

**Oregon Department of Transportation**

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Engineering & Technical Services

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**DATE: Tuesday, November 7, 2023**

**TO:** Susan C. Ortiz, P.E., G.E.

 State Geotechnical Engineer

**FROM:** Sophie Brown, P.E. Phone: 503-509-4538

 Senior Retaining Wall Engineer

 ODOT Geotechnical Engineering, Engineering Geology and Hazmat

**SUBJECT:** Proposed Revision to Geotechnical Design Manual

 To Section Number 16.6.15.4 Geosynthetic Reinforced Soil Integrated Bridge System (GRS-IBS) Bridge Abutment

**Problem Statement:**

In 16.6.15.4 under the heading “Overview of design and construction constraints for use of GRS-IBS:” the bullet list includes “GRS-IBS may be considered for locations with a low seismic hazard (As≤0.15g for the 1000 year return period).”

This was introduced in the first version of GRS-IBS discussion in the GDM from 2014/2015 to provide the option of GRS-IBS in Oregon, but initially limit its use to low seismic regions in Oregon until more/repeatable research are available. The 2012 FHWA GRS-IBS resource manuals, that were the basis for GRS-IBS in the GDM, report that GRS-IBS behaves well with shaking up to 1g. This was based on a set of shake table tests on three 9’ high GRS-IBS abutment models: the beam in the testing model was seated on the GRS abutment at one end and a rigid on the other end, rather than a GRS-IBS abutment. ODOT’s opinion for implementing GRS-IBS guidance in the GDM was to conservatively limit use to low seismic areas until more testing and research was performed to duplicate the findings and possibly develop internal analysis method for seismic loading.

Since that time, FHWA’s 2012 guidance was updated by FHWA-HRT-17-080, June 2018, Design and Construction Guidelines for Geosynthetic Reinforced Soil Abutments and Integrated Bridge Systems and there has been more testing and modeling of closely spaced reinforcement. Based on experiments and parametric analysis conducted in research projects, it can generally be concluded that GRS with close reinforcement spacing and modular block facing, even when designed using standard static loading methods, can also withstand earthquakes shaking with moderate horizontal ground acceleration (up to 0.4g) with almost no damage or appreciable deformation. The results also indicated that properly designed bearing pads on the bridge sill with a natural frequency below the ground dominant frequency are effective in isolating the superstructure inertia force from the GRS abutment. By isolating this motion, it will greatly reduce the potential for bridge sill sliding on the GRS. Note that the superstructure is integrated within an IBS whereby it is embedded within the integrated approach and side walls, which help limit sliding.

A GRS structure should be designed for external stability with respect to seismic loads as with any other gravity wall., The National Cooperative Highway Research Program (NCHRP) recently completed a study, 12-59(1), The Seismic Performance of GRS Abutments. This study showed, through full scale shake table tests up to 1g and numerical modeling, that a GRS abutment could withstand ground these types of loading conditions. For these reasons, a no seismic design requirement is suggested for the internal stability of a GRS-IBS provided it is built as outlined in section 5.4, page 73 in the Implementation Guide (FHWA-HRT-11-026). For single span bridges, the loads from the superstructure due to seismic shaking needs to be addressed in the design to make sure the bridge does not slide off of the bearing areas. With the GRS IBS, the bridge is restrained longitudinally and laterally by the passive resistance from the GRS integrated approach. In the design of a single span bridge, the main concern is ensuring that the bridge will not shake off of its support. This is achieved either by anchoring, developing a sufficient bearing area to accommodate the anticipated displacement, or a combination.

**Proposal:**

Replace the bullet:

* GRS-IBS may be considered for locations with a low seismic hazard (As≤0.15g for the 1000 year return period).

With the following:

* GRS-IBS may be considered for locations with a seismic hazard up to As=0.4g for the 1000 year return period.
* Design bridge following BDM requirements and ensure superstructure will not pull off longitudinally or laterally.

**Analysis / Research / Other Supporting Data:**

[ ] None

[ ] Attached:

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**Geotechnical Engineering, Engineering Geology & HazMat Section Response:**

[ ]  Accepted for consideration as submitted

[ ]  Accepted for consideration as noted

[ ]  Proposal tabled, see Remarks

[ ]  Proposal not accepted, see Remarks

**Remarks:**

[Enter Remarks here]

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