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Model Uncertainty Characterization in the Simplified Method for Soil Liquefaction

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ABSTRACT

Both the model and parameter uncertainties should be taken into consideration for evaluation of soil liquefaction potential during earthquake. The paper aims to develop a new method to quantify the model uncertainty of the simplified method. The proposed method is constructed by the random simulation technique. The CPT-based liquefied/non-liquefied case histories are collected from documents to determine the Roberson and Wride(1998) model (RW) uncertainty for example. The results show that the RW model uncertainty can be defined by a c_1 parameter with an expected value is 1.16 and a coefficient of variance value is 0.12 for all case histories. Finally, results comparison is presented for the validity of the proposed method.

KEY WORDS: liquefaction, model uncertainty, expected value, coefficient of variance.

INTRODUCTION

In the simplified methods of soil liquefaction by earthquake, one mathematics function is often used to develop a limit state that separates liquefied case form non-liquefied case. The limit state of simplified method is an empirical model through a great quantity of history cases and test data. If a mathematics function can be used to express the idealized limit state of simplified method; it is referred herein as ILS. The ILS is closest to the real limit state; it is referred herein as RLS. Take the simplified model by Roberson and Wride (1998) as an example; it is referred herein as RW model. Although the several calibrations to the original RW model were addressed because of the increasing case histories, the original mathematics function still was followed (Hwang and Yang, 2001; Youd and Idriss, 2001). One often uses enough case histories to determine the empirical model shown as Figure 1. In Figure 1, the black dot and hollow dots mean the liquefied and non-liquefied cases respectively. The black line marked by C represents the state of the highest success rate, in which only three cases are misclassified. However, if considering the non-liquefied case histories more reflecting the real soil resistance against liquefaction, the dotted line marked by C would be the limit state. As if considering the conservation and the liquefied case histories being reliable, the dotted line marked by B, would be the conservative state by the liquefied case histories. In general, a limit state would be determined in the range of the dotted line A to B with lower success rate then the one of line C. It has some degree of uncertainty. For statistics, line C with the state of the highest success rate or the least mistake is called as the most probable limit state (MPLS). The lines between A and B are called the probable limit states (PLS). The parts outside the ranges between A and B are unlikely to express a limit state. The overlap possibility of the limit state and ILS decreases progressively from line C (MPLS) to line A or to line B (PLS). The more case histories, the model uncertainty (the range between A and B) is smaller.

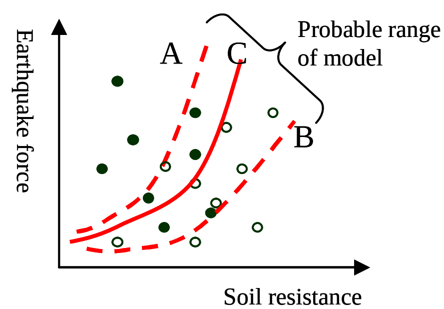

Figure 1 the probable range of the simplified models

The model uncertainty is one of the important issues for evaluating the liquefaction probability. The main sources of liquefaction model uncertainties include (1) sample size, (2) sedentary parameter neglect, (2) the explanatory of mathematics model, (3) the bias of subjective experience. There are several methods for evaluating the model uncertainties, including (1) the comparisons with other models that can relatively represent the actual state, (2) the comparisons with data collected from field or experimental tests (Ditlevsen, 1982) and, and (3) reliability index and Bay's theorem (Juang et al. 2004, 2005, 2006). Nowadays, the related studies to quantify the model uncertainty are less. And, the first and second methods of above mentioned have some limitation, such as the complexity of liquefaction issue and the difficulty of case histories collection. Consequently, in this paper, a