Confining Masonry using Pre-cast RC Elements for Earthquake Resistance

Samaresh Paikara and Durgesh C Rai
Department of Civil Engineering, Indian Institute of Technology Kanpur

Abstract

Earthquake resistance of URM structures depends on energy dissipation potential of well detailed portions which enable it to undergo large but controlled inelastic deformations. A grid of horizontal, vertical and/or diagonal pre-cast RC elements break a large wall into smaller wall areas and confine them adequately. The straining and sliding of masonry and confining elements dissipates significant amount of earthquake induced energy.

Background

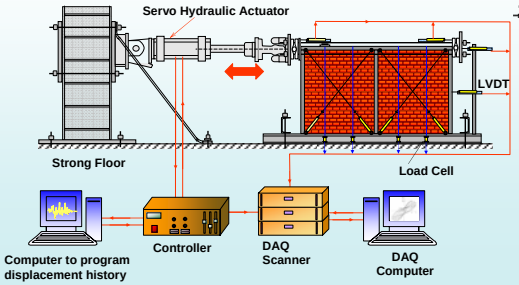
Some traditional masonry construction involving timber frame (e.g. *Dhajji-dewari*) have shown acceptable performance in past earthquakes. Timber lacing of masonry introduces preferential planes of weakness for sliding, arrests the propagation of cracks and reduces the possibility of out-of-plane instability [**1**].

The present study investigates the effectiveness of such confinement schemes using pre-cast RC grid elements.

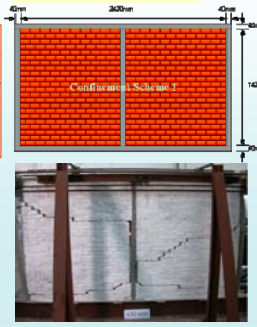
Dhajji-dewari Masonry, Kashmir

Experimental Results

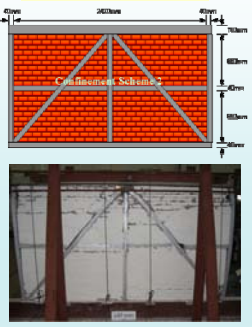
Test Set-up

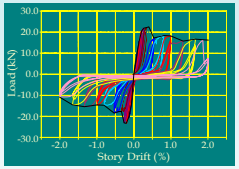


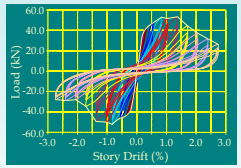
Specimen 1



Specimen 2

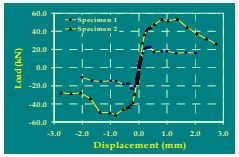






A half-scale models of confined wall specimens of 2.5 x 1.5 m with two different confinement schemes were subjected to gradually increasing slow cycles of lateral displacements. Grid elements are 60 mm wide covering half-brick wall laid using half-scaled bricks in 1:1:6 mortar [**2**].

Enhanced confinement and presence of preferred planes of sliding led to higher lateral load , greater deformability and sliding mode of failure in the specimen 2.

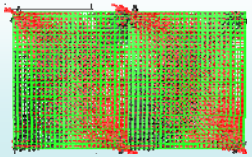


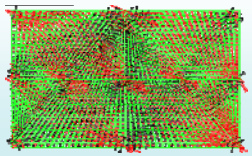
Backbone Curves

Analytical Results

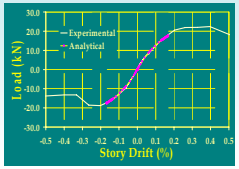
Smeared-cracked modeling under ABAQUS environment was attempted using CPS4R element and *CONCRETE material option [**3**]. Interface elements are used for simulation of sliding behavior between masonry and grid element and rotational springs included for connecting grid elements.

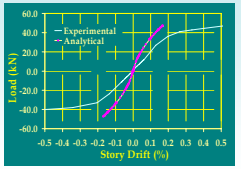
More grid elements in Specimen 2 mobilized larger portions of masonry for load sharing. Models could not adequately capture the effect of sliding along brick joints.





Major Principal Stress vector Plot





Comparison of Load-Drift Envelopes

Conclusions

- Breaking wall in smaller panels with the use of grid elements can enhance deformability and energy dissipation capacity of such walls.
- The grid elements improve the performance by providing guided shearing plane and there by increasing the energy dissipation potential of the wall without significant increase in stiffness.
- Placement and spacing of confining grid elements greatly influence the behaviour of the system as a whole.
- Smeared crack modeling with elements for interface sliding is adequate as long as behavior is not dominated by sliding along bed joints.

References

1. Gülkan, P., Langenbach, R. (2004). "The Earthquake Resistance of Traditional Timber and Masonry Dwellings in Turkey," *Proc., 13th WCEE*, Vancouver, B. C., Canada, Aug 1-6, 2004, Paper No. 2297.
2. Paikara, S. (2005). "In-Plane Lateral Resistance of Masonry Confined by Grid Elements," *M.Tech. Dissertation*, Dept. Civil Engg., Indian Institute of Technology, Kanpur, India.
3. Rai, D. C. & Goel, S. C. (1996). "Seismic strengthening of unreinforced masonry piers with steel elements." *Earthquake Spectra*, EERI, vol. 12, no. 4, November, 845-862.

Acknowledgements

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