South Carolina
Department of Transportation

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PRECONSTRUCTION DESIGN MEMORANDUM

MEMO: PCDM-11

SUBJECT: Supplemental Design Criteria for Low Volume Bridge Replacement Projects

DATE: REVISED – July 9, 2024

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

George R. Bedenbaugh, Jr., P.E.
Director – Office of Engineering Support

Immediately
Effective Date

GRB:
Attachment
ec:
Rob Perry, Deputy Secretary for Engineering
John Boylston, Chief Engineer for Project Delivery
Julie Barker, Director of Preconstruction
Robbie Isgett, Director of Construction
Jeff Terry, Director of Maintenance
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U.S. Department of Transportation
Federal Highway Administration

South Carolina Department of Transportation

Supplemental Design Criteria
For
Low Volume Bridge Replacement Projects

July 2024

RECOMMENDED

George R. Bedenbaugh, Jr. Date: 07-01-2024
George R. Bedenbaugh, Jr, P.E.
Director of Engineering Support, SCDOT

Chris Lacy Date: 7/1/24
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Director of Bridge Management, SCDOT

Michael W. Barbee Date: 7/1/2024
for John Boylston, P.E.
JPB Chief Engineer for Project Delivery, SCDOT

APPROVED

Date: JULY 8, 2024
Emily O. Lawton, P.E.
Division Administrator, FHWA SC Division

Rob Perry Date: July 1, 2024
Rob Perry, P.E.
Deputy Secretary for Engineering, SCDOT

Purpose

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

While the selection criteria below outline 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 Project Development Team 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 minimum criteria and greater design requirements can be applied as deemed appropriate.

No design exception/variance documentation is required if the design criteria within this document are applied to the project. Approved design exceptions/variances will be required when the design criteria set forth in this document are 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

Traffic Volumes

- Less than or equal to 1,000 AADT measured at initial PE obligation year
    - In instances where construction funding has been removed from a project, the project should be reevaluated to ensure compliance with current policies at the time funding is reallocated

Bridge Crossing Type

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

Existing Bridge Length

- Less than or equal to 350 feet

Hydraulics

- Bridge site must have riverine dominant flow; consultation should be made with the Hydraulic Design Support Office for guidance on sites with tidal dominant flow

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.

QUALITY ASSURANCE REVIEWS

The Office of Engineering Support provides Quality Assurance (QA) reviews of designs, reports and specifications for low volume bridge (LVB) replacement projects. Program Managers (PMs) should reference Preconstruction Design Memorandum-23 for required submittals and for associated submittal and review procedures.

STRUCTURAL DESIGN CRITERIA

The requirements of the SCDOT Bridge Design Manual (BDM), 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 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 ($S_{D1\text{-}SEE}$).

Structure Types

- Structure types other than those identified in the BDM may be substituted after coordination and acceptance between the Project Development Team (PDT) and the Office of Engineering Support (OES).
- Culverts may be substituted only after coordination between the PDT and the OES.

GEOTECHNICAL DESIGN CRITERIA

The requirements of the SCDOT Geotechnical Design Manual (GDM), the Geotechnical Design Bulletins (GDBs) 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. Ensure geological hazards are noted in accordance with the GDM.

  Geotechnical Summary Report (GSR) – The GSR shall include a brief discussion of the project information and encountered subsurface conditions. Following this brief discussion, the next section of the GSR shall contain the project recommendations. Please note that neither a Preliminary Geotechnical Engineering Report nor a Final Geotechnical Engineering Report are required, the only report that should be submitted is a GSR. An outline of the GSR is available on the SCDOT website at: https://www.scdot.org/business/geotech.aspx.

- **Field Exploration**

  Use a single-phase geotechnical exploration for these bridge projects. For these projects, the use of all cone penetration tests is allowed. No correlation boring is required. Table 1 provides the minimum testing location requirements.

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

  Roadway embankment borings are not required for these projects.

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. The use of drilled piles at interior bents requires coordination between the PDT and OES.
[(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.

Geotechnical Analysis

- **LRFD**

  - **EE I Analysis**

    For an SDC A, no soil shear strength loss (SSL) or pseudo-static slope stability analyses will be required for slopes or earth retaining structures (ERSs). Therefore, since SSL analysis is not to be performed, none of the laboratory testing required in the GDM associated with this analysis shall be performed. However, a limited number of classification tests may be performed as necessary to confirm soil classifications. In addition, the corrosion testing series is still required.

  - **Acceleration Design Response Spectrum**

    An acceleration design response spectrum curve will not be developed for these projects. Therefore, an $S_{D1\text{-}SEE}$ of 0.25 g shall be used for all projects west of US Highway 1 and an $S_{D1\text{-}SEE}$ of 0.45 g shall be used east of US Highway 1.

  - **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.

    Earth Retaining Structures
    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 a 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 of 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 1inch in 60 inches (1:60). All walls shall have appropriate drainage.

Use of modular gravity walls (e.g. gabion or prefabricated concrete) is permitted. 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.

Embankments/Bridge Embankments

Global slope stability and settlement analyses are not required for these projects.

HYDRAULIC DESIGN CRITERIA

The SCDOT Requirements for Hydraulic Design Studies (RHDS) and Hydraulic Design Bulletins (HDBs) apply with the amendments noted below. All requirements in the RHDS and HDBs not amended below must be followed.

If in the judgement of the hydraulic design engineer there are site conditions that indicate the need to follow the RHDS and HDBs without the amendments below, then the design standards in the RHDS will be used.

Qualitative Site Assessment

- A qualitative assessment, following the guidance in the 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.

Design Frequency

- 25-year (4% Annual Exceedance Probability (AEP)) event.
- The roadway embankment may be overtopped a minimum of 50 feet away from the bridge ends for the design event. This is only allowed at crossings that currently have embankment overtopping for the design event. To prevent erosion brought on by shear stresses, the segment of the embankment affected by overtopping must be stable or protected with riprap, matting, or vegetation for the design and 100-year (1% AEP) events.

Freeboard

- The freeboard should be at least 1 foot for the design event. Additionally, free surface flow should be maintained through the bridge for the 100-year (1% AEP) event.

Low Chord

- The low chord elevation should be set by the engineer of record in accordance with the design criteria in this document, and should consider the presence of debris and the type of stream. This may allow for a low chord elevation lower than that of the existing bridge.

Backwater

- The hydraulic design shall maintain or improve the existing level of hydraulic performance for the 100-year (1% AEP) event.

Abutments

- A minimum 5-foot abutment toe setback from any point along the channel bank to the face of the abutment's riprap protection is required. The projection of the abutment riprap protection slope shall not intersect any point on the channel bank or bottom.
- Shall be spill-through on a 2:1 or flatter slope.

Span Arrangements

- To avoid the risk of debris buildup, the channel should be fully spanned when possible.

Setbacks

- Outside of the stream channel:
  - A minimum 5-foot setback is required for piers or piles with widths larger than 2 feet and an angle of attack of the flow approaching the pier is greater than 10 degrees. A minimum 5-foot setback is desirable for other configurations
- Within the stream channel:
  - A minimum 5-foot setback from the face of the pier/pile to the channel bank and thalweg is required for piers or piles with widths larger than 2 feet and an angle of attack of the flow approaching the pier is greater than 10 degrees. A minimum 5-foot setback is desirable for other configurations.

Scour

- The scour design event is the 50-year (2% AEP) event.
- The scour check event is the 100-year (1% AEP) event.
- Scour depths are to be placed on the project plans consistent with current practices.

Report

- A hydraulic design report and scour assessment shall be developed following the guidance in the RHDS and HDBs.

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 Traffic Safety Department 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 (RDM). *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.*

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. Refer to Departmental Directive 28 (SCDOT's Complete Streets policy) for guidance on the inclusion of multimodal accommodations on LVB projects.

Horizontal Alignment

- Retain existing alignment if horizontal radius is within 15 mph of design speed. If a minor shift to the alignment is necessary to accommodate contextual impacts, the horizontal alignment may be retained within 15 mph of the design speed of the corridor. For significant shifts in the alignment, the horizontal radius should meet the design speed of the corridor, in consultation with the PDT and the OES.

Vertical Alignment

- Retain existing if K values are within 15 mph of design speed. If vertical alignment must be raised, retain existing K values if they are within 15 mph of design speed. The profile should be designed to ensure positive drainage. Coordinate with SCDOT standard drawings to ensure that bridge end drainage can be appropriately placed.

Maximum Grades

- Retain existing or flatter.

Stopping Sight Distance (SSD)

- Retain existing if value is within 15 mph of design speed. If vertical alignment must be raised, retain existing SSD values if they are within 15 mph of design speed.

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 design 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.

Roadside Safety

- Use SCDOT RDM 3R (Non-Freeway) Guidance found in Chapter 18.