Performance Comparisons of Analytical Seismic Assessment Methods with a Pseudo Dynamic Test Results of a Deficient RC Frame

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Abstract

The seismic assessment guidelines were implemented in the Turkish Earthquake Code (TEC) in 2007. The assessment procedures in TEC(2007), namely linear force based and nonlinear displacement based analysis methods follow precisely their counterparts given in FEMA 356 (2000). The accuracy of estimating the performance levels of an existing deficient RC frame according to these guidelines is investigated in this study. This was achieved by comparing the response of a structure tested with pseudo-dynamic testing and estimated by the procedures presented in the aforementioned guidelines along with nonlinear dynamic analysis. The test structure (three bay-two storey planar frame) is a ½ scale frame having masonry infill walls in the central span. The structure contains a number of structural deficiencies such as low concrete compressive strength (7MPa), lack of transverse reinforcement detailing at potential plastic hinge regions and beam-column joints. A number of preliminary multi-level detail nonlinear dynamic analyses were conducted to select the most suitable ground motion using the general purpose finite element analysis program Diana and Opensees Software Framework. We report on our findings from dynamic analysis results and comparisons of estimations on local and global engineering demand parameters from both programs. Based on our findings it was decided to use the NS component of 7.14 magnitude 1999 Duzce Earthquake. The earthquake record was used at three different scale factors, 0.1, 0.5 and 1.0 respectively. These scale factors were decided based on the preliminary analyses to force the structure into various levels of nonlinearity, namely cracking, plastic hinge formation at column bases and infill wall collapse proceeded with severe strength degradation in lateral force resisting elements. Test results indicated that drift deformation demands estimated using nonlinear dynamic analysis were within 20% of those observed in the tests. On the other hand, damage estimations of TEC and FEMA 356 were found to be very conservative yielding retrofit decisions even low to moderate earthquake levels. It was also observed that although nonlinear dynamic analysis provided reasonable estimations for story displacements, local demand parameters such as column curvature demands were estimated with less accuracy.