CAPACITY CONTROL PROCEDURE FOR SEISMIC ASSESSMENT OF MEDIUM-RISE ORDINARY RC BUILDINGS

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The majority of existing buildings in seismic areas on the world do not conform to the minimum safety requirements of modern earthquake engineering. Recent strong earthquakes in the last two decades have revealed that a large urban building stock over the world, mostly consisting of low to medium-rise substandard reinforced concrete buildings, is seismically vulnerable. Their number possibly exceeds several millions. Common weaknesses of these buildings are low concrete quality (usually less than 20 MPa), lack of confinement at critical regions and inadequate structural forms for seismic resistance. These weaknesses generally lead to insufficient deformation capacity.

Recent developments in performance-based approaches produced powerful tools for the seismic safety assessment of existing buildings (ATC-40, FEMA-356). These methods provide valuable and detailed information on the expected seismic performances of such vulnerable buildings. However, there are two important shortcomings on their effectiveness in handling the global seismic safety issues. First, they require inelastic analysis capabilities which are not available to most structural engineering professionals. Moreover, inelastic structural analysis tools are not standard as the linear elastic analysis methods (Wight et al., 1999). Second, the size of the problem or the number of buildings that has to be assessed before the next earthquake is too large. Simpler and more convenient seismic performance assessment procedures may serve to overcome these shortcomings. FEMA-356 (ASCE, 2000) and Eurocode-8 Part 3 (CEN, 2002) provide simple linear elastic procedures for such buildings, however the obtained results are extremely conservative and insufficient in capturing the seismic performance of such simpler buildings in an approximate fashion (Heinz et al., 1999).

The vulnerable concrete buildings mentioned above have an important common feature regarding their lateral displacement response. They are stiff due to both short spans (usually less than 6 meters) and the presence of masonry infills. On the other hand, their inelastic deformation capacities are limited due to the weaknesses stated above. Accordingly, these buildings develop inelastic response at lower displacements and interstory drifts under strong seismic excitation. Hence, the redistribution of internal forces after the onset of inelastic actions is not as significant as the redistributions observed in flexible and ductile structural systems.

A practical and convenient seismic assessment procedure is developed in this study for the seismic assessment of low to medium-rise ordinary reinforced concrete buildings that possess limited ductility capacity. The procedure combines the advantages of linear procedures with the merits of capacity principles. Conventional structural analysis tools and standard capacity calculations form the basis of its implementation. In this procedure which is named as “Capacity Control Procedure”, first the expected locations of inelastic regions are determined under the combination of gravity and earthquake effects, then flexural demand-to-capacity ratios (DCR) at the member ends possessing the possibility of inelastic behavior are employed as a key parameter for the acceptability of component performances. Sucuoglu et al. (2004) showed that member-end DCR’s may be used effectively in similar concrete building types for damage prediction.

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The proposed procedure is implemented on three existing buildings which survived strong seismic excitations with moderate damages. The results obtained from the proposed procedure are evaluated in comparison with the results from the nonlinear static procedure of FEMA-356 (ASCE, 2000).

References

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