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From: John Lawson
Manager, Geotechnical Design Section
Materials Group (068R)

Subject: Geotechnical Design Policy SF-3
Load Resistance Factor Design (LRFD)
Resistance Factors for the Estimation of Factored Sliding and Bearing Resistance for Spread Footings of Gravity and Semi-gravity Walls based on Load and Resistance Factor Design (LRFD) Methodology.

The AASHTO (2010) LRFD Bridge Design Specifications are mandatory for all federally funded projects. The purpose of this policy memorandum is to provide guidance for the selection of resistance factors for the evaluation of sliding and bearing resistance for spread footings of gravity and semi-gravity walls. The guidance in this memorandum shall be applied to ADOT SD 7.01 and 7.02 walls (formerly referred to as B-Standard Walls) that address reinforced concrete cantilever and masonry walls and other similar walls.

Personnel, both within ADOT and design consultants working on projects that require LRFD for substructures, shall follow the attached policy. The designer should contact the ADOT Materials Group for an updated version of this policy in the event any interim revisions are made to AASHTO (2010) or a new edition of AASHTO is issued.

If you have any questions regarding this design policy please contact Jim Wilson at 602-712-8081 or John Lawson at 602-712-8130.

Arizona Department of Transportation

Materials Group - Geotechnical Design Section

MEMORANDUM

To: **John Lawson, P.E., Manager, Geotechnical Design Section** **Jean Nehme, Ph.D., P.E., State Bridge Engineer**	**Date: December 1, 2010**
From: **Norman H. Wetz, P.E., Senior Geotechnical Engineer** **James D. Wilson, P.E., Geotechnical Planning Engineer** **Amin Islam, Ph.D., P.E., Bridge Technical Section Leader** **Navaphan Viboolmate, P.E., Bridge Design Section Leader**	**Subject: Resistance Factors for the Estimation of Factored Sliding and Bearing Resistance for Spread Footings of Gravity and Semi-gravity Walls based on Load and Resistance Factor Design (LRFD) Methodology[1]**

ADOT POLICY MEMORANDUM: ADOT SF-3

This memorandum presents guidance for the selection of resistance factors for the evaluation of sliding and bearing resistance for spread footings of gravity and semi-gravity walls. The guidance in this memorandum shall be applied to ADOT SD 7.01 and 7.02 walls (ADOT, 2010) that address reinforced concrete cantilever and masonry walls and other similar walls.

I. Recommended Resistance Factors for Evaluating Factored Bearing and Sliding Resistances for Spread Footings of Permanent Gravity and Semi-Gravity Walls

Table 11.5.6.1 in Section 11 (Abutment, Piers and Walls) of AASHTO (2010) provides the following information on resistance factors for permanent gravity and semi-gravity walls:

- Resistance factor for bearing resistance = 0.55
- Resistance factor for sliding = 1.0

For permanent gravity and semi-gravity walls, the resistance factors provided in Table 1 (Table 10.5.5.2.2-1 of Section 10 of AASHTO, 2010) shall be used instead of the resistance factors noted above. This recommendation is based on the consideration that the guidance in Table 1 takes into account the method of analysis, method of investigations, method of construction, and soil conditions rather than providing a single value of resistance factor that covers a wide range of possible configurations and conditions. Furthermore, the guidance in Table 1 provides a specific resistance factor for incorporating passive resistance for cases where a sliding key may be used.

[1] This memorandum is based on AASHTO (2010) – 5th Edition. The designer should contact ADOT Materials Group for an updated version of this memorandum in the event any interim revisions to AASHTO (2010) are issued or a new edition of AASHTO is issued.

Table 1
Resistance Factors for Geotechnical Resistance of Shallow Foundations at the Strength Limit State (After Table 10.5.5.2.2-1 of Section 10 of AASHTO, 2010)

Method/Soil/Condition			Resistance Factor
Bearing Resistance	ϕ_b	Theoretical method (Munfakh et al., 2001), in clay	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using Cone Penetration Test (CPT)	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using Standard Penetration Test (SPT)	0.45
		Semi-empirical methods (Meyerhof, 1957), all soils	0.45
		Footings on rock	0.45
		Plate Load Test	0.55
Sliding	ϕ_τ	Precast concrete placed on sand	0.90
		Cast-in-Place Concrete on sand	0.80
		Cast-in-Place or precast Concrete on Clay	0.85
		Soil on soil	0.90
	ϕ_{ep}	Passive earth pressure component of sliding resistance	0.50

II. Consideration of Sliding Key

Where a sliding key is used, the sliding resistance shall be computed as follows:

1. Use the resistance factor $\phi_\tau = 0.90$ for soil-on-soil interface for the bottom horizontal plane of the footing between the toe and the front of the sliding key.
2. For the balance of the bottom horizontal plane of the footing, use a value of ϕ_τ that is based on the type of concrete and soil from Table 1.

In either case, the resistance factor for the passive resistance component of the sliding resistance (ϕ_{ep}) shall be 0.50 in accordance with Table 1.

III. Bearing Resistance

The bearing resistance shall be evaluated in accordance with the procedures in ADOT SF-1 (2010) based on the development and use of bearing resistance charts. In the development of the bearing resistance charts, the geotechnical specialist shall use the bearing resistance factor (ϕ_b) appropriate for the geomaterials and methods of analysis listed in Table 1.

IV. Closing Comments

This memorandum contains guidance for the selection of resistance factors to evaluate the factored bearing and sliding resistances for spread footings of permanent gravity and semi-gravity walls similar to ADOT SD 7.01 and 7.02 walls (ADOT, 2010). Close interaction and communication between geotechnical and bridge specialists will be required to apply this

guidance correctly. The recommendations in this memorandum do not apply to mechanically stabilized earth (MSE) walls.

V. References

AASHTO (2010). ***AASHTO LRFD Bridge Design Specifications***. ***Fifth Edition***. American Association of State Highway and Transportation Officials, Washington, D.C.

ADOT (2010). ***Bridge Group Structure Detail***, Arizona Department of Transportation. Phoenix, AZ. (http://www.azdot.gov/highways/bridge/detaildwg/Retaining.asp)

ADOT SF-1 (2010). ***Development of Factored Bearing Resistance Chart by a Geotechnical Engineer for Use by a Bridge Engineer to Size Spread Footings on Soils Based on Service and Strength Limit States Based on Load and Resistance Factor Design (LRFD) Methodology***, Memorandum from N. H. Wetz and J. D. Wilson to J. Lawson, Dated March 19, 2008 (Revision 1), Arizona Department of Transportation. Phoenix, AZ. (http://www.azdot.gov/Highways/Materials/Geotech_Design/Policy.asp)

Meyerhof, G. G. (1957). "The Ultimate Bearing Capacity of Foundations on Slopes." ***Proceeding 4th International Conference on Soil Mechanics and Foundation Engineering***, London.

Munfakh, G., Arman, A., Collin, J. G., Hung, J. C.-J., and R. P. Brouillette, (2001). ***Shallow Foundations Reference Manual,*** FHWA-NHI-01-023. Federal Highway Administration, U.S. Department of Transportation, Washington, DC.