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Numerical Evaluation of the Seismic Performance of GSI Foundation Systems for Buildings Using Gravel-rubber Mixtures

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Abstract

Geotechnical seismic isolation (GSI) using gravel-rubber mixtures (GRMs), as an energy dissipative horizontal layer, is a promising foundation technology to enhance the seismic resilience of low-rise residential buildings. This paper presents preliminary results of a numerical study carried out to evaluate the seismic performance of a selected GSI-GRM system and compare it to that of a standard non-isolated foundation system placed on a compacted gravel layer (i.e., without rubber). To this scope, a 3-dimensional FE model is created in OpenSees and calibrated using experimental data. In the model, a 12m × 6m × 50cm concrete raft foundation is placed on a 60cm-thick layer of GRM (having volumetric rubber content (VRC) of 40%) or gravel (VRC = 0) resting on a 20m-thick medium-dense dry sand deposit. No structures were placed on the foundation. The model was subjected to a ramped sinusoidal input base acceleration (ab = 0.1 - 0.5 g) at different frequency levels (f = 1 - 8 Hz). The accelerations at the base (aGIS,base) and top (aGIS,top) of the GRM/gravel layer are compared an it is found that, the effectiveness of GSI-GRM systems significantly increased with increasing ab and f. The best seismic performance is attained at f = 8 Hz, where the acceleration reaching the GSI top (aGIS,top) is reduced up to 60% as compared to that of the non-isolated gravel foundation.

Keywords: Geotechnical seismic isolation, Gravel-rubber mixtures, Numerical model, Seismic performance