

RESEARCH NEEDS FOR CONFINED MASONRY

Research inputs are primarily needed to characterize the structural action and load-sharing mechanism of confined masonry (CM) system under in-plane as well as out-of-plane seismic loads, requiring both experimental as well analytical studies. Several serious research efforts have been made to address many aspects of confined masonry behaviour, especially in Central and South Americas. It appears that a collaborative and concerted effort will help resolve many issues more conclusively. In the following, research areas have been listed which need further investigation along with those which require fresh initiative:

I. Analysis Aspects of Confined Masonry

- Modeling issues
 - Idealization of CM system (modeling) for the analysis procedure for both in-plane and out-of-plane response (*e.g., system of strut and tie, wide beam-column model for coupling beams, macro-modeling as assemblages of rigid blocks, FEM, etc.*)
 - Simplified analysis procedure
 - Qualifying criteria, such as limitations on building size, layout of openings in walls, expected seismic loading, etc.
 - Leads to prescriptive design and detailing of CM components
- Capacity and fragility curves
 - Structural behaviour of CM in terms of 'generic' load-deformation response (pushover curve) and failure pattern/mechanisms
 - Fragility curves for comparison with other structural systems and for loss estimation studies

II. Structural Design Aspects for Confined Masonry

- Response reduction (or behavior) factor
 - Rational estimate based on key CM parameters which control its seismic performance (*e.g., wall density, building characteristics, seismic zone, site soils, etc*)
- Primary structural requirement in terms of strength/stiffness for various components/elements of CM
 - Out-of-plane resistance and height/thickness ratio (*Current limits appear to be conservative. Is it true even if the wall is damaged due to in-plane action?*)
 - Minimum size of tie-columns (*usually controlled by wall thickness*)
 - Frame vs. wall lateral stiffness (*Is it a controlling factor? Does it distinguish CM from infilled frames? Should there be a limit on lateral stiffness of confining elements?*)
 - Openings - restrictions on size and spacing/location of openings, tie-columns around openings (*Should they be different from main tie-columns at wall ends?*)

- Reinforcement issues: number and size of vertical reinforcement, tie size and spacing, uniform/nonuniform tie spacing along column length, transverse stirrups at tighter spacing near tie-column ends
- Horizontal reinforcement versus sill and lintel bands, concentrated versus distributed horizontal steel, its effectiveness against bed-joint sliding
- Soft story mechanism in multi-storied CM buildings (*When does it happen and how can it be checked?*)

III. Construction Aspects of Confined Masonry

- Masonry bond (*e.g., Flemish versus English, what if bricks are not modular in size*)
- Interface connection (*e.g., need for such connection, such as tothing, joint rebar anchorage as its alternative to prevent separation from tie-columns*)
- Diaphragm issues (*flexible versus rigid, tall gable walls versus hipped roofs*)
- Use of mesh (embedded in plaster) as damage control strategy (*i.e., enumeration of possible benefits and design guidelines, etc.*)

IV. Material Aspects of Confined Masonry

- Bond related issues (*e.g., use of lime in mortar, water transport between mortar & units, mortars filling voids in perforated units, etc.*)
- Strength of units (*e.g., compressive and tensile strength of units, especially hollow concrete blocks, perforated clay units, etc., Should there be minimum strength for units, mortar, masonry, concrete and rebar? Should strength of confining elements be related to that of masonry?*)
- Easy and reliable field testing (*What tests are must for quality control? How can they be determined at the site?*)