Analysis of Reinforced Concrete Framed Building with & Without Shear Wall

Kumari Kshama, Yudhvir Yadav, Yatendra Singh, Saurav Kumar, Neha

Abstract: ***Shear wall, 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 addition to the weight of structure and occupants; create powerful twisting (torsional) 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. Structural walls provide an efficient bracing system and offer great potential for lateral load resistance. The properties of these seismic shear walls dominate the response of the buildings, and therefore, it is important to evaluate the seismic response of the walls appropriately. Shear walls are especially important in high-rise buildings subject to lateral wind and seismic forces. It is very necessary to determine effective, efficient and ideal location of shear wall. In this study, a G+10 story building in Zone III is presented with some preliminary investigation which is analyzed by changing various positions of shear wall with different shape like C-shape and L-shape shear wall for determining parameters like axial load and moments in columns and beams. This analysis is done by using standard package STADD-pro. The comparison of these models for different parameters like shear force, Bending moment, Displacement, Storey drift and lateral forces has been presented.***

Keywords: Shear wall, construction, diaphragm, C-shape, L-shape, STADD-pro, a G+10, (torsional),

I. INTRODUCTION

Shear wall is a structural member used to resist lateral forces i.e. parallel to the plane of the wall. For slender walls where the bending deformation is more, shear wall resist the loads due to cantilever action and for short walls where the shear deformation is more it resists the loads due to truss action. These walls are more important in seismically active zones because during earthquakes shear forces on the structure increases. Shear walls should have more strength and stiffness. When a building has a story without shear walls, or with poorly placed shear walls, it is known as a soft story building. Shear walls provide adequate strength and stiffness to control lateral displacements.

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Shear walls perform dual action that is these have lateral as well as gravity load bearing elements.Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation. Shear walls are part of the lateral force resisting systems that carry vertical loads, bending moments about the wall strong axis, and shear forces parallel to the wall length. Shear wall system is one of the most common and effective lateral load resisting systems that is widely used in medium- to high-rise buildings. It can provide the adequate strength and stiffness needed for the building to resist wind and earthquake loadings, provided that a proper design is considered, that cares for both the wall strength and ductility.

A. Possible Geometry of shear wall

Different Shear Wall on the basis of geometry are as following:

1. C shape Shear Wall
2. L shape Shear Wall
3. Shear Wall at Corner
4. Shear Wall on Exterior Mid Bay

B. Types of Shear Walls

There are following five types of shear walls which are as follows:

1. RC Shear Wall
2. Plywood Shear wall
3. Mid Ply Shear Wall
4. RC Hollow Concrete Block Masonry Wall
5. Steel Plate Shear Wall

C. RC Shear Wall

Reinforced concrete (RC) shear walls are considered as effective lateral force resisting system that has been widely used in the last decades. RC walls can provide the required lateral stiffness and strength for resisting the lateral loads due to wind or earthquakes. Hence, several experimental and analytical studies were conducted to investigate the behaviour of RC shear walls under the lateral loads in order to enable the designers to predict their seismic response in a building when subjected to a severe ground motion.

D. Objective of Study

The different objectives of providing shear wall to high rise buildings are as following:

a) To understand the purpose of using shear walls using stadd pro. Through this work.
b) To analyse an R.C. building frame using stadd pro. Software setup.
c) To judge the effect of an R.C. shear walls on an R.C. Building when provided at different locations.
d) To study the results of Storey drift, maximum shear force and maximum bending moment. When shear walls are attached at different locations

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e) To know the best location of shear wall for parameters considered.
f) To study the seismic effects of earthquake forces on buildings.
g) To provide 3-D stability for the building structures by providing shear wall. Shear-walled structural systems are more firm and stable because their area of support (total area of cross section of each shear walls) with as referred to total plan area of building is more, unlike in the case of Reinforced concrete framed building.

II. LITERATURE REVIEW

This chapter covers the literature used to help guide the experimental tests, data analysis, and conclusions documented in this report. Literature used in this report includes previous experimental test results and theory published in the structural concrete building code. The general findings of these resources are discussed in the following sections, focusing on the information used specifically in the production of this document.

A lot of research work has been done in the direction of shear wall multi-storey building. However the study related to shear wall effect has not been yet done much. Development of shear wall system for construction has developed dramatically over the past few years. Some of the research work related to shear wall multi-storey building is described here. **Bessason et al. (2000)** presented a paper on the capacity and earthquake response analysis of Reinforced Concrete shear walls. In June 2000, two major earthquakes of magnitude 6.5 on Ritcher Scale struck the South Iceland and caused considerable damage, especially to older structures. In this research work, a non-linear, finite-element model was validated by experimental data and used to evaluate the load deformation curves of reinforced-concrete shear wall with different reinforcement configurations. The evaluated load deformation curves were then used in earthquake response analysis. The solid element SOLID 65 in the ANSYS program was used in the analysis.

Dugal (2010) on his deep interest on structures proposed a detail explanation about reinforced concrete buildings in his book "Earthquake resistant design of structures" describing a wall in a building which resist horizontal load originating from wind or earthquakes are recognized as shear walls. He brought in to consideration flexural strength in the wall to be prevailing force based on which design of structure is to be carried out in tall shear walls. he describe in detail about different types of shear walls with their load bearing capacity as per code requirements. **Rahangdale et al. (2013)** conducted a large number of tests in G+5 story plain and reinforced concrete shear wall. These buildings were analyzed by changing various position of shear wall with different shapes for determining parameters like axial load and moments. This analysis was done by using standard package STADD.Pro. **Patil (2013)** described about equivalent static analysis of tall structures using STADD Pro. With different circumstances of lateral stiffness system. He compared the result obtain among bare frame, braced frame and shear walled frame buildings.

Choudhary et al (2014) proposed a performance-based design procedure for control the structural damage based on precise estimation of proper response parameter. In performance based seismic analysis he evaluated how building is likely to perform. It was an iterative process with selection of performance objective followed by development of preliminary design, an assessment whether or not the design meets the performance objective; in his study pushover analysis has been done the two multi-storeyed R.C frame building; in which plan of one building was taken symmetrical and it consist of 2 bay of 5m in x direction & 2 bay of 4m in y direction and second building having L shaped unsymmetrical plan. The shear wall was provided for studying their resisting lateral forces. In his paper the effect of shear wall on R.C frame building when shear wall providing along the longer and shorter side of the building was highlighted. The base shear and displacement decreased of building. The comparative study had been done for base shear, story drift, spectral acceleration, special displacement, story displacement.

III. THEORETICALDEVELOPMENT

A. *Modelling Of Shear Wall*

We need to consider flexural deformation and shear deformation in shear walls. If we can provide shear walls in the model considering shear wall frame interaction, we can effectively create a model where lateral force will be carried by the shear wall and gravity loads will be carried by frames. It is better to model shear wall in STADD.Pro using plate elements or surface elements. If we model shear wall using Surface elements, we can design them in STADD.Pro.

Specially if we are interested in analyzing the wall and finding out the forces (shears and moments) for design of the wall. However it is worth noting that although we can extract the wall forces, the reinforcement calculation for shear wall is not done by STADD.Pro when these walls are modeled using plates. In other words, if we are modeling shear walls using plates, we will have to calculate the reinforcements manually. Normally we would need the in-plane shear and the in-plane moment for designing the shear wall. These can be obtained by using Results along Line feature in STADD.Pro which can be accessed from within the Post Processing mode. At any elevation along the height of the wall, one can get the in-plane shear (Fxy) and the In-plane moment (Mz) both of which are reported within the Total Force tab of the Results along Line table. These data can be used subsequently to design shear wall as per any design code manually. STADD.Pro does have the ability to carry out reinforcement design for a shear wall as per certain design codes like the ACI, BS 8110 and IS 456. However to get the software to do the design, the shear walls have to modeled using surface elements.

B. *Designing of Shear Wall*

There are three types of designing methods:
1. Segmented-shear Wall method
2. Force transfer method
3. Perforated-shear wall method

The segmented-shear wall method uses overall height of shear wall segments which conform with ratio requirements and they are generally restrained against overturning by the help of devices at each ends of segment. The second method which is force transfer method considers the entire

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shear wall having openings and the pier of the wall close to openings as segments. The forces around the boundary of the wall openings are to be thoroughly designed, analysed and detailed. With the help of this method, the devices generally occurring at the ends of the shear wall, special reinforcement about the opening is essential. The third method is the perforated-shear wall method which is an experimental approach which doesn't need special detailing for force transfer next to the wall openings. This method however, needs devices at every end of the perforated-shear wall.

C. Structural Modelling of Shear Wall

The following models are considered to get the analysis results.

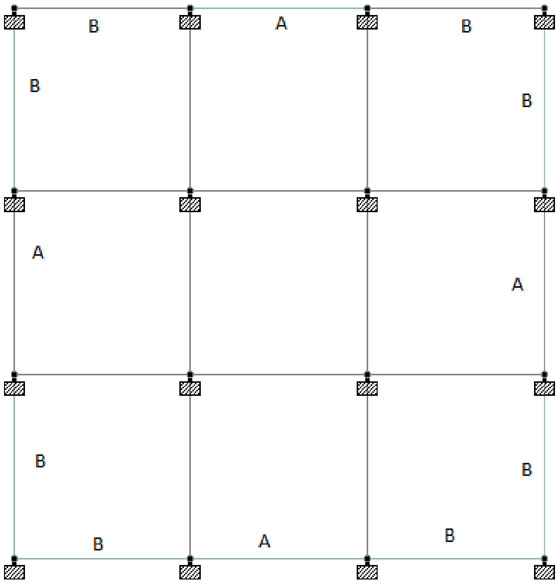

Figure1: Plan Showing All Cases of Shear Walled Building

1 .Ordinary RCC framed building
2. RCC framed building with shear wall at exterior mid bays (position A)
3. RCC framed building with shear wall at all four corners. (Position B)
4. RCC framed building with L shape shear wall
5. RCC framed building with C shape shear wall (using A and B both)

The plan and elevation of each case is shown below from figure 2 To 4

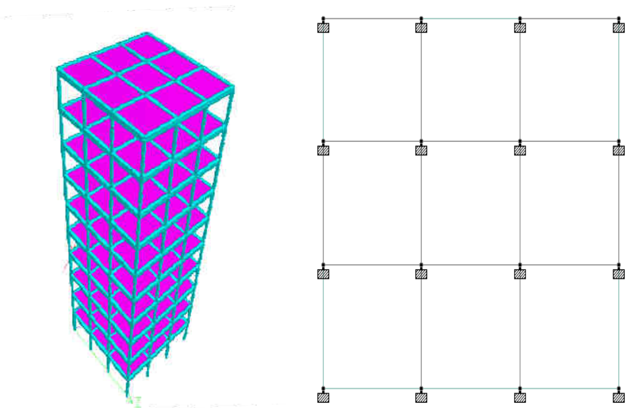

Figure2: 3-D View & plan of Building without Shear Wall

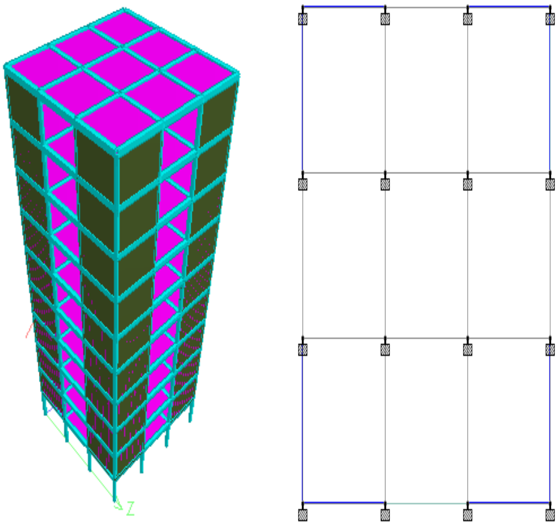

Figure3:3D view and plan of Shear wall At 4 Corners

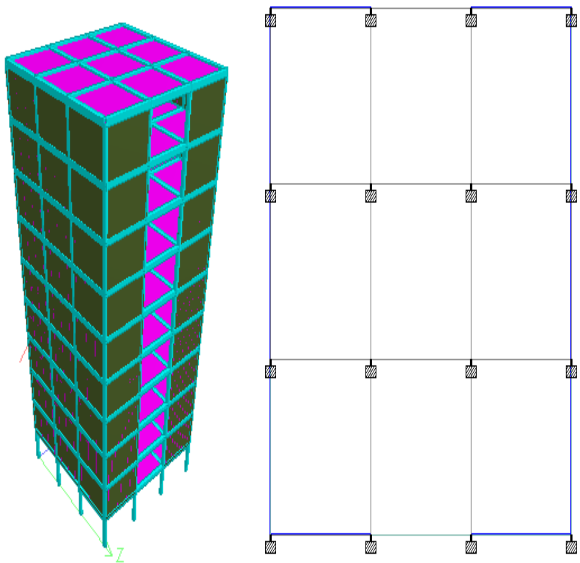

Figure 4: D View& Plan of C-Shape Shear Walled Building

IV. METHODOLOGY

A. Problem Statement

The structure consisting of ten stories with three bays in horizontal direction and three bays in lateral direction is taken and analysed it by equivalent static method and response spectrum analysis and designed. The storey height is 3.5 meters and horizontal spacing between bays is 4 meters and lateral spacing of bays is also 4 meters.

The seismic parameters of building site are as following

- Seismic zone: 4
- Zone factor, Z = 0.24
- Building frame System: RC moment resisting frame
- Response reduction factor: 1.0
- Damping ratio: 5

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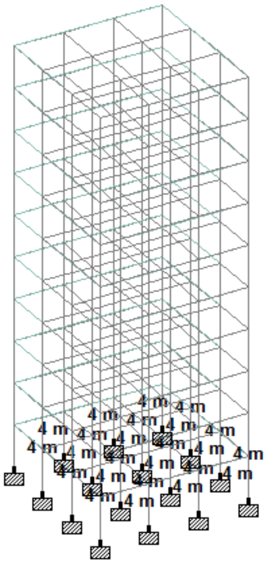

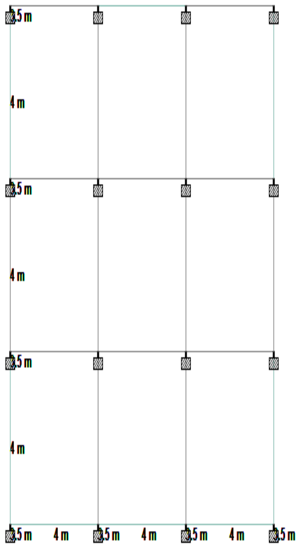

Fig 5: 3-D view of RC building frame Figure 6: Plan of the building

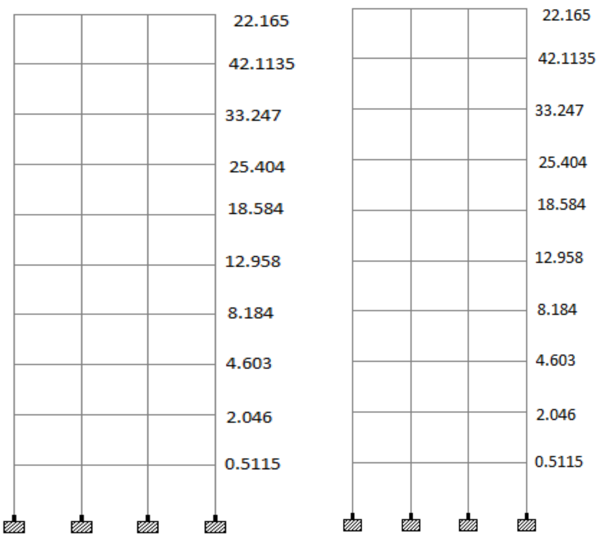

Fig.7: Design seismic Force On The Building For X-direction, And Z-Direction In kN

Table 1: Preliminary Data

1	**Type of structure**	**Multi-storey rigid jointed frame**
2	Zone	IV
3	Layout	As shown in figure 3.2, 3.3, 3.4
4	Number of stories	Ten (G + 9)
5	Ground Storey height	3.5 m
6	Floor-to-Floor height	3.5 m
7	External Walls	250 mm thick including plaster
8	Internal walls	150 mm thick including plaster
9	Dead load on floor	3.5kN/m^2
10	Dead load on roof	1.5kN/m^2
11	Materials	M 30 and Fe 415
12	Seismic Analysis	Equivalent static method IS 1893 (part 1):(2002)
13	Design Philosophy	Limit state method conforming to IS 456:1978
14	Ductility design	IS 13920 : 1993
15	Diameter of Column	300 mm
16	Size of beams in longitudinal and transverse direction	300 X 450
17	Total depth of slab	210mm

V. ANALYSIS AND DISCUSSION

The purpose of this project is to study the behaviour of high rise structures in earthquake zones when shear walls are provided at different places and to compare those values obtained to get the desired structure which is best for resisting the earthquake action. This is done with the help of stadd. Pro software.

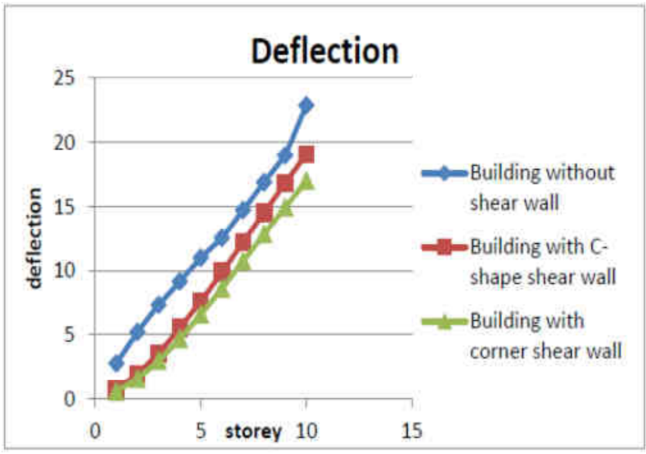

Figure 8: Graph showing storey Deflection in All 3 Cases

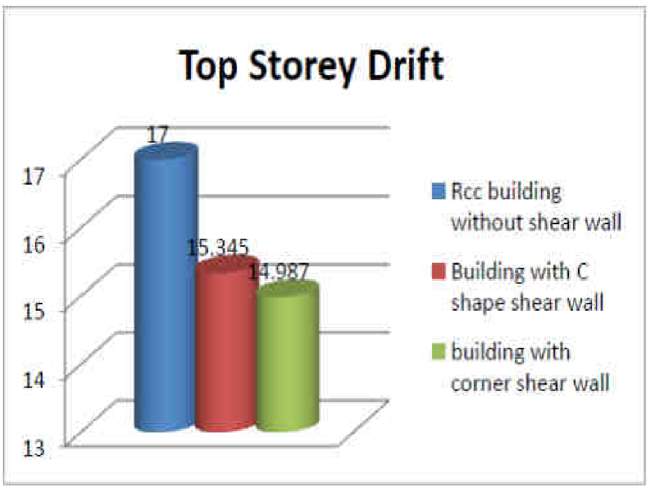

Figure 9: Graph showing Top storey Drift

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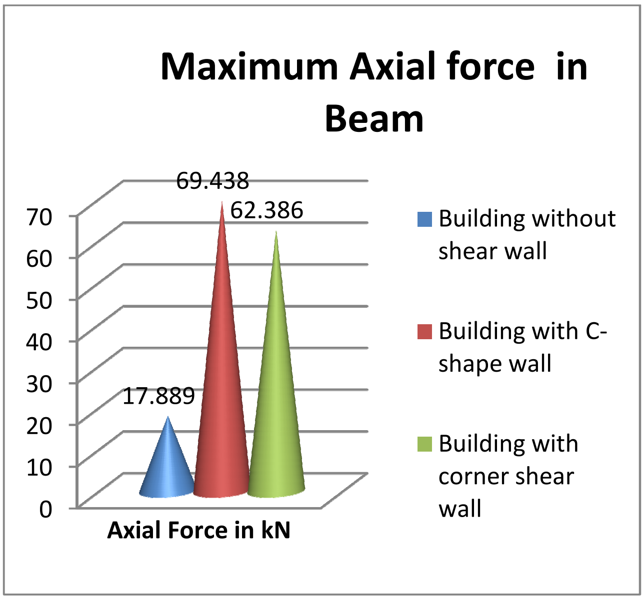

Figure 10: Comparison Between Axial Force in Beam

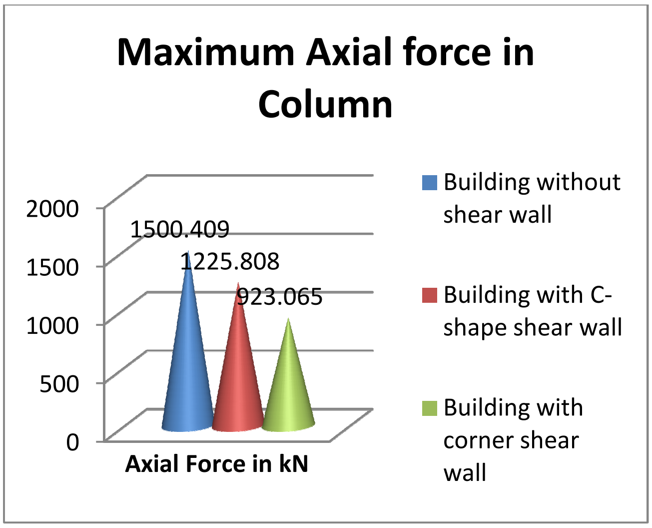

Figure 11: Comparison Between Axial Force in Column

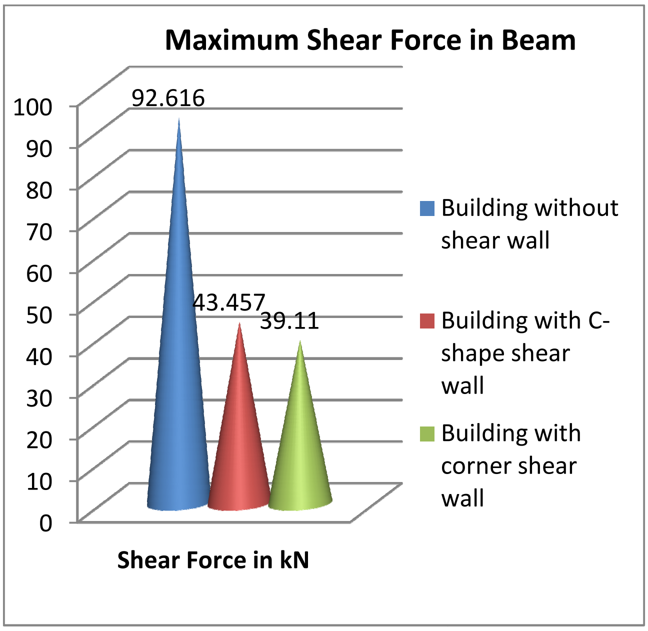

Figure 12: Comparison between Shear Forces in Beam

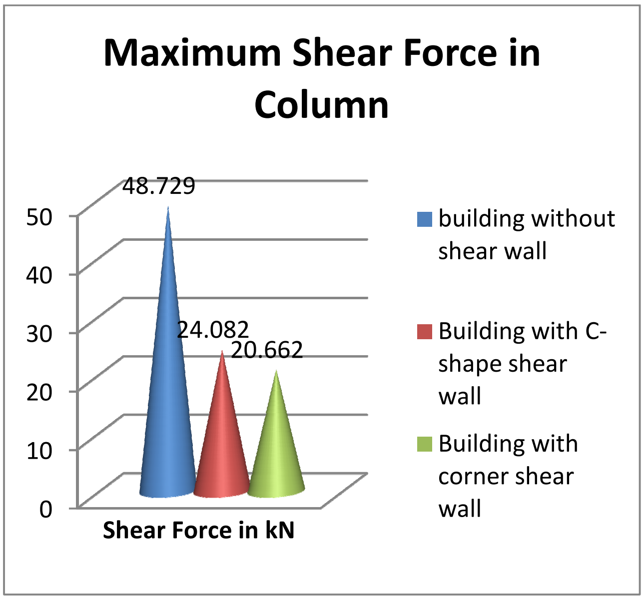

Figure 13: Comparison between maximum shear force in Column

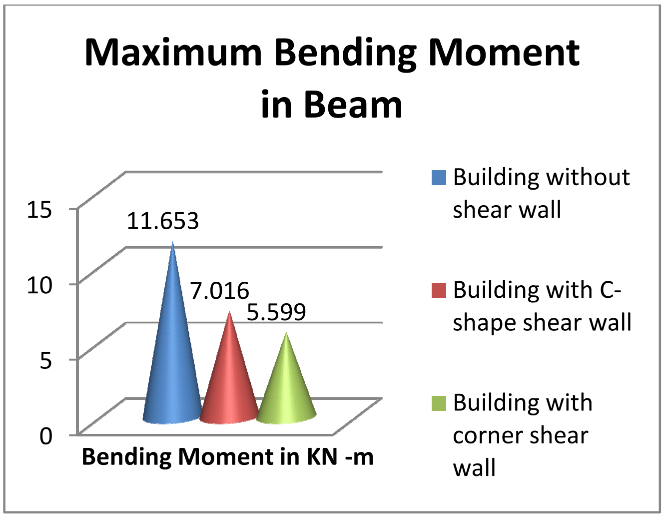

Figure 14:Comparison between bending moment in Beam

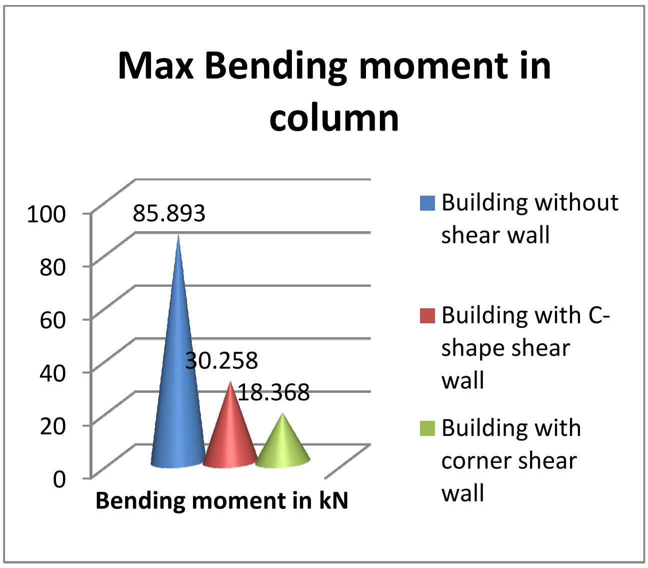

Figure 15: Comparison between maximum bending moment in Column

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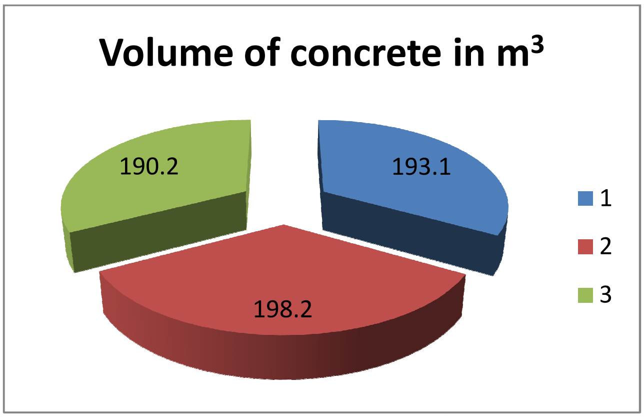

Figure 16: Graph showing Comparison in Volume of Concrete

Where
1 = Building without shear wall
2 = Building with C-shape shear wall
3 = Building with corner shear wall

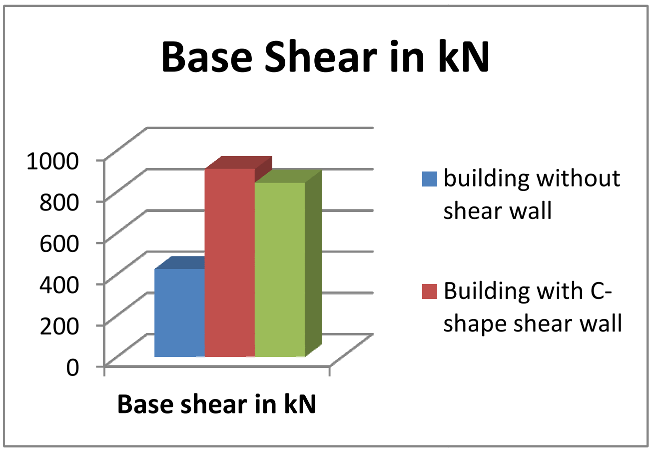

Figure 17: Variations in Base Shear

VI. CONCLUSION

High-rise building (G + 9) with different lateral load resisting system is analysed by using equivalent static method. Detailed parametric study has been performed for a variety of models. Some important conclusions are summarized here.

1. A significant amount of increase in the lateral stiffness has been observed in building with C-shape shear wall and building with shear wall at 4 corners as compared to normal building.
2. Comparing the volume of concrete used in all the cases, it is observed that when structure built using shear wall at corners and C-type shear wall used less volume of concrete and thus cost will be less.
3. Lateral forces increases up to 9^{th} floor in all the cases and then decreases at the roof. However, as compared with all cases, building having shear wall connected at all the four corners are facing least lateral forces.
4. Deflection is minimum when shear walls are provided at all 4 corners throughout the height of the building.
5. A considerable amount of decrease in storey drift has been observed in model having shear wall at corners and C-type shear wall i.e. lateral stiffness in all shear wall frame models are compared. Also building having shear wall at corners, gives less storey deflection and storey drift than other cases.

SCOPE FOR FUTURE WORK

The aim of providing the shear wall is to examine the different ways in which the tall structures can be stabilized against the effects of strong horizontal wind loading and seismic loading. Some other reasons of using 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. This study helps in the investigation of strength and ductility of walls.

REFERENCES

1. Bureau of Indian Standard, IS–1893, Part 1 (2002), "Criteria for earthquake resistant design of structures."
2. Bureau of Indian Standard, IS-456 (2002), "Plain and Reinforced concretecode of Practice."
3. Bureau of Indian Standard IS: 13920:1993,"Seismic Detailing of RC Structure."
4. Rahangdale, H. and Satone, S. R.(2013), "Design And Analysis of Multi-storeyed Building With Effect of shear Wall", International Journal of Engineering Research and Applications (IJERA), Volume 3, Issue 3, pp 223-232.
5. Choudhary, N. and wadia, M. (2014), "Pushover Analysis of R.CFrame Building with shear Wall", IOSR Journal of Mechanical and civil Engineering (IOSR-JMCE), Volume 11, Issue 2.
6. Dugal, S.K (2010), "Earthquake Resistant Design Structures". Oxford University Press YMCA library building, Jai Singh road, New Delhi.
7. Patil, S.S., Konapure, C.G and Ghadge, S.A (2013),"Equivalent Static Analysis of High-Rise Building with Different Lateral Load Resisting Systems", International Jouranal of Engineering Research & Technology, Vol. 2 Issue 1, January-2013.
8. C.K. Wang, Intermediate structures (McGraw Hills, 2004).
9. Aggarwal and Shrikhande, Earthquake resistant design of structures,(PHI Learning Limited, 2006).

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