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IOWA DEPARTMENT OF TRANSPORTATION

To Office Bridges and Structures Date September 4, 2007

Attention All Employees Ref No. 521.1

From Gary Novey

Office Bridges and Structures

Subject Method's Memo No. 145 (Pier Foundation Design and Check for Scour Conditions)

In bridge scour discussions with the Preliminary Design Section, it was brought to my attention that FHWA is requiring geotechnical and structural check of bridge foundations based on scour levels during flood conditions. Therefore, the Preliminary Design Section will begin providing two scour elevations (design and check) on the TS&L sheets for final design to use [BDM 3.2.2.6.1, in process]. The design scour is the based on a 100-year or lesser flood, depending on which results in the more severe condition. The check scour is based on the 500-year or lesser flood depending on, which condition results in the more severe scour.

The analysis that will be required for the two scour conditions are as follows:

1. Pile geotechnical (bearing) capacity under design scour

   The design of the pile geotechnical capacity shall be made neglecting the soil side friction above the design scour elevation. Typical safety factors apply to this analysis.

2. Pile geotechnical (bearing) capacity under check scour

   The check of the pile geotechnical capacity shall be made neglecting the soil side friction above the check scour elevation using a factor of safety for the soil resistance of 1.1.

3. Pile stability check of the unsupported length.

   Piles subject to scour shall be designed and checked for stability. Piles should be designed with a factor of safety of at least 4.0 for the design scour (100-year or lesser flood, depending on which results in the more severe condition).
   In addition, piles should be checked to ensure that the factor of safety is at least 2.2 for the check scour condition caused by the 500-year or lesser flood. The slenderness ratio, KL/r, shall not exceed 120 [AASHTO-I 10.7.1].

   Unless more specific information is available, the unsupported steel H-pile length for a scour condition may be assumed to extend from a simple support at the bottom of the footing to an inflection point 4 feet (1200 mm) below the scour

elevation. Preferred pile size is HP 10 x 57 (HP 250 x 85), and the designer may lower the footing as much as 2 feet (600 mm) to permit use of that pile size. Allowable unsupported pile lengths are given in the table below.

Table of allowable unsupported Grade 50 H-pile lengths

Pile size	**Unsupported length for piles with 6 or 9 ksi (41 or 62 MPa) axial stress, feet (m)**		**Unsupported length for piles with 12 ksi (83 MPa) axial stress, feet (m)**	
	Design scour	**Check scour**	**Design scour**	**Check scour**
HP 10 (HP 250)	16 (4.877)	24 (7.315)	6 (1.829)	20 (6.096)
HP 12 (HP 300)	19 (5.791)	28 (8.534)	7 (2.134)	24 (7.315)
HP 14 (HP 350)	23 (7.010)	35 (10.668)	8 (2.438)	30 (9.144)

See Attachment A for background information and summary of calculations.

GAN/dgb/kfd/bj

Attachment A

Grade 50 computations for H-piles loaded to 9 ksi

Methods Memo No. 1 used a FS = 3.38 for 9 ksi loading. Because the allowable axial stress in the pile always is based on KL/r, that slenderness is the governing factor. The MM No. 1 unsupported lengths all are approximately 70 for Grade 36 H-piles.

In AASHTO Specifications Article 10.7.1, the limiting slenderness for main compression members is set at 120. The usual FS = 2.12.

With our upgrade to Grade 50, at a slenderness of 80 with F_a = 9 ksi, the FS = 4.0. This FS is larger than the present FS even though the slenderness is greater. If we set KL/r = 120, the maximum for a main member, with F_a = 9 ksi the FS = 2.2, which is larger than the ordinary FS = 2.12.

It seems reasonable to set the 9-ksi pile limits based on slenderness, 80 for design scour and 120 for maximum scour and to revise the manual.