Seismic Behavior of Steel Moment and Braced Frames and Concrete Moment and Shear Wall Frames Considering Uplift and Soil-Structure Interaction

Abstract

A common assumption when analyzing a structure for earthquake forces is that the building is positively attached to a rigid ground so that it can sustain possible tensile forces without being detached, or uplifted, from its bearing points. Considering the facts that almost no tension can be transferred between a surface foundation and soil, and that soft soils interact with the supported structure during earthquakes, in this research the effects of uplift and soil-structure interaction (SSI) on nonlinear seismic response of structures are evaluated. Several reinforced concrete and steel structures under different suits of consistent ground motions are considered. The base of the buildings is modeled with vertical no-tension springs nonlinear in compression. The total SSI system is modeled within Opensees and the seismic behavior is evaluated using nonlinear dynamic analysis. The nonlinear force and deformation responses of buildings are determined and compared between three cases of fixed-base, flexible-base without uplift, and flexible-base with uplift. As a result, the cases for which uplift in conjunction with SSI should be considered are identified and simple conversion factors are presented by which the rigid-base responses can be easily converted to their SSI-uplift counterparts.

Keywords: uplift, soil-structure interaction, reinforced concrete, steel, nonlinear dynamic analysis.