

Performance-Based Evaluation of Bridge on Liquefiable Soils Using OpenSees

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In this paper the performance of a bridge resting on an area underlain by liquefiable soil conditions is evaluated in the PEER framework using the OpenSees analytical tool. To this purpose an OpenSees model of the bridge, its foundations, and the soils that support it is developed. The model is capable of computing the free-field response of the site, including pore pressure generation, and dissipation in liquefiable soils along with the effects of those phenomena on the stiffness and strength of the soils, the interaction of the pile foundations with the liquefiable soils, including the effects of pore pressure changes on that interaction, and the response of the above-ground portions of the structure.

The validated OpenSees model is then used to investigate the dependence of appropriate EDPs on various IMs. To this purpose tornado diagrams are constructed to identify most significant soil parameters and FOSM analyses are performed to estimate dispersion caused by uncertainty in soil parameters.

Using motions for four hazard levels record-to-record uncertainty is evaluated by means of “cloud” analyses and efficient intensity measures for cases with and without liquefaction are identified. A framework for expressing EDPs in liquefiable soils as product of EDP in absence of liquefaction and “liquefaction multiplier” is developed. The method shows potential for reduction of dispersion by using different IMs for non-liquefaction EDP and liquefaction multiplier.