ELIMINATING THE COUPLING BEAMS OF UPPER STORIES IN TORSIONAL IRREGULAR MID-RISE RC-COUPLED SHEAR WALL STRUCTURES

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Based on valid seismic codes like ASCE/SEI 7-16, the drift of all structures should be controlled to satisfy service requirements. Although one of the most conventional choices is to apply dual reinforced concrete frames, placing openings in shear walls are sometimes unavoidable due to architectural demands. In the other hand, since the coupling beam (C-beam) between walls may reduce the net height of story, it is desirable to omit aforementioned coupling beam. In case of lateral loading, moment-resisting frames usually deflect in shear mode while, RC-shear walls deformation usually happens in flexural mode which can be supposed as a flexural cantilever beam. Combination of these two behavior in dual RC-frames shown in Figure 1, will lead to special mode shape in which the frame and the shear wall support each other in bottom stories while, in upper stories the excessive deformation of the shear wall may increase the lateral load carried by the moment-frame.

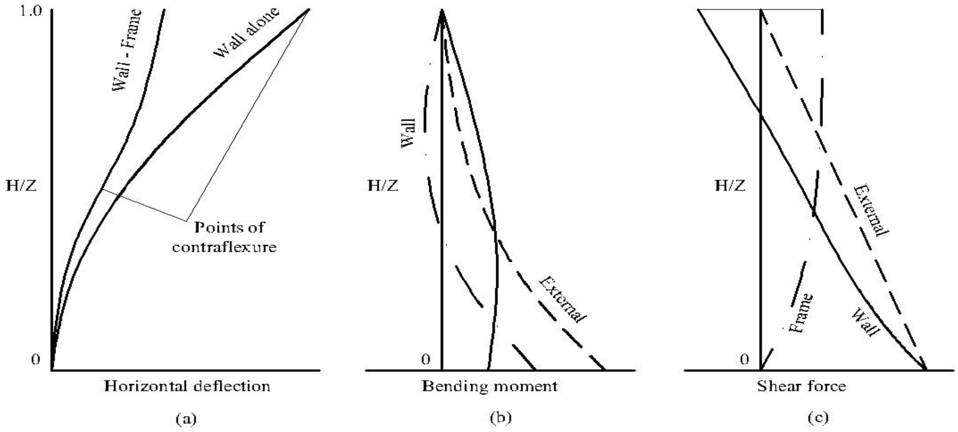

Figure 1. Laterally loaded wall-frame structure; (a) Typical deflection, (b) Typical moment diagrams for components, (c) Typical shear diagram for components.

It seems that the reduction of shear walls flexural stiffness by eliminating the coupling beams in upper stories may lead to less bending moment and shear force in frame. Further, eliminating the coupling beams can decrease the limitations of interior design at least in the upper stories. Therefore, omitting the coupling beam may result more economical and probably more efficient structure design. Therefore, in this paper, five torsional irregular dual RC mid-rise buildings in same site and different stories ($3<h/b<7$) have been considered and omitting the coupling beams were studied. In all models the torsional irregularity was generated by making distance between center of mass and center of rigidity. The codes ASCE-16 and ACI-318 were used to analysis and design the structures in ETABS 2016 software by spectral analysis method. Figure 2 shows the stress distribution and roof displacement of 15 story building (h/b=3) before and after eliminating the coupling beams in upper stories. Obviously, the displacement and maximum stress were not changed significantly.

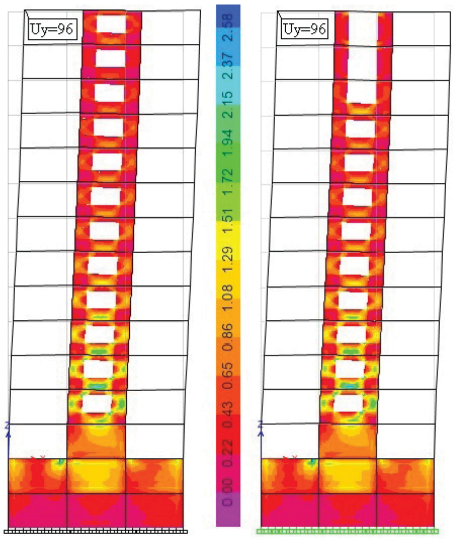

Figure 2. Stress distribution in shear wall (MPa) and roof displacement (mm) of 15 story structure under lateral loading; (a) Before eliminating coupling beams (b) After eliminating coupling beams.

The results show that by omitting the coupling beams in up to nearly 20% of models height from above, the roof maximum displacement was not increased at all. The story shears were almost constant and the natural dynamic frequency of structures was decreased up to 16%. Although the shear stress in some areas of wall was slightly increased, the maximum shear stress was constant. Finally, by eliminating the coupling beams the design shears and bending moments of the upper stories were decreased up to 10%. Therefore, eliminating the coupling beams of upper stories in torsional irregular mid-rise RC-coupled shear wall structures is possible.

REFERENCES

Kolozvari, K., Terzic, V., Miller, R., and Saldana, D. (2018). Assessment of dynamic behavior and seismic performance of a high-rise RC coupled wall building. *Engineering Structures, 176*, 606-620.

Smith, B.S. and Coull, A. (1991). *Tall Building Structures: Analysis and Design.* New York: John Wiley & Sons.

Taranath, B.S. (2017). *Tall Building Design: Steel, Concrete, and Composite Systems.* Boca Raton: CRC Press.