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Determination of Seismic Force Reduction Factor for Coupled Concrete Shear Walls

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Abstract

The force reduction factor (R-factor) is one of the main seismic design parameters used to estimate the seismic design forces. The main objective of this thesis is to evaluate the value of the force reduction factor for reinforced concrete coupled shear wall lateral load resisting systems. Three different nonlinear analysis methods were used to estimate the force reduction factor. These analyses are nonlinear static pushover, nonlinear dynamic time history and nonlinear incremental dynamic time history analysis. SeismoStruct software Program, was utilized to conduct the inelastic static and dynamic analyses, which takes into account the effect of geometric nonlinearities and material inelasticity. The effects of the following factors on the R-factor were studied in this study: span/depth ratios of the coupling beams, number of floors, confinement factor of the wall boundary ends, axial load values of the shear walls, the main reinforcement ratio of the walls and the coupling beams, the shear and diagonal reinforcement of the coupling beams and finally the width of the wall boundary ends at each end of each wall. Three typical structures with 6, 10, and 14 floor buildings were modeled using nonlinear static pushover analysis to estimate the over-strength and ductility reduction factors which affect the value of R-factor. To verify the validity of the results obtained by the pervious nonlinear static analysis, both nonlinear incremental dynamic and nonlinear dynamic time history analysis were applied.

The results obtained by static pushover analysis indicated that, the force reduction factor was inversely proportional to the height of the structure, axial load ratio of the shear walls, span/depth ratio, the reinforcement ratio of the shear wall, main and shear reinforcement of the coupling beams. On the other hand, it was directly proportional to the confinement factor of the shear walls boundary ends and the increase of their width. The coupled shear walls provided with diagonal reinforcement in coupling beams had a value less than those with the conventional shear reinforcement. No clear relationship was observed in the relation between the R-factor, the number of floors and the main reinforcement ratio of the coupling beams when nonlinear dynamic time history was applied. Also, it was inferred that the R-factor was inversely proportional to the axial load ratio of the shear walls and the shear reinforcement ratio of the coupling beams. Finally, it was concluded that the R-factor is directly proportional to the span/depth ratio, confinement factor of the shear wall boundary ends and the main reinforcement ratio of the shear wall. Results obtained from the nonlinear incremental dynamic time history analysis showed that the values of the "R" factor increases with the increase of the

number of floors, the ratio of the axial load of the shear walls, main reinforcement ratio of the coupling beams and the confinement factor of the shear wall boundary ends. Also, it was observed that R-factor was inversely proportional with the span/depth ratio and the shear reinforcement ratio of the coupling beams. Among the studied analyses, the incremental dynamic analysis method obtained the most reliable and accurate results, because response of structure is obtained by applying actual earthquake record. Also, contains some dynamic characteristic such as the higher modes effect and sources of energy dissipation and the effect of period changing.