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SEISMIC RETROFITTING OF LOW- RISE BUILDINGS WITH BRACINGS AND SHEAR CORE

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Introduction

Earthquakes are considered to be a one of the most severe hazard for buildings. The retrofitting of the existing structures against seismic loadings are becoming more important to mitigate disaster events It is quite difficult to develop a general rule for retrofitting since one structure has many differences over another. Numerical investigation procedure is one of the recommended methods to investigate the retrofitting scheme and it is becoming more reliable with the advancement of the computer packages. In this study, comparison of effectiveness of the steel bracing against concrete shear core to retrofit a reinforced concrete low-rise four storey building was investigated and the performance were evaluated in term of the inter-storey drift ratio, storey shear force and displacements.

Methodology

Four storey building was modeled in SAP2000 (Fig.1) finite element package. Firstly, the steel bracing was introduced (Fig.2) and performance was investigated under expected earthquake loading. Then, the behaviour of the structure was investigated with the introduction of the shear core (Fig.2) and performance was evaluated. Finally, the conclusion was drawn up on the basis of the numerical analysis results by comparing the effectiveness of using of bracing against shear core for low rise buildings to withstand the expected seismic loading.

In order to investigate the dynamic performance of the building model, the nonlinear time history analysis was performed with SAP 2000 package by considering geometric nonlinearity of the structural elements. Moment- rotational behavior of structural elements was estimated with RESPONSE 2000 and manually input in to the. Furthermore, fix connections were used

A Newmark acceleration time integration scheme were adopted in this analysis with β and α equal to 0.25 and 0.5 respectively with 5% damping ratio. The geometric transformation was taken account through P-Δ effect and the performance building was investigated against the El centro ground acceleration.

Results and discussions

Fig. 1. FE model of the structure

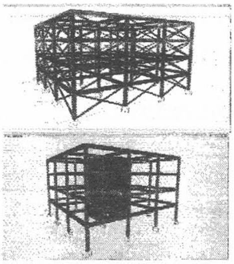

Fig. 2. FE model with bracing and shear core

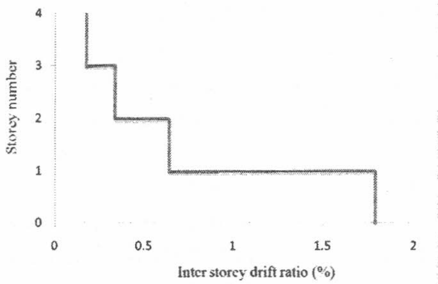

Fig. 3. Inter-storey drift ratio (gravity design building) (%)

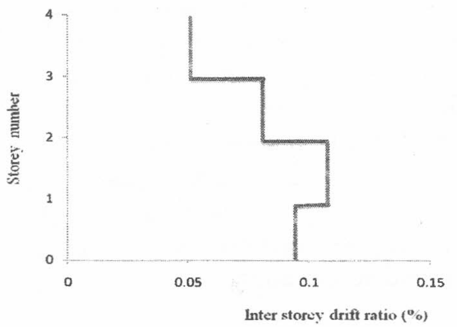

Fig.4. Inter-storey drift ratio (%) (Fully braced building)

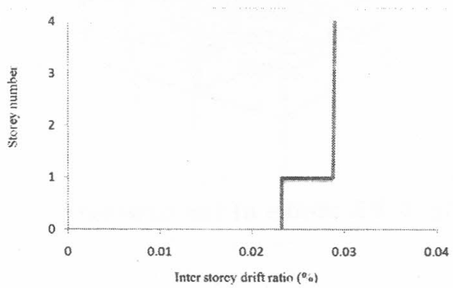

Fig. 5. Inter-storey drift ratios (%) (With shear core)

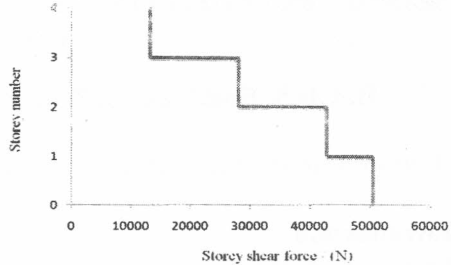

Fig. 6. Storey shear force (N) (gravity design building)

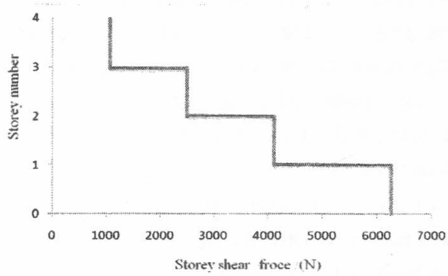

Fig. 7. Story shear force (N) (Fully braced building)

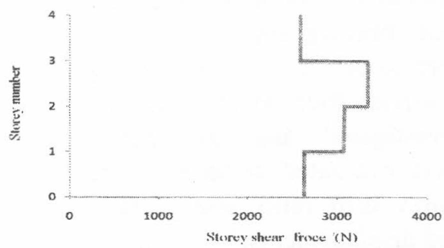

Fig. 8. Storey shear force (With shear core)

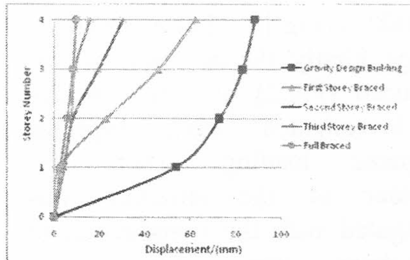

Fig. 9. Floor displacement over height (With bracings)

The corresponding results obtained for the gravity design buildings are shown in the figures 3, 6 and 9, and the fundamental period of the building was found to be 3.06s.

After introducing bracing under the expected earthquake loading and the average profile of the peak displacements, storey shear force, inter-storey drift ratio was investigated and the results are shown in the figures 4,7,9. Furthermore, reduction of lateral displacement was investigated with the level of bracing. However, full brace model showed approximately uniform lateral stiffens over height. The change of the structural period was taken in to the consideration and it was 0.91s.

Shear core was placed in the middle of the structure to avoid possible torsion responses. The introduction of the shear core, resulted a dramatically reduction of the lateral displacement of the structure. Other than that, approximately uniform drift ratio (fig 5) and storey shear force (fig 8) was found. The fundamental period of the structure was found to be 0.47s.

It was identified that, the level of the bracing and its configuration have direct impact on the lateral load baring capacity of the structure. Therefore, selection of the bracings have to be done by considering allowable inter-storey drift ratio, storey shear force and the improvement of the fundamental period of the structure. Moreover, the introduction of bracings resulted in a gradual reduction of the storey shear force over the height of the building.

Conclusion

The introduction of the shear core was resulted in an approximately uniform variation of the inter-storey drift ratio and floor shear force variation over the height. The resulted displacement is dramatically reduced. The improvement of the fundamental period with the presence of shear core is approximately twice than the full braced structure. Therefore, the possibility of resonance under the seismic action can be avoided up to certain extend. Finally, it can be concluded that, the introduction of the shear core for a gravity design low-rise building has improved its lateral load bearing capacity and reduces the fundamental period of the structure with respect to braced building. The numerical investigation results obtained from this research will be helpful in determining the retrofitting scheme for low-rise buildings in seismic prone regions.

References

ATC (1996). "Seismic Evaluation and Retrofit of Concrete Buildings", Report ATC-40, Applied Technology Council, Redwood City, U.S.A.

CSI Analysis Reference Manual for SAP2000®, ETABS, Computers and Structures, Inc.1995 University Avenue Berkeley, California 94704 USA