Symmetrically and Non Symmetrically Pattern of Shear Walls

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Abstract

Shear wall is one of the most commonly used lateral load resisting in high rise building. Shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal load and support gravity load. The objective of the present study is to study the behavior of building frame under symmetrically and asymmetrically placed shear walls. To generalize the conclusions frame Symmetrical plan has been used. To achieve the objective, building frame has been analyzed without shear wall as well as shear wall placed symmetrically and asymmetrically.
Keywords: Shear Wall, Torsionally, Non-Symmetrically Wall, Symmetrically Wall, Behavior against Forces

I. Introduction

Shear wall is a rigid vertical diaphragm capable of transferring lateral forces from interior /exterior walls, floors, and roofs to the foundation in a direction parallel to their planes. Shear walls are generally parts of the elevator and service corps and main frame. Forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants, create bending and twisting forces. Reinforcing the frame by placing a rigid wall inside, provides stiffness to frame and prevents rotation at the joints. Shear walls are especially important in high-rise and important structures subject to lateral wind and seismic forces. Since the late 1940s, when the first shear wall introduced, their use in high rise building to resist lateral loads has been extensive, in particular to supplement frames that, if unaided, often could not efficiently designed to satisfy lateral load requirements.

The resistance of tall building to wind as well as earthquakes is the main determinant in the formulation of new structural systems to increase building height while keeping the deflection within acceptable limits and minimizing the size of structural members. Shear walls satisfy these conditions favorably up to moderate heights. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and nonstructural elements (like glass windows and building contents). Shear walls are designed to resist vertical load (due to its self-weight and imposed loads) but most importantly designed for lateral load due to earthquake and wind.

Shear walls structurally integrate with roof and diaphragms (floor) and other lateral walls running across at right angles, thereby giving stability in three dimensions of building structure. Structures with cast-in-situ R.C.C shear walls are widely used in many earthquake-prone areas, such as Canada, Chile, Romania, Japan, Turkey, Colombia, some parts of China the republics of the former Soviet Union, etc. In India 60% of geographical area comes in earthquake zone 3, 4 and 5. So use of shear wall structures has become popular in buildings up to 70 storeys. Shear walls in high seismic regions require special detailing. However, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse.

Fig. 1: Torres Del Sol Building, Vina Del Mar, Chile [16]

Fig. 1 shows Torres del sol building, Vina del mar, Chile. These 22 stories, R.C.C structure with shear walls survived in the 1985 Chile earthquake with only modest damage.

A. Pattern of Shear Walls

Different geometries are possible. Shear walls are oblong in cross-section, i.e., one dimension of the cross-section is much larger than the other. While rectangular cross-section is common, L and U shaped sections are also used. Thin-walled hollow RC shafts around the elevator core of buildings also act as shear walls.

If the shear wall locates on plan unsymmetrical then there are increased chances of torsion besides shear force and bending moment. Walls are connected by floor slabs or beams which are assumed to have negligible bending resistance Therefore, only horizontal interactive forces are transmitted.

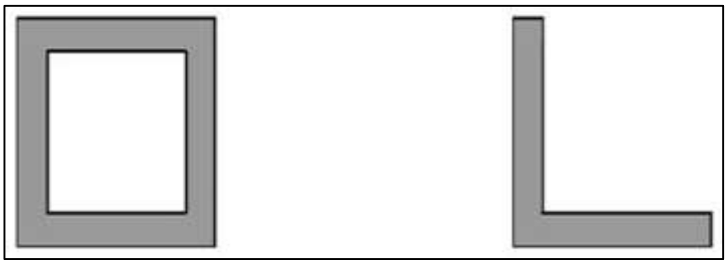

Fig. (a): BOX section Fig. (b): L-section

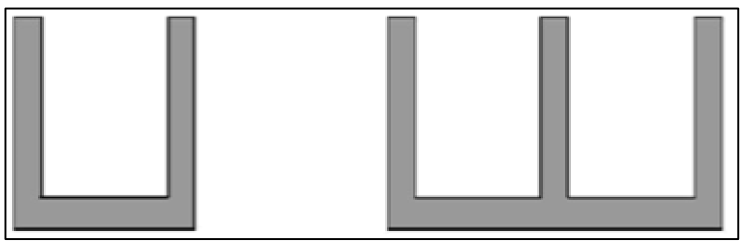

Fig. (c): U-section Fig. (d): W- section

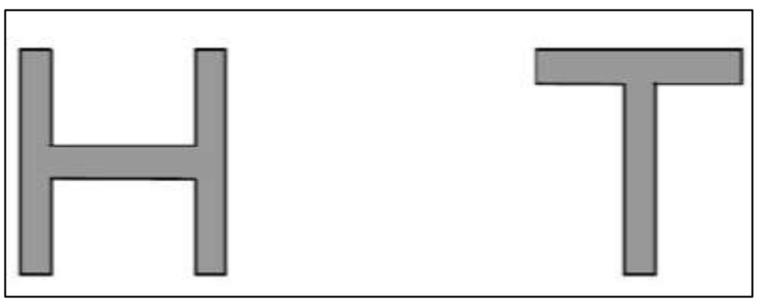

Fig. (e): H-section Fig. (f): T-section

Fig. 2: Typical Sections

B. Location of Shear Wall

Individual wall may be subjected to axial, translational, and torsional displacements. The extent to which a wall will contribute to the resistance of overturning moments, storey forces, and storey torsion depends on its geometric configuration, orientation and location within the plane of the building. Position of shear wall is usually dictated by functional requirements. These may or may not suit structural planning. The purpose of building and the consequent allocation of floor space may dictate arrangement of walls that can often be readily utilized for lateral force resistance. Building sites, architectural interest, or client's desires may lead, on the other hand, to position of walls that are undesirable for structural point of view. It is more difficult to ensure satisfactory overall building response to large earthquakes when wall locations deviate considerably from those dictated by seismic considerations. In case of wind a fully elastic response is expected, while in case of earthquake, inelastic response will arises. The key in the strategy of planning for shear wall is desire that inelastic deformations be distributed reasonably uniformly over whole plan of building rather than being allowed to concentrate in only a few walls. The torsional stability of the wall systems can be examined with the aid of Fig. 3. Many shear walls are open thin walled sections with small torsional rigidities. Hence in seismic design it is customary to neglect torsional resistance of individual walls. Tubular sections are exceptions. Torsional resistance of wall arrangement Fig. 3(a) (b) and (c) could only be achieved if the laterals force resistance of each wall with respect to its weak axis is significant. As this is not the case, these examples represent torsional unstable systems. In case of Fig. 3 (a) and (c), computation may show no eccentricity of inertia forces.

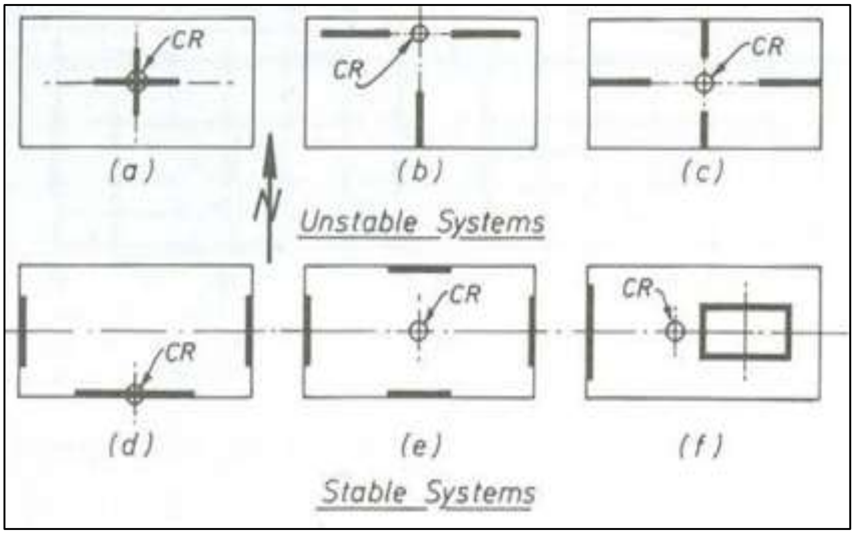

Fig. 3: Torsional Stability of Wall System

Fig. 3(d) to (f) show torsionally stable configurations. Even in case of the arrangement in Fig. 3(d), where significant eccentricity is present under east-west lateral force, torsional resistance can be effectively provide by the actions induced in the plane of short wall. However eccentric system such as Fig 3(d) and (f), are particular example that should not be favored in ductile earthquake-resisting building unless additional lateral force resisting systems, such as ductile frame are also present.

In choosing suitable locations for lateral- force-resisting shear walls, three additional aspects should be considered:

1) For the best torsional resistance, as many of the walls as possible should be located at the periphery of the building.
2) In multistory buildings situated in high-seismic-risk areas, a concentration of the total lateral force resistance in only one or two shear walls is likely to introduce very large forces to the foundation structure, so that special enlarged foundation may be required.
3) The more gravity load can be routed to the foundations via a shear wall, the less will be the demand for flexural reinforcement in that wall and the more readily can foundations be provided to absorb the overturning moments generated in that wall. [3]

II. Conclusion

1) Shear wall is very effective in resisting horizontal forces in multistory structure. If shear wall is located properly, then it will reduce shear force, bending moment, and also reduces storey displacements.
2) Most effective location of shear wall is at the outer periphery of building as a core in plan. It significantly reduces the axial force, shear force, moment and also displacement.
3) The shear wall located symmetrically at the centre of plan as core is a good option for balance between cost and reduction in member forces and lateral displacements.
4) Unsymmetrical shear wall configurations i.e. C, L or other type's core shear walls which are placed asymmetrically in plan produces torsion which also increases forces and displacements in some of the members.

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