I N T E R O F F I C E M E M O

TECHNICAL SERVICES
Bridge Engineering Section
Office Phone: (503) 986-4200
Fax Number: (503) 986-3407

DATE: August 9, 2016

TO: Alex Lim (Sections 1 or 3)
Bridge Design Standards Engineer

FROM: Susan C. Ortiz, PE, GE
Sr Geotechnical Engineer
ODOT
Phone: 503.986.3377

SUBJECT: Proposed Revision to Bridge Design & Drafting Manual

RE: BDDM Section 1.10.5.3 – Spread Footing Foundation Design

Problem Statement:

The resistance factors listed in Section 1.10.5.3(2) are inconsistent with resistance factors in the GDM. Replace "Foundation designer" with "Geotechnical designer".

Proposal:

Modify Section 1.10.5.3 as follows:

1.10.5.3 Spread Footing Foundation Design

Spread footings are considered early on in the design process as a possible economical foundation option if the foundation conditions are suitable. The design of spread footings is usually an interactive process between the Geotechnical and ~~s~~Structural D~~d~~esigners. The bottom of spread footings should be at least 6 feet below the bottom of the streambed unless non-erodable bedrock is present. The bottom of spread footings should also be below the estimated depth of scour for the 500 year flood event. The top of the footing should be below the depth of scour estimated for the 100 year event. Spread footings are not to be constructed on soils that may liquefy under earthquake loading. If spread footings are recommended the ~~foundation~~ Geotechnical D~~d~~esigner will provide the following design recommendations in the ~~Foundation~~ Geotechnical Report:

(1) Footing Elevations

The elevations of the proposed footings will be provided along with a clear description of the foundation materials the footing is to be constructed on.

(2) Nominal and Factored Bearing Resistances

The nominal and factored bearing resistances will be provided for various effective footing widths likely to be used. Resistance factors for all applicable load combinations should be consistent with the most recent version of AASHTO LRFD Bridge Design Specifications. ~~For scour conditions the following resistance factors should be used unless otherwise justified.~~

~~100-yr scour or Overtopping Flood: 0.70~~
~~500-yr scour or Overtopping: 1.0~~
~~Extreme Event Limit I (Earthquake Loading): 1.0~~

Bearing resistances corresponding to 1 inch of settlement (Service Limit State) should also typically be provided unless other settlement limits are established by the structural designer. The ~~s~~Structural ~~designer~~ Designer should communicate all footing settlement limits to the ~~Foundation~~ Geotechnical Designer. For soil conditions, the bearing resistances provided assume the footing pressures are uniform loads acting over effective footing dimensions B' and L' (i.e. effective footing width and length ((B or L) - 2e) as determined by the Meyerhof method. For footings on rock, the resistances provided assume triangular or trapezoidal stress distribution and maximum toe bearing conditions.

Minimum footing setback on slopes and embedment depths will be provided.

(3) Sliding Stability and Eccentricity

The following soil parameters will be provided for calculating frictional sliding resistance and active and passive earth pressures.

Soil Unit Weight, γ (soil above footing base)
Soil Friction Angle, ϕ~~,~~ (soil above footing base)
Active Earth Pressure Coefficient, Ka
Passive Earth Pressure Coefficient, Kp
Coefficient of Sliding, tan δ

(4) Overall Stability

The ~~foundation~~ Geotechnical ~~d~~Designer will evaluate overall stability ~~and provide~~using the maximum footing load which can be applied to the design slope while maintaining ~~a factor of safety of at least 1.5 (1.0 for extreme event conditions).~~ resistance factor of 0.65 as outlined in ~~AASHTO (2014) Article~~LRFD 11.6.2.3.

Analysis / Research / Other Supporting Data:

☐ None
☒ Attached:

- 2015 Interim Revisions to AASHTO LRFD Bridge Design Specifications
- Oregon Geotechnical Design Manual, Chapter 8
- Oregon Geotechnical Design Manual, Chapter 7.4

Table 3.4.1-1—Load Combinations and Load Factors

Load Combination Limit State	*DC* *DD* *DW* *EH* *EV* *ES* *EL* *PS* *CR* *SH*	*LL* *IM* *CE* *BR* *PL* *LS*	*WA*	*WS*	*WL*	*FR*	*TU*	*TG*	*SE*	Use One of These at a Time				
										EQ	*BL*	*IC*	*CT*	*CV*
Strength I (unless noted)	γ_p	1.75	1.00	—	—	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Strength II	γ_p	1.35	1.00	—	—	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Strength III	γ_p	—	1.00	1.40	—	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Strength IV	γ_p	—	1.00	—	—	1.00	0.50/1.20	—	—	—	—	—	—	—
Strength V	γ_p	1.35	1.00	0.40	1.0	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Extreme Event I	γ_p	γEQ	1.00	—	—	1.00	—	—	—	1.00	—	—	—	—
Extreme Event II	γ_p	0.50	1.00	—	—	1.00	—	—	—	—	1.00	1.00	1.00	1.00
Service I	1.00	1.00	1.00	0.30	1.0	1.00	1.00/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Service II	1.00	1.30	1.00	—	—	1.00	1.00/1.20	—	—	—	—	—	—	—
Service III	1.00	0.80	1.00	—	—	1.00	1.00/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Service IV	1.00	—	1.00	0.70	—	1.00	1.00/1.20	—	1.0	—	—	—	—	—
Fatigue I—*LL, IM & CE* only	—	1.50	—	—	—	—	—	—	—	—	—	—	—	—
Fatigue II—*LL, IM & CE* only	—	0.75	—	—	—	—	—	—	—	—	—	—	—	—

- Extreme Event II—Load combination relating to ice load, collision by vessels and vehicles, check floods, and certain hydraulic events with a reduced live load other than that which is part of the vehicular collision load, *CT*. The cases of check floods shall not be combined with *BL*, *CV*, *CT*, or *IC*.

loads indicates that $\gamma_{EQ} = 0.50$ is reasonable for a wide range of values of average daily truck traffic (ADTT).

The following applies to both Extreme Event I and II:

- The recurrence interval of extreme events is thought to exceed the design life.
- Although these limit states include water loads, *WA*, the effects due to *WA* are considerably less significant than the effects on the structure stability due to scour. Therefore, unless specific site conditions dictate otherwise, local pier scour and contraction scour depths should not be combined with *BL*, *EQ*, *CT*, *CV*, or *IC*. However, the effects due to degradation of the channel should be considered. Alternatively, one-half of the total scour may be considered in combination with *BL*, *EQ*, *CT*, *CV*, or *IC*.
- The joint probability of these events is extremely low, and, therefore, the events are specified to be applied separately. Under these extreme conditions, the structure may undergo considerable inelastic deformation by which locked-in force effects due to *TU*, *TG*, *CR*, *SH*, and *SE* are expected to be relieved.

The 0.50 live load factor signifies a low probability of the concurrence of the maximum vehicular live load (other than *CT*) and the extreme events.

From Oregon GDM Chapters 8.9.2 & 7.4

Foundation design for the scour condition associated with the base flood (typ. 100-yr. event) is the same as the "no-scour" condition. Factored foundation resistances must be adequate to resist the factored loads associated with the strength and service limit states (AASHTO (2014), Article 3.7.5). For the check flood condition the foundations must provide nominal bearing resistances (resistance factor equal to 1.0) sufficient to support the structure loads associated with the Extreme Limit State (AASHTO (2014), Article 10.5.5.3.2).

7.4 Resistance Factors and Safety Factors for Slope Stability Analysis

For overall stability analysis of walls and structure foundations, design shall be consistent with Chapter 6, Chapter 8 and Chapter 15 and the *AASHTO LRFD Bridge Design Specifications*. For slopes adjacent to but not directly supporting structures, a maximum resistance factor of 0.75 should be used. For foundations on slopes that support structures such as bridges and retaining walls, a maximum resistance factor of 0.65 should be used. Exceptions to this could include minor walls that have a minimal impact on the stability of the existing slope, in which the 0.75 resistance factor may be used. Since these resistance factors are combined with a load factor of 1.0 (overall stability is assessed as a service limit state only), these resistance factors of 0.75 and 0.65 are equivalent to a safety factor of 1.3 and 1.5, respectively. For general slope stability analysis of cuts, fills, and landslide repairs, a minimum safety factor of 1.25 should be used. Larger safety factors should be used if there is significant uncertainty in the slope analysis input parameters. For seismic analysis, if seismic analysis is conducted see Chapter 6 for policies on this issue, a maximum resistance factor of 0.9 should be used for slopes involving or adjacent to walls and structure foundations. This is equivalent to a safety factor of 1.1. For other slopes (cuts, fills, and landslide repairs), a minimum safety factor of 1.05 should be used.

Bridge Engineering Section Response:

☒ Accepted for consideration as submitted ☐ Accepted for consideration as noted ☐ Proposal tabled, see Remarks ☐ Proposal not accepted, see Remarks		
Remarks:		
Susan C. Ortiz, PE, GE Digitally signed by Susan C. Ortiz, PE, GE DN: cn=Susan C. Ortiz, PE, GE, o=ODOT, ou=Bridge Engineering Section, email=susan.c.ortiz@odot.state.or.us, c=US Date: 2016.09.08 08:51:11 -07'00'		
Susan Ortiz Bridge Design Standards Reviewer		Date 8/9/2016
Alex Lim Digitally signed by Alex Lim DN: cn=Alex Lim, o=ODOT, ou=BDDM Standards Engineer, email=Alex.K.LIM@odot.state.or.us, c=US Date: 2016.08.16 10:36:04 -07'00'		
Alex Lim (Sections 1 or 3) Bridge Design Standards Engineer		Date 8/16/2016

Cc: file