



South Carolina
Department of Transportation

PRECONSTRUCTION DESIGN MEMORANDUM

MEMO: 2017-11

SUBJECT: Supplemental Design Criteria for Low Volume Bridge Replacement Projects

DATE: REVISED - July 1, 2019

The attached document has been adopted by the Department and is applicable to all state and Federal funded bridge replacement projects delivered by Preconstruction.

Immediately

George R. Bedenbaugh, Jr.
Preconstruction Support Engineer

Effective Date

GRB
Attachment
ec:

John Boylston, Director of Preconstruction
Robert Isgett, Director of Construction
David Cook, Director of Maintenance
Robert Perry, Director of Traffic Engineering
Mike Barbee, Director of Right of Way
Chris Gaskins, RP Engineer-Design Build
Ladd Gibson, Director of Mega Projects

Jennifer Necker, RP Engineer – Lowcountry
Leah Quattlebaum, RP Engineer - Pee Dee
Philip Sandel, RP Engineer - Midlands
Julie Barker, RP Engineer - Upstate
Chad Long, Dir. of Environmental Services
Tad Kitowicz, FHWA





Supplemental Design Criteria
For
Low Volume Bridge Replacement Projects

May 2019

RECOMMENDED

George R. Bedenbaugh, Jr.
George R. Bedenbaugh, Jr, P.E.,
Preconstruction Support Engineer, SCDOT

Date: 05-01-2019

John D. Boylston
John D. Boylston, P.E.,
Director of Preconstruction, SCDOT

Date: 5/1/2019

David B. Cook
David B. Cook, P.E.,
Director of Maintenance, SCDOT

Date: 5/1/2019

APPROVED

Emily O. Lawton
Emily O. Lawton, P.E.,
Division Administrator, FHWA SC Division

Date: 6/14/2019

Leland D. Colvin
Leland D. Colvin, P.E.,
Deputy Secretary for Engineering, SCDOT

Date: 5/1/2019

Purpose

The design criteria established within this document supplements new construction/reconstruction design criteria as established by Department and AASHTO design guidelines. This design criteria is applicable to all bridge replacement projects that meet the Selection Characteristics identified in this document.

While the criteria below outlines characteristics that qualify a bridge project to be designed using this document, it may not be appropriate to design each qualifying bridge project using these criteria. The responsible Regional Production Group or the Design Build Group should evaluate each project to determine if the standard SCDOT design criteria should be used in lieu of this document. Factors for not using these supplemental criteria may include, but are not limited to, economic development, lifeline functionality, detour lengths, and route management. The criteria included in this document are a minimum criteria and greater design requirements can be applied as deemed appropriate.

No design exception documentation is required if the design criteria within this document is applied to the project. Approved design exceptions will be required when the design criteria set forth in the document is not met.

Selection Characteristics

The project must meet all of the following characteristics to apply the design criteria found within this document:

Route Designation

- Secondary Route
- Non-NHS

Functional Classifications

- Collector or Local Road/Street

Current Traffic Volumes

- Less than or equal to 750 AADT

Bridge Crossing Type

- Bridge site must NOT cross any of the following:
 - Interstates
 - Other Freeways and Expressways
 - Arterials
 - Collectors
 - Railroads

Proposed Bridge Superstructure Type

- Prestressed Concrete Cored/Solid Slab
- Reinforced Concrete Flat Slab
- Prestressed Concrete I-Shaped Girders
- Structural Steel I-Shaped Welded Plate Girders
- Structural Steel I-Shaped Rolled Beams

Proposed Bridge Length

- Less than or equal to 210 feet

Hydraulics

- Bridge site must be riverine dominant; consultation should be made with the Hydraulic Design Support Office for guidance on tidal dominant sites
- Stream channel width: ≤ 100 feet
- Does not require coordination with FEMA for a Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR). If the project meets SCDOT's requirement for a finding of "No Impact", then a No Impact" Certification and letter should be sent to the local community following the process outlined in the SCDOT Hydraulic Design Requirements.

SURVEY REQUESTS

The level of survey may be limited, but shall be commensurate with the amount of detail necessary to satisfy the design criteria in this document. All design disciplines shall be consulted prior to establishing the survey request.

STRUCTURAL DESIGN CRITERIA

The requirements of the SCDOT Bridge Design Manual, the SCDOT Seismic Design Specifications for Highway Bridges, and the SCDOT Bridge Drawings and Details apply with the amendments noted below.

Seismic Design Requirements

- The bridges qualified for use under this document will not have an Operational Classification (OC) assigned. Therefore, the requirements of Table 3.1, Bridge Operational Classification (OC), in the *SCDOT Seismic Design Specifications for Highway Bridges* will not apply.
- The bridges qualified for use under this document shall, as a minimum, meet the seismic design and detailing requirements of Seismic Design Category (SDC) A. Reference the Geotechnical Design Criteria to determine the Coefficient at the One-Second Period (S_{D1-SEE}).

GEOTECHNICAL DESIGN CRITERIA

The requirements of the SCDOT Geotechnical Design Manual and the SCDOT Geotechnical Drawings and Details apply with the amendments noted below.

Geotechnical Exploration

- **Office**

The office portion of the geotechnical exploration consists of reviewing available documentation. This documentation may include, but is not limited to, previous soil borings in the general vicinity of the project; USDA soils maps, USGS topographic maps, aerial photographs, and wetland inventory maps. In addition, the backup documentation should include information pertaining to the existence or extent of geological hazards (e.g. artesian conditions, sinkholes, liquefiable sands, etc.) that may be present at the project site or in the immediate vicinity of the site. Further, geological hazards shall be noted on the boring records and a geotechnical summary report shall discuss the anticipated foundation system and any impacts of geologic hazards on the construction of the project. The appendices of the geotechnical summary report should include a brief description of the analyses performed and the results of the analyses. Also include in the Appendices should be any plan notes required for the project.

- **Field Exploration**

The geotechnical exploration for these bridge projects may be performed in a single phase. If a second phase is performed for these projects it should be limited to those areas of the site where there is questionable subsurface conditions, geologic hazards, or to collect undisturbed samples. For these bridge projects, either all soil test borings with Standard Penetration Testing or all cone penetration testing, or a combination of these testing methods will be allowed. For those projects where cone penetration testing is the only field exploration method used, a correlation soil test boring with continuous Standard Penetration Testing may be performed if in the opinion of the GEOR it is required. Provided below in Table 1 are the minimum testing location requirements.

Table 1, Foundation Exploration Requirements

Foundation Type	Geotechnical Site Investigation
Pile Foundation	Minimum one testing per bent location ⁽¹⁾
Drilled Pile Foundation	Minimum two testing locations per bent location ^{(1),(2)}
Single Foundation - Drilled Shaft (hammerhead)	Minimum one testing location per foundation location
Multiple Foundation – Drilled Shaft	Minimum two testing locations per bent location ⁽³⁾
Shallow Foundation – Founded on Soil	Minimum two testing locations per bent location
Shallow Foundation – Founded on Rock	Minimum one testing locations per bent location

⁽¹⁾Spacing may exceed 70 feet longitudinally if site subsurface is laterally homogeneous. .

⁽²⁾Drilled piles are only allowed at end bents. Prior approval of the RPG/GDS and the RPG/SDS shall be required prior to using drilled piles at interior bents.

⁽³⁾Minimum one testing location per bent allowed in Aiken, Allendale, Bamberg, Barnwell, Beaufort, Berkeley, Calhoun, Charleston, Chesterfield, Clarendon, Colleton, Darlington, Dillon, Dorchester, Florence, Georgetown, Hampton, Horry, Jasper, Kershaw, Lee, Marion, Marlboro, Orangeburg, Sumter, and Williamsburg Counties.

All bridge foundations (deep and shallow) bearing on rock should have a minimum of 5 feet of rock coring.

Geotechnical Analysis

- **LRFD**

These projects will be designed using LRFD design methodologies as contained in the GDM and the latest version of the AASHTO LRFD Bridge Design Specifications. The following paragraphs indicate changes to the current GDM and shall supersede the requirements of the current GDM.

- **EE I Analysis**

As indicated previously, these bridges will have a Seismic Design Category (SDC) of A. Based on an SDC A for these bridges, no soil shear strength loss (SSL) or pseudo-static slope stability analyses will be required for slopes or ERSs. However, if in the opinion of the GEOR these may be performed.

- **Acceleration Design Response Spectrum**

An acceleration design response spectrum curve will not be developed for these projects. Therefore an S_{D1-SEE} of 0.25 g shall be used for all projects west of US Highway 1 and an S_{D1-SEE} of 0.45 g shall be used east of US Highway 1. Any bridge that crosses from the west to the east side of US Highway 1 shall use an S_{D1-SEE} of 0.45 g.

- **Design**

Considerations used in selecting the appropriate foundation system should follow the approach outlined in Chapter 3 of Design and Construction of Driven Pile Foundations – Volume I, September 2016, FHWA-NHI-16-009, GEC 12 – Volume I.

There are 4 potential types of ERSs, rigid gravity, flexible gravity, cantilevered and in-situ reinforced. For ERSs with wall heights less than or equal to 7-1/2 feet, no global slope stability analysis will be required. If the ERS is part of larger slope (i.e. the ground slopes up behind the wall or down in front of the wall) a detailed design will be required. However if the ground both in front and behind the wall has a slope of 10H:1V or flatter it is not considered to be part of a larger slope. In addition, no external loads shall be allowed (i.e. no vehicular traffic or parked vehicles) on the ERSs. All ERSs shall have a positive batter of 1 inch in 60 inches (1:60). All walls shall have appropriate drainage. It is noted that the wall maximum ERS height of 7-1/2 feet precludes the use of in-situ reinforced walls which typically have a minimum height of 10 feet; therefore, in-situ reinforced walls should not be considered.

Rigid gravity retaining walls should conform to the requirements of the most current SCDOT Standard Drawing for Concrete Gravity Wall, if available. All flexible gravity walls shall be constructed using modular blocks. Use a B-3 geogrid as the reinforcement for these walls (see SC-M-203-2 – *Geogrid Soil Reinforcement*). Place the reinforcement at every other level of block vertically not to exceed 18 inches. The reinforcement shall have a minimum length of 7-1/2 feet measured from the front face of the wall. The coverage of the reinforcement shall be 100 percent. Granular backfill shall be used for these walls. A template drawing is available on the SCDOT website.

All cantilevered walls should have a minimum of 15 feet of penetration beneath the finished grade in front of the wall. All fascia panels used with H-piles and timber lagging shall be designed to resist lateral earth pressures. This requirement is based on the anticipated life of these structures and the anticipation of the complete deterioration of the timber lagging over the life of the structure.

The no global slope stability analysis may be disregarded if in the opinion of the GEOR global slope stability analysis is required.

HYDRAULIC DESIGN CRITERIA

The requirements of the SCDOT Requirements for Hydraulic Design Studies and SCDOT Stormwater Quality Design Manual apply with the amendments noted below.

Qualitative site assessment

- A qualitative assessment, following the guidance in the Requirements for Hydraulic Design Studies (RHDS) shall be used to evaluate basin and site conditions that may adversely impact the bridge of interest. This qualitative assessment should include a Level 1 assessment and a review of the flood history, scour history, and comparative bridge data. If in the judgement of the hydraulic design engineer there are site conditions that indicate the need for a higher design standard, then the design standards in the RHDS may be used. The other design disciplines should be consulted prior to making this decision.

Design frequency

- 25-year event or existing level of service, whichever is greater.
- If the design flood overtops the existing road grade, the proposed bridge may be designed to account for a comparable amount of overtopping flow, but preferably on the road approaches at a location 50 feet beyond the bridge end. In this situation, it is desirable to elevate the bridge above the road approaches to prevent the bridge from being overtopped.

Freeboard

- To permit the passage of debris, a minimum clearance of 2 feet should be provided between the design approach water surface elevation and the low chord of the bridge where practical. Where this is not practicable, the clearance should be established by the hydraulics design engineer based on the type of stream and level of protection desired.

Backwater

- Should be 1 foot or less for the proposed bridge when compared to unrestricted or natural conditions for the 100-year event.
- The hydraulic design shall maintain or improve the existing level of hydraulic performance.

Low chord

- Shall not be less than existing bridge.

New bridge ends

- Shall not be inside the limits of the existing bridge ends.

Span Arrangements

- The stream channel (top-of-bank to top-of-bank) should be fully spanned when possible.
- For piers on the overbank (outside of the stream channel), a minimum 5-foot setback of the pier from the top of the channel bank is desirable.
- For piers in the stream channel, a minimum 5 foot setback of the pier from the toe of the channel bank is desirable.

Abutments

- Shall be spill-through on a 2:1 or flatter slope.
- New abutment toes shall not exceed the limits of the existing toe and projection of the abutment slope shall not intersect any point on the channel bank or bottom.
- A minimum 5 foot abutment toe setback from the top of the channel bank.

Riprap

- Shall be placed on all bridge end fills per SCDOT standard drawing.

Scour

- Shall be evaluated for the lesser of the 100-year event or the flow just prior to overtopping, following the guidance in the RHDS; scour evaluation for the 500-year event is not required.
- Scour assessments shall be provided to the Bridge Maintenance Office.

Report

- A site report shall be developed following the guidance in the RHDS.

ROADWAY DESIGN CRITERIA

The following roadway design criteria will be used whenever crash history at the project location is below the statewide average as determined by the Highway Safety Office within Traffic Engineering. If crash history is higher than the statewide average, the following roadway design criteria is not applicable and will be established using new construction design standards from the SCDOT Roadway Design Manual. *Note: When the existing condition is greater than the design criteria for new construction the designer may use the new construction value from the RDM. Additionally all values below are minimum values and it is acceptable to exceed these values.*

Design Year

- Current year minimum.

Design Speed

- Equal to or greater than the existing design speed.

Lane Width

- 10 feet minimum, retain existing width if existing width is greater.

Shoulder Width

- 4 feet minimum (2 feet paved + 2 feet earth), retain existing width if existing width is greater. Review for bicycle accommodations if route is on a SC Designated Bicycle Touring Route.

Roadway Bridge Width

- Sum of the applicable lane widths and shoulder widths, retain existing roadway bridge width if existing roadway bridge width is greater than the sum of the applicable lane widths and shoulder widths.

Horizontal Centerline

- Retain existing centerline.

Horizontal Alignment

- Retain existing if horizontal radius is within 15 mph of design speed and the design year volume is less than 750 AADT.

Vertical Alignment

- Retain existing if K values are within 15 mph of design speed and design year volume is less than 750 AADT. Low points should not be located within 50 feet of the begin/end of bridge.

Stopping Sight Distance

- Retain existing if value is within 15 mph of design speed and design year volume is less than 750 AADT.

Min/Max Grades

- Retain existing.

Cross Slopes

- Use new construction design standards.

Superelevation

- Desirably, the curve superelevation should meet criteria for new construction. On low volume bridge replacement projects, constraints of excessive costs often preclude the use of desirable superelevation rates. If the curve is to remain and minimum superelevation rates cannot be achieved, provide proper signing and pavement markings for the appropriate speed in accordance with the MUTCD. In some cases, reconstruction of substandard horizontal curves to larger radii may be feasible in lieu of increasing the superelevation.

Vertical Clearance

- Use new construction design standards.

Roadside Safety

- Use SCDOT Roadway Design Manual 3R (Non-Freeway) Guidance found in Chapter 18.