Chapter 11

GENERAL REQUIREMENTS

SCDOT BRIDGE DESIGN MANUAL

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CHAPTER 11

GENERAL REQUIREMENTS

11.1 BASIC APPROACH

The following describes the basic approach for Part II of the *SCDOT Bridge Design Manual*:

1. Application. The *Manual* is an application-oriented document.

2. Theory. The *Manual* is not a structural design theory resource nor a research document. The *Manual* provides background information as absolutely necessary so that the user understands the basis for the Department's bridge design criteria and application.

3. Details. Where beneficial, the *Manual* provides design details for various bridge elements.

4. Coordination with *LRFD Bridge Design Specifications*. The *SCDOT Bridge Design Manual* is basically a Supplement to the *LRFD Bridge Design Specifications* (*LRFD Specifications*) that:

   - in general, does not duplicate information in the *LRFD Specifications,* unless absolutely necessary for clarity;
   - elaborates on specific articles of the *LRFD Specifications*;
   - presents interpretative information, where required;
   - modifies sections from the *LRFD Specifications* where the Department has adopted a different practice;
   - indicates the Department's preference where the *LRFD Specifications* presents more than one option; and
   - indicates bridge design applications presented in the *LRFD Specifications* that are not typically used in South Carolina.

   In addition, the *SCDOT Bridge Design Manual* discusses, for selected applications, the original intent in the development of the *LRFD Specifications*, which will assist the bridge designer in the proper application of the *LRFD Specifications*.

11.2 *SCDOT MANUAL* APPLICATION

11.2.1 Project Responsibility

The *SCDOT Bridge Design Manual* applies to all bridge design projects under the responsibility of the SCDOT, including bridge projects designed by:

- in-house personnel,
- consultants retained by the Department,
- contractors retained by the Department for design/build projects, and
- local agencies where the project is funded with State and/or Federal money.

11.2.2 Hierarchy of Priority

Where conflicts are observed in those publications and documents used by SCDOT, the following hierarchy of priority shall be used to determine the appropriate application:

- Bridge Design Memoranda,
- *SCDOT Bridge Design Manual,*
- *SCDOT Seismic Design Specifications for Highway Bridges,*
- *LRFD Bridge Design Specifications,* and
- all other publications.

11.2.3 Design Exceptions

This Section discusses the Department's procedures for identifying, justifying, and processing exceptions to the structural design criteria in the *SCDOT Bridge Design Manual* and *LRFD Specifications*.

11.2.3.1 Department Intent

The general intent of the South Carolina Department of Transportation is that all design criteria in this *Manual* and the *LRFD Bridge Design Specifications* shall be met. However, recognizing that this may not always be practical, the Department has established a process to evaluate and approve exceptions to its structural design criteria.

11.2.3.2 Procedures

Formal, written design exception approvals are only required where criteria or policies in either the *SCDOT Bridge Design Manual* or *LRFD Specifications* are presented in one of the following contexts (or the like):

- "shall,"
- "mandatory," or
- "required."

In addition, at many locations in Part II, the text specifically states that any proposed exceptions to the indicated structural design criteria must be approved by the State Bridge Design Engineer.

When the bridge designer proposes a design element that does not meet the requirements of the *SCDOT Bridge Design Manual* or *LRFD Bridge Design Specifications* in the above context, the following procedure will apply:

1. Documentation. The bridge designer will present the justification for the exception at the earliest possible stage of the project, which may include:

    - site constraints,
    - construction costs,
    - construction considerations,
    - environmental impacts, and/or
    - right-of-way impacts.

2. Approval. All proposed exceptions must be approved, in writing, by the State Bridge Design Engineer.

11.3 STRUCTURAL DESIGN LITERATURE (National)

This Section discusses the major national publications available in the structural design literature. It provides 1) a brief discussion on each publication, and 2) the status and application of the publication by the Department. This Section is not all inclusive of the structural design literature; however, it does represent a hierarchy of importance. In all cases, designers must ensure that they are using the latest edition of the publication, including all interim revisions to date.

11.3.1 ***LRFD Bridge Design Specifications***

11.3.1.1 Description

11.3.1.1.1 General

The AASHTO *Load and Resistance Factor Design* (LRFD) *Bridge Design Specifications* serves as the national standard for use by bridge engineers or for the development of a transportation agency's own structural specifications. The *LRFD Specifications* establishes minimum requirements, consistent with current nationwide practices, which apply to common highway bridges and other structures such as retaining walls and culverts. Long-span structures may require design provisions in addition to those presented in the *LRFD Specifications*. Because of the continually changing nature of structural design, interim revisions are issued annually, and periodically AASHTO publishes a completely updated edition.

11.3.1.1.2 LRFD Methodology

The *LRFD Specifications* presents a load and resistance factor methodology for the structural design of bridges, which replaces the load factor and allowable stress methodologies of the AASHTO *Standard Specifications*. The *LRFD Specifications* applies live-load factors that are lower than the traditional AASHTO *Standard Specifications* load factors but balances this reduction with an increase in vehicular live load that more accurately models actual loads on our nation's highways. Basically, the LRFD methodology requires that bridge components be designed to satisfy four sets of limit states: Strength, Service, Fatigue-and-Fracture, and Extreme-Event limit states. Through the use of statistical analyses, the provisions of the *LRFD Specifications* reflect a uniform safety index for all structural elements, components, and systems.

The *LRFD Specifications* reflects a fundamentally different approach to design theory than the AASHTO *Standard Specifications for Highway Bridges*. The information in the *LRFD Specifications* supersedes, partially or completely, several AASHTO structural design publications. However, although superseded, some of these publications contain background information or other presentations that may be useful to a bridge designer. The *LRFD Specifications* supersedes the following publications:

1. *Standard Specifications for Alternate Load Factor Design Procedures for Steel Beam Bridges Using Braced Compact Sections*. This publication provides information on the inelastic design of compact steel members (resistance beyond first yield), historically known as autostress. An Appendix to the *LRFD Specifications* contains an updated inelastic design process for compact steel sections.

2. *Guide Specifications for Strength Design of Truss Bridges*. This document provides provisions for the design of steel trusses using the Load Factor Design (LFD) methodology. Herein, the load combination for long-span bridges (i.e., the Strength IV load combination of the *LRFD Specifications*) first appeared.

3. *Standard Specifications for Seismic Design of Highway Bridges*. See Section 11.3.3.

4. *Guide Specifications for Fracture Critical Non-Redundant Steel Bridge Members*. This document provides recommended requirements for identifying, fabricating, welding, and testing of fracture critical, non-redundant steel bridge members whose failure would be expected to cause a bridge to collapse. This document includes specifications on welding requirements that are in addition to those in the ANSI/AASHTO/AWS *Bridge Welding Code*. This document also discusses the need for proper identification of fracture critical members on plans, and it contains useful information addressing background, example problems, etc., that are not included in the *LRFD Specifications*.

5. *Guide Specifications — Thermal Effects in Concrete Bridge Superstructures*. This publication provides guidance on the thermal effects in concrete superstructures with special attention to the thermal gradient through the depth of the superstructure. These provisions have been incorporated into the *LRFD Specifications*.

6. *Guide Specifications for Fatigue Design of Steel Bridges*. This publication provides an alternative procedure to that of the AASHTO *Standard Specifications for Highway Bridges* wherein the actual number of cycles are used for fatigue design. Such a procedure has now been adopted in the *LRFD Specifications*.

7. *Guide Specifications for Design and Construction of Segmental Concrete Bridges*. This document provides details on the design and construction of segmental concrete bridges. The most important details have subsequently been included in the *LRFD Bridge Design Specifications* and the *LRFD Bridge Construction Specifications*, respectively.

8. *Guide Specification and Commentary for Vessel Collision Design of Highway Bridges*. This publication is a comprehensive document that includes information relative to designing bridges to resist damage from vessel collisions. To the extent feasible, it is based on probabilistic principles. The *LRFD Specifications* contains only the load section of this document. The *Guide Specification and Commentary for Vessel Collision Design of Highway Bridges* contains considerably more information.

11.3.1.1.3 Significant Features

A few significant features of the *LRFD Specifications* are:

1. The *LRFD Specifications* are supplemented with a comprehensive commentary placed immediately adjacent to the *LRFD Specifications* provisions in a parallel column.

2. The vehicular live load is designated HL-93. This live-load model retains a truck configuration similar to the HS-20 design truck and a tandem slightly heavier than the traditional military loading. However, the model has been modified to include simultaneously applied lane loading over full or partial span lengths to produce extreme force effects.

3. Maximum and minimum load factors have been introduced for permanent loads that must be used in combination with factored transient loads to produce extreme force effects. The minimum load factors are most significant for substructure design.

4. Fatigue loading consists of a single truck with axle weights and spacings that are the same as an HS-20 truck with a constant 30-ft spacing between the 32-kip axles that can be located anywhere on the bridge deck to produce the maximum stress range.

5. In addition to regular load combinations, two design trucks are used for negative moments and interior bent reactions in combination with the lane load; the distance between the rear axle of the first truck and the front axle of the second truck cannot be less than 50 ft; and the combined force effect is reduced by 10%.

6. The *LRFD Specifications* includes two methods for the design of concrete bridge decks — the traditional bending method and an empirical deck design, which allows for reduced deck reinforcement. SCDOT does not allow the use of the empirical deck design method.

7. The *LRFD Specifications* allows for relatively easy and more precise estimates of live-load distribution by tabulated equations.

8. The *LRFD Specifications* allows the optional use of deflection criteria. SCDOT requires the use of the optional deflection criteria.

9. The method of shear design in concrete has been revised; modified compression field theory and strut-and-tie models are used.

10. The *LRFD Specifications* recognizes the detrimental effect of salt-laden water seeping through deck joints and promotes a reduction in the number of such joints to an absolute minimum.

11.3.1.2 Department Application

11.3.1.2.1 State Highway System

The South Carolina Department of Transportation has adopted the use of the AASHTO *LRFD Bridge Design Specifications* as the mandatory document for the structural design of highway bridges on the State highway system. Exceptions to this policy must be approved by the State Bridge Design Engineer and may be appropriate for:

- widening of existing bridges, or
- bridge rehabilitation projects.

Part II presents the Department's specific application of the *LRFD Specifications* to structural design, which modify, replace, clarify, or delete information from the *LRFD Specifications* for SCDOT's application.

11.3.1.2.2 Off State Highway System

For bridge projects not on the State highway system, the Department's policy is:

1. Federal and/or State Funds. For off State highway system projects funded with Federal and/or State funds, Department policy on the use of the *LRFD Specifications* is identical to projects on the State highway system. See Section 11.3.1.2.1.

2. Locally Funded Projects. For projects funded with 100% local money, SCDOT encourages the use of the *LRFD Specifications* and the *SCDOT Bridge Design Manual*.

11.3.2 ***Standard Specifications for Highway Bridges***

11.3.2.1 Description

The AASHTO *Standard Specifications for Highway Bridges* was first published in the late 1920s with annual interim revisions and, until the adoption of the *LRFD Bridge Design Specifications*, served as the national standard for the design of highway bridges. The final version of the AASHTO *Standard Specifications* is based on the Service Load Design and Load Factor Design methodologies. AASHTO maintained the AASHTO *Standard Specifications* through 2000, and published the final comprehensive 17th edition in 2002.

11.3.2.2 Department Application

SCDOT only allows the use of the AASHTO *Standard Specifications* with approval by the State Bridge Design Engineer, which may be appropriate for:

- widening of existing bridges, or
- bridge rehabilitation projects.

The minimum highway live load for strength considerations in the application of the AASHTO *Standard Specifications* shall be HS-25. The HS-25 live-load model is defined as 1.25 times the HS-20 live loading as given in the AASHTO *Standard Specifications*. The standard HS-20 live-load model shall be used for fatigue considerations.

11.3.3 ***Standard Specifications for Seismic Design of Highway Bridges***

11.3.3.1 Description

The AASHTO *Standard Specifications for Seismic Design of Highway Bridges* presents design criteria for the seismic design of highway bridges to, within reason, limit significant structural damage or structural failure of a highway bridge during an earthquake. This document is based upon the observed performance of bridges during earthquakes and upon research that has been conducted worldwide. As stated in Section 11.3.1, the *Standard Specifications for Seismic Design of Highway Bridges* is superseded by the *LRFD Specifications*.

11.3.3.2 Department Application

The Department has published and adopted the *SCDOT Seismic Design Specifications for Highway Bridges*, which supersedes Division 1-A "Seismic Design" of the AASHTO *Standard Specifications for Highway Bridges* and the seismic requirements of the *LRFD Specifications.*

11.3.4 ***Guide Specifications for Seismic Isolation Design***

11.3.4.1 Description

AASHTO published the *Guide Specifications for Seismic Isolation Design,* which is supplemental to the *Standard Specifications for Seismic Design of Highway Bridges.* The *Guide Specifications for Seismic Isolation Design* presents specifications for the design of bearings to seismically isolate the superstructure from the substructure of highway bridges.

11.3.4.2 Department Application

The AASHTO *Guide Specifications for Seismic Isolation Design* should be used, where applicable, in conjunction with the *SCDOT Seismic Design Specifications for Highway Bridges.*

11.3.5 *Guide Specifications for Horizontally Curved Steel Girder Highway Bridges*

11.3.5.1 Description

The AASHTO *Guide Specifications for Horizontally Curved Steel Girder Highway Bridges* presents specifications and methodologies for the design of steel I-girder and steel box girder bridges that are on a horizontal curve. This document is applicable to simple and continuous spans and to composite or non-composite structures of moderate length employing either rolled or fabricated sections. The design methodology is based on both working stress and load factor principles and, therefore, is not compatible with the *LRFD Specifications*.

11.3.5.2 Department Application

A 2005 interim change to the *LRFD Specifications* integrates horizontally curved girders, both I-shaped and box girders, in common equations for both straight and curved girders. Therefore, SCDOT only allows the use of the *Guide Specifications for Horizontally Curved Steel Girder Highway Bridges* for the same applications as for the AASHTO *Standard Specifications for Highway Bridges*. When this document is used, the analysis shall be performed using refined methods as described in Article 4.3.2.

11.3.6 ANSI/AASHTO/AWS *Bridge Welding Code D1.5M/D1.5*

11.3.6.1 Description

The *Bridge Welding Code* presents current criteria for the welding of structural steel in bridges. The *Code* superseded the 1981 AASHTO *Standard Specifications for Welding of Structural Steel Highway Bridges* and supplements the *Structural Welding Code, AWS D1.1*.

For the first time, with the 2002 edition, the *Code* includes a commentary on selected sections.

11.3.6.2 Department Application

The Department has adopted the use of the *Bridge Welding Code D1.5* for the design and construction of structural steel highway bridges. However, for items not specifically addressed in D1.5, such as welding of existing structures or welding of reinforcing steel, refer to the current edition of ANSI/AWS D1.1 and ANSI/AWS D1.4.

11.3.7 *Manual on Subsurface Investigations*

11.3.7.1 Description

The AASHTO *Manual on Subsurface Investigations* discusses many of the techniques used in the highway industry for subsurface geotechnical investigations. The objective is to describe

accepted procedural and technical methods to determine the geotechnical properties of soils and rocks that will support the highway facility. The range of topics includes data requirements, field reviews, evaluation of geotechnical data, subsurface water impacts, equipment, and laboratory testing procedures.

11.3.7.2 Department Application

The Department recommends that this publication be used for all subsurface investigations, which is primarily the responsibility of the SCDOT Office of Materials and Research.

11.3.8 *LRFD Movable Highway Bridge Design Specifications*

11.3.8.1 Description

The AASHTO *LRFD Movable Highway Bridge Design Specifications* addresses the design of movable highway bridges using the *LRFD Bridge Design Specifications*. This document provides guidance for the structural design and machinery design of swing, bascule, and vertical-lift spans.

11.3.8.2 Department Application

The AASHTO *LRFD Movable Highway Bridge Design Specifications* shall be used for the design of any movable bridges.

11.3.9 *Guide Specifications for Design of Pedestrian Bridges*

11.3.9.1 Description

The AASHTO *Guide Specifications for Design of Pedestrian Bridges* applies to bridges intended to carry pedestrian traffic and/or bicycle traffic. This document is not based upon the LRFD design methodology, but is based upon allowable stress design (ASD) and load factor design (LFD) methodologies.

11.3.9.2 Department Application

The AASHTO *Guide Specifications for Design of Pedestrian Bridges* shall be used for the design of pedestrian bridges in conjunction with the AASHTO *Standard Specifications for Highway Bridges*. The publication shall not be used in conjunction with the AASHTO *LRFD Specifications*.

11.3.10 ***Guide Specifications for Distribution of Loads for Highway Bridges***

11.3.10.1 Description

The AASHTO *Guide Specifications for Distribution of Loads for Highway Bridges* provides more refined live-load distribution factors than the traditional "S over" factors of the AASHTO *Standard Specifications for Highway Bridges*. Although the refined equations appear similar, they are not the same as those provided in the *LRFD Specifications* and shall not be used with the *LRFD Specifications*.

11.3.10.2 Department Application

SCDOT does not allow the use of the AASHTO *Guide Specifications for Distribution of Loads for Highway Bridges*.

11.3.11 ***Guide Design Specifications for Bridge Temporary Works***

11.3.11.1 Description

The AASHTO *Guide Design Specifications for Bridge Temporary Works* has been developed for use by State agencies to include in their existing construction Standard Specifications for falsework, formwork, and related temporary construction used to construct highway bridge structures.

11.3.11.2 Department Application

The AASHTO *Guide Design Specifications for Bridge Temporary Works* may be used at the discretion of the individual bridge designer.

11.3.12 ***Guide Specifications for Structural Design of Sound Barriers***

11.3.12.1 Description

The AASHTO *Guide Specifications for Structural Design of Sound Barriers* provides criteria for the structural design of sound barriers to promote the uniform preparation of plans and specifications. The publication allows the design of masonry sound barriers in addition to concrete, wood, steel, synthetics and composites, and aluminum.

11.3.12.2 Department Application

The AASHTO *Guide Specifications for Structural Design of Sound Barriers* shall be used for all sound barrier designs.

11.3.13 ***Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals***

11.3.13.1 Description

The AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* presents structural design criteria for the supports of various roadside appurtenances. The publication presents specific criteria and methodologies for evaluating dead load, live load, ice load, and wind load. This document also includes criteria for several types of materials used for structural supports such as steel, aluminum, concrete, and wood.

11.3.13.2 Department Application

The Department has adopted the use of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. The SCDOT Traffic Engineering Division is primarily responsible for the design of these supports.

11.3.14 **AISC *LRFD Manual of Steel Construction***

11.3.14.1 Description

The *LRFD Manual of Steel Construction*, published by the American Institute of Steel Construction (AISC), provides dimensions, properties, and general design guidance for structural steel for various applications. Although the *Manual* contains AISC criteria for steel buildings, the properties of the rolled structural shapes are useful for designing bridge structures.

11.3.14.2 Department Application

Designers may use the AISC *LRFD Manual of Steel Construction* at their discretion.

11.3.15 **AREMA *Manual for Railway Engineering***

11.3.15.1 Description

The AREMA *Manual for Railway Engineering*, published by the American Railway Engineering and Maintenance-of-Way Association (AREMA), provides detailed structural specifications for the design of railroad bridges. The AREMA specifications has approximately the same significance for railroad bridges as the *LRFD Specifications* has for highway bridges; i.e., the structural design of railroad bridges shall meet the AREMA requirements.

11.3.15.2 Department Application

For the design of railroad bridges, the specifications of the AREMA *Manual* must be met, except as modified by railroad companies operating in South Carolina. In addition, the AREMA *Manual* contains the AREMA requirements for the geometric design of railroad tracks passing beneath a highway bridge. As appropriate, these criteria have been incorporated into Chapter 22 of the *SCDOT Bridge Design Manual*.

11.3.16 Other Structural Design Publications

The structural design literature contains many other publications which may, on a case-by-case basis, be useful. The following briefly describes several other structural design publications:

1. *Prestressed/Precast Concrete Institute (PCI) Design Handbook*. This publication includes information on the analysis and design of precast and/or prestressed concrete products in addition to a discussion on handling, connections, and tolerances for prestressed products. It contains general design information, specifications, and standard practices. Designers may use their discretion in the use of this publication.

2. *Prestressed/Precast Concrete Institute (PCI) Bridge Design Manual*. This two-volume, comprehensive design manual includes both preliminary and final design information for standard girders and precast, prestressed concrete products and systems used for transportation structures. This document contains background, strategies for economy, fabrication techniques, evaluation of loads, load tables, design theory, and numerous design examples. This publication is designed to explain the application of both the AASHTO *Standard Specifications* and *LRFD Specifications*.

3. *Post-Tensioning Institute (PTI) Post-Tensioning Manual*. This publication discusses the application of post-tensioning to many types of concrete structures, including concrete bridges. This publication also discusses types of post-tensioning systems, specifications, the analysis and design of post-tensioned structures, and their construction. The use of this publication is mandatory for all post-tensioning applications.

4. *Concrete Reinforcing Steel Institute (CRSI) Handbook*. This publication meets the ACI Building Code Requirements for Reinforced Concrete. Among other information, it provides values for design axial load strength and design moment strength for tied columns with square, rectangular, or round cross sections. It also provides pile cap design information. Designers may use their discretion in the use of this publication.

5. *National Steel Bridge Alliance (NSBA) Highway Structures Design Handbook*. This document addresses many aspects of structural steel materials, fabrication, economy, and design. Recently updated with LRFD examples in both US customary units and SI units, the general computational procedure is helpful to designers using the *LRFD Bridge Design Specifications*. Designers may use their discretion in the use of this publication.

6. *American Concrete Institute (ACI) — Analysis and Design of Reinforced Concrete Bridge Structures*. This publication contains information on various concrete bridge types, loads, load factors, service and ultimate load design, prestressed concrete, substructure and superstructure elements, precast concrete, reinforcing details, and metric conversion. Designers may use their discretion in the use of this publication.

7. *CRSI Manual of Standard Practice*. This publication explains generally accepted industry practices for estimating, detailing, fabricating, and placing reinforcing bars and bar supports. SCDOT requires that reinforcing steel shall be detailed as shown in the *CRSI Manual of Standard Practice* as modified by SCDOT practices.

8. *PTI — Post-Tensioned Box Girder Bridges*. This publication contains information on economics, design parameters, analysis and detailing, installation, prestressing steel specifications, post-tensioning tendons, systems, and sources. The use of this publication is mandatory for all post-tensioned box girder bridge applications.

9. *United States Navy — Design Manual for Soil Mechanics, Foundations and Earth Structures*. This *Manual* is a comprehensive document that addresses embankments, exploration and sampling, spread footings, deep foundations, pressure distributions, buried substructures, special problems, seepage and drainage analysis, settlement analysis, soil classifications, stabilization, field tests and measurements, retaining walls, etc. Note that the loading sections of this document are superseded by the *LRFD Specifications*.

10. *United States Department of Agriculture (USDA) Forest Service Timber Bridge Manual*. This *Manual* is a comprehensive document that addresses all aspects of traditional timber bridge construction plus the latest developments in laminated deck systems using adhesives or prestressing forces. Designers may use their discretion in the use of this publication.

11. *Timber Construction Manual*. This document, published by the American Institute of Timber Construction (AITC), provides comprehensive criteria for the design of timber structures, including bridges. This document contains information for both sawn and laminated timber. The designer should use the AITC *Timber Construction Manual* to supplement the AASHTO publications on the design of timber bridges.

12. *Uniform Building Code*. This document, published by the International Conference of Building Officials (ICBO), provides criteria for the design of buildings throughout the United States and abroad. It is intended to be used directly by an agency or to be used in the development of an agency's own building codes.

13. NCHRP 343 *Manuals for Design of Bridge Foundations.* This publication provides valuable additional information on the application of the *LRFD Specifications* to foundations.

14. AASHTO *Manual for Condition Evaluation of Bridges*. This publication serves as a standard and provides uniformity in the procedures and policies for determining the physical condition, maintenance needs, and load capacity of highway bridges in the United States. This publication assists bridge owners by establishing inspection procedures and load rating practices that meet the National Bridge Inspection Standards (NBIS). The load rating procedures are based upon both the allowable stress rating methodology and the load factor rating methodology.

15. AASHTO *Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*. This document is an updated version of the AASHTO *Manual for Condition Evaluation of Bridges* (see Item #14). The rating procedures in this document are based upon the LRFR methodology. If an owner does not use the LRFR methodology for load rating, this document is important because it is an update of the AASHTO *Manual for Condition Evaluation of Bridges*.

16. American Concrete Institute (ACI) 318 *Building Code Requirements for Structural Concrete* and *Commentary*. This document addresses the proper design and construction of buildings of structural concrete. Although this document is intended for building design, bridge designers may find it useful because it provides details on aspects of concrete design that are not typical in highway bridges.

17. *PCA Notes on ACI 318 Building Code Requirements for Structural Concrete with Design Applications*. The primary purpose of the PCA Notes is to assist the engineer in the proper application of the ACI 318 design standard. Each chapter of the publication starts with a description of the latest Code changes. Numerous design examples illustrate the application of the Code provisions.

11.4 SCDOT DOCUMENTS

The Department has prepared many publications in addition to the *SCDOT Bridge Design Manual* that may apply to a bridge design project. This Section briefly discusses other relevant SCDOT publications that may have a significant impact on a bridge design project.

11.4.1 ***SCDOT Seismic Design Specifications for Highway Bridges***

The Bridge Design Section is responsible for the *SCDOT Seismic Design Specifications for Highway Bridges*. This document provides guidance on seismic design criteria, analysis methods, and detailing procedures for the preparation of bridge plans.

The *SCDOT Seismic Design Specifications for Highway Bridges* presents minimum requirements for use in bridge design and are intended to:

- safeguard against major failures and loss of life,
- minimize damage,
- maintain functionality, and/or
- provide for expedited repair.

11.4.2 ***SCDOT Geotechnical Design Manual***

The Geotechnical Design Section is responsible for the *SCDOT Geotechnical Design Manual*. This document presents the Department's criteria for geotechnical investigations and designs performed by the Department. The *SCDOT Geotechnical Design Manual* discusses:

- site surveys;
- field investigations (e.g., subsurface);
- pavement section support (e.g., pavement subgrade, subgrade drainage, erosion control);
- embankments/slopes (e.g., settlement, slope stability);
- foundations for structures (e.g., geotechnical properties);
- retaining walls (e.g., external stability); and
- geotechnical involvement in construction.

11.4.3 ***SCDOT Highway Design Manual***

The Road Design Section is responsible for the *SCDOT Highway Design Manual*. The *SCDOT Highway Design Manual* presents the Department's criteria for the design of a wide range of roadway elements. These include:

- in-house procedures for road design projects;

- geometrics (e.g., cross sections, design speed, horizontal and vertical alignment, at-grade intersections, interchanges);

- roadside safety;
- special design elements (e.g., rest areas, weigh stations, bicycle accommodation);
- design criteria for individual functional classes;
- environmental procedures;
- traffic engineering;
- SCDOT criteria for compliance with the *Americans with Disabilities Act*; and
- the assembly of contract documents for road design projects (e.g., plan preparation, quantities, cost estimates).

11.4.4 ***South Carolina Requirements for Hydraulic Design Studies***

The Hydraulic Engineering Section is responsible for the *South Carolina Requirements for Hydraulic Design Studies*, which presents design criteria on the following topics:

- hydraulic surveys;
- hydrologic methods used in South Carolina;
- hydraulic design of culverts, open channels, bridge waterway openings, and closed drainage systems; and
- erosion control.

11.4.5 ***SCDOT Standard Specifications for Highway Construction***

The Construction Division is responsible for the *SCDOT Standard Specifications for Highway Construction*. The *SCDOT Standard Specifications* presents the work methods and materials approved by the Department for the construction of road, traffic, and bridge projects. These specifications present information on:

- contract administration (e.g., bidding, awarding the contract, contractor duties, contractor and Department legal requirements, measuring and paying for contract items);
- earthwork;
- bases and subbases;
- bituminous pavements;
- rigid pavements;

- traffic control;
- structures; and
- incidental construction items.

The *SCDOT Standard Specifications* are modified by the Supplemental Specifications. The Supplemental Specifications set forth the latest Department requirements.

11.4.6 ***SCDOT Construction Manual***

The Construction Division is responsible for the *SCDOT Construction Manual*. This document is intended for use by engineering personnel in the administration of construction contracts, especially the application of the *SCDOT Standard Specifications for Highway Construction*. As such, the *SCDOT Construction Manual* addresses each of the items listed for the *SCDOT Standard Specifications for Highway Construction*, but not within the context of a contractual document.

11.4.7 ***SCDOT Survey Manual***

The Surveys Office is responsible for the *SCDOT Survey Manual*, which presents the Department's criteria for the following:

- survey datums and coordination systems,
- survey measurements and equipment,
- errors and maximum closure,
- preliminary surveys,
- property corner ties, and
- construction surveys.

11.5 STATE PLANE COORDINATE SYSTEM

See the *SCDOT Survey Manual* and the *SCDOT Highway Design Manual* for the application of the South Carolina State Plane Coordinate System for road and bridge projects.