Simplified models for assessing annual liquefaction probability — A case study of the Yuanlin area, Taiwan

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Abstract

For management and mitigation of liquefaction hazards on a regional basis, it is generally desirable to evaluate liquefaction hazards in terms of annual probability of liquefaction (APL). In this study, an approach that combines the knowledge-based, clustered partitioning technique with the Hasofer–Lind reliability method is developed for estimating the annual liquefaction probability. Because it is generally difficult to validate the computed annual liquefaction probability, the results obtained from a modified version of the Davis and Berrill’s energy dissipation model are used as a reference. The two models are examined with borehole data in the Yuanlin, Taiwan area that were investigated shortly after the 1999 Chi-Chi Earthquake. Results of the analysis reveal that annual probabilities of liquefaction estimated by the two models are consistent with each other and both deemed reasonable.

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1. Introduction

Earthquake-induced soil liquefaction in loose sand layers often causes settlement and tilting of buildings. Structural failure caused by liquefaction has been observed in many earthquakes (e.g., the 1964 Niigata, Japan earthquake, the 1971 Los Angeles, California earthquake, the 1995 Hyogoken-Nambu, Japan earthquake, the 1999 Kocaeli, Turkey earthquake, and the 1999 Chi-Chi, Taiwan earthquake) (Hamada et al., 1987; Ishihara, 1993; Japanese Geotechnical Society, 1996; Earthquake Engineering Research Institute, 2000; Stewart, 2001; Ku et al., 2004). Located in the western part of the circum-Pacific earthquake belt, Taiwan is the site of convergence between the Philippine Sea plate and the Eurasian plate that results in frequent earthquakes of all magnitudes (Jeng et al., 2002). Furthermore, the heavily-populated western coastal plain of Taiwan is underlain by Quaternary alluvium composed of structurally weak silt, sands, and fine gravels that are susceptible to liquefaction. According to field investigation...