South Carolina
Department of Transportation

BRIDGE DESIGN MEMORANDUM – DM0122

To: RPG Structural Engineers
Design Consultants

Date: April 25, 2022

RE: **Seismic Design Summary Reports for New Bridges**

Apply these updated requirements to all projects where design has not advanced beyond the preliminary design phase.

Preliminary and final seismic design summary reports shall be provided for all new bridges with Seismic Design Categories (SDC) of B, C, and D. The exceptions to this are the following:

- single span bridges, which do not require detailed seismic analysis
- bridge plans developed under the *Supplemental Design Criteria for Low Volume Bridge Replacement Projects*

PRELIMINARY SEISMIC DESIGN SUMMARY REPORT

The structural design engineer shall submit along with the preliminary bridge plans and preliminary bridge geotechnical engineering report a preliminary seismic design summary report for the bridge documenting the design strategy that will be used to meet the required seismic performance criteria and the analysis approach to capture and verify the intended design strategy. The preliminary report shall be signed by the structural engineer. The report shall describe the seismic design strategy and analysis approach for the bridge and shall include, at a minimum, the following information:

- A project description (including Project ID, county, route, crossing, longitude and latitude); the geological and hydrological features of the site; preliminary bridge configuration including construction staging or temporary widening; layout showing superstructure, bearing types, span types and lengths, end bent types, interior bent types, skew angle; diaphragms; shear keys; superstructure to substructure connections; expansion joints; wing walls; abutment types; shear walls, etc.

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Columbia, SC 29202-0191

- Any special issues (including construction, geotechnical, hydrological, right-of-way, environmental, etc.) that have driven the selection of the structure configuration
- Any unique structural issues that will affect the seismic design
- Any geotechnical issues that may affect the design of the bridge including:
    - Any indication of whether soil shear strength loss (SSL) is anticipated
    - Any indication of whether there is the potential for slope instability
    - Any indication of whether structural or geotechnical mitigation will be utilized
- The seismic design specifications or manuals used for the design (including document edition and applicable Bridge Design Memoranda)
- The design earthquake(s), the Acceleration Design Response Spectra (ADRS) data (with complete design response spectrum curve data and curves attached),
- the Operational Classification (OC)
- the Seismic Design Category (SDC)
- The performance objectives of the bridge per specifications in regard the expected service performance and damage levels
- Ductility criteria to be achieved
- Intended design strategy to achieve the performance objectives, such as what elements are capacity protected, how ductile elements are going to be detailed to achieve the intended behavior, how structural elements and connections are configured to satisfy balanced stiffness distribution and load transfer path.
- The analysis approaches to capture and verify the bridge's seismic behavior that the performance objectives have been achieved, including all applicable seismic models to be analyzed and how structural elements (including soils in contact) are going to be modeled.
- The name(s) of computer software that will be used for modeling structure and soil

FINAL SEISMIC DESIGN SUMMARY REPORT

The structural design engineer shall submit along with the 95% bridge plans and final bridge geotechnical engineering report a final seismic design summary report for the bridge documenting the design strategies that have been used to meet the required seismic performance criteria for the bridge and the analysis approaches that have been used to capture the bridge seismic behavior and verify the design strategies. The final report shall be signed and sealed by the structural design engineer, who shall be a registered professional engineer in the state of South Carolina. The report shall describe the seismic design strategies and analysis approaches for the bridge and shall include, at a minimum, the following information:

- A project description (including information required in the preliminary seismic summary report and any changes since preliminary design submittal)
- The seismic design specifications and or manuals used for the design (including document edition and applicable Bridge Design Memoranda)

- The design earthquake(s), the ADRS data (with complete design response spectrum curve data and curves attached)
- The Operational Classification (OC)
- The Seismic Design Category (SDC)
- The objectives of service performance and damage levels
- Ductility criteria achieved
- Seismic design strategy to achieve the required seismic performance including allowed damages and capacity protected elements, stiffness balances between bents, fused versus non-fused superstructure to substructure connections, potential plastic hinge locations, any unique aspects of the project that have driven the structural configuration and seismic modeling performed
- Brief discussion of how geotechnical and or hydrological hazards, such as SSL and scour, have been considered in the modeling process.
- Seismic analysis/design software used in the project (for structure and soils)
- Brief discussion of methodologies to model nonlinear properties in both Multimodal Spectral Analysis (MSA) and pushover analysis (if applicable) including backwall pressure, wing wall pressure, soils, plastic hinges, joints, expansion bearings, shear walls (if applicable),
- Mass participation ratio achieved
- Fundamental periods, discussion of short period check, soil column-structure-earthquake resonance check
- Easy to read tabulated and graphed results from the design earthquake analysis including Safety Evaluation Earthquake (SEE) and Functional Evaluation Earthquake (FEE) cases (if applicable); tension and compression models (if applicable); pushover models; analysis of bridge with and without SSL (including scour scenarios, if applicable, referring to AASHTO LRFD Bridge Design Specifications for recommended scour depth for seismic analysis); a brief discussion of the modeling results; and engineering justification for choices of design and detailing, including the following at a minimum:
    - Global displacement demand vs. global yield displacement and displacement capacity
    - Global ductility demand vs. specified limits
    - Local ductility capacity vs. specified limit
    - Seismic detailing, including design of cap support length for superstructure, hinge region detailing, shear keys, retaining blocks, anchor bolts, bearings, wing walls, abutments, shear walls, pile-cap joints, column-cap joints, pile-footing joints, column-footing joints, etc.
    - Discussion of approved design variances and justifications (with design variance approval attached),
    - Brief discussion of seismic hazard mitigation (if applicable)

To provide additional guidance for creating consistent formatting of the reports, please see the report outlines attached below.

Terry B. Koon, P.E.
Structural Design Support Engineer

TBK:hl

ec:
John Boylston, Director of Preconstruction
Robbie Isgett, Director of Construction
David Cook, Director of Maintenance
Robert Perry, Director of Traffic Engineering
Chris Gaskins, Director of Alternative Delivery
Rob Bedenbaugh, Director of Engineering Support
Jennifer Necker, RP Engineer - Lowcountry
Leah Quattlebaum, RP Engineer – Pee Dee
Adam Humphries, RP Engineer - Midlands
Julie Barker, RP Engineer – Upstate
Jae Mattox, Alternative Delivery Engineer
Tad Kitowicz, FHWA
Blake Gerken, FHWA

File: PC/TBK/HL

(Preliminary or Final) Seismic Summary Report

County
Project ID
Route and Local Road Name
Replace Bridge or Construct Bridge
Crossing Description

Prepared for

SCDOT

955 Park Street

Columbia SC 29201

Consultant ABC (or SCDOT RPG)

Consultant ABC Address (if applicable)

Date of report

SCDOT logo if in-house report

Outline of the Preliminary Seismic Summary Report

1. Project Description

1.1 Basic Project Information

1.2 Unique Structural, Geotechnical and Other Issues, if Applicable

2. Seismic Design Criteria and Objectives

2.1 Seismic Design Specifications

2.2 Operational Classification

2.3 Design Earthquakes

2.4 Seismic Design Category

2.5 Expected Seismic Performance and Damage Levels

2.6 Ductility Criteria

3. Seismic Design Strategy and Analysis Approach

3.1 Seismic Design Strategy

3.2 Seismic Analysis Approach

3.3 Seismic Design Software

Outline of the Final Seismic Summary Report

1. Project Description

1.1 Basic Project Information

1.2 Unique Structural, Geotechnical and Other Issues, if Applicable

2. Seismic Design Criteria and Objectives

2.1 Seismic Design Specifications

2.2 Operational Classification

2.3 Design Earthquakes

2.4 Seismic Design Category

2.5 Expected Seismic Performance and Damage Levels

2.6 Ductility Criteria

3. Seismic Design Strategy and Analysis Approach

3.1 Seismic Design Strategy

3.2 Demand Analysis Approach

3.3 Capacity Analysis Approach

3.4 Seismic Design Software

4. Seismic Modeling Results and Analysis

4.1 Mass participation Ratio Achieved and Fundamental Periods

4.2 Global Displacement Demand vs. Global Displacement Capacity

4.3 Global Ductility Demand vs. Specified Global Ductility Demand Limits

4.4 Local Ductility Capacity vs. Specified Limit

5. Approved Design Variances, if Applicable

6. Seismic Detailing

7. Seismic Hazard Mitigation, if Applicable