Nonlinear Dynamic Analysis of a Mission Critical Reinforced Concrete Building Including the SSI Effects for Seismic Risk Assessment

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ABSTRACT: The structural performance assessment of mission critical facilities to quantify their seismic risk relies on high-fidelity structural response analyses. Such analysis should be capable of representing the seismic response of the site and structure as well as their interaction over a broad range of seismic ground motion intensities. The soil-structure system response would potentially encompass significantly nonlinear response regimes including structural member yielding, nonlinear site response, and gapping and sliding at the soil-structure interfaces. This study presents the nonlinear dynamic analysis of a partially embedded reinforced concrete (RC) shear wall building via a detailed integrated soil-structure system evaluation in LS-DYNA. In this integrated soil-structure interaction (SSI) analysis approach the site is explicitly modeled as a continuum interacting with the detailed finite element (FE) representation of the structural system in a single model. The model would capture the 3D nonlinear seismic site response effects and the nonlinear response of the structural components, i.e. shear walls, floor slabs, and RC columns as well as structural joints. Appropriate modeling strategies were employed to represent important limit states related to the critical function of the building. The site and structure responses were coupled via contact surfaces allowing for gapping and sliding at the soil-structure interfaces in the integrated SSI model. Extensive studies were performed to test and verify the response of the key structural components and the site. Experimental data obtained from the tests on the RC shear walls and columns of similar designs as reported in the literature were used to verify the proposed FE modeling strategy for the key structural components. Furthermore, comparative 1D site response analyses in LS-DYNA and DeepSoil were performed to verify the geomaterials constitutive modeling and seismic wave propagation. Finally, the seismic response of the structure and soil-structure system were evaluated in detail through nonlinear response history analyses and are presented at various ground motion intensities.