EFFECTS OF AN INPUT EARTHQUAKE MOTION ON THE SEISMIC RESPONSE OF AN INVERTED T-TYPE WALL

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ABSTRACT
Post-earthquake residual displacement of geotechnical structures must be factored in a performance based seismic design of infra structures. While estimating the reliable residual displacement of structures following an earthquake, not only a rigorously verified numerical analysis technique, but also input motion scenarios must be considered. This study examines the effects of an input earthquake motion on the post-earthquake residual displacement of an inverted T-type wall by using the rigorously verified finite difference code and bins of spectral-matched real earthquake records. The maximum residual displacement is 6 times higher than the minimum value depending on the input motion.

Keywords: Earthquake, performance based design, response history analysis.

INTRODUCTION
The post-earthquake residual displacement of geotechnical structures is difficult to estimate because of the uncertainty in impending earthquake motion. The ideal approach to determining the expected earthquake motion is to deaggregate the uniform hazard spectrum (UHS) into several earthquake time histories corresponding to the epicentral distance, magnitude, etc. (Lin, 2011). Therefore, countries with high seismicity define the way to select earthquake histories for response history analysis (RHA) in their design standards (Katsanos, 2010). However, deaggregating the UHS is practically difficult in the absence of active fault information, fault mechanism, historic earthquake records in low seismicity countries such as Korea. Thus, most seismically less active countries have to rely on the UHS and the spectral matching technique to determine arbitrary earthquake motion that matches past seismic occurrences in their respective countries. This study aims to examine the effect of an input earthquake motion on RHA. The target structure used is an inverted T-type wall. Estimating the post-earthquake residual displacements of a geotechnical structure required the use and verification of a numerical analysis based on time integration, material, and geometric nonlinearity. FLAC 3D, a finite difference analysis tool used in this study, was rigorously verified based on the geotechnical dynamic centrifuge test in prototype scale (Lee, 2015). The dimensions of the prototype inverted reinforced concrete T-type wall were as follows: 5.4 m in height and 3.91 m in base length. The verified numerical model was used for a parametric study by varying the input earthquake motion. The effect of an input earthquake motion on the permanent deformation was investigated by constructing three bins that spectrally matched real earthquake records of different magnitudes from diverse regions and epicentral distances. Each bin contains seven different earthquake events measured at rock outcrop stations. The first bin contains the largest Korean domestic earthquakes after instrumental measurement started. The second bin contains international records with a magnitude similar
to that of bin#1. The third bin also contains international records that meet the magnitude of the Korean design standard performance goal. The records in bin#2 and bin#3 were selected from the Pacific Earthquake Engineering Research Center (PEER) data base (Next Generation Attenuation (NGA)-WEST2).

RESULTS AND CONCLUSIONS

The effects of nonstationary characteristics of an input motion were analyzed in terms of post-earthquake residual displacement at the top of the stem by using twelve earthquake motion parameters. The most influential parameter affecting permanent displacement is the magnitude. The other parameters associated with earthquake motion were not found to significantly increase residual displacement of the inverted T-type wall except for energy related parameters such as the cumulative absolute intensity, characteristic intensity.

Fig. 1 - Representative correlation between residual horizontal displacement and ground motion parameters

This study shows the effect of input earthquake motion on the post-earthquake residual displacement. Even though the records show almost the same spectral contents, results show quite different post-earthquake residual displacement data. The most influential earthquake motion parameter was the magnitude.

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