Geophysical Research Abstracts
Vol. 19, EGU2017-88, 2017
EGU General Assembly 2017

A framework of predicting the earthquake-induced displacements of finite and infinite slopes for regional slope stability assessment

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The accurate assessment of the stability of slopes during earthquakes has become a critical issue in seismically active areas. The Newmark-type displacement method, which is capable of estimating permanent earthquake-induced displacements, is extensively adopted to evaluate slope stability under seismic loading. This approach, however, becomes unmanageable for regional assessment because thousands of iterations through the conventional slope stability analyses are required to obtain the yield acceleration (ky) of each slope. Only infinite slopes have close form solution for quickly estimating ky, which has limited the regional assessment to shallow types of failures. On the other hand, although several prediction models have been developed to correlate ground motion parameters with permanent displacements, these models are only applicable to shallow slope failures (i.e. infinite slopes), in which the sliding mass is approximated as a rigid block. For finite slopes or deep failures, however, ground motions could be modified because of its interaction with the deformable sliding mass above. The interaction behavior should be considered in estimating earthquake-induced displacement. To overcome these limitations, a framework of predicting the earthquake-induced displacements for both finite and infinite slopes is developed in this study. A methodology to quickly estimate ky of finite slope is first established. In addition, a unified empirical model for estimating seismic slope displacements for both shallow and deep types of failures is developed. The framework can be used to readily evaluate seismic slope hazards in a region.