What are the Essential Features of Confined Masonry Houses?

Scope of Construction of Buildings with Confined Masonry

Confined Masonry (CM) system is suitable for construction of low- and medium-rise buildings, and can be implemented with relatively lower engineering inputs and technical supervision. Some countries permit construction of CM houses of up to six storeys tall, supported by design codes and engineering inputs. CM system is not intended for use in the construction of commercial buildings or large span buildings.

Architectural Guidelines

Architectural configuration critically determines overall earthquake behaviour of CM houses.

(a) Overall Geometry

The overall shape of houses should be regular in both plan and elevation. Best performance is achieved in CM buildings, when, in plan, they (i) are rectangular, (ii) have no significant re-entrant corners and no interior cut-outs, and (iii) have plumb vertical walls along the entire building perimeter (Figure 1a). Buildings with re-entrant corners, cut-outs, vertical offsets and large cantilever overhangs (Figure 1b) perform poorly during earthquakes.

Plan aspect ratio, i.e., ratio of longer and shorter plan dimension (L/B), of a CM house should not exceed 4 (Figure 2); seismic gap can be used in buildings with elongated plan shapes. Typical storey height should not exceed about 3m. Even though buildings up to 6 storeys high have been built in high seismic regions in Mexico, Chile and Peru, the recommended maximum number of storeys is 4, 3 and 2 in seismic zones III, IV and V of India, respectively (for now as design codes are unavailable) (Figure 2).

(b) Wall Configuration

Walls in a CM house should be aligned preferably on a rectangular grid that is symmetrical in plan (Figure 3). Further, all walls must run through from the base of the building to the roof, without being terminated at any intermediate level.

Openings in walls deteriorate earthquake performance of CM buildings. Hence, openings should ideally be kept to a minimum in number and size. Larger openings must be confined by cast-in-situ RC elements all around, otherwise a wall with large openings is considered as unconfined. Openings in all storeys must be positioned at the same location along the height of the building.

Structural Guidelines

Wall thickness required in a building will depend on loads and masonry strength. This should be carefully checked. Masonry walls should be at least 110 mm thick; their height should not exceed 25 times thickness. Storey height should not exceed 3 m, even if thicker walls are used. Ideally, all masonry walls should be fully-confined with RC tie-columns on both sides of openings and at wall intersections, and RC tie-
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In tie-columns, at least 4 deformed steel bars of 10 mm diameter should be provided, and tied with 6 mm diameter mild steel ties at 200 mm centers (Figure 6a); closely spaced ties are required in top and bottom portion of a tie-column, with spacing of 100 mm. Ties should have 135° hook ends. In RC tie-beams, minimum reinforcement to be provided is somewhat similar.

**Constructional Guidelines**

Using quality materials, ensuring good workmanship and faithfully implementing architectural and structural guidelines are vital in construction of CM buildings. For improved earthquake performance, the interface between masonry walls and tie-columns should be toothed, i.e., bricks of masonry courses are staggered at the interface with tie-columns (Figure 5a). This ensures that masonry walls are held snugly between tie-columns. Toothed should be such that the minimum gap from bars of tie-column is 25 mm to the nearest brick face and 75 mm to the farthest brick face.

Maximum vertical lift per day of masonry walls should be 1.2 m. And, concrete for the tie-columns should be poured before the next lift of 1.2 m of masonry wall is built. This ensures that concrete in tie-columns is reasonably compacted, especially when it is hand compacted.

The formwork is butted against the masonry wall segment for pouring concrete in tie-columns of CM construction. This is the main strength of this construction – snug fit between masonry walls and concrete poured in-situ after the masonry walls are in place. Hence, significant care is required in preparing the formwork (made of wood or steel) and ensuring that gaps are plugged between masonry walls and formwork, before pouring the in-situ concrete of tie-columns.