0.800
0.663	0.592	0.928	0.772	0.875

3.5.6.4 Using the first number in the first set of random numbers, calculate the longitudinal distance to the first sample in subsection 1:

(1000 feet subsection) (0.629) = 629 feet

Add this value to the beginning station number of the subsection to obtain the station number of the sample in subsection 1:

STA 0+00 + 629 feet = STA 6+29

Using the first number in the second set of random numbers, calculate the transverse distance from the right edge to the sample location:

(0.663) (10 feet) + 1 feet = 7.6 feet from right edge

Therefore, the first sample location is at STA 6+29 and is located 7.6 feet from the right edge.

3.5.6.5 Repeat Step 3.5.6.4. for each subsection, as shown in Figure SC-T-100E.

SUBSECTION	RANDOM NO.	FEET TO SAMPLE	SAMPLE LOCATION
1	0.629	(0.629)(1000 ft.) = 629 ft.	STA 0+00 + 629 = STA 6+29
	0.663	(0.663)(10 ft.) + 1 = 7.6 ft.	8 ft. from right edge
2	0.399	(0.399)(1000 ft.) = 399 ft.	STA 10+00 + 399 = STA 13+99
	0.592	(0.592)(10 ft.) + 1 = 6.9 ft.	7 ft. from right edge
3	0.511	(0.511)(1000 ft.) = 511 ft.	STA 20+00 + 511 = STA 25+11
	0.928	(0.928)(10 ft.) + 1 = 10.3 ft.	10 ft. from right edge
4	0.564	(0.564)(1000 ft.) = 546 ft.	STA 30+00 + 546 = STA 35+46
	0.772	(0.772)(10 ft.) + 1 = 8.8 ft.	9 ft. from right edge
5	0.800	(0.800)(1000 ft.) = 800 ft.	STA 40+00 + 800 = STA 48+00
	0.875	(0.875)(10 ft.) + 1 = 9.8 ft.	10 ft. from right edge

LOCATING SAMPLES OF IN-PLACE HIGHWAY MATERIALS
Figure SC-T-100E

4. CALCULATIONS

4.1. Calculations for this test are listed in the procedure section.

5. REPORT

5.1. Record what times the samples should be taken, where in the truck bed the samples are to be obtained and where the cores are to be taken from the roadway. For asphalt mixtures, report sampling times on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection and roadway core locations on SCDOT Form 400.16 – In-Place Density Contractor QA or SCDOT Form 400.17 – In-Place Density Contractor QC / QA PWL, as appropriate.

Standard Method of Test for

Random Method of Sampling Hot-Mix Asphalt (HMA)

SCDOT Designation: SC-T-101

1. SCOPE

1.1. This test method outlines the procedure for randomly sampling highway construction materials at the production plants and on the roadway. A table of random numbers is used to pre-determine the sampling tonnage and location for in-place density. This method may be used in any situation requiring random selection procedures.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to obtain random asphalt samples that are representative of the asphalt mixtures being produced. This procedure is used in determining sample tonnages and sample locations that are necessary for obtaining random samples used for acceptability of asphalt mixtures according to SCDOT specifications.

3. PROCEDURE

3.1. Determine Sampling Tonnages:

3.2. Sampling Frequency: Samples of the material are to be obtained from each sublot (500 tons) during a normal day's production. In-place density samples are taken depending on the type of asphalt mix.

3.3. Randomization:

3.3.1. At the beginning of each day, select from Figure SC-T-101A the set of the random numbers that corresponds to the calendar day of the month on which you are producing asphalt mix. This determines the sampling tonnages for your daily samples numbered from 1-10.

3.3.2. Each sublot sample should be taken from the truck that contains the total tonnage from the beginning of the lot or day’s production.

3.4. Sampling from a Truck Bed: A suitable sampling platform shall be provided on which the Plant Inspector is able to stand and sample the material in the truck bed. The platform shall be constructed such that the truck is able to park on either side to prevent the Inspector from having to climb up onto the truck. If it is not possible for the platform to be constructed in this manner, then two appropriately constructed separate platforms shall be provided or the truck required to reverse direction so that the sample may be obtained.

3.5. Random Roadway Sampling of In-Place Highway Materials:

3.5.1. Determine the sublot size for core locations depending on what type of asphalt mixture is being placed. Note the beginning station number for the day’s run.

1	2	3	4	5	6	7
0.117	0.391	0.764	0.414	0.710	0.086	0.748
0.724	0.105	0.943	0.653	0.910	0.344	0.807
0.013	0.440	0.252	0.515	0.955	0.776	0.752
0.717	0.066	0.389	0.368	0.113	0.816	0.600
0.723	0.182	0.853	0.141	0.582	0.896	0.206
0.875	0.970	0.497	0.080	0.442	0.998	0.718
0.493	0.552	0.592	0.680	0.449	0.676	0.013
0.866	0.488	0.931	0.997	0.394	0.481	0.157
0.768	0.261	0.994	0.324	0.383	0.542	0.590
0.093	0.123	0.827	0.936	0.458	0.312	0.413
8	9	10	11	12	13	14
0.966	0.750	0.689	0.586	0.140	0.535	0.600
0.595	0.188	0.371	0.051	0.985	0.911	0.692
0.114	0.948	0.906	0.966	0.756	0.631	0.599
0.024	0.971	0.435	0.986	0.534	0.676	0.543
0.933	0.172	0.186	0.895	0.918	0.827	0.757
0.381	0.167	0.618	0.362	0.519	0.963	0.963
0.739	0.340	0.553	0.131	0.359	0.004	0.054
0.833	0.112	0.360	0.667	0.080	0.594	0.968
0.481	0.915	0.617	0.165	0.348	0.874	0.502
0.138	0.724	0.478	0.092	0.872	0.193	0.708
15	16	17	18	19	20	21
0.479	0.890	0.883	0.406	0.359	0.090	0.853
0.802	0.787	0.093	0.327	0.101	0.078	0.489
0.506	0.352	0.689	0.649	0.940	0.899	0.800
0.094	0.656	0.693	0.644	0.751	0.406	0.643
0.282	0.418	0.158	0.598	0.092	0.994	0.498
0.108	0.580	0.785	0.859	0.656	0.245	0.853
0.878	0.751	0.837	0.971	0.939	0.533	0.804
0.908	0.575	0.470	0.957	0.920	0.692	0.863
0.516	0.130	0.725	0.705	0.059	0.628	0.556
0.965	0.188	0.881	0.691	0.770	0.092	0.239
22	23	24	25	26	27	28
0.143	0.278	0.858	0.672	0.785	0.407	0.708
0.243	0.503	0.714	0.280	0.523	0.918	0.139
0.530	0.102	0.293	0.557	0.944	0.621	0.707
0.697	0.818	0.520	0.860	0.639	0.229	0.563
0.372	0.015	0.185	0.173	0.673	0.767	0.528
0.749	0.489	0.923	0.227	0.452	0.587	0.630
0.524	0.277	0.664	0.759	0.945	0.040	0.602
0.106	0.924	0.649	0.149	0.560	0.225	0.773
0.274	0.481	0.424	0.692	0.834	0.208	0.889
0.608	0.557	0.612	0.412	0.077	0.203	0.734

29	30	31
0.599	0.165	0.051
0.573	0.951	0.432
0.362	0.314	0.602
0.784	0.138	0.331
0.354	0.511	0.097
0.664	0.942	0.510
0.986	0.389	0.428
0.099	0.932	0.596
0.079	0.218	0.820
0.440	0.354	0.544

RANDOM TONNAGE SELECTION
Figure SC-T-101A

3.5.2. Select the set of random numbers from Figure SC-T-101B that corresponds to the calendar day that paving is beginning (day or night). The first column of the table is to be used to determine the longitudinal distance from each beginning sublot station number.

3.5.3. Select from the second column of random numbers in the same set to determine the transverse distance from the right edge of the roadway to the sample location.

3.5.4. For the first sample, multiply the first random number of the first column by the number of feet in the sublot (usually 1500 feet to 2000 feet). Add this value to the beginning station number of that sublot. This will yield the station number of the sample location. To determine the transverse distance from the right edge of the roadway to the sample location, multiply the width of the lane available (available = width of lane - 2 feet) by the random number from the second set and add one foot.

Assume that the roadway is 12 feet wide; therefore, the available roadway width is:

Width = 12 feet - 2 feet = 10 feet

3.5.5. Continue this procedure for each sample location.

3.6. Example of Locating Samples of In-Place Highway Materials:

3.6.1. Given:

Suppose a day's run was 5000 feet
Average width of 12 feet
(Surface Type 1C)
Date: August 15, 2002
Starting Station: STA 0+00

Refer to the Contract Specifications to determine the sublot lengths: Surface Course > 140 pounds per square yard requires a random core sample every 2000 feet.

5000 feet / 2000 feet per sublot = (2.5 => 3 sublots)

Recall the beginning station number for the day. Add 2000 feet to the station number to obtain the beginning station number for the next subsection. Do this for all 3 sublots.

3.6.2. Select from the first column of random numbers from Figure SC-T-101B: Date: August 15, so use the 15^{th} set (see Figure SC-T-101C).

1		2		3		4		5		6		7	
0.735	0.720	0.133	0.188	0.697	0.384	0.079	0.028	0.916	0.547	0.165	0.479	0.517	0.131
0.695	0.151	0.961	0.944	0.752	0.175	0.769	0.723	0.292	0.596	0.885	0.970	0.616	0.745
0.708	0.057	0.016	0.352	0.053	0.091	0.318	0.199	0.153	0.177	0.582	0.624	0.802	0.498
0.549	0.203	0.434	0.018	0.796	0.768	0.323	0.294	0.086	0.010	0.932	0.907	0.532	0.524
0.190	0.951	0.736	0.080	0.220	0.800	0.943	0.585	0.108	0.261	0.637	0.183	0.113	0.299
0.569	0.579	0.805	0.757	0.833	0.066	0.542	0.063	0.936	0.776	0.685	0.498	0.266	0.810
0.919	0.107	0.558	0.007	0.922	0.671	0.501	0.531	0.470	0.333	0.734	0.564	0.654	0.750
0.691	0.368	0.922	0.712	0.506	0.821	0.443	0.589	0.094	0.867	0.966	0.515	0.586	0.267
0.608	0.681	0.617	0.773	0.291	0.611	0.487	0.792	0.135	0.807	0.547	0.467	0.479	0.506
0.070	0.459	0.845	0.169	0.647	0.364	0.098	0.156	0.971	0.067	0.025	0.231	0.113	0.599

8		9		10		11		12		13		14	
0.611	0.622	0.540	0.406	0.792	0.338	0.493	0.338	0.351	0.462	0.260	0.714	0.358	0.909
0.840	0.966	0.873	0.468	0.096	0.962	0.457	0.864	0.469	0.266	0.985	0.173	0.547	0.505
0.918	0.879	0.733	0.767	0.056	0.607	0.113	0.715	0.293	0.729	0.410	0.984	0.217	0.547
0.366	0.007	0.147	0.243	0.004	0.745	0.047	0.235	0.288	0.408	0.900	0.137	0.103	0.799
0.576	0.884	0.109	0.252	0.835	0.968	0.643	0.060	0.463	0.325	0.661	0.179	0.917	0.044
0.472	0.517	0.955	0.357	0.622	0.740	0.796	0.768	0.586	0.196	0.884	0.951	0.975	0.588
0.306	0.437	0.703	0.376	0.212	0.610	0.649	0.055	0.369	0.661	0.086	0.536	0.003	0.883
0.900	0.559	0.645	0.665	0.027	0.601	0.776	0.178	0.487	0.124	0.635	0.020	0.808	0.924
0.920	0.960	0.306	0.796	0.640	0.550	0.604	0.609	0.374	0.714	0.351	0.729	0.273	0.405
0.091	0.049	0.624	0.144	0.790	0.379	0.206	0.720	0.462	0.468	0.966	0.535	0.239	0.678

15		16		17		18		19		20		21	
0.477	0.893	0.747	0.057	0.651	0.040	0.902	0.251	0.102	0.773	0.788	0.570	0.109	0.372
0.943	0.406	0.002	0.080	0.702	0.484	0.429	0.501	0.579	0.809	0.912	0.425	0.539	0.300
0.536	0.397	0.382	0.656	0.549	0.435	0.786	0.396	0.649	0.705	0.510	0.542	0.575	0.667
0.375	0.330	0.383	0.357	0.187	0.714	0.988	0.297	0.479	0.959	0.921	0.793	0.065	0.865
0.028	0.549	0.616	0.590	0.771	0.954	0.476	0.811	0.723	0.702	0.333	0.680	0.886	0.551
0.593	0.329	0.552	0.903	0.978	0.703	0.402	0.339	0.506	0.372	0.315	0.165	0.792	0.048
0.882	0.288	0.014	0.925	0.926	0.504	0.629	0.414	0.553	0.087	0.864	0.096	0.054	0.055
0.587	0.117	0.863	0.050	0.395	0.300	0.080	0.451	0.489	0.418	0.552	0.809	0.546	0.211
0.555	0.316	0.164	0.824	0.595	0.654	0.182	0.371	0.625	0.670	0.140	0.957	0.240	0.780
0.745	0.479	0.415	0.711	0.961	0.309	0.579	0.226	0.151	0.359	0.584	0.538	0.830	0.249

22		23		24		25		26		27		28	
0.708	0.978	0.805	0.011	0.269	0.710	0.741	0.065	0.553	0.732	0.796	0.401	0.039	0.841
0.034	0.110	0.917	0.392	0.195	0.052	0.079	0.063	0.537	0.099	0.634	0.876	0.451	0.034
0.684	0.299	0.090	0.908	0.938	0.556	0.928	0.262	0.983	0.413	0.699	0.110	0.320	0.295
0.800	0.198	0.551	0.087	0.056	0.183	0.771	0.836	0.396	0.337	0.456	0.678	0.628	0.229
0.560	0.330	0.270	0.320	0.343	0.957	0.283	0.256	0.402	0.835	0.221	0.406	0.829	0.064
0.119	0.631	0.474	0.741	0.536	0.778	0.580	0.108	0.806	0.580	0.935	0.282	0.674	0.138
0.078	0.441	0.515	0.899	0.919	0.888	0.920	0.059	0.114	0.908	0.074	0.255	0.164	0.664
0.479	0.187	0.270	0.585	0.924	0.510	0.032	0.033	0.803	0.199	0.766	0.870	0.061	0.799
0.244	0.660	0.871	0.437	0.032	0.050	0.530	0.992	0.672	0.407	0.898	0.249	0.615	0.950
0.065	0.253	0.957	0.036	0.110	0.441	0.415	0.893	0.489	0.933	0.596	0.446	0.848	0.244

29		30		31	
0.584	0.706	0.132	0.792	0.553	0.931
0.178	0.820	0.017	0.712	0.996	0.658
0.536	0.009	0.698	0.506	0.372	0.970
0.898	0.981	0.439	0.046	0.832	0.660
0.331	0.388	0.435	0.581	0.828	0.736
0.107	0.893	0.828	0.156	0.597	0.580
0.462	0.495	0.280	0.150	0.246	0.484
0.033	0.344	0.475	0.238	0.742	0.163
0.994	0.818	0.759	0.251	0.487	0.235
0.599	0.512	0.710	0.027	0.351	0.186

CORE LOCATIONS — LONGITUDINAL/TRANSVERSE

Figure SC-T-101B

15th	
0.477	0.893
0.943	0.406
0.536	0.397
0.375	0.330
0.028	0.549
0.593	0.329
0.882	0.288
0.587	0.177
0.555	0.316
0.745	0.479

Note: These random numbers were obtained from Figure SC-T-101B.

EXAMPLE RANDOM NUMBERS FOR AUGUST 15TH
Figure SC-T-101C

3.6.3. Using the first number in the first column of random numbers (see Figure SC-T-101C), calculate the longitudinal distance to the first sample in sublot number 1.

(2000 feet subsection) (0.477) = 954 feet

Add this value to the beginning station number of the subsection to get the station number of the sample in sublot number 1.

STA 0+00 + 954 feet = STA 9+54

3.6.4. Using the first number in the second column of random numbers (see Figure SC-T-101C), calculate the transverse distance from the right edge to the sample location.

(0.893) (10 feet) + 1 feet = 9.9 feet from right edge

Therefore, the first sample location is at STA 9+54 and is located 9.9 feet from the right edge.

3.6.5. Repeat this procedure for each sublot as shown in Figure SC-T-101D.

4. CALCULATIONS

4.1. Calculations for this test are listed in the procedure section.

SUBLOT	RANDOM NO.	FEET TO SAMPLE	SAMPLE LOCATION
1	0.477	(0.477)(2000 ft.) = 954 ft.	STA 0+00 + 954 = STA 9+54
	0.893	(0.893)(10 ft.) + 1 = 9.9 ft.	9.9 ft. from right edge
2	0.943	(0.943)(2000 ft.) = 1886 ft.	STA 20+00 + 1886 = STA 38+86
	0.406	(0.406)(10 ft.) + 1 = 5.1 ft.	5.1 ft. from right edge
3	0.536	(0.536)(2000 ft.) = 1072 ft.	STA 40+00 + 1072 = STA 50+72 STA 50+72 is beyond the ending STA 50+00 for the day; therefore, no core needs to be taken.
	0.397	(0.397)(10 ft.) + 1 = 5.0 ft.	

EXAMPLE LOCATIONS
Figure SC-T-101D

5. REPORT

5.1. Record what tonnage the samples should be taken and where the cores are to be taken from the roadway. Report sampling tonnages on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection and roadway core locations on SCDOT Form 400.16 – In-Place Density Contractor QA or SCDOT Form 400.17 – In-Place Density Contractor QC / QA PWL, as appropriate.

Standard Method of Test for

Measuring the Field Application Rate of Portland Cement

SCDOT Designation: SC-T-141

1. SCOPE

1.1. This standard describes the procedure for determining the field spread rate of Portland cement for Cement Modified Subbase, Cement Stabilized Earth Base, Cement Stabilized Aggregate Base, or Reclaimed Asphalt Pavement.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1. None.

3. SIGNIFICANCE AND USE

3.1. This practice provides standardized requirements for measuring the field spread rate of Portland cement used in road-mix applications of Cement Modified Subbase, Cement Stabilized Aggregate Base, Cement Stabilized Earth Base, and Reclaimed Asphalt Base.

3.2. Proper cement spread rate is essential to achieving a high quality base or subbase. The use of too little cement can result in weak layers and premature pavement failure. The use of excessive cement can result in shrinkage cracks that can reflect through overlying asphalt layers. Consequently, operations should strive to consistently place the specified quantity of cement.

4. APPARATUS

4.1. *Square Yard Pan* — A pan with an area equal to one square yard. These pans are available from the Research and Materials Laboratory.

4.2. *Balance* — A balance accurate to the nearest 0.1 pounds with a capacity sufficient to adequately measure the pan and contents.

5. DIRECT MEASUREMENT

5.1. Measure and record the weight of the empty pan to the nearest 0.1 pounds. Place the pan in front of the spreader. After the spreader has passed over the pan, reweigh the pan and its contents and subtract the weight of the empty pan. The weight of the contents should be within ±5% of the recommended spread rate.

5.2. If the cement spread rate is outside the tolerance, require the Contractor to adjust the spreader and repeat Step 5.1 until the desired spread rate is achieved.

6. INDIRECT MEASUREMENT

6.1. Once the proper spread rate is established using the Direct Method given in Section 5, make periodic checks of the spread rate by calculating the distance a load of cement should cover.

6.2. *Example* —The printout ticket for a cement tanker shows it is carrying 50,000 pounds of cement. The application rate established by the Research and Materials Laboratory is 48 pounds per square yard. The spreader is set to cover a width of 12 feet. Cement application will start at Station 100+00. Determine at what station the tanker should run out.

First, determine the area the tanker should cover at the established application rate:

(50,000 pounds / 48 pounds/yd^2) = 1041.7 yd^2

Next, calculate how many linear feet the tanker will cover at a width of 12 feet:

(1041.7 yd^2 x 9 ft^2/yd^2) / 12 feet = 781 feet

So, the tanker should run out of cement at approximately Station 107+80. If the tanker runs out more than ±5% (40 feet) of the estimated point, the spreader should be readjusted and recalibrated using the Direct Method given in Section 5.

APPENDIX D
Miscellaneous Data

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

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Section **Page**

Appendix D
Miscellaneous Data

Appendix D presents common tables, figures and miscellaneous data that SCDOT field personnel use such as soils classification, mathematical tables and equations, procedures for measuring and documenting vertical and lateral clearances at structures, and dry run depth check procedures.

COMPARISON OF UNIFIED AND AASHTO SOIL CLASSIFICATION SYSTEMS

UNIFIED	AASHTO	SOIL TYPE
GW	A-1-a	GRAVEL – well graded
GP	A-1-a	GRAVEL – poorly graded
GM	A-1-b	GRAVEL – silty
GC	A-2-6 A-2-7	GRAVEL – clayey
SW	A-1-b	SAND – well graded
SP	A-3	SAND – poorly graded
SM	A-2-4 A-2-5	SAND – silty
SC	A-2-6 A-2-7	SAND – clayey
ML	A-4	SILT – inorganic SILT – sandy
CL	A-6 Lean Clay	CLAY – inorganic
OL	A-4	SILT – organic
MH	A-5	SILT – inorganic
CH	A-7	CLAY – inorganic Fat Clays
OH	A-7	CLAY - organic
PT	---	PEAT – muck
Rock	---	---

Dry Run Depth Checks for Bridge Deck Pours

-SAMPLE-

Centerline of Beams (Girders)

	Near End of Span	¼ Point	½ Point (Midspan)	¾ Point	Near End of Span
Bay 1	(1)	(5)	(9)	(13)	(17)
Bay 2	(2)	(6)	(10)	(14)	(18)
Bay 3	(3)	(7)	(11)	(15)	(19)
Bay 4	(4)	(8)	(12)	(16)	(20)

Measurements Taken:

* 1	=	8¾″	6	=	8″	11	=	8¼″	16	=	8″
2	=	8″	7	=	8¼″	12	=	8″	17	=	8¼″
3	=	8¼″	8	=	8″	13	=	8″	18	=	8″
4	=	8¼″	9	=	8¼″	14	=	8½″	19	=	8½″
* 5	=	7⅜″	10	=	8″	15	=	8″	* 20	=	8¾″

Based on an 8″ deck.

Note to Inspector:

1) A set of depth checks should be taken for each span.

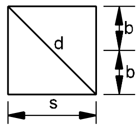
2) Depths should be taken in all bays (between beams) at quarter points and near ends of span. For long spans, it may be necessary to take additional depth checks. (Maximum distance between depth checks shall not exceed 25 feet.

3) Check reinforcing bar clearance at same time as depth checks and record measurements.

4) Check slab depth and clearances along all longitudinal and transverse construction joints.

5) *Notify Bridge Construction Engineer of any variance(s) greater than ± 1/2″ from plan dimension.

AREAS OF PLANE FIGURES



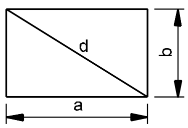
Square

Diagonal = d = $s\sqrt{2}$

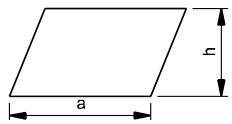
Area = $s^2 = 4b^2 = 0.5d^2$

Example: s = 6; b = 3; Area = $(6)^2$ = 36 Ans.

d = 6 x 1.414 = 8.484 Ans.



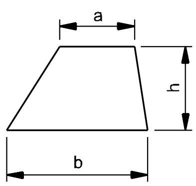
Rectangle and Parallelogram



Area = ab or $b\sqrt{d^2 - b^2}$

Example. a = 6; b = 3.

Area = 3 x 6 = 18 Ans.

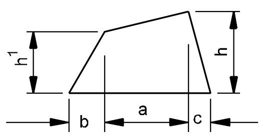


Trapezoid

Area = $\frac{1}{2}h\left(a+b\right)$

Example: a = 2; b = 4; h = 3

Area = $\frac{1}{2}\times 3\left(2+4\right) = 9$ Ans.

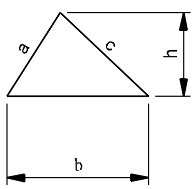


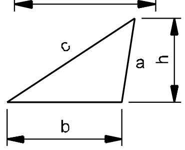
Trapezium

Area = $\frac{1}{2}\left[a\left(h+h^1\right)+bh^1+ch\right]$

Example: a = 4; b = 2; c = 2; h = 3; h^1 = 2.

Area = $\frac{1}{2}\left[4\left(3+2\right)+\left(2\times 2\right)+\left(2\times 3\right)\right] = 15$ Ans.





Triangles

Both formulas apply to both figures.

Area = $\frac{1}{2}$ bh

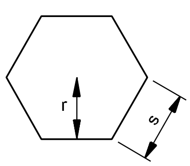
Example: h = 3; b = 5

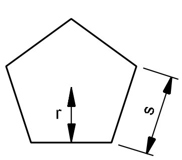
Area = $\frac{1}{2}\left(3\times 5\right) = 7\frac{1}{2}$ Ans.

Area = $\sqrt{S\left(S-a\right)\left(S-b\right)\left(S-c\right)}$ where $S = \frac{a+b+c}{2}$

Example: a = 2; b = 3; c = 4

$S = \frac{2+3+4}{2} = 4.5$; Area = $\sqrt{4.5\left(4.5-2\right)\left(4.5-3\right)\left(4.5-4\right)}$ = 2.9 Ans.





Regular Polygons

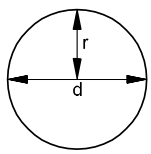
$$\text{Area}\left\langle\begin{array}{l} 5\text{ sides} = 1.720477\,S^2 = 3.63271\,r^2 \\ 6\text{ sides} = 2.598150\,S^2 = 3.46410\,r^2 \\ 7\text{ sides} = 3.633875\,S^2 = 3.37101\,r^2 \\ 8\text{ sides} = 4.828427\,S^2 = 3.31368\,r^2 \\ 9\text{ sides} = 6.181875\,S^2 = 3.27573\,r^2 \\ 10\text{ sides} = 7.694250\,S^2 = 3.24920\,r^2 \\ 11\text{ sides} = 9.365675\,S^2 = 3.22993\,r^2 \\ 12\text{ sides} = 11.196300\,S^2 = 3.21539\,r^2 \end{array}\right.$$

n = number of sides; r = short radius; S = length of side; R = long radius.

$$\text{Area} = \frac{n}{4}S^2\cot\frac{180^\circ}{n} = \frac{n}{2}R^2\sin\frac{360^\circ}{n} = nr^2\tan\frac{180^\circ}{n}$$

AREAS OF PLANE FIGURES (continued)

Circle



$\pi = 3.1416$; A = area; d = diameter

p = circumference or periphery; r = radius

$p = \pi d = 3.1416d$ $\qquad$ $p = 2\sqrt{\pi A} = 3.54\sqrt{A}$

$p = 2\pi r = 6.2832r$ $\qquad$ $p = \frac{2A}{r} = \frac{4A}{d}$

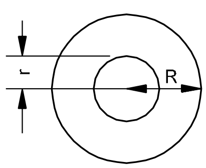
$d = \frac{p}{\pi} = \frac{p}{3.1416}$ $\qquad$ $d = 2\sqrt{\frac{A}{\pi}} = 1.128\sqrt{A}$

$r = \frac{p}{2\pi} = \frac{p}{6.2832}$ $\qquad$ $r = \sqrt{\frac{A}{\pi}} = 0.564\sqrt{A}$

$A = \frac{\pi d^2}{4} = 0.7854d^2$ $\qquad$ $A = \frac{p^2}{4\pi} = \frac{p^2}{12.57}$

$A = \pi r^2 = 3.1416r^2$ $\qquad$ $A = \frac{pr}{2} = \frac{pd}{4}$

Circular Ring



$\text{Area} = \pi\left(R^2 - r^2\right) = 3.1416\left(R^2 - r^2\right)$

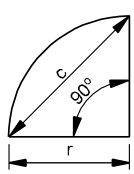
$\text{Area} = 0.7854(D^2-d^2) = 0.7854(D-d)(D+d)$

Area = difference in areas between the inner and outer circles.

Example: R = 4; r = 2.

$\text{Area} = 3.1416(4^2-2^2) = 37.6992$ Ans.

Quadrant

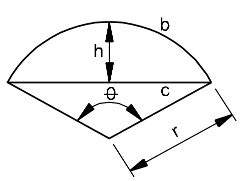


$\text{Area} = \frac{\pi r^2}{4} = 0.7854r^2 = 0.3927c^2$

Example. r = 3; c = chord.

$\text{Area} = 0.7851 \times 3^2 = 7.0686$ Ans.

Segment



b = length of arc; θ = angle in degrees; c = chord = $\sqrt{4\left(2hr - h^2\right)}$

$\text{Area} = \frac{1}{2}\left[br - c\left(r - h\right)\right] = \pi r^2 \frac{\theta}{360} - \frac{c\left(r-h\right)}{2} p$

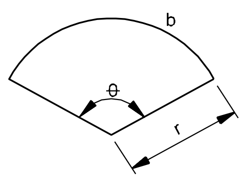
When θ is greater than 180° then $\frac{c}{2} \times$ difference between r and h is added to

the fraction $\frac{\pi r^2 \theta}{360}$.

Example: r = 3; $\theta = 120°$; h = 1.5

$\text{Area} = 3.1416 \times 3^2 \times \frac{120}{360} - \frac{5.196\left(3 - 1.5\right)}{2} = 5.5278$ Ans.

AREAS OF PLANE FIGURES (continued)



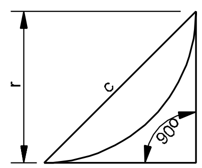
Sector

Area = $\dfrac{br}{2} = \pi r^2 \dfrac{\theta}{360°}$

θ = angle in degrees; b = length of arc

Example: r = 3; θ = 120°

Area = $3.1416 \times 3^2 \times \dfrac{120}{360} = 9.4248$ Ans.

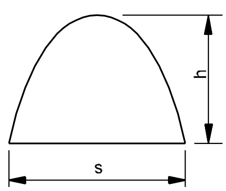


Spandrel

Area = $0.2146r^2 = 0.1073c^2$

Example: r = 3

Area = $0.2146 \times 3^2 = 1.9314$ Ans.



Parabola

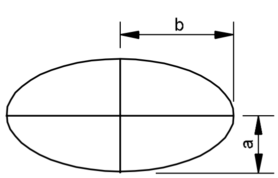
l = length of curved line = periphery – s

$$l = \frac{s^2}{8h}\left[\sqrt{c\,(1+c)} + 2.0326 \times \log\left(\sqrt{c} + \sqrt{1+c}\right)\right] \text{ where } c = \left(\frac{4h}{s}\right)^2$$

Area = $\dfrac{2}{3}sh$

Example: s = 3; h = 4

Area = $\dfrac{2}{3} \times 3 \times 4 = 8$ Ans.



Ellipse

Area = $\pi ab = 3.1416ab$

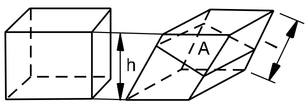
Circum. = $2\pi\sqrt{\dfrac{a^2+b^2}{2}}$ (close approximation)

Example. a = 3; b = 4.

Area = $3.1416 \times 3 \times 4 = 37.6992$ Ans.

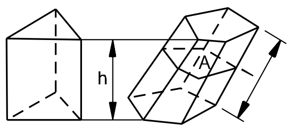
Circum. = $2 \times 3.1416\sqrt{\dfrac{(3)^2+(4)^2}{2}} = 6.2832 \times 3.5355 = 22.21$ Ans.

SURFACE AND VOLUME OF SOLIDS



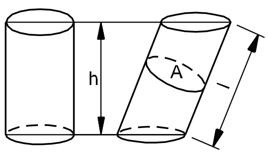
Parallelopiped

S = perimeter, P, perp. to sides x lat. length, l:	Pl
V = area of base, B, x perpendicular height, h:	Bh
V = area of section, A, perp. to sides x lat. length, l:	Al



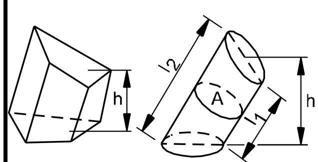
Prism, Right or Oblique, Regular or Irregular

S = perimeter, P, perp. to sides x lat. length, l:	Pl
V = area of base, B, x perpendicular height, h:	Bh
V = area of section, A, perp. to sides x lat. length, l:	Al



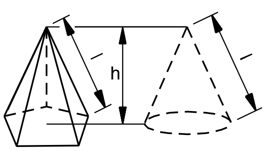
Cylinder, Right or Oblique, Circular or Elliptic, etc.

S = perimeter of base, P, x perp. height, h:	Ph
S = perimeter, P_1, perp. to sides x lat. length, l:	$P_1 l$
V = area of base, B, x perpendicular height, h:	Bh
V = area of section, A, perp. to sides x lat. length, l:	Al



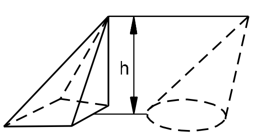
Frustum of any Prism or Cylinder

V = area of base, B, x perp. distance, h, from base to center of gravity of opposite face:	Bh
For cylinder:	$\frac{1}{2} A\left(l_1 + l_2\right)$



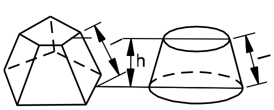
Pyramid or Cone, Right and Regular

S = perimeter of base, P, x $\frac{1}{2}$ slant height, l:	$\frac{1}{2}$Pl
V = area of base, B, x $\frac{1}{8}$ perp. height, h:	$\frac{1}{8}$Bh



Pyramid or Cone, Right or Oblique, Regular or Irregular

V = area of base, B, x $\frac{1}{3}$ perp. height, h:	$\frac{1}{3}$Bh
V = $\frac{1}{3}$ volume of prism or cylinder of same base and perpendicular height	
V = $\frac{1}{2}$ volume of hemisphere of same base and perpendicular height	

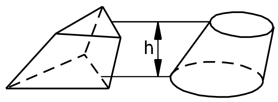


<u>Frustum of Pyramid or Cone, Right and Regular, Parallel Ends</u>

S = (sum of perimeter of base, P, and top, p) x $\frac{1}{2}$ slant height, l:	$\frac{1}{2}$l (P+p)
V = (sum of areas of base, B, and top, b + square root of their products) x $\frac{1}{3}$ perp. height, h:	$\frac{1}{3}h(B+b+\sqrt{Bb})$

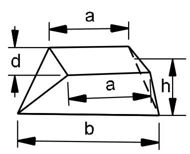
S = Lateral or Convex Surface *V = Volume*

SURFACE AND VOLUME OF SOLIDS (continued)



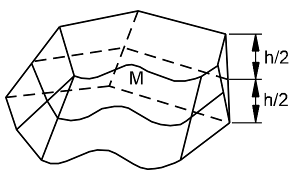
Frustum of any Pyramid or Cone, Parallel Ends

V = (sum of areas of base, B, and top, b + square root of their products) x $\frac{1}{8}$ perp. height, h: $\frac{1}{8}h(B+b+\sqrt{Bb})$



Wedge, Parallelogram Face

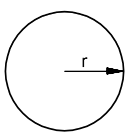
V = $\frac{1}{6}$ (sum of three edges, a b a, x perpendicular height, h x perpendicular width, d): $\frac{1}{6}dh(2a+b)$



Prismatoid

V = $\frac{1}{6}$ perp. height, h (sum of areas of base, B, and top b, +4 x area of section, M, parallel to bases and midway between them): $\frac{1}{6}h(B+b+4M)$

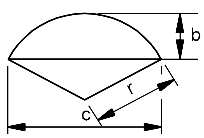
The Prismatoid formula applies also to any of the foregoing solids with parallel bases, to pyramids, cones, and spherical sections, and to many solids with irregular surfaces.



Sphere

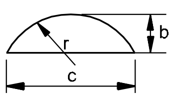
$S = 4\pi r^2 = \pi d^2 = 3.14159265\, d^2$

$V = \frac{4}{3}\pi r^3 = \frac{1}{6}\pi d^3 = 0.52359878\, d^3$



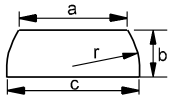
Spherical Sector

$S = \frac{1}{2}\pi r(4b + c)$ $V = \frac{2}{3}\pi r^3 b$



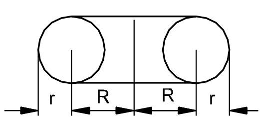
Spherical Segment

$S = 2\pi r b = \frac{1}{4}\pi(4b^2 + c^2)$ $V = \frac{1}{3}\pi b^2(3r - b) = \frac{1}{24}\pi b(3c^2 + 4b^2)$



Spherical Zone

$S = 2\pi r b$ $V = \frac{1}{24}\pi b(3a^3 + 3c^2 + 4b^2)$



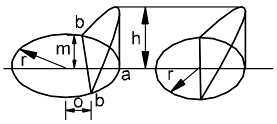
Circular Ring

$S = 4\pi^2 Rr$ $V = 2\pi^3 Rr^2$

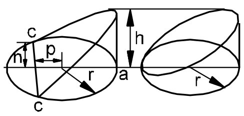
S = Lateral or Convex Surface *V = Volume*

SURFACE AND VOLUME OF SOLIDS (continued)

Ungula of Right, Regular Cylinder

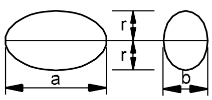


Base = Segment, b a b	Base = Half Circle
$S = (2\ r\ m - o \times \text{arc, b a b})\ \dfrac{h}{r - o}$	$S = 2rh$
$V = \left(\dfrac{2}{3} m^3 - o \times \text{area, b a b}\right)\dfrac{h}{r - o}$	$V = \dfrac{2}{3} r^2 h$



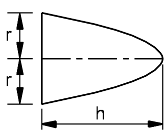
Base = Segment, c a c	Base = Circle
$S = (2\ r\ n + p \times \text{arc, c a c})\ \dfrac{h}{r + p}$	$S = r\ \pi\ h$
$V = \left(\dfrac{2}{3} n^3 + p \times \text{area, cac}\right)\dfrac{h}{r + p}$	$V = \dfrac{1}{2} r^2 \pi h$

Ellipsoid



$V = \dfrac{1}{3} \pi\ r\ a\ b$

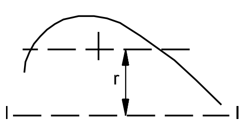
Paraboloid



$V = \dfrac{1}{2} \pi\ r^2 h$

Ratio of corresponding volumes of a Cone, Paraboloid, Sphere, and Cylinder of equal height: $\dfrac{1}{3} : \dfrac{1}{2} : \dfrac{2}{3} : 1$

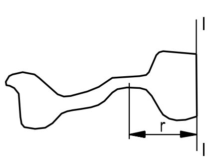
Bodies Generated by Partial or Complete Revolution



$\left.\begin{array}{l} l = \text{length of a curve} \\ A = \text{area of a plane} \end{array}\right\}$ rotating about an axis 1-1 on one side and in plane of axis

r = distance of center of gravity of line or plane from axis 1-1 and for any angle of revolution, a°

$\dfrac{2\ r\ \pi\ a°}{360}$ = length of arc described by center of gravity.



S = length of curve x length of arc about axis = $l\ \dfrac{2\ r\ \pi\ a°}{360}$

For complete revolution, $S = 2 r \pi\ l$

V = area of plane x length of arc about axis = $A\ \dfrac{2\ r\ \pi\ a°}{360}$

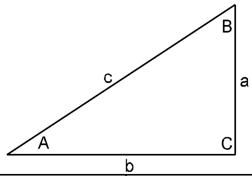
For complete revolution, $V = 2\ r\ \pi A$

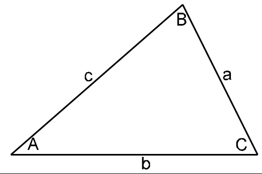
S = Lateral or Convex Surface *V = Volume*

TRIGONOMETRIC FUNCTIONS

Angle	Sin	Cos	Tan	Angle	Sin	Cos	Tan
0	0.000	1.000	0.000	46	0.719	0.695	1.04
1	0.017	0.999	0.017	47	0.731	0.682	1.07
2	0.035	0.999	0.035	48	0.743	0.699	1.11
3	0.052	0.999	0.052	49	0.755	0.656	1.15
4	0.070	0.998	0.070	50	0.766	0.643	1.19
5	0.087	0.996	0.087	51	0.777	0.629	1.23
6	0.105	0.995	0.105	52	0.788	0.616	1.28
7	0.112	0.993	0.123	53	0.799	0.602	1.33
8	0.139	0.990	0.141	54	0.809	0.588	1.38
9	0.156	0.988	0.158	55	0.819	0.574	1.43
10	0.174	0.985	0.176	56	0.829	0.559	1.48
11	0.191	0.982	0.194	57	0.839	0.545	1.54
12	0.208	0.978	0.213	58	0.848	0.530	1.60
13	0.225	0.974	0.231	59	0.857	0.515	1.66
14	0.242	0.970	0.249	60	0.866	0.500	1.73
15	0.259	0.966	0.268	61	0.875	0.485	1.80
16	0.276	0.961	0.287	62	0.883	0.469	1.88
17	0.292	0.956	0.306	63	0.891	0.454	1.96
18	0.309	0.951	0.325	64	0.898	0.438	2.05
19	0.326	0.946	0.344	65	0.906	0.423	2.14
20	0.342	0.940	0.364	66	0.914	0.407	2.25
21	0.358	0.934	0.384	67	0.921	0.391	2.36
22	0.375	0.927	0.404	68	0.927	0.375	2.48
23	0.391	0.921	0.424	69	0.934	0.358	2.61
24	0.407	0.914	0.445	70	0.940	0.342	2.75
25	0.423	0.906	0.466	71	0.946	0.326	2.90
26	0.438	0.898	0.488	72	0.951	0.309	3.08
27	0.454	0.891	0.510	73	0.956	0.292	3.27
28	0.469	0.883	0.532	74	0.961	0.276	3.49
29	0.485	0.875	0.554	75	0.966	0.259	3.73
30	0.500	0.866	0.577	76	0.970	0.242	4.01
31	0.515	0.857	0.601	77	0.974	0.225	4.33
32	0.530	0.848	0.625	78	0.978	0.208	4.70
33	0.545	0.839	0.649	79	0.982	0.191	5.14
34	0.559	0.829	0.675	80	0.985	0.174	5.67
35	0.574	0.819	0.700	81	0.988	0.156	6.31
36	0.588	0.809	0.727	82	0.990	0.139	7.12
37	0.602	0.799	0.754	83	0.993	0.122	8.14
38	0.616	0.788	0.781	84	0.995	0.105	9.51
39	0.629	0.777	0.810	85	0.996	0.087	11.43
40	0.643	0.766	0.839	86	0.998	0.070	14.30
41	0.656	0.755	0.869	87	0.999	0.052	19.08
42	0.699	0.743	0.900	88	0.999	0.035	28.64
43	0.682	0.731	0.933	89	0.999	0.017	57.28
44	0.695	0.719	0.966	90	1.000	0.000	Infinity
45	0.707	0.707	1.000				

TRIGONOMETRIC SOLUTION OF TRIANGLES





$$S = \frac{a+b+c}{2}$$

Given:	Sought:	Formulae:
RIGHT-ANGLED TRIANGLES		
a,c	A,B,b	$\sin A = \frac{a}{c}$, $\cos B = \frac{a}{c}$, $b = \sqrt{c^2 - a^2}$
	Area	Area = $\frac{a}{2}\sqrt{c^2 - a^2}$
a,b	A,B,c	$\tan A = \frac{a}{b}$, $\tan B = \frac{b}{a}$, $c = \sqrt{a^2 + b^2}$
	Area	Area = $\frac{ab}{2}$
A,a	B,b,c	$B = 90° - A$, $b = a \cot A$, $c = \frac{a}{\sin A}$
	Area	Area = $\frac{a^2 \cot A}{2}$
A,b	B,a,c	$B = 90° - A$, $a = b \tan A$, $c = \frac{b}{\cos A}$
	Area	Area = $\frac{b^2 \tan A}{2}$
A,c	B,a,b	$B = 90° - A$, $a = c \sin A$, $b = c \cos A$
	Area	Area = $\frac{c^2 \sin A \cos A}{2}$ or $\frac{c^2 \sin 2A}{4}$
OBLIQUE-ANGLED TRIANGLES		
a,b,c	A	$\sin\frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{bc}}$, $\cos\frac{1}{2}A = \sqrt{\frac{s(s-2)}{bc}}$, $\tan\frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$
	B	$\sin\frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{ac}}$, $\cos\frac{1}{2}B = \sqrt{\frac{s(s-b)}{ac}}$, $\tan\frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{s(s-b)}}$
	C	$\sin\frac{1}{2}C = \sqrt{\frac{(s-a)(s-b)}{ab}}$, $\cos\frac{1}{2}C = \sqrt{\frac{s(s-c)}{ab}}$, $\tan\frac{1}{2}C = \sqrt{\frac{(s-a)(s-b)}{s(s-c)}}$
	Area	Area = $\sqrt{s(s-a)(s-b)(s-c)}$
a,A,B	b,c	$b = \frac{a \sin B}{\sin A}$, $c = \frac{a \sin C}{\sin A} = \frac{a \sin(A+B)}{\sin A}$
	Area	Area = $\frac{1}{2} a b \sin C = \frac{a^2 \sin B \sin C}{2 \sin A}$

TRIGONOMETRIC SOLUTION OF TRIANGLES (continued)

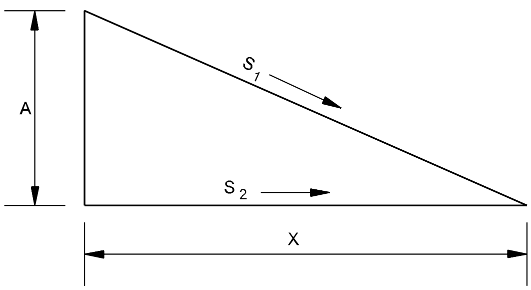
a,b,A	B	$\sin B = \frac{b \sin A}{a}$
	c	$c = \frac{a \sin C}{\sin A} = \frac{b \sin C}{\sin B} = \sqrt{a^2 + b^2 - 2ab\cos C}$
	Area	$\text{Area} = \frac{1}{2}ab \sin C$
a,b,C	A	$\tan A = \frac{a \sin C}{b - a\cos C}$ $\tan \frac{1}{2}(A - B) = \frac{a - b}{a + b}\cot \frac{1}{2}C$
	c	$c = \sqrt{a^2 \div b^2 - 2ab\cos C} = \frac{a \sin C}{\sin A}$
	Area	$\text{Area} = \frac{1}{2}ab \sin C$
$a^2 = b^2 + c^2 - 2bc\cos A$, $b^2 = a^2 + c^2 - 2ac\cos B$, $c^2 = a^2 + b^2 - 2ab\cos C$		

SLOPE EQUATIONS

GIVEN: Dimensions A and B
Slopes S_1 and S_2 in feet per foot

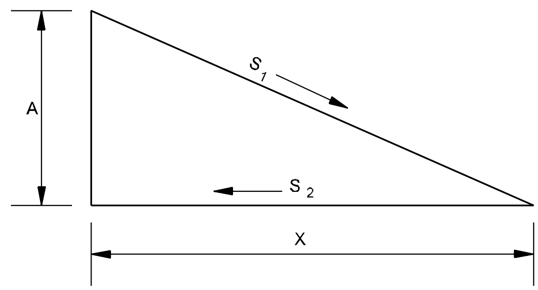
FIND: Horizontal distance X
Area

CASE I



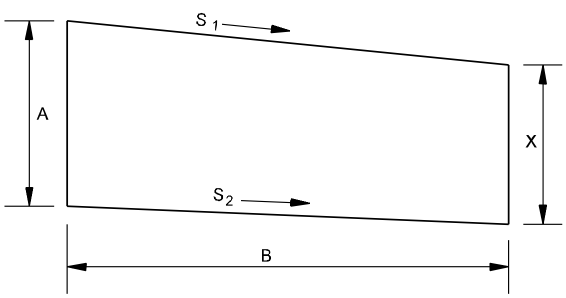
$X = \frac{A}{S_1 - S_2}$ Area = $\frac{AX}{2}$

CASE II



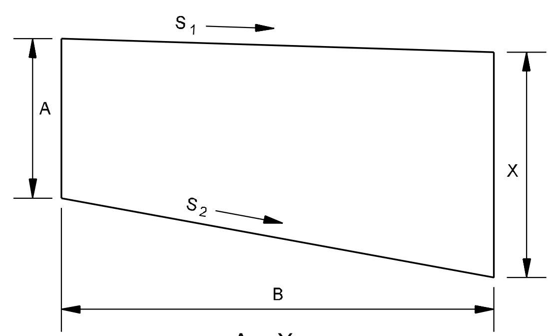
$X = \frac{A}{S_1 + S_2}$ Area = $\frac{AX}{2}$

CASE III



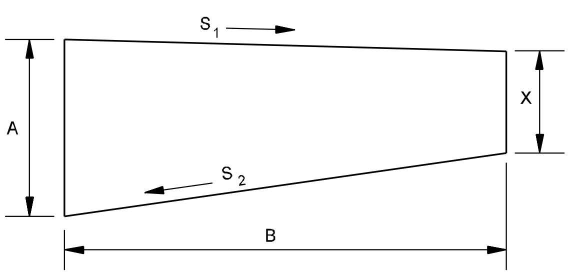
$X = A - (S_1 - S_2) B$ Area = $\frac{A + X}{2}$ (B)

CASE IV



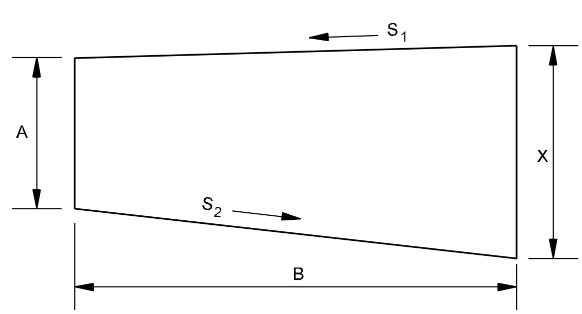
$X = A - (S_1 S_2) B$ Area = $\frac{A + X}{2}$ (B)

CASE V



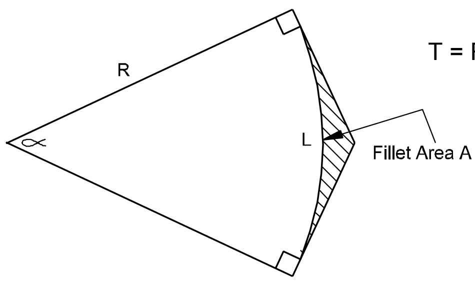
$X = A - (S_1 + S_2) B$ Area = $\frac{A + X}{2}$ (B)

CASE VI



$X = A + (S_1 + S_2) B$ Area = $\frac{A + X}{2}$ (B)

METHODS OF ESTIMATING AREA OF FILLETS, APRONS AND APPROACHES



$$T = R \tan \frac{\alpha}{2}$$

ESTIMATING FILLETS & RETURN

FILLET AREA

$$\text{Area } A = 2 \times \frac{1}{2} \times R \times R \tan \frac{\alpha}{2} - \pi R^2 \frac{\alpha}{360^\circ}$$

$$= R^2 \left[\tan \frac{\alpha}{2} - (0.008727 \times \alpha) \right]$$

Area 90° Fillet = $0.2146 \times R^2$

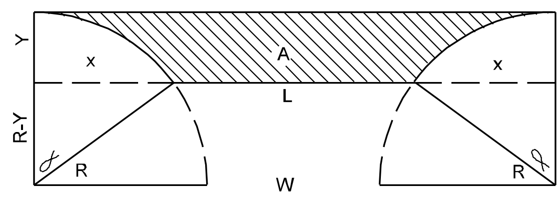
Length of Return

$$L = 2\pi R \times \frac{\alpha}{360^\circ}$$

$$= 0.01745 \times R \times \alpha$$

Length of 90° Return

$$L = 1.5708 \times R$$

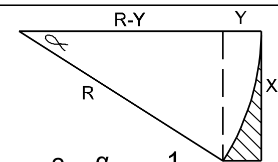


ESTIMATING AREA 90° APRON

$$L = (2R + W) - 2X \qquad \cos \alpha = \frac{R - Y}{R}$$

$$X = \sqrt{2RY - Y^2} \qquad A = \text{Area}$$

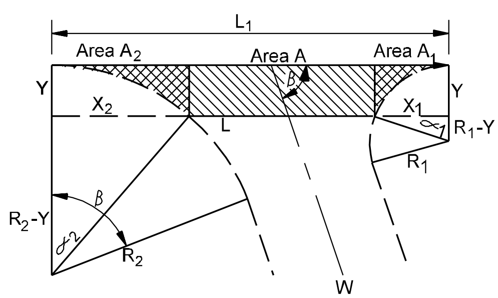
$$A = (2R + W)Y + X(R-Y) - 0.01745\, R^2\alpha$$



A = Area

$$A = XY - \left[\pi R^2 \frac{\alpha}{360^\circ} - \frac{1}{2} \times (R - Y) \right]$$

$$= XY + \frac{X(R-Y)}{2} - 0.08727 R^2 \alpha$$



ESTIMATING AREA APRON OTHER THAN 90°

$$\cos \alpha_1 = \frac{R_1 - Y}{R_1} \qquad \cos \alpha_2 = \frac{R_2 - Y}{R_2}$$

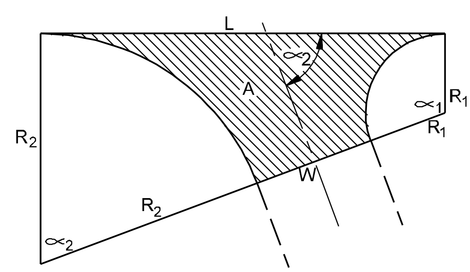
$$X_1 = \sqrt{2R_1Y - Y^2} \qquad X_2 = \sqrt{2R_2Y - Y^2}$$

$$L_1 = (R_2 - R_1) \tan \beta \qquad L = L_1 - (X_1 + X_2)$$

$$A = LY$$

$$A_1 = X_1 Y + \frac{X_1(R_1 - Y)}{2} - 0.008727 R_1^2\, \alpha_1$$

$$A_2 = X_2 Y + \frac{X_2(R_2 - Y)}{2} - 0.008727 R_2^2\, \alpha_2$$



ESTIMATING AREA APPROACH OTHER THAN 90°

$$\alpha_1 = 180^\circ - \alpha_2$$

$$L = (R_2 - R_1) \tan \alpha_2$$

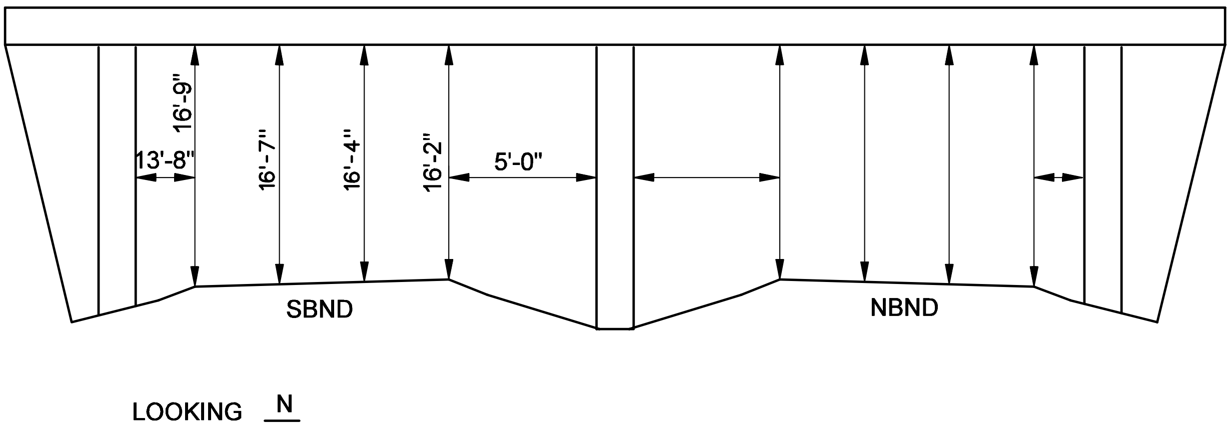
$$\text{Area } A = \frac{(R_1 + R_2)L}{2} - 0.008727(R_1^2\, \alpha_1 + R_2^2\, \alpha_2)$$

NOTES:

$$\pi = 3.1416 \qquad \frac{\pi}{180} = 0.01745$$

$$\frac{\pi}{2} = 1.5708 \qquad \frac{\pi}{360} = 0.008727$$

PROCEDURE FOR MEASURING AND DOCUMENTING VERTICAL
AND LATERAL CLEARANCES FOR BRIDGES AND SIGNS
(Applicable to New Construction, Reconstruction,
Overlay, and Rehabilitation Projects)



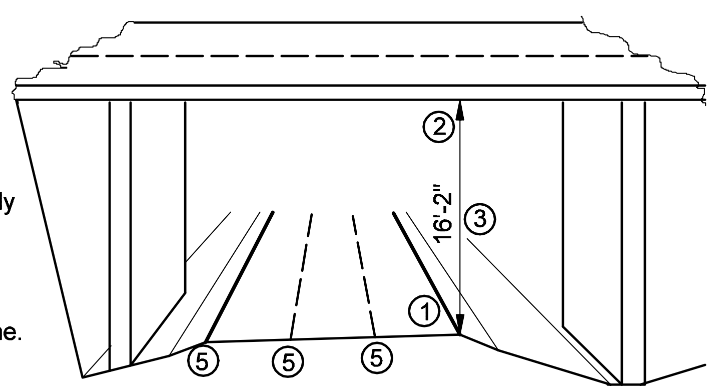
EXAMPLE

Recording Vertical and Lateral Clearances

1. Make an accurate sketch of bridge or sign structure.
2. Take measurements of vertical clearances as shown below. Be sure to measure the clearances under all the girders to determine the minimum along each lane line. Also meaure and record lateral clearances.
3. On sign structures, the minimum may not be the sign support. It may be a cat walk or an appurtenance hanging lower.
4. Record the measurements on a sketch of the bridge or sign as shown above.
5. Note which direction you are looking on the sketch. On a divided highway, record measurements for both structures while looking in one direction only. Do not look in the direction of traffic for each of the bridges.
6. Send the information to Bridge Maintenance.

Where to Measure Vertical Clearances

1. Locate the edge of roadway, excluding shoulder. Typically, a solid white line represents the edge of roadway.
2. Locate the lowest point of the structure directly above that line.
3. Measure the clearance.
4. Record the measurement.
5. Repeat steps 2, 3, and 4 for each roadway line.



CONVERSION FACTORS — US CUSTOMARY TO METRIC

TYPE OF MEASUREMENT	TO CONVERT FROM US CUSTOMARY	TO METRIC		MULTIPLY BY
Length	inch	millimeter	mm	25.4
	foot	millimeter	mm	304.8
	foot	meter	m	0.3048
	yard	meter	m	0.9144
	mile	kilometer	km	1.609344
Area	square inch	square millimeters	mm^2	645.16
	square foot	square meters	m^2	0.09290304
	square yard	square meter	m^2	0.83612736
	acre	hectare (10,000 m^2)	ha	0.404687
	square mile	square kilometer	km^2	2.589998
Volume	gallon	liter	L	3.785412
	cubic inch	cubic millimeter	mm^3	16,387.06
	cubic foot	cubic meter	m^3	0.02831685
	cubic yard	cubic meter	m^3	0.7645549
	acre-foot	cubic meter	m^3	1233.489
Mass	pound	kilogram	kg	0.4535924
	ton (2000 lbs)	metric ton (1 Mg)	t	0.9071847
Mass per Unit Length	pound per inch	kilogram per meter	kg/m	17.85797
	pound per foot	kilogram per meter	kg/m	1.488164
	pound per yard	kilogram per meter	kg/m	0.496055
Mass per Unit Area	gallon per square foot	liter per square meter	L/m^2	41.13219
	gallon per square yard	liter per square meter	L/m^2	4.527317
	gallon per acre	liter per hectare	L/ha	9.353925
	pound per square foot	kilogram per square meter	kg/m^2	4.8824248
	pound per square yard	kilogram per square meter	kg/m^2	0.542492
	pound per acre	kilogram per hectare	kg/ha	1.120847
	ton per square foot	metric ton per square meter	t/m^2	9.764856
	ton per square yard	metric ton per square meter	t/m^2	1.084984
	ton per acre	metric ton per hectare	t/ha	2.241695
Mass per Unit Volume	pound per cubic foot	kilogram per cubic meter	kg/m^3	16.01846
	pound per cubic yard	kilogram per cubic meter	kg/m^3	0.5932763
	ton per cubic yard	metric ton per cubic meter	t/m^3	1.186553

Conversion Examples:

To convert a rate-of-application of 50 gallons per acre to liters per hectare (L/ha), multiply by 9.353925.

(50 gallons/acre)(9.353925) = 467.70 L/ha Possible rounding: 478 L/ha or 480 L/ha

To convert a mowing pay item from $15 per acre to dollars per hectare, divide by 0.404687.
($15/acre)/(0.404687) = $37.07/ha Possible rounding: $37/ha, $35/ha or $40/ha

CONVERSION TABLE – INCHES TO DECIMALS OF A FOOT

INCH	0″	1″	2″	3″	4″	5″
0	0	0.0833	0.1667	0.2500	0.3333	0.4167
1/32	0.0026	0.0859	0.1693	0.2526	0.3359	0.4193
1/16	0.0052	0.0885	0.1719	0.2552	0.3385	0.4219
3/32	0.0078	0.0911	0.1745	0.2573	0.3411	0.4245
1/8	0.0104	0.0938	0.1771	0.2604	0.3438	0.4271
5/32	0.0130	0.0964	0.1797	0.2630	0.3464	0.4297
3/16	0.0156	0.0990	0.1823	0.2656	0.3490	0.4323
7/32	0.0182	0.1016	0.1849	0.2682	0.3516	0.4349
1/4	0.0208	0.1042	0.1875	0.2708	0.3542	0.4375
9/32	0.0234	0.1068	0.1901	0.2734	0.3568	0.4401
5/16	0.0260	0.1094	0.1927	0.2760	0.3594	0.4427
11/32	0.0288	0.1120	0.1953	0.2786	0.3620	0.4453
3/8	0.0313	0.1146	0.1979	0.2812	0.3646	0.4479
13/32	0.0339	0.1172	0.2005	0.2839	0.3672	0.4505
7/16	0.0365	0.1198	0.2031	0.2865	0.3698	0.4531
13/32	0.0391	0.1224	0.2057	0.2891	0.3724	0.4557
1/2	0.0417	0.1250	0.2083	0.2917	0.3750	0.4583
17/32	0.0443	0.1276	0.2109	0.2943	0.3778	0.4609
9/16	0.0469	0.1302	0.2135	0.2969	0.3802	0.4635
19/32	0.0495	0.1328	0.2161	0.2995	0.3828	0.4661
5/8	0.0521	0.1354	0.2188	0.3021	0.3854	0.4688
21/32	0.0547	0.1380	0.2214	0.3047	0.3880	0.4714
11/16	0.0573	0.1406	0.2240	0.3073	0.3906	0.4740
23/32	0.0599	0.1432	0.2266	0.3099	0.3932	0.4766
3/4	0.0625	0.1458	0.2292	0.3125	0.3958	0.4792
25/32	0.0651	0.1484	0.2318	0.3151	0.3984	0.4818
13/16	0.0677	0.1510	0.2344	0.3177	0.4010	0.4844
27/32	0.0703	0.1536	0.2370	0.3203	0.4036	0.4870
7/8	0.0729	0.1563	0.2396	0.3229	0.4063	0.4896
29/32	0.0755	0.1589	0.2422	0.3255	0.4089	0.4922
15/16	0.0781	0.1615	0.2448	0.3281	0.4115	0.4948
31/32	0.0807	0.1641	0.2474	0.3307	0.4141	0.4974

CONVERSION TABLE – INCHES TO DECIMALS OF A FOOT (continued)

INCH	6″	7″	8″	9″	10″	11″
0	0.5000	0.5833	0.6667	0.7500	0.8333	0.9167
1/32	0.5026	0.5859	0.6693	0.7526	0.8359	0.9193
1/16	0.5052	0.5885	0.6719	0.7552	0.8385	0.9219
3/32	0.5078	0.5911	0.6745	0.7578	0.8411	0.9245
1/8	0.5104	0.5938	0.6771	0.7604	0.8438	0.9271
5/32	0.5130	0.5964	0.6797	0.7630	0.8464	0.9297
3/16	0.5156	0.5990	0.6823	0.7656	0.8490	0.9323
7/32	0.5182	0.6016	0.6849	0.7682	0.8516	0.9349
1/4	0.5208	0.6042	0.6875	0.7708	0.8542	0.9375
9/32	0.5234	0.6068	0.6901	0.7734	0.8568	0.9401
5/16	0.5260	0.6094	0.6927	0.7760	0.8594	0.9427
11/32	0.5286	0.6120	0.6953	0.7786	0.8620	0.9453
3/8	0.5313	0.6146	0.6979	0.7813	0.8646	0.9479
13/32	0.5339	0.6172	0.7005	0.7839	0.8672	0.9505
7/16	0.5365	0.6198	0.7031	0.7865	0.8698	0.9531
13/32	0.5391	0.6224	0.7057	0.7891	0.8724	0.9557
1/2	0.5417	0.6250	0.7083	0.7917	0.8750	0.9583
17/32	0.5443	0.6276	0.7109	0.7943	0.8776	0.9609
9/16	0.5469	0.6302	0.7135	0.7969	0.8802	0.9635
19/32	0.5495	0.6328	0.7161	0.7995	0.8828	0.9661
5/8	0.5521	0.6354	0.7188	0.8021	0.8854	0.9688
21/32	0.5547	0.6380	0.7214	0.8047	0.8880	0.9714
11/16	0.5573	0.6406	0.7240	0.8073	0.8906	0.9740
23/32	0.5599	0.6432	0.7266	0.8099	0.8932	0.9766
3/4	0.5625	0.6458	0.7292	0.8125	0.8958	0.9792
25/32	0.5651	0.6484	0.7318	0.8151	0.8984	0.9818
13/16	0.5677	0.6510	0.7344	0.8177	0.9010	0.9844
27/32	0.5703	0.6536	0.7370	0.8209	0.9036	0.9870
7/8	0.5729	0.6563	0.7396	0.8229	0.9063	0.9896
29/32	0.5755	0.6589	0.7422	0.8255	0.9089	0.9922
15/16	0.5701	0.6615	0.7448	0.8281	0.9115	0.9948
31/32	0.5807	0.6641	0.7474	0.8307	0.9141	0.9974

SQUARE YARDS OF ROAD SURFACE FOR VARIOUS ROAD WIDTHS

ROAD WIDTH	PER LINEAL FOOT	PER 100 FEET	PER MILE	ROAD WIDTH	PER LINEAL FOOT	PER 100 FEET	PER MILE
6′	0.67	66.67	3,520	24′	2.67	266.67	14,080
7′	0.78	77.78	4,107	25′	2.78	277.78	14,667
8′	0.89	88.89	4,693	26′	2.89	288.89	15,253
9′	1.00	100.00	5,280	28′	3.11	311.11	16,427
10′	1.11	111.11	5,867	30′	3.33	333.33	17,600
11′	1.22	122.22	6,453	32′	3.56	355.56	18,773
12′	1.33	133.33	7,040	34′	3.78	377.78	19,947
13′	1.44	144.44	7,627	36′	4.00	400.00	21,120
14′	1.56	155.56	8,213	38′	4.22	422.22	22,293
15′	1.67	166.67	8,800	40′	4.44	444.44	23,467
16′	1.78	177.78	9,387	50′	5.56	555.56	29,333
17′	1.89	188.89	9,973	60′	6.67	666.67	35,200
18′	2.00	200.00	10,560	70′	7.78	777.78	41,067
20′	2.22	222.22	11,733	75′	8.33	833.33	44,000
22′	2.44	244.44	12,907	80′	8.89	888.89	46,933

LINEAR FEET COVERED BASED ON TANK CAPACITY AND WIDTH AND RATE OF APPLICATION

To compute the number of linear feet which will be covered by a tank of any capacity, for various widths and rates of application, use the following formula:

$$L = \frac{9C}{RW}$$

Where:

L = Number of linear feet which will be covered.
C = Capacity of tank in gallons (or quantity of asphalt in tank).
R = Rate of application in gallons per square yard.
W = Width of application in feet.

QUANTITIES FOR VARIOUS DEPTHS OF CYLINDRICAL TANKS IN HORIZONTAL POSITION

% DEPTH FILLED	% OF CAPACITY	% DEPTH FILLED	% OF CAPACITY	% DEPTH FILLED	% OF CAPACITY	% DEPTH FILLED	% OF CAPACITY
1	0.20	26	20.73	51	51.27	76	81.50
2	0.50	27	21.86	52	52.54	77	82.60
3	0.90	28	23.00	53	53.81	78	83.68
4	1.34	29	24.07	54	55.08	79	84.74
5	1.87	30	25.31	55	56.34	80	85.77
6	2.45	31	26.48	56	57.60	81	86.77
7	3.07	32	27.66	57	58.86	82	87.76
8	3.74	33	28.84	58	60.11	83	88.73
9	4.45	34	30.03	59	61.36	84	89.68
10	5.20	35	31.19	60	62.61	85	90.60
11	5.98	36	32.44	61	63.86	86	91.50
12	6.80	37	33.66	62	65.10	87	92.36
13	7.64	38	34.90	63	66.34	88	93.20
14	8.50	39	36.14	64	67.56	89	94.02
15	9.40	40	37.39	65	68.81	90	94.80
16	10.32	41	38.64	66	69.97	91	95.55
17	11.27	42	39.89	67	71.16	92	96.26
18	12.24	43	41.14	68	72.34	93	96.93
19	13.23	44	42.40	69	73.52	94	97.55
20	14.23	45	43.66	70	74.69	95	98.13
21	15.26	46	44.92	71	75.93	96	98.66
22	16.32	47	46.19	72	77.00	97	99.10
23	17.40	48	47.45	73	78.14	98	99.50
24	18.50	49	48.73	74	79.27	99	99.80
25	19.61	50	50.00	75	80.39		

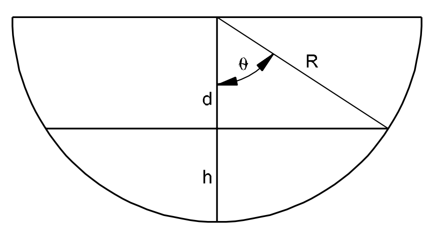
Full capacity of tank in U.S. gallons = $\frac{0.7854 \times D^2 \times L}{231}$

Note: The formula for direct computation of quantity when tank is less than half full is shown below. When more than half full, compute the full capacity of the tank as noted above; consider the shaded portion to represent the unfilled portion at the top of the tank and compute its volume as indicated below; then, deduct the volume determined for the unfilled portion from the total volume of the tank to arrive at the volume of the filled portion

First, compute θ where $\cos\theta = \frac{d}{R} = \frac{R - h}{R}$

Then $A = \pi R^2 \frac{\theta}{180} - R \sin\theta (R - h)$

And $V = \frac{L\left[\pi R^2 \frac{\theta}{180} - R \sin\theta (R - h)\right]}{231}$



Where: A = Cross-section area of filled portion of tank in square inches
V = Volume of filled portion of tank in U.S. gallons
L = Length of interior of tank in inches
D = Diameter of interior of tank in inches
R = Radius of interior of tank in inches
h = Depth of liquid in inches
d = R – h, inches

Note: The volume occupied by any piping, fittings or other material inside the tank must be deducted from the volume computed by use the table or formula.

GLOSSARY

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

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-Acronyms-

AASHTO – American Association of State Highway and Transportation Officials
AGC – Associated General Contractors of America
AMRL – AASHTO Materials Reference Library
ASTM – American Society for Testing and Materials
BAMS – Bid Analysis and Management System
BCA – Bridge Construction Access
BMP – Best Management Practices
BSG – Bulk Specific Gravity
CCRL – Cement and Concrete Reference Laboratory
CFR – Code of Federal Regulations
CSL – Crosshole Sonic Logging
DBE – Disadvantaged Business Enterprise
DWR – Daily Work Report
EEO – Equal Employment Opportunity
EPA – Environmental Protection Agency
FHWA – Federal Highway Administration
HMA – Hot-mix Asphalt
IA – Independent Assurance
MSG – Maximum Specific Gravity
MUTCD – *Manual on Uniform Traffic Control Devices*
NCHRP – National Cooperative Highway Research Program
NHS – National Highway System
NOI – Notice of Intent
NPDES – National Pollutant Discharge Elimination System
OJT – On-the-Job Training
OSHA – Occupational Safety and Health Administration
PCC – Portland Cement Concrete
PG – Performance Grade
QC/QA – Quality Control/Quality Assurance
QC – Quality Control
RAP – Recycled Asphalt Pavement
SCDHEC – South Carolina Department of Health and Environmental Control
SCDOT – South Carolina Department of Transportation
SCPP – South Carolina Partnering Program
SWPPP – Stormwater Pollution Prevention Plan
UST – Underground Storage Tank
WEAV – Wave Equation Analysis Program

Absorbed Moisture (Water). Absorbed moisture is the water that has penetrated the aggregate pores, which is not visible on the surface of the aggregate particle.

Absorption. Absorption refers to the susceptibility of an aggregate to absorb water. Percent absorption is the ratio of the weight of water that fills pores to the oven-dry weight of the aggregate, excluding free moisture. A porous aggregate will absorb asphalt, and if not considered during design, the mixture will be dry. An aggregate with 1% or less absorption is considered good for HMA mixtures. Most South Carolina aggregates, excluding marine limestone, have absorption rates of less than 1%.

Apparent Specific Gravity (ASG). ASG is the ratio of the weight of dry aggregate to the weight of a volume of water equaling the solid volume of the aggregate, excluding its permeable pores (i.e., the volume of water in any permeable pores is excluded in the volume of water used in the ratio calculation). ASG will be higher than the aggregate's BSG and ESG.

Bank Sand. Bank sand is fine aggregate material that is obtained directly from a river bank. Bank sand may be used directly from the river bank or it may be stockpiled for later use. Bank sand that has been stockpiled is considered processed and is sometimes referred to as processed sand.

Base Course. The base course is the layer or layers of specified material of designated thickness or rate of application placed on the subbase or subgrade to support subsequent layers of the pavement structure.

Bulk Specific Gravity (BSG). BSG is the ratio of the weight of dry aggregate to the weight of water having a volume equal to the volume of the aggregate, including both its permeable and impermeable pores (i.e., the volume of water in any permeable and impermeable pores is included in the volume of water used in the ratio calculation). BSG will be lower than the aggregate's ESG and ASG.

Bulk Specific Gravity-Saturated Surface Dry (BSG-SSD). BSG-SSD is the ratio of the weight of the aggregate, including the weight of the water it contains when its permeable voids are saturated, to the weight of an equal volume of water. The free moisture on the surface of the aggregate is removed and not considered in calculating the ratio.

Chemical Reactivity/Resistance. Chemical reactivity refers to the susceptibility of the aggregate structure to change due to a chemical reaction with the asphalt binder. Chemical resistance refers to the ability of the aggregate to resist attack by chemicals.

Coarse Aggregate (CA). Coarse aggregate is generally considered to be crushed stone, crushed gravel or natural gravel of a size that is predominantly retained on the No. 4 sieve.

Coarse-Graded. Coarse-graded aggregate is an aggregate material that consists primarily of coarse particles with few fine particles present.

Compaction. The mechanical densification of a material by packing together the solids and squeezing out the air.

Contract. The term Contract refers to a combined set of documents, including the Plans and Specifications, that defines the agreement between SCDOT and the Contactor for performing the work, furnishing labor and materials, accepting and measuring the work and materials and the basis of payment.

Contract Plans. The term Contract Plans refers to the approved engineering drawings including profiles, cross-sections and supplemental drawings that show the location, character, dimensions and details of the work to be performed.

Contract Specifications. The term Contract Specifications refers to the written technical requirements for the project and include *Standard Specifications*, Supplemental Specifications, Special Provisions and notes on plans that pertain to the method and manner of performing the work or to the quantities and qualities of materials to be furnished under the Contract. It is important to note that the Contract Specifications supplement the Contract Plans by providing information and instructions that are not on the drawings.

Crushed Glass. The use of recycled crushed glass as an aggregate material is permitted in some situations. There are critical administrative and environmental testing requirements associated with managing stockpiles and using crushed glass. The material must meet South Carolina Department of Environmental Control regulations as a non-hazardous material (e.g., lead content) and applicable EPA standards. Ensure that the Contractor's Certification Letter of Material Compliance is retained and that SCDOT assigned stockpile numbers are used to properly track materials from source through production.

Crushed Gravel. Crushed gravel is the product resulting from the artificial crushing of gravel. Its use is limited by the Contract Specifications.

Crushed Stone. Crushed stone is the product resulting from the artificial crushing of rocks, boulders or large stones, which have been obtained through excavation and/or blasting. It is the most common type of coarse aggregate material used in South Carolina for HMA mixtures (e.g., granite, granite gneiss).

Deleterious Material (Cleanliness). Aggregate materials must be free of deleterious materials (e.g., clay, organic materials). Aggregate cleanliness may often be determined by visual inspection, but a washed sieve analysis (SC-T-5) usually provides better results. A sand equivalency test (e.g., AASHTO T 176) is also used to determine the reactive proportion of detrimental fine dust or clay-like materials that are in the portion of the aggregate passing the No. 4 sieve.

Dense-Graded. Dense-graded aggregate is an aggregate material with approximately equal amounts of particles across the entire range of sizes.

Density. The weight of a given volume of material.

Drainage. Features used to control surface and subsurface water flow.

Durability (Aggregate). Durability is related to aggregate hardness and toughness. It is a measured through a series of freeze-thaw cycles or by immersion in a sodium sulfate solution (AASHTO T 104).

Durability (HMA). Durability describes the ability of an HMA mixture to retain its original properties and resist environmental aging induced by the damaging action of air, water, temperature and traffic. Over time, the properties of the asphalt binder can change due to oxidation and volatilization and the binder-aggregate bond can be broken due to water infiltration and freeze-thaw cycles. Such changes can cause pavement failure. Densely graded aggregate, high asphalt binder content and well compacted, watertight mixtures tend to improve pavement durability. However, a high asphalt binder content can cause pavement rutting, shoving, bleeding and flushing to occur.

Dust Ratio. The dust ratio of an aggregate material is the percent material that passes the No. 200 sieve divided by that which passes the No. 40 sieve.

Effective Specific Gravity (ESG). ESG is the ratio of the weight of dry aggregate to the weight of an equal volume of water, excluding the voids permeable to asphalt binder. ESG will be less than the aggregate's ASG, but more than its BSG.

Embankment (Fill). A material used in highway construction to carry traffic over valleys and low areas.

Fatigue Resistance (HMA). Fatigue resistance is the ability of an HMA pavement to resist repeated traffic loading. An HMA mixture with high asphalt binder content and densely graded aggregate material will typically have a greater fatigue resistance than an open-graded mixture.

Fine Aggregate. Fine aggregate is considered to be any material that passes a No. 4 sieve.

Fine-Graded. Fine-graded aggregate is an aggregate material that consists primarily of fine particles with few coarse particles present.

Flexibility (HMA). An HMA pavement should be able to bend slightly without cracking under traffic loading and during moderate movement of the subbase and base course. Flexibility of the HMA mixture is optimized by high asphalt binder content and relatively open-graded mixtures.

Free Moisture. Free moisture is the water on the surface of the aggregate which makes its surface appear shiny.

Gap-Graded. Gap-graded and open-graded aggregates are essentially the same with one important difference. Gap-graded aggregate generally has a greater amount of fine aggregate particles and the amount of medium sized aggregate particles, if present, will be very small.

Gradation. Gradation is the relative distribution of particle sizes in the aggregate. It affects mix workability, compactability, stability, permeability and surface texture. Gradation is determined by mechanically shaking the aggregate over a nest of sieves having decreasingly smaller openings. AASHTO T 27 is used for fine and coarse aggregates, and AASHTO T 11 is used for wet sieve analysis of fine material passing the No. 200 sieve. The percent material retained on each sieve is plotted (e.g., 0.45 Power Gradation Curve) to classify the gradation of the aggregate as follows: uniform, coarse, fine, dense, open and gap. Gradation will be specified in the Contract for the HMA mixture required, and the *Standard Specifications* will specify the upper and lower limits for the percent material passing each designated sieve size for the various types of HMA mixtures. Note that these values are not gradation design values, but are maximum allowable tolerances.

Gravel. Gravel is considered a coarse aggregate, except that its source is from the natural disintegration and abrasion of rock or weakly bound conglomerate. The production of gravel is different from that of crushed stone in that it is mined from the natural surroundings and no blasting is involved. It goes through a screening and washing process and is separated by size. The use of gravel in HMA mixtures is limited by the Contract Specifications.

Hardness. Hardness refers to an aggregate's ability to resist wear and is typically measured using the Los Angeles Abrasion Test (AASHTO T 96).

Intermediate Course. The term intermediate course refers to the HMA material placed immediately below the surface course.

Laboratory. The term Laboratory refers to, as appropriate, the Research and Materials Laboratory, District Materials Laboratory or any other project materials and testing laboratory that may be approved by the Research and Materials Engineer.

Limestone. The limestone found in South Carolina is predominantly sedimentary in nature. The production is similar to that of crushed stone in that blasting, crushing, screening and blending may be required. The use of limestone is limited by the Contract Specifications.

Low-Tonnage Paving. The term low tonnage paving refers to HMA production as defined in the Contract Specifications.

Main-Line Paving. The term main-line paving refers to the construction of the pavement of the roadway, including shoulders, ramps and acceleration/deceleration lanes.

Materials. Any substance to be incorporated in the work during construction.

Maximum Dry Density. The dry unit weight obtained from a given compactive effort as defined by the peak of a compaction curve.

Maximum Particle Size. Maximum particle size refers to the minimum sieve size of which 100% of the aggregate material will pass.

Mineral Filler. Mineral filler is material that passes the No. 200 sieve that is incorporated in the HMA mixture.

Moisture Content. The ratio of the weight of water in a given mass of material to the weight of solid particles in the mass (expressed as percent).

Moisture Susceptibility. The term moisture susceptibility (i.e., affinity for asphalt) refers to the susceptibility of the aggregate to strip or separate from the asphalt binder coating through the action of water and traffic. Such a tendency may make an aggregate source unsuitable for an HMA mixture. To minimize this tendency, SCDOT HMA mixtures generally require a liquid anti-stripping additive or the addition of 1% hydrated lime by weight of total aggregate.

Muck. A mixture of organic matter, soils and water.

Natural Sand. Natural sand is often referred to as local sand and is considered a fine aggregate. Natural sand comes from the natural disintegration and abrasion of rock or friable sandstone in particular locations in South Carolina and may be processed through a screening operation. When natural sands come directly from a riverbank, they are referred to as bank sands. Natural sands that have been stockpiled prior to use are typically referred to as processed sand. Natural sands typically provide lower stability than manufactured sand due to their rounded particles; however, they are easier to compact than manufactured sand. The use of natural sand in HMA mixtures is limited by the Contract Specifications.

Nominal Maximum Particle Size. The definition of nominal maximum particle size differs depending on its application in construction. In general, for most applications, the nominal maximum particle size is defined as the largest sieve to retain any material. For asphalt mixtures, the nominal maximum aggregate size is defined as one sieve size larger than the first sieve to retain more than 10% material.

Non Main-Line Paving. The term non main-line paving refers to the HMA courses that are not controlled by density requirements, which generally include patching, leveling, less than 8-foot widening, wedges and driveways.

Open-Graded. Open-graded aggregate is an aggregate material that consists primarily of coarse aggregate particles with a minimal amount of fine particles. Its primary purpose is to provide a very open surface texture, which promotes surface water drainage and skid resistance.

Optimum Moisture Content. The amount of water at which the maximum density of a material can be obtained within a given compactive effort (usually established by the Research and Materials Engineer for the given mixture).

Pavement Structure. The term pavement structure refers to the combination of subbase, base course and surface course, as specified, placed on the subgrade to support and distribute the traffic load to the roadbed. See Section 300.2 for additional information on the pavement structure.

Permeability (HMA). Permeability of an HMA mixture is its ability to resist the passage of air and water through the pavement. Air void content, as well as the interconnection of the voids and their access to the pavement surface, are very critical to keep the mixture less permeable and more durable.

Pore Structure. Pore structure refers to the size, volume and shape of the voids in the aggregate. Some pores are permeable, and some are not.

Porosity. Porosity is the percent of the total volume of aggregate that is occupied by pores.

Processed Sand. The term processed sand refers to natural sand that has been excavated from a river, river bank or other natural source and has been stockpiled for use. Processed sands may also be screened and washed.

Recycled Asphalt Pavement (RAP). RAP tends to be a good source of aggregate material for HMA mixtures. The use of reprocessed aggregate material obtained from SCDOT RAP milling projects is permitted in select asphalt courses. There are critical administrative and testing requirements associated with managing RAP stockpiles and using RAP in HMA mixtures. Ensure that the Contractor's Certification Letter of Material Compliance is retained and that SCDOT assigned stockpile numbers are used to properly track materials from source through production.

Roadbed. The roadbed is the graded portion of a roadway between the outside shoulder lines, prepared as a foundation for the pavement structure, median and shoulders. Extensive areas between the roadway of divided highways are not considered roadbed.

Roadway. That portion of highway lying within the limits of construction.

Sample Identification Card. The term Sample Identification Card refers to a Research and Materials Laboratory form (i.e., card) that is used to identify and ship material samples. See Appendix B for additional information on Sample Identification Cards.

Saturated Surface Dry (SSD). Saturated surface dry aggregate refers to aggregate that has its interior pores saturated with absorbed moisture with no free moisture visible on the aggregate's surface.

SC-T-(#). SC-T-(#) is nomenclature that is used to designate SCDOT sampling and testing procedures that must be used where specified in the Contract. See Appendix C for additional information on SCDOT sampling and testing procedures.

SCDOT Construction Forms. The term SCDOT Construction Forms refers to the set of hard copy and electronic forms used by construction personnel during contract administration, inspection and sampling and testing duties. These forms supplement information entered into SiteManager Daily Work Reports. See Appendix A for a list of SCDOT Construction Forms.

Shape. Shape refers to the angularity of aggregate edges. Sharp, angular edges (e.g., crushed stone) tend to increase interlocking of aggregate particles, while rounded edges (e.g., gravel) tend to increase the workability of the HMA mixture.

Shoulders. The term shoulders refers to the portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use and for lateral support of base and surface courses.

Slag. Slag is considered a coarse aggregate, but its use in HMA mixtures is limited in the Contract Specifications. Slag is porous and will readily absorb the asphalt binder. There are critical administrative and testing requirements associated with managing slag stockpiles and using slag in HMA mixtures. Ensure that the Contractor's Certification Letter of Material Compliance is retained and that SCDOT assigned stockpile numbers are used to properly track materials from source through production.

Soil. Any unconsolidated earthen material, excluding bedrock, composed of insoluble minerals, organic matter, water and gases that can be excavated.

Special Provisions. The term Special Provisions refers to provisions that have been inserted into the Contract as a revision or supplement for conditions peculiar to the individual project under Contract.

Specific Gravity (SG). Specific gravity is the ratio of the mass of a given volume of aggregate to the mass of an equal volume of water at 77°F. SCDOT will not approve an HMA mixture if the specific gravity of the aggregate is higher than 2.90. Specific gravity is used to determine the void content in a compacted HMA mixture. If the specific gravity used in the compacted mixture is greater than the actual value, the mixture will have an excessive amount of asphalt binder, which will cause flushing. If the specific gravity used in the compacted mix is less than the actual value, the mixture will have less than optimum asphalt binder content, which can lead to raveling. AASHTO T 85 is used to determine specific gravity for coarse aggregates, and AASHTO T 84 is used to determine specific gravity for fine aggregates.

Stability (HMA). Stability describes the ability of an HMA pavement to resist deformation caused by traffic loading. An improperly designed HMA mixture can cause the pavement to rut or washboard. Stability depends primarily on internal friction and cohesion within the mixture. An increase in internal friction and cohesion tends to increase a mixture's stability. Internal friction depends on the surface texture, particle shape and gradation of the aggregate and the grade and quantity of asphalt binder used in the mixture. Rougher aggregate surfaces and more angular particles tend to increase internal friction. On the other hand, an excessive quantity of asphalt binder will decrease internal friction and lower stability. Cohesion is the internal binding force that is inherent in HMA mixtures and varies with the grade of asphalt binder. Cohesion increases with increasing asphalt binder content up to an optimum point, then decreases.

Standard Specifications. Where referenced, the term *Standard Specifications* refers to the SCDOT publication entitled *South Carolina Department of Transportation Standard Specifications for Highway Construction*.

Stone Screenings (Manufactured Sand). The term stone screenings refers to fine aggregate material that is produced during the crushing operation of coarse aggregate production. This material may be processed through a screening and washing process. Stone screenings that have been through a washing process are typically referred to as washed screenings. Stone screenings that have not gone through this washing process are typically referred to as regular screenings. Stone screenings typically provide higher stability than natural sand due to their angular shaped particles; however, they are more difficult to compact than natural sand.

Subbase. The term subbase refers to the layer or layers of specified material of designated thickness or rate of application placed on the subgrade to support the base course and surface course of the pavement structure.

Subgrade. The term subgrade refers to the top 18 inches of the roadbed upon which the pavement structure and shoulders will be constructed.

Supplemental Specifications. The term Supplemental Specifications refers to work and material specifications adopted after the publication of the *Standard Specifications* that constitute a part of the Contract. When referenced, Supplemental Specifications will prevail over *Standard Specifications*.

Surface Charge. Surface charge refers to the distribution of electric charge on the surface of an aggregate particle.

Surface Course. The surface course is generally the uppermost layer of material placed on the traveled way, shoulders, or both, provided as the riding surface of the pavement structure.

Total Moisture. Total moisture is the sum of the absorbed moisture in and the free moisture on the aggregate.

Toughness. Toughness is the capacity of the aggregate to absorb the energy of an applied force, which is usually measured by impact testing.

Traveled Way. The term traveled way refers to the portion of the roadway that is used for the movement of vehicles, exclusive of the shoulders.

Uniform-Graded. Uniform-graded aggregate is an aggregate material with a large percentage of particles approximately the same size.

Workability (HMA). Workability describes the ease with which an HMA mixture can be placed and compacted. Aggregate properties that tend to promote higher stability (e.g., surface roughness, angularity) will usually decrease the mixture's workability.

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