South Carolina
Department of Transportation

BRIDGE DESIGN MEMORANDUM – DM0115

To: RPG Structural Engineers
Design Consultants

Date: November 3, 2015

Re: SCDOT Seismic Design Specifications for Highway Bridges, Version 2.0
Revisions to Section 3, Section 6, Section 7, Section 8 and Section 9.

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

REVISIONS TO SECTION 3

3.6 SEISMIC DEMAND: Delete second paragraph and replace it with:

Displacement demand can be obtained from a Multimode Spectral Analysis (MSA). Section 5 covers displacement demand modeling and computations.

Table 3.6 Bridge System Seismic Displacement Performance Limits: Delete this table.

3.11 DESIGN REQUIREMENTS FOR TEMPORARY BRIDGES AND STAGED CONSTRUCTION: Delete last paragraph and replace it as follows:

The following applies to widening of existing bridges. If the bridge has been seismically designed using the 2001 Seismic Design Specifications for Highway Bridges or the 2008 Seismic Design Specifications for Highway Bridges, the widened section shall be designed to meet the same seismic performance requirements as the existing bridge. For widening of existing bridges that were not seismically designed using the above specifications, seismic design requirements are determined on a case-by-case basis by the Regional Production Engineer.

3.12 DESIGN REQUIREMENTS FOR PEDESTRIAN BRIDGES: Delete subsection and replace it with the following:

3.12 DESIGN REQUIREMENTS FOR NON-HIGHWAY BRIDGES
Pedestrian bridges over roads carrying vehicular traffic shall satisfy OC III performance objectives as indicated in Table 3.3. Pedestrian bridges owned or maintained by the Department or located within Department right-of-way will also satisfy the OC III performance objectives.

Railroad bridges over roads carrying vehicular traffic shall satisfy the requirements of AREMA Chapter 9 for life safety and any other AREMA or railroad specific requirements.

Utility bridges over roads carrying vehicular traffic shall satisfy OC III performance objectives.

REVISIONS TO SECTION 6

6.2 DEFINITION OF PLASTIC HINGES: Replace equation (6-3) with:

$$L_p = D^* + 0.08H' \le 1.5D^*$$

6.4 PLASTIC HINGE ACCESSIBILITY: Delete the last paragraph and replace it with the following:

The key to forcing the plastic hinge above ground with the oversized drilled shaft is placing the transverse reinforcement in the shaft at a larger diameter than the column framing into the shaft. Providing a larger diameter of transverse reinforcement increases the area of confined concrete in the region. Oversized shafts shall be at least 24 inches larger than the diameter of the column framing into the shaft. Column longitudinal reinforcement shall extend into oversized shafts in a staggered manner as shown in Figure 6.2.

Figure 6.2 Typical and Oversized Drilled Shafts: Delete figure and replace it with the following:

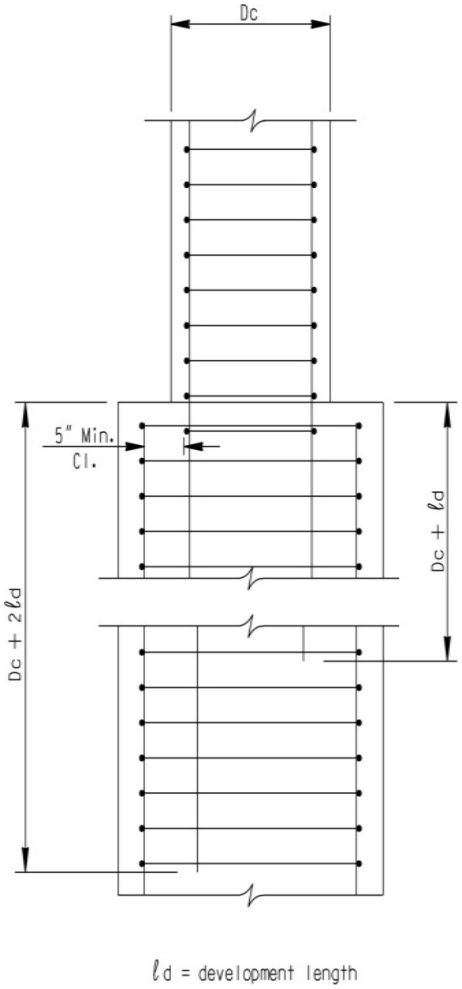


Figure 6.2 Oversized Drilled Shaft

6.5.2 Member Displacement Capacity: Delete equation (6-6) and replace it with the following:

$$\Delta_y = \frac{1}{3}\phi_y (L + L_{sp})^2 \qquad \text{Where } L_{sp} = 0.15 f_{ye} d_{bl}$$

L_{sp} = Strain Penetration

Delete equation (6-17) and replace it with the following:

$$\Delta_{y_1} = \frac{1}{3}\phi_{y_1} (L_1 + L_{sp})^2$$

Delete equation (6-18) and replace it with the following:

$$\Delta_{y_2} = \frac{1}{3}\phi_{y_2} (L_2 + L_{sp})^2$$

6.6.5 Confined Concrete Model: Delete equation (6-46) and replace it with the following:

$$\varepsilon_{ccu} = 0.004 + \frac{1.4 f_{yh} \rho_s \varepsilon_{su}^R}{f'_{cc}}$$

REVISIONS TO SECTION 7

7.1.3 Ductility Capacity: Delete subsection and replace it with the following:

7.1.3 Local Member Ductility Capacity

Local displacement ductility capacity of a member is defined using Equations 7-3a or 7-3b.

$$\mu_c = \frac{\Delta_c}{\Delta_y} \text{ for Free Head condition} \qquad (7\text{-}3a)$$

$$\mu_{c1} = \frac{\Delta_{c1}}{\Delta_{y1}} \;\&\; \mu_{c2} = \frac{\Delta_{c2}}{\Delta_{y2}} \text{ for Fixed Head condition} \qquad (7\text{-}3b)$$

Where:

μ_c	Ductility capacity (dimensionless).	See Figure 6.3.
μ_{c1}	Ductility capacity of first cantilever (dimensionless).	See Figure 6.4.
μ_{c2}	Ductility capacity of second cantilever (dimensionless).	See Figure 6.4.

Member displacement capacity is defined in Section 6.5.2. Each ductile member shall have a minimum local displacement ductility capacity of 3; ($\mu_c \geq 3$, or $\mu_{c1} \geq 3$ and $\mu_{c2} \geq 3$; see equations 7-3a and 7-3b) to ensure dependable rotational capacity in the plastic hinge regions regardless of the displacement demand imparted to that member.

The minimum displacement ductility capacity of 3 may be difficult to achieve for columns and drilled shafts with large diameters (D > 10 ft.), or components with large L/D ratios. Local displacement ductility capacities less than 3 require the approval of the RPG Structural Engineer in consultation with the Structural Design Support Engineer.

Table 7.1 Substructure Unit Quantitative Damage Criteria (Maximum Ductility Demand μ_d):

Delete table and replace it with the following:

Table 7.1 Substructure Unit Quantitative Damage Criteria (Maximum Ductility Demand μ_d)

Bridge System		Design Earthquake	Operational Classification (OC)		
			I	**II**	**III**
Superstructure		**FEE**	1.0	1.0	See Note
		SEE	1.0	1.0	1.0
Substructure	**Prestressed Concrete Pile Interior Bents**	**FEE**	1.0	2.0	See Note
		SEE	2.0	4.0	4.0
	Prestressed Concrete Pile End Bents	**FEE**	1.0	2.0	See Note
		SEE	2.0	4.0	4.0
	Single Column Bents	**FEE**	1.0	2.0	See Note
		SEE	2.0	3.0	4.0
	Multi Column Bents	**FEE**	2.0	3.0	See Note
		SEE	4.0	6.0	6.0
	Pier Walls Weak Axis	**FEE**	2.0	3.0	See Note
		SEE	3.0	5.0	5.0
	Pier Walls Strong Axis	**FEE**	1.0	1.0	See Note
		SEE	1.0	1.0	1.0

Note: Analysis for FEE is not required for OC III bridges.

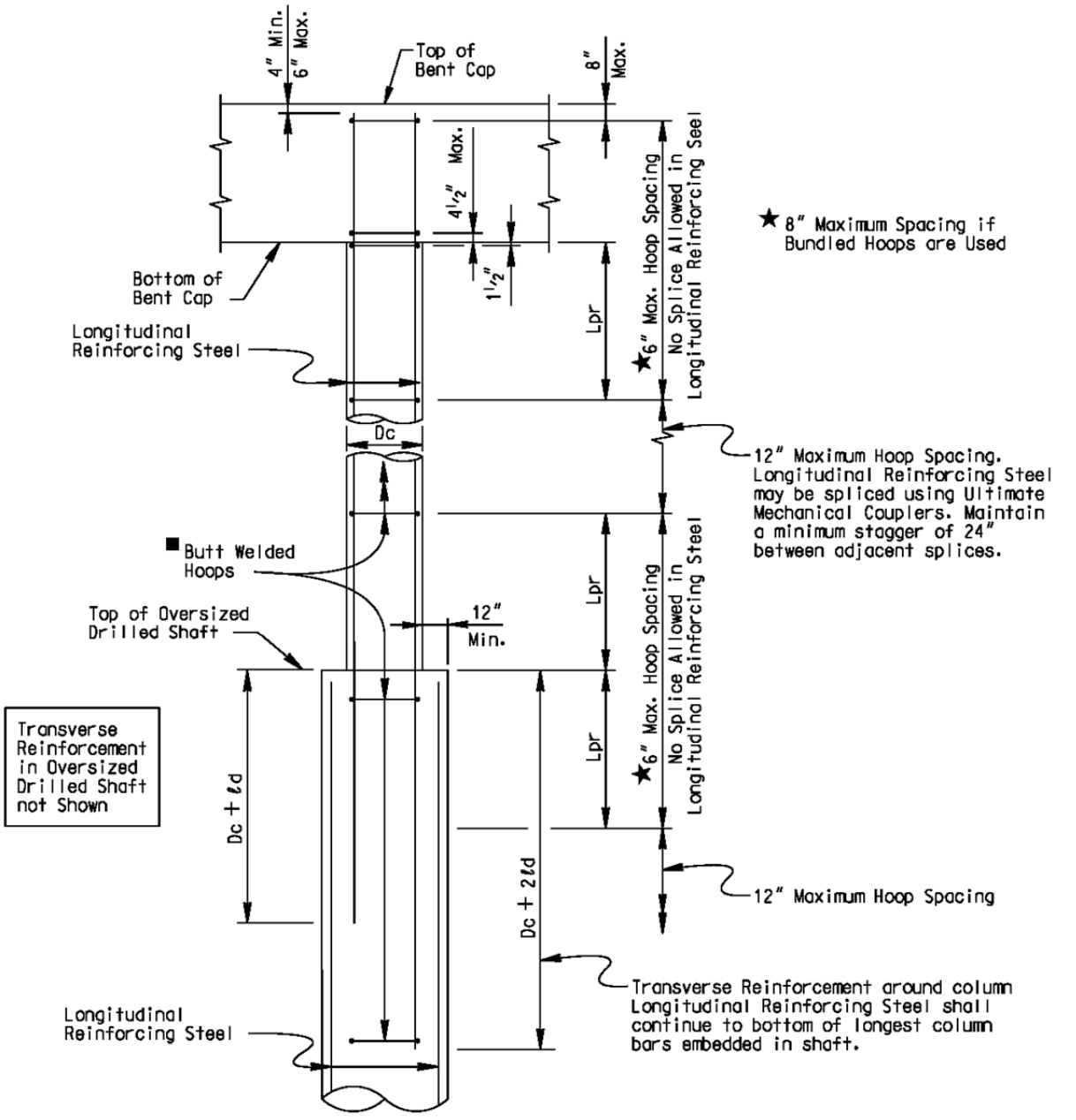
REVISIONS TO SECTION 8

8.4.9 Minimum Development Length of Longitudinal Column Reinforcement Extended into Oversized Shafts: Delete subsection and replace it with the following:

8.4.9 Minimum Development Length of Longitudinal Column Reinforcement Extended into Oversized Shafts

Longitudinal column reinforcement shall be extended into oversized shafts in a staggered manner with the minimum embedment lengths of $(D_c + l_{d,})$ and $(D_c + 2l_d)$ where D_c,is the cross sectional dimension of the column and l_d is the tension development length of the longitudinal column reinforcement. See Figures 6.2 and 8.4.

Figure 8.4 Reinforcement for Column on Oversized Drilled Shaft: Delete figure and replace it with the following:



■ Hoops shall have butt welded splices. The minimum size shall be #19 (#6) and the maximum size shall be #25 (#8). To prevent the hoop weld splices from being located on the same vertical plane, the locations of the splices shall be staggered around the perimeter of the column by a minimum distance of 1/3 of the hoop circumference.

Figure 8.4 Reinforcement for Column on Oversized Drilled Shaft

Note: Shaft transverse reinforcement does not have the same diameter as the column transverse reinforcement.

REVISIONS TO SECTION 9

9.2.2 Concrete Superstructure Shear Key Design: Add the following as the first paragraph:

Shear keys shall be provided at bents with expansion joints, except as noted in except for SDC A bridges.

9.2.3 Steel Superstructure Shear Key Design: Add the following as the first paragraph:

Shear keys shall be provided at bents with expansion joints, except as noted in except for SDC A bridges.

Please note these revisions in your copy of the *SCDOT Seismic Design Specifications for Highway Bridges*.

James W. Kendall, Jr., P.E.
Preconstruction Support Engineer

JWK:afg
ec: Bridge Construction Engineer
Bridge Maintenance Engineer
FHWA Structural Engineer
Preconstruction Support Managers
Regional Production Engineers
RPG Design Managers
Design Build Engineer

File:PC/TK