INDIANA DEPARTMENT OF TRANSPORTATION

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GEOTECHNICAL DESIGN MEMORANDUM No. 2010-02

August 5, 2010

TO: **All Geotechnical Consultants**

FROM: **Athar Khan, P.E.**
Manager, Office of Geotechnical Engineering

SUBJECT: **Liquefaction Susceptibility Assessment Procedure for the I-69 Extension Project, Sections 2 and 3**

EFFECTIVE: **April 1, 2010**

Liquefaction Susceptibility Assessment Procedure

In evaluating liquefaction susceptibility/potential, engineering judgment shall be used with respect to the age of the deposit, the thickness of the deposit, and whether or not the suspect layer is confined between two low-permeability layers. Some or all of these factors can be used to rationally eliminate a granular layer from liquefaction consideration.

Determine the Site Class and Seismic Zone from the AASHTO *Load Resistance Factor Design (LRFD) Bridge Design Specifications*, 2008 Interim, Article 3.10.1. Site Class shall be determined using the AASHTO method verified by means of shear wave velocity data. The design ground-motion parameters shall be derived using the AASHTO/USGS Seismic Design Parameters Version 2.10 software.

If the Seismic Zone is 3 or 4, a liquefaction assessment shall be conducted. A liquefaction assessment shall also be considered where very loose to loose saturated sand, e.g., $(N_1)_{60}$ <10 bpf or q_{c1n} < 75 ksf, exists in Seismic Zone 2 and the Acceleration Coefficient, A_s, is 0.15 or higher.

The procedure for evaluating liquefaction shall be based on AASHTO *LRFD*, 2009 Interim, Article 10.5.4.2.

Susceptibility Determination

In general, only non-plastic soils such as sands or silts will liquefy. However, there are some low plasticity soils that will liquefy too.

1. If granular soil such as sand, non-plastic silt, or loose gravel is present within 75 ft of the ground surface, and groundwater is within 50 ft of the ground surface, then continue. Otherwise stop.

2. If the soil is cohesive, determine initial susceptibility using the following criteria. If either criterion shows that the soil is susceptible to liquefaction, then continue. Otherwise stop.

    - Boulanger and Idriss, 2006, suggest that soils with PI ≥ 7 are not susceptible to liquefaction.

    - Bray and Sancio, 2006, suggest that a soil with PI < 12 and a water content to LL ratio Wc/LL > 0.85 will be susceptible to liquefaction.

Liquefaction-Potential Determination

1. Calculate the liquefaction potential for each sample interval in each granular layer using the Simplified Method from *Semi-Empirical Procedures for Evaluating Liquefaction Potential During Earthquakes*, I.M. Idriss and R.W. Boulanger, January 2004. Where available, CPT data shall be used, otherwise use SPT data in evaluating liquefaction potential. The earthquake moment magnitude, M_W, shall equal 6.5. The peak ground surface acceleration shall equal A_s based on Seismic Design Parameters (AASHTO/USGS). Where soils are determined to be susceptible to liquefaction, a liquefaction-potential analysis shall be performed at each bridge bent or pier.

2. If the Factor of Safety against liquefaction is less than 1.2 (per INDOT, 2-16-2010), the effects of liquefaction shall be assessed. For a design-build contract, the contractor is responsible for the mitigation methods. For a design-bid-build contract, the design consultant is responsible for the mitigation methods.

3. In reporting liquefaction potential for a design-build contract, provide the depth for which mitigation shall be performed.

    During liquefaction, pore-water pressure build-up occurs, resulting in a temporary loss of strength, then settlement as excess pore-water pressure dissipates. Potential effects include slope failure, flow failure or lateral spreading, and downdrag on deep

foundations. The design of the mitigation method is the responsibility of the design-build design consultant and is subject to approval by the Office of Geotechnical Engineering.

If you have questions, please contact Mir Zaheer at (317) 610-7251 ext 224, or via e-mail at MZaheer@indot.in.gov.

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