INDIANA DEPARTMENT OF TRANSPORTATION

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Mitchell E. Daniels, Jr., Governor
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GEOTECHNICAL DESIGN MEMORANDUM No. 2010-05

August 9, 2010

TO: All Geotechnical Engineers, Structure, Design, Operations and District Personnel and Consultants

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

SUBJECT: Seismic Slope Stability of Embankments

EFFECTIVE: Immediately

The following procedure as taken from NCHRP Report 611 shall be followed to check for Seismic slope stability:

Step 1: Complete an assessment of Static Slope Stability. The resistance factors or factors of safety shall be as required:

	Min. Factor of Safety	Max. Resistance Factors
Roadway Embankments	1.3	0.75
Approach Embankments at Structures	1.5	0.65

Step 2: Determine Slope Aspect and Site Specific Seismic Coefficients, A_S, SD_S, and SD_1 as per AASHTO

Step 3: Check if liquefaction potential exists at the approach embankments as described in Geotechnical Design Memo #2.
If Yes – Mitigation is required. After mitigation has been designed proceed to Step 4.
If No - Proceed to Step 4

For other roadway embankments outside of the bridge approach embankments, proceed to Step 4.

Step 4: Check the no-analyses cut off criteria below:

Slope Angle	A_S	Action
3H:1V	<0.3	No analysis required
2.5H:1V	<0.25	No analysis required
2H:1V	<0.2	No analysis required

If the above criteria are satisfied then no further analyses are required for seismic slope stability.

If the above criteria are not satisfied proceed to Step 5.

Step 5: If the proposed slope fails the above criteria Seismic Slope Stability Analysis is required. Undrained Total Stress/Strength parameters shall be used in the analysis.

The peak ground acceleration used in the analysis shall be defined as:

$A_g = A_S * 0.5 * \alpha$

Where $\alpha = 1 + 0.01H[(0.5\beta)-1]$

H = fill height in feet

$\beta = (F_V S_1)/A_S$

$\alpha = 1$, where slope height is <30 ft

Step 6: Check the Resistance factor or the factor of safety achieved from seismic slope stability analyses. If the resistance factor is less than 0.9 or the factor of safety is greater than 1.1, the slope meets seismic design requirements. If the requirements are not met mitigation must be performed.