PROBABILISTIC ESTIMATE OF SURFACE EARTHQUAKE FAULTS BY USING SPECTRAL STOCHASTIC FINITE ELEMENT METHOD

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The prediction of surface earthquake fault behaviors have been a hot topic for earthquake engineering, since they can cause local but serious damages to buildings and infrastructures due to large ground deformation. The analysis of faulting is not easy since fault behaviors have large variability due to the bifurcation phenomena during the rupture processes and the complicated structures of surface unconsolidated layers.

The authors have been developing a numerical simulation method for the surface earthquake faulting. A stochastic model is used for the underground structures, such that the uncertainty of the structures due to the limitation of the measurement is expressed in terms of random variables. A non-liner spectral stochastic finite element method (NL-SSFEM) is used to solve this stochastic model. NL-SSFEM, which is based on the spectral stochastic finite element method [1], is aimed to solve material non-linearity by taking perturbation expansion from the expectation and linearizing the stochastic problem for incremental behaviors.

The basic validity of NL-SSFEM to simulate surface faulting is verified by reproducing results of several model experiments [2]. It is shown that the parameters of the simulated fault configuration coincide with observed ones fairly well. NL-SSFEM computes the failure probability which gives the probability of the appearance of faults on the ground surface for a given base movement. This probability is in good agreement with the observed mean and standard deviation of the base movement that causes the failure.

NL-SSFEM is applied to two actual cases of surface earthquake faults, the Nojima Earthquake Fault in Japan and the Chelungpu Fault in Taiwan [2]. When in-situ measurement data are used for the simulation, NL-SSFEM computes the faulting behaviors, and the computed faulting parameters agree with the observed ones. Although the validity of the computed failure probability cannot be verified for the actual earthquakes, it appears reasonable based on the geological and seismological observations and data.

References

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