ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

BEHAVIOUR OF SHEAR WALL IN EARTH QUAKE RESISTANT STRUCTURES

M.Tholkapiyan, A.Mohan
Department of civil engineering, Vel tech high tech Dr.Rangarajan Dr.Sakunthala engineering college, Chennai 600062, India.
Email: m.tholkapiyan@gmail.com, drtholkapiyan@velhightech.com

Abstract— The aim of the shear wall is to investigate the different ways in which the tall structures can be established against the effects of strong horizontal wind loading and seismic loading. Some other reasons why we use shear walls are tall structures can be constructed which reduces the area used and we can accommodate a large population in that particular area. Other objective is to construct a cost effective structure in less period of time. Shear walls are not only designed to resist gravity / vertical loads (due to its self-weight and other living / moving loads), but they are also designed for lateral loads of earthquakes / wind. The walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three dimensional stability for the building structures.

Shear wall structural systems are more stable. Because, their supporting area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more, unlike in the case of RCC framed structures. Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building.

Shear walls are quick in construction, and in a country like India where shelter is very important in a short lapse of time shear walls can be built very quickly. The precision to which they are built is also very high compared to normally built brick structures. Hence the key objective of shear wall is to build a safe, tall, aesthetic building. This study helps in the investigation of strength and ductility of walls. The scope is to analyze the constructed shear wall that is to be constructed.

1. Introduction

1.1 SHEAR WALLS RESPONSE TO SESMIC FORCES

1.1.1 Inertia Forces in Structures

Earthquake causes shaking of the ground. So a building resting on it will experience motion at its base. From Newton's First Law of Motion, even though the base of the building moves with the ground, the roof has a tendency to stay in its original position. But since the walls and columns are connected to it, they drag the roof along with them. This is much like the situation that you are faced with when the bus you are standing in suddenly starts; your feet move with the bus, but your upper body tends to stay back making you fall backwards!! This tendency to continue to remain in the previous position is known as inertia. In the building, since the walls or columns are flexible, the motion of the roof is different from that of the ground (Romy Mohan, C Prabha) .

Consider a building whose roof is supported on columns .Coming back to the analogy of yourself on the bus: when the bus suddenly starts, you are thrown backwards as if someone has applied a force on the upper body. Similarly, when the ground moves ,even the building is thrown backwards, and the roof experiences a force, called inertia force (P. P. Chandurkar, Dr. P. S. Pajgade). If the roof has a mass M and experiences an acceleration a, then from Newton's Second Law of Motion, the inertia force FI is

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

mass M times acceleration a, and its direction is opposite to that of the acceleration. Clearly, more mass means higher inertia force. Therefore, lighter buildings sustain the earthquake shaking better.

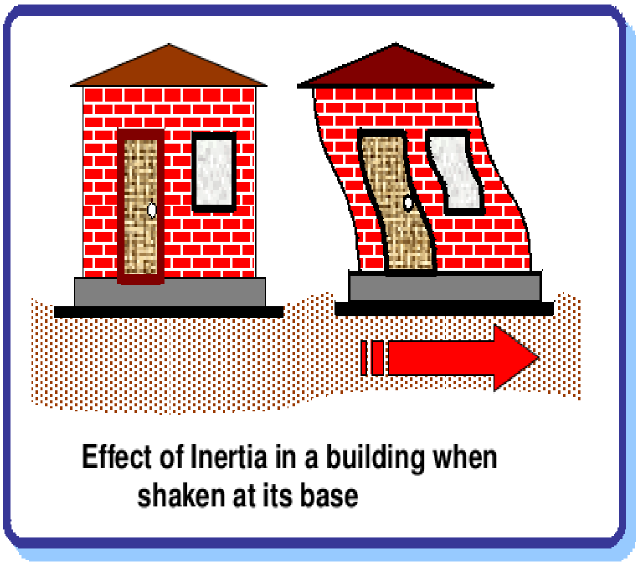

Fig 1.1.1 Effect of inertia force in building

1.1.2. Effect of Deformations in Structures

The inertia force experienced by the roof is transferred to the ground via the columns, causing forces in columns. These forces generated in the columns can also be understood in another way. During earthquake shaking, the columns undergo relative movement between their ends. In this movement is shown as quantity ubetween the roof and the ground. But, given a free option, columns would like to come back to the straight vertical position, i.e., columns resist deformations(P. P. Chandurkar, Dr. P. S. Pajgade)..

In the straight vertical position, the columns carry no horizontal earthquake force through them. But, when forced to bend, they develop internal forces. The larger is the relative horizontal displacement **u** between the top and bottom of the column, the larger this internal force in columns. Also, the stiffer the columns are (i.e., bigger is the column size), larger is this force. For this reason, these internal forces in the columns are called stiffness forces. In fact, the stiffness force in a column is the column stiffness times the relative displacement between its ends(Parme, L).

1.1.3. Flow of Inertia Forces to Foundations

Under horizontal shaking of the ground, horizontal inertia forces are generated at level of the mass of the structure (usually situated at the floor levels). These lateral inertia forces are transferred by the floor slab to the walls or columns, to the foundations, and finally to the soil system underneath. So, each of these structural elements (floor slabs, walls, columns, and foundations) and the connections between them must be designed to safely transfer these inertia forces through them(Kazimi, S.M.A. and Chandra, R).Walls or columns are the most critical elements in transferring the inertia forces. But, in traditional construction, floor slabs and beams receive more care and attention during design and construction, than walls and columns. Walls are relatively thin and often made of brittle material like masonry. They are poor in carrying horizontal earthquake inertia forces along the direction of their thickness. Failures of masonry walls have been observed in many earthquakes in the past Similarly, poorly designed and constructed reinforced concrete columns can be disastrous. The failure of the ground storey columns resulted in numerous building collapses during the 2001 Bhuj (India) earthquake .

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

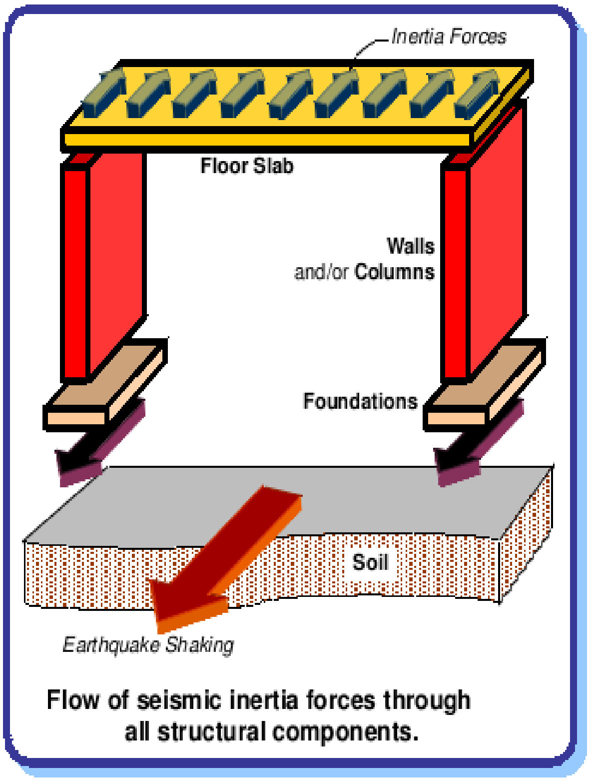

Fig 1.1.3 Flow of seismic forces in building

1.1.4. SHEAR WALL

What is a Shear Wall Building

Reinforced concrete (RC) buildings often have vertical plate-like RC walls called Shear Walls in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings. Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation. (Romy Mohan, C Prabha)

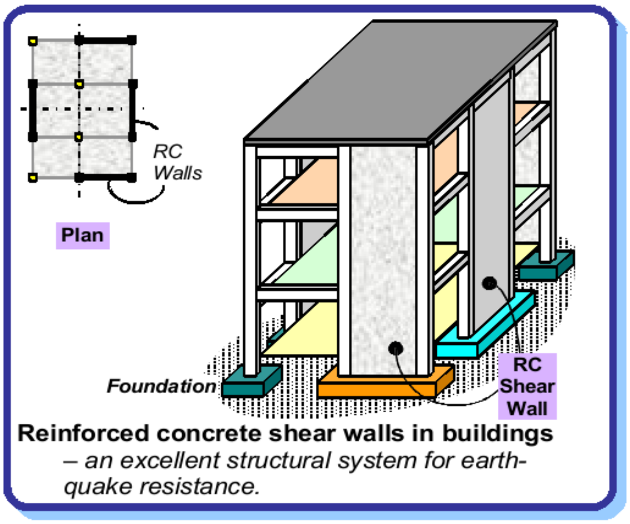

Fig 1.1.4 typical diagram of RC shear wall

1.1.5. Advantages of Shear Walls in RC Buildings

Properly designed and detailed buildings with shear walls have shown very good performance in past earthquakes. The overwhelming success of buildings with shear walls in resisting strong earthquakes is summarized in the quote:

"We cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls."

Mark Fintel, a noted consulting engineer in USA

Shear walls in high seismic regions require special detailing. However, in past earthquakes, 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. Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. 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).

1.1.6.Architectural Aspects of Shear Walls

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

Most RC buildings with shear walls also have columns; these columns primarily carry gravity loads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Thus, design of their foundations requires special attention. Shear walls should be provided along preferably both length and width(Kazimi, S.M.A. and Chandra, R).

However, if they are provided along only one direction, a proper grid of beams and columns in the vertical plane (called a moment-resistant frame) must be provided along the other direction to resist strong earthquake effects. Door or window openings can be provided in shear walls, but their size must be small to ensure least interruption to force flow through walls. Moreover, openings should be symmetrically located. Special design checks are required to ensure that the net cross sectional area of a wall at an opening is sufficient to carry the horizontal earthquake force.

Shear walls in buildings must be symmetrically located in plan to reduce ill-effects of twist in buildings. They could be placed symmetrically along one or both directions in plan. Shear walls are more effective when located along exterior perimeter of the building – such a layout increases resistance of the building to twisting.

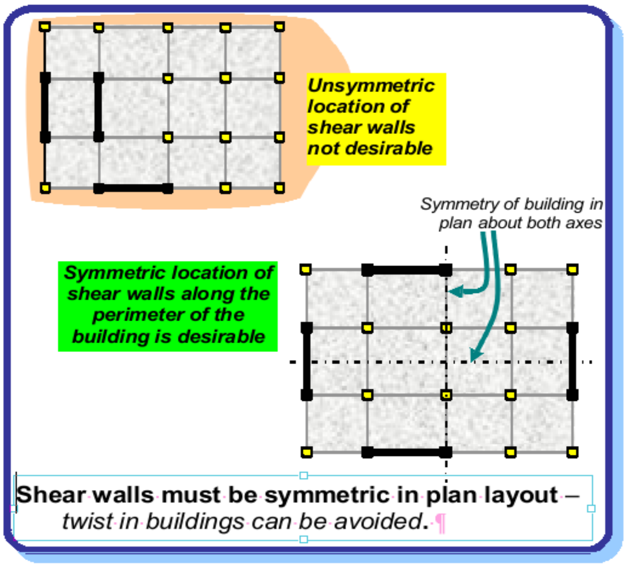

Fig 1.1.6 Layout of shear wall in building.

1.1.7.Overall Geometry of Walls

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, and should be taken advantage of to resist earthquake forces.

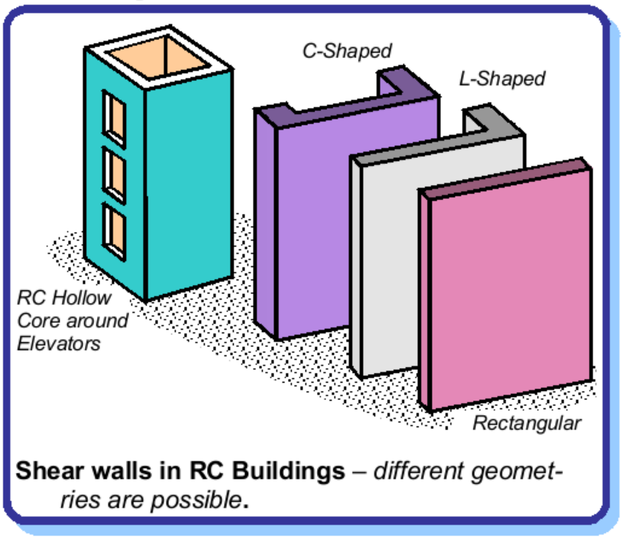

Fig 1.1.7 Types of shear walls

1.1.8.Boundary Elements

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

Under the large overturning effects caused by horizontal earthquake forces, edges of shear walls experience high compressive and tensile stresses. To ensure that shear walls behave in a ductile way, concrete in the wall end regions must be reinforced in a special manner to sustain these load reversals without losing strength . End regions of a wall with increased confinement are called boundary elements. This special confining transverse reinforcement in boundary elements is similar to that provided in columns of RC frames. Sometimes, the thickness of the shear wall in these boundary elements is also increased. RC walls with boundary elements have substantially higher bending strength and horizontal shear force carrying capacity, and are therefore less susceptible to earthquake damage than walls without boundary element

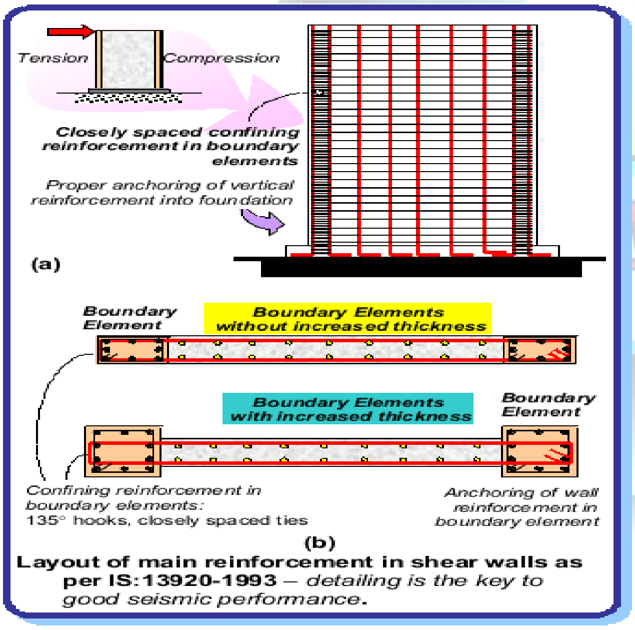

Fig 1.1.8 layout of reinforcement in shear wall

1.1.9. Base Isolation

The concept of base isolation is explained through an example building resting on frictionless rollers (Figure 1a). When the ground shakes, the rollers freely roll, but the building above does not move. Thus, no force is transferred to the building due to shaking of the ground; simply, the building does not experience the earthquake(Parme, L). Now, if the same building is rested on flexible pads that offer resistance against lateral movements , then some effect of the ground shaking will be transferred to the building above. If the flexible pads are properly chosen, the forces induced by ground shaking can be a few times smaller than that experienced by the building built directly on ground, namely a fixed base building (P. P. Chandurkar, Dr. P. S. Pajgade).

1.1.9 .Base Isolation in Real Buildings

Seismic isolation is a relatively recent and evolving technology. It has been in increased use since the 1980s, and has been well evaluated and reviewed internationally. Base isolation has now been used in numerous buildings in countries like Italy, Japan, New Zealand, and USA. Base isolation is also useful for retrofitting important buildings (like hospitals and historic buildings). By now, over 1000 buildings across the world have been equipped with seismic base isolation. In India, base isolation technique was first demonstrated after the 1993 Killari (Maharashtra) Earthquake [EERI, 1999]. Two single storey buildings (one school building and another shopping complex building) in newly relocated Killari town were built with rubber base isolators resting on hard ground. Both were brick masonry buildings with concrete roof. After the 2001 Bhuj (Gujarat) earthquake, the four-storey Bhuj Hospital building was built with base isolation technique.

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

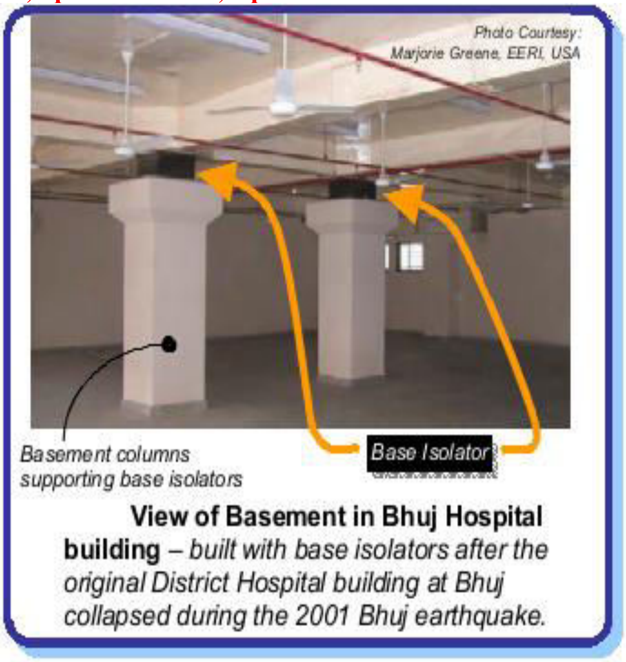

Fig 1.1.9 Example of base isolation

1.2. SEISMIC DAMPERS

Another approach for controlling seismic damage in buildings and improving their seismic performance is by installing seismic dampers in place of structural elements, such as diagonal braces. These dampers act like the hydraulic shock absorbers in cars – much of the sudden jerks are absorbed in the hydraulic fluids and only little is transmitted above to the chassis of the car. When seismic energy is transmitted through them, dampers absorb part of it, and thus damp the motion of the building. Dampers were used since 1960s to protect tall buildings against wind effects. However, it was only since 1990s, that they were used to protect buildings against earthquake effects. Commonly used types of seismic dampers include viscous dampers (energy is absorbed by silicone-based fluid passing between piston-cylinder arrangement), friction dampers (energy is absorbed by surfaces with friction between them rubbing against each other), and yielding dampers (energy is absorbed by metallic components that yield) (Figure 3). In India, friction dampers have been provided in a 18-storey RC frame structure in Gurgaon

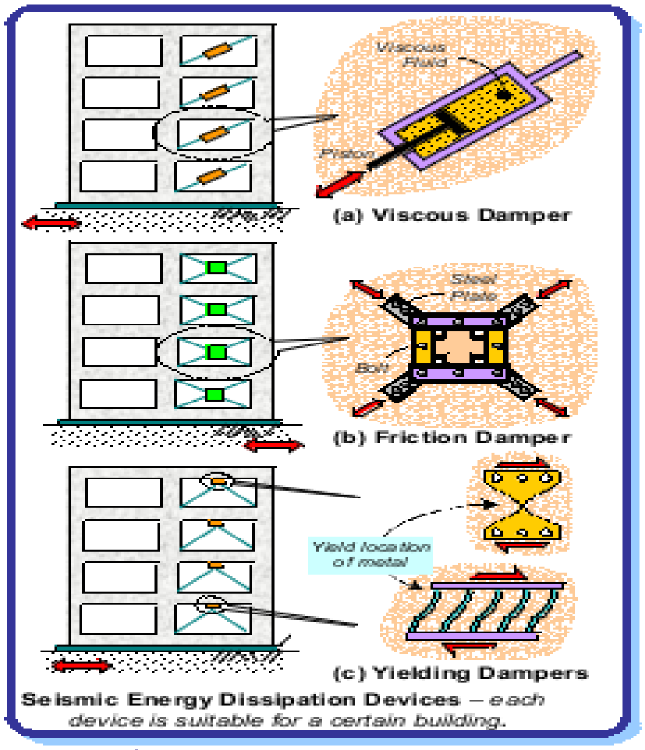

Fig 1.2 Layout of seismic damper

1.3 SHEAR WALL STRUCTURAL SYSTEMS

Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces. (Kazimi, S.M.A. and Chandra, R). In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall or vertical truss. Lateral forces caused by wind, earthquake, and uneven settlement loads, in

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

addition to the weight of structure and occupants; create powerful twisting (torsion) forces. These forces can literally tear (shear) a building apart. Reinforcing a frame by attaching or placing 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 subjected to lateral wind and seismic forces.Shear wall buildings are usually regular in plan and in elevation. However, in some buildings, lower floors are used for commercial purposes and the buildings are characterized with larger plan dimensions at those floors. In other cases, there are setbacks at higher floor levels. Shear wall buildings are commonly used for residential purposes and can house from 100 to 500 inhabitants per building(Parme, L)..

1.3.1 Purpose of Constructing Shear Walls:

Shear walls are not only designed to resist gravity / vertical loads (due to its self-weight and other living / moving loads), but they are also designed for lateral loads of earthquakes / wind. The walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three dimensional stability for the building structure. Shear wall structural systems are more stable. Because, their supporting area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more, unlike in the case of RCC framed structures.

Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building. Shear walls are quick in construction, as the method adopted to construct is concreting the members using formwork. Shear walls doesn't need any extra plastering or finishing as the wall itself gives such a high level of precision, that it doesn't require plastering.

1.3.2Comparisons of Shear Wall With Construction of Conventional Load Bearing Walls:

Load bearing masonry is very brittle material. Due to different kinds of stresses such as shear, tension, torsion, etc., caused by the earthquakes, the conventional unreinforced brick masonry collapses instantly during the unpredictable and sudden earthquakes.

The RCC framed structures are slender, when compared to shear wall concept of box like three-dimensional structures. Though it is possible to design the earthquake resistant RCC frame, it requires extraordinary skills at design, detailing and construction levels, which cannot be anticipated in all types of construction projects.

On the other hand even moderately designed shear wall structures not only more stable, but also comparatively quite ductile. In safety terms it means that, during very severe earthquakes they will not suddenly collapse causing death of people. They give enough indicative warnings such as widening structural cracks, yielding rods, etc., offering most precious moments for people to run out off structures, before they totally collapse.

For structural purposes we consider the exterior walls as the shear-resisting walls. Forces from the ceiling and roof diaphragms make their way to the outside along assumed paths, enter the walls, and exit at the foundation.

1.3.3Forces on Shear Wall:

Shear walls resist two types of forces: shear forces and uplift forces. Shear forces are generated in stationary buildings by accelerations resulting from ground movement

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

and by external forces like wind and waves. This action creates shear forces throughout the height of the wall between the top and bottom shear wall connections(Kazimi, S.M.A. and Chandra, R).

Uplift forces exist on shear walls because the horizontal forces are applied to the top of the wall. These uplift forces try to lift up one end of the wall and push the other end down. In some cases, the uplift force is large enough to tip the wall over. Uplift forces are greater on tall short walls and less on low long walls. Bearing walls have less uplift than non-bearing walls because gravity loads on shear walls help them resist uplift. Shear walls need hold down devices at each end when the gravity loads cannot resist all of the uplift. The hold down device then provides the necessary uplift resistance.

Shear walls should be located on each level of the structure including the crawl space. To form an effective box structure, equal length shear walls should be placed symmetrically on all four exterior walls of the building. Shear walls should be added to the building interior when the exterior walls cannot provide sufficient strength and stiffness.

Shear walls are most efficient when they are aligned vertically and are supported on foundation walls or footings. When exterior shear walls do not provide sufficient strength, other parts of the building will need additional strengthening. Consider the common case of an interior wall supported by a sub floor over a crawl space and there is no continuous footing beneath the wall. For this wall to be used as shear wall, the sub floor and its connections will have to be strengthened near the wall. For Retrofit work, existing floor construction is not easily changed. That's the reason why most retrofit work uses walls with continuous footings underneath them as shear walls.

1.3.4. Classification of Shear Walls:

- Simple rectangular types and flanged walls (bar bell type)
- Coupled shear walls
- Rigid frame shear walls
- Framed walls with in filled frames
- Column supported shear walls
- Core type shear wall

Types of Shear Walls Based on Material:

- RC Shear Wall
- Plywood Shear Wall
- Mid ply Shear Wall
- RC Hollow Concrete Block Masonry Wall
- Steel plate shear wall

RC Shear Wall:

It consists of reinforced concrete walls and reinforced concrete slabs. Wall thickness varies from 140 mm to 500 mm, depending on the number of stories, building age, and thermal insulation requirements. In general, these walls are continuous throughout the building height; however, some walls are discontinued at the street front or basement level to allow for commercial or parking spaces(LadislavCerny and Roberto Lean). Usually the wall layout is symmetrical with respect to at least one axis of symmetry in the plan.

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

Fig R.C.Shear wall

Floor slabs are either cast-in-situ flat slabs or less often, precast hollow-core slabs. Buildings are supported by concrete strip or mat foundations; the latter type is common for buildings with basements. Structural modifications are not very common in this type of construction(Parme, L)..

Reinforcement requirements are based on building code requirements specific for each country. In general, the wall reinforcement consists of two layers of distributed reinforcement (horizontal and vertical) throughout the wall length. In addition, vertical reinforcement bars are provided close to the door and window openings, as well as at the wall end zones (also known as boundary elements or barbells).

Plywood Shear Wall:

Plywood is the traditional material used in the construction of Shear Walls. The creation of prefabricated shear panels have made it possible to inject strong shear assemblies into small walls that fall at either side of a opening in a shear wall. As well as the use of a sheet steel, and steel-backed shear panel (i.e. Sure-Board) in the place of structural use plywood in shear walls, has proved to be far stronger in seismic resistance when used in shear wall assemblies.

Fig Plywood shear wall

Plywood shear walls consist of:

- Plywood, to transfer shear forces
- Chords, to resist tension/compression generated by the over turning moments
- Base connections to transfer shear to foundations.

Midply Shear Wall:

The MIDPLY shear wall is an improved timber shear wall that was developed by redesigning the joints between sheathing and framing members, so that the failure modes observed in standard wall testing are virtually eliminated at lateral load levels high enough to cause failures in standard walls(LadislavCerny and Roberto Lean).

In MIDPLY shear wall design, one ply of sheathing material is placed at the center of the wall between a series of pairs of studs oriented in a 90° rotated position relative to those in standard shear walls.

RC Hollow Concrete Block Masonry Walls:

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

RHCBM walls are constructed by reinforcing the hollow concrete block masonry, by taking advantage of hollow spaces and shapes of the hollow blocks. It requires continuous steel rods (reinforcement) both in the vertical and horizontal directions at structurally critical locations of the wall panels, packed with the fresh grout concrete in the hollow spaces of masonry blocks (LadislavCerny and Roberto Lean). Reinforced Hollow Concrete Block Masonry (RHCBM) elements are designed both as load bearing walls for gravity loads and also as shear walls for lateral seismic loads, to safely with stand earthquakes. This structural system of construction is known as shear wall - diaphragm concept, which gives three-dimensional structural integrity for the buildings.

Steel Plate Shear Wall:

In general, steel plate shear wall system consists of a steel plate wall, boundary columns and horizontal floor beams. Together, the steel plate wall and boundary columns act as a vertical plate girder. The columns act as flanges of the vertical plate girder and the steel plate wall acts as its web. The horizontal floor beams act, more-or-less, as transverse stiffeners in a plate girder(Parme, L).

Fig . Steel plate shear wall

Steel plate shear wall systems have been used in recent years in highly seismic areas to resist lateral loads.

Figure shows two basic types of steel shear walls; unstiffened and stiffened with or without openings.

1.4.Advantages of Steel Plate Shear Wall to Resist Lateral Loads:

1. The system, designed and detailed properly is very ductile and has relatively large energy dissipation capability. As a result, steel shear walls can be very efficient and economical lateral load resisting systems.

2. The steel shear wall system has relatively high initial stiffness, thus very effective in limiting the drift.

3. Compared to reinforced concrete shear walls, the steel shear wall is much lighter which can result in less weight to be carried by the columns and foundations as well as less seismic load due to reduced mass of the structure.

4. By using shop-welded, field-bolted steel shear walls, one can speed-up the erection process and reduce the cost of construction, field inspection and quality control resulting in making these systems even more efficient.

5. Due to relatively small thickness of steel plate shear walls compared to reinforced concrete shear walls, from architectural point of view, steel plate shear walls occupy much less space than the equivalent reinforced concrete shear walls. In high-rises, if reinforced concrete shear walls are used, the walls in lower floors become very thick and occupy large area of the floor plan.

6. Compared to reinforced concrete shear walls, steel plate shear walls can be much easier and faster to construct when they are used in seismic retrofit of existing building.

7. Steel plate shear wall systems that can be constructed with shop welded-field bolted elements can make the steel

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

plate shear walls more efficient than the traditional systems. These systems can also be very practical and efficient for cold regions where concrete construction may not be economical under very low temperatures.

8.

CONCLUSION

Properly designed and detailed buildings with shear walls have shown very good performance in past earthquakes. Shear walls in high seismic regions require special detailing. However, in past earthquakes, 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. Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight forward and therefore easily implemented at site. Shear walls are efficient, both interims of construction cost and effectiveness in minimizing earthquake damage in structural and nonstructural elements like glass windows and building contents

1.5REFERENCES

1. Romy Mohan, C Prabha,"Dynamic analysis of RCC buildingswith shear wall", International Journal of Earth Sciences andEngineering. Vol. 04, No. 06 SPL, October 2011, pp. 659-662, 2011.
2. P. S. Kumbhare, A. C. Saoji,"Effectiveness of reinforcedconcrete shear wall for multi-storyed building", InternationalJournal of Engineering Research & Technology, Vol. 1, Issue4, 2012.
3. LadislavCerny and Roberto Lean, Column supported shear walls, in *Concrete Framed Structures—StabilityandStrength,*R. Narayanan (Ed.), Elsevier Applied Science, London, 1986.
4. Kazimi, S.M.A. and Chandra, R., *Analysis of Shear Walls Buildings,* Torsteel Research Foundation in India, Calcutta, 1980.
5. Bryan Stafford and Alex Coult, *Tall Building Structures—Analysis and design,*John Wiley & Sons, New York, 1991.
6. Parme, L., *Design of Combined Frames and Shear Walls,*Portland Cement Association, Illinois, 1967.
7. Iain, A. MacLeod, *Shear Wall Frame. Interaction—A design aid,*Portland Cement Association, Illinois, 1970.
8. IS 13920 (1993), *Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces,* New Delhi.
9. Medhekar, M.S. and Jain, S.K,, Seismic Behaviour, Design and Detailing of R.C. Shear Walls—Parts 1 and 2. *Indian Concrete Journal,*Bombay, July and September, 1993
10. Clough, R.W., King I.P., Wilson E.L. (1963). Structural analysis of multistory buildings. *Journal of the Structural Division, ASCE.Structural Division, ASCE..*
11. Khan F. (1980). Tall building systems and concepts. *Journal of the Structural Division, ASCE.*
12. Taranath, B.S. (1997). Steel, Concrete, and Composite Design of Tall Buildings, McGraw-HILL.
13. Council on Tall Buildings and Urban Habitat, (1995). Structural Systems for Tall Buildings, Mc
14. P. P. Chandurkar, Dr. P. S. Pajgade,"Seismic analysis of RCCbuilding with and without shear wall", International Journalof Modern Engineering Research. Vol. 3, Issue 3, pp. 1805-1810, 2013