Issue 9 vol 3 ISSN: 2321-8134

IJFEAT

INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

STUDY OF SHEAR WALL IN MULTISTOREYED BUILDING

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Abstract

The paper investigates effect of different thickness and corresponding reinforcement percentages required for shear walls on multi-storied buildings. Building models with shear walls are developed using ETABS. The location of the shear walls are kept same and a comparative study is done for different thickness of the shear wall for different height of the building In each cases corresponding reinforcement percentages required found out. It observed that for a constant thickness of shear wall, reinforcement percentage increases with increase of both seismicity and number of stories. It also observed that for all zones, the reinforcement percentage increases if the shear wall thickness increases for a certain range of thickness and decreases for a certain range of thickness.the results indicate that increase of shear wall thickness is not always effective for earthquake resistant design.

Keywords:- *Shear Wall, ETABS, Earthquake Resistant Design.*

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INTRODUCTION

Now a day, Shear Walls are the most common structures built inside the structures in order counteract severe earthquake forces. Earthquake is a major concern for the engineers to give stability to the buildings. Properly designed detailed buildings with shear walls have shown very good performance in past earthquakes. Shear walls must provide the necessary lateral strength resist horizontal earthquake forces. If shear walls are strong enough, there will be transfer that horizontal forces to the next element in the load path below. These other components in the load path may be other shear wall, floor, foundation walls, slabs, footings etc. Shear walls also provide lateral stiffness prevent the roof or floor above from excessive side-sway. When shear walls stiff enough, they will prevent floor and roof framing members from moving their supports. Also, buildings that are sufficiently stiff will usually suffer less nonstructural damage.

1.1 GENERAL

Adequate stiffnessbe ensured in high rise buildings for resistance to lateral loads induced by wind or seismic events. Reinforced concrete shear walls are designed for buildings located in seismic areas, because of their high bearing capacity, high ductility and rigidity. In high rise buildings, beam and column dimensions work out large and reinforcement at the beam-column joins are quite heavy, so that, there is a lot of clogging at these joints and it is difficult to place and vibrate concrete at these places which does not contribute to the safety of buildings. The practical difficulties introduction of the shear walls inthe high rise buildings.

3. SHEAR WALL

A shear wall is a wall that is used to resist the shear, produced due to lateral forces. Many codes made the shear wall design for high rise buildings a mandatory. Shear walls are generally provided if there centre of gravity in building area and loads acted on the structure differs by more than 30%. To bring the centre of gravity and centre of rigidity in range of 30%, concrete walls are provided i.e. Lateral forces may not increase much. These shear walls start at foundation level and extend throughout the building height. The thickness of the shear wall may vary from 150mm to 400mm. Shear walls are oriented in vertical direction like wide beams which carry earthquake loads downwards to the foundation and they are usually provided along both width and length of the buildings. Shear walls in structures located at high seismic regions require special detailing. The construction of shear walls is simple, because reinforcement detailing of walls is relatively straight forward and easy to implement at the site.

3.1 FUNCTIONS OF A SHEAR WALL

- **Strength**
  - Shear walls provide the necessary lateral strength to resist the horizontal earthquake forces.
  - When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them, such as other shear walls, floors, foundation walls, slabs or footings.

ISSN: 2321-8134

- **Stiffness**
  - Shear walls provided lateral stiffness to prevent the roof and floor above the excessive side-sway.
  - When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports.And buildings are the sufficiently stiff will usually less nonstructural damages.

3.2 REQUIREMENT OF SHEAR WALL

Shear wallsin building construction the rigid vertical capable of transferring lateral forces to the exterior walls, floors, and roofs to the ground foundation direction parallel to their planes. Examples are the reinforced-concrete wall or vertical truss Forces causes thewind, earthquake and uneven settlement of loadscreate powerful twisting forces. Reinforcing the frame to attached theplacing of a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints. Shear walls are especially important in high-rise buildings subject to lateral wind and seismic forces.

3.3 LOCATION OF SHEAR WALLS

Shear walls should be located on each level of the structure including the crawl space.Itforms effective box structure, will equal to the lengthof shear walls placed symmetrically on all of the four exterior walls of the building.when Shear walls should be Added into the building interior when the exterior walls cant provided sufficient Strength and stiffness or when the allowable span-width ratio for the roof. Diaphragm is exceeded. For subfloors with conventional diagonal sheathing, the Span-width ratio is 3:1.That is 25-foot wide building with this subflooris not require interior shear walls until it is length exceeds 75 foot unless the Strength and stiffness of the exterior shear walls are inadequate conditions.

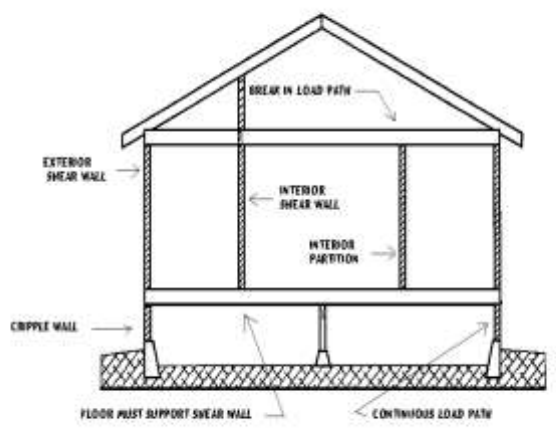

Fig.1: STRUCTURE OF SHEAR WALL

Shear walls are most efficient when they align vertically and are supported on Foundation walls or footings.If shear walls didn’t align the other parts of the Building is need additional strength. If the common case of the Interior wall supported by the subfloor above the crawl space and that is no Continuous footing beneath the wall. The Subfloor and it is connections are strengthened and near to the wall. For new Construction, thicker plywood or extra nailing and connections can be added. For Retrofit work, removing floor construction not easily change in structure. That’s the reason why most retrofit work uses walls with continuous footings underneath them as Shear walls.

3.5 SHAPES OR GEOMETRY OF SHEAR WALLS

Shear walls are rectangle in cross section, i.e. one dimension is much larger than the other. While rectangular cross-section is frequent, L- and U-shaped sections are also used. Thin walled hollow RC shafts around the elevator core of the structure also act as shear walls, and should be taken advantage of to resist earthquake forces. The Shear Wall sections are classified as six types. (1) Box Section (2) L Section (3) U Section (4) W Section (5) H Section (60) T Section.

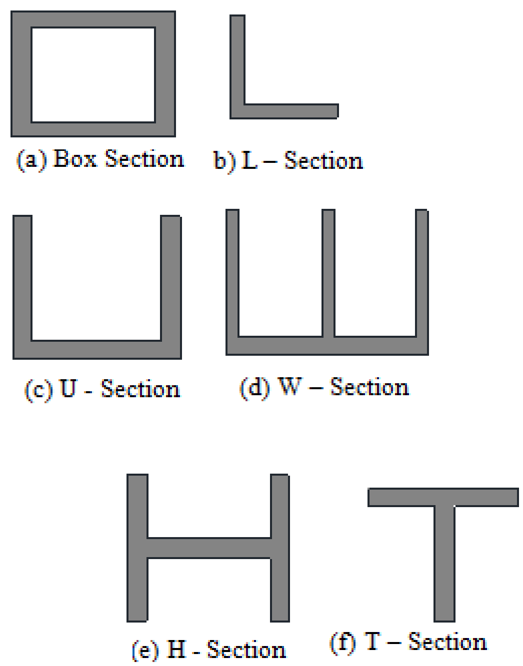

Fig. 2: Different Shapes or Geometries of Shear Walls

3.6 CLASSIFICATION OF SHEAR WALLS

Shear walls can also be classified according to their behavior also, they are as follows:

[1] Shear-shear walls in which strength and deflection are controlled by shear. These types of shear walls are usually constructed in low rise buildings.

[2] Ordinary moment shear walls in which deflection and strength are controlled by means of flexure. These are generally uses in multistoried buildings to resist high winds pressure and cyclones.

[3] Ductile moment shear walls are special walls meant for seismic regions and which have good energy dissipation characteristics under reversed cyclic loads.

3.7 COMPONENTS OF SHEAR WALLS

Whenever a wall has doors, windows, or other openings, the wall must be considered as an assemblage of relatively flexible components like column segments and wall piers and relatively stiff elements like wall segments.

- Column segments: A column segment is a vertical member whose height exceeds three times its thickness and whose width is less than two and one-half times its thickness. Its load is usually mainly axial. it may contributed little to lateral force resistance of the shear walls rigidity must be consider. When a column is built integral with a wall, the portion of the column that project from the face the wall is called a pilaster.
- Wall piers: A wall pier is a portion of a wall whose horizontal length is in between two and one-half and six times its thickness whose clear height at least two times its horizontal length.
- Wall segments: Wall segments are components of shear wall that are longer than wall piers. They are the primary resisting components in the shear wall. Important features in planning and design of shear walls: For all high rise buildings, the problem of providing adequate stiffness and preventing large displacements, are as important as providing adequate strength. Thus shear wall system has two distinct advantage above a frame system.

4. METHODOLOGY

4.1 Design Aspect

Earthquakes can occur on both land and sea, at any place on the surface of the earth where there is a major fault. When earthquake occur on land it affected the man made structure surrounding its origin leading to human fail. When a major earthquake occurs underneath the ocean or sea, it not only affects the structures near it, but also produces large tidal waves known as Tsunami, thus affecting the places far away from its origin. All the structured are design for the combine effect of gravity loads and seismic loads to verify that sufficient vertical, lateral strength and stiffness are achieve to satisfy the structural concert and acceptable deformation levels prescribed in the governing building code. Because of the innate factor of safety used in the design specifications, most structures tend to be adequately protected against vertical shaking. Vertical acceleration should also be considered in structures with large spans, those in which stability for design, or for overall stability analysis of structures.

4.1.1 Serviceability Limit State

The structure undergoes little structural damage in this case. Important buildings such as hospitals, atomic power stations, places of assembly etc, which affects a community, should be designed for elastic behavior under expected earthquake forces. These type of structure should be serviceable after the occurrence of earthquake or cyclones.

4.1.2 Damage Controlled Limit State

In this case, if an earthquake or cyclone occur, there can be some damages to the structure but it can be repair even after the occurr of the disaster. Most of the permanent building should came under this categories, so, the structure should be designe for limited ductility only.

4.1.3 Survival Limit State

In this case, the structure is allowed to be damaged in the event earthquake or cyclone disasters. But, the supports should stand and support the permanent loads coming on to it so that there should be no caving in of the structure and no loss of life. Limited ductile response is cheaper and full ductile response is cheapest. The full ductile detailing is achieved by the theory of plastic hinge formation and also by careful ductile detailing. The design practice is to constructed the structure for the first two limit state as other is under develop stage.

4.2 Design Approach

a) Design basic earthquake (DBE): It is the earthquake which occurs reasonably at least once during the designed life of the structure.
b) Maximum considered earthquake (MCE): This is the most severe earthquake that can occur in that region as considered by the code.
The value of Z, the seismic zone factor given in the code relates the realistic values of effective peak ground acceleration considering MCE and the service life of the structure. The following principles are the basis for the design approach

- The structure should have the strength to withstand minor earthquakes less than DBE without any damage.
- The structure should able to resist earthquake equal to DBE without significant damages though some non structural damages may occurred.
- The structure should able to prevent an earthquake equal to MCE without collapsing so that there is no loss of life as, the actual force will be much larger than the design force specified by the code, the ductility arising from the inelastic material behavior and detailing along with the reserved strength are upon to account for the difference in the actual and the design lateral load. Conceptual representation of earthquake resistant design philosophy is depicted in the following figure;

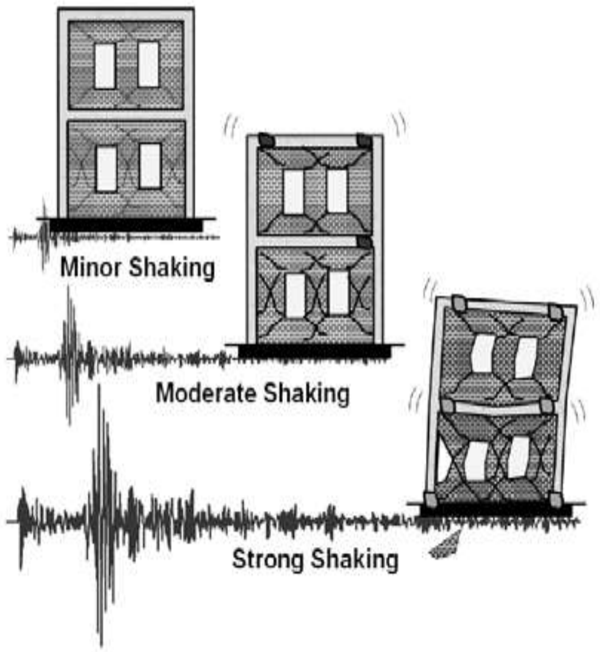

Fig.3: Schematic Diagram Depicting Earthquake Resistant Design Philosophy For Different Levels Shaking

4.3 Equivalent Static Method

The equivalent static method of finding lateral forces is also known as the static method or the seismic coefficient method. This method is the simple method it requires less computational attempt and is based on formulae given in code of practice. In all the methods of analyzing a multi storey buildings recommended in the code, the structure is treated as discrete system having concentrated masses at floor levels which comprise the weight of column and wall in any storey should be equally distribute to the floor above and below the storey. In addition, the suitable amount of imposed load at this floor is also lumped with it. It is also assume that the structures flexible and will deflected with respect to position of foundation; the lump mass system reduce to the solution of a system of second order differential equation. These equations are formed by distribution of mass and stiffness in a structure, together with its damping characteristics of the ground motion.

4.4 Equivalent Frame Method

Code of practice for reinforced concrete buildings permit the used of an equivalent frame for the analysis of real beam and slab buildings. The success of the idealization requires that realistic data be available concerning the effective size of the equivalent beams and the initial joint moments corresponding to the type of load on the beam-slab structure. Many different rules appear in codes and other references for the evaluation of this information. From an extensive investigation of beam-slab structures, based on finite element analyses, simple rules are proposed for the evaluation of the effective flexural stiffness of the equivalent beams. Also, initial joints moment for three types of floor /beam loads may be evaluate.

4.5 Dynamic Method

The structural system of a multistoried building often has a more declared effect than a low rise building on the total building cost and the architecture aspect of buildings. Shear walls are lateral loads resisting structural system which may provide stability to the structures from lateral loads like winds and seismic Loads. The design of high rise building is to have good lateral load resisting Systems along with gravity load system for safety of occupant and for better performance of structure even in most contrary condition. The main purpose of the project is to apply class room knowledge in the real world by designing a high rise residential building.

5. CONCLUSIONS

1) The center of mass and center of rigidity is influence by addition and positioning of shear wall. It can be decide that all models are symmetric about x-direction and there are no effects of torsion due to center of mass and center of rigidity in x-direction. The performances of structures with shear walls are better than structure without shear walls because center of mass and center of rigidity become closer.
2) Provision of shear walls generally result in reduces the displacement because the shear walls increases the stiffness of buildings and sustains the lateral forces. The better performances are observed and displacements are reduced in both x and y directions and shows better performances with respect to displacement when analysis are carried out by using response spectrum method.
3) It is evident that shear walls which are provided from foundation to the roof top, are one of the excellent mean for providing earthquake resistance in high rise buildings. These are little expensive but desirable for safe structure.

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