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EFFECT OF SHEAR WALL POSITION IN MULTI-STORIED BUILDING

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Abstract - *Earthquake is the natural calamity, it produce strong ground motions which affect the structure. Small or weak motions, that can or cannot be felt by the humans. Shear walls are installed to enhance the lateral stiffness, ductility, minimum lateral displacements and safety of the structure. Storey drift and lateral displacements are the critical issues in seismic design of buildings. Different types of frame models are developed and evaluated by Time history analysis and response spectrum analysis by STAAD-Pro. Shear walls are RC walls that are projected along the structure from base. Shear walls reduce the Storey displacement when seismic forces counter the building. Since, the structure may not have aesthetic appearance if the structure is closed with shear wall along the building so shear wall is proved in side of the building. For low rise buildings, bracings may not be suitable.*

In the present work G + 10 multi Storey building is analyzed by using shear wall at different positions. The structure is analyzed and results for different models of structure are evaluated.

Keywords:Shear wall, Time history, Response spectrum, Displacement, Reactions and moment

1. INTRODUCTION

Now-a-days Earthquakes are the most unpredictable and common natural disasters which occurs frequently in some parts of the world (zones). An abrupt released of energy in Earth's crust which forms seismic waves and results in EARTHQUAKE also known as tremor. Which are very difficult to save life, Engineering and other properties. The seismic waves travel outward from the source of the earthquake at varying speeds and are measured by two important parameters those are magnitude and intensity. Intensity is the apparent effect experienced at that location and amount of energy released is measure of magnitude.

Structures on earth, Experiences this effect and causes damage, to resist the lateral forces (seismic waves) structure should adopt stiffness and lateral strength to the buildings. Hence in order to overcome these issues we need to identify the seismic act of the built environment through the development of various methodical procedures, which ensure the structures to withstand during frequent minor earthquakes and produce enough risk avoidance whenever subjected to major earthquake events. So that can save as many lives as possible by adopting Shear walls and bracings to the structure can resist the lateral forces. All over the world, there are several guidelines which has been over and over again updating on this topic.

In case of earthquake prone areas RC shear walls have been used to resist the lateral forces because they have high lateral stiffness. RC shear walls resist earthquake forces with minor damage. When compare to irregular structures, the buildings with uniform load distribution, stiffness and regular geometry in plan and elevation suffer less damage.

2. STRUCTURAL AND GEOMETRICALPROPERTIES

2.1 Preliminary data for G + 10 plane frame

1. Type of structure : Multistorey rigid jointed planeframe
2. Zone : II
3. Number of stories: G + 10
4. Imposed load : 2 kN/m² at roof and 4 kN/m² at floors
5. Terrace water proofing (TWF) : 1.5 kN/m²
6. Floor finish : 0.5 kN/m²
7. Depth of slab : 120 mm
8. Materials : M 30 concrete and Fe 415 steel
9. Unit weight of RRC : 25 kN/m³
10. Unit weight of masonry : 20 kN/m³
11. Modulus of elasticity of concrete : 2 x 107 kN/m²
12. Bay width of plane frame (in both x and z): 3 m
13. Total height of building frame : 33 m
14. Height of storey : 3m
15. Depth of foundation : 2 m
16. Beams : 300 x 300 mm
17. Columns upto 5 storeys : 300 x 500 mm
18. Columns top 5 storeys : 300 x 400 mm
19. Clear cover of beam : 25 mm
20. Clear cover of Column : 40 mm

21. Thickness of wall exterior : 230 mm
22. Thickness of wall interior and parapet: 100 mm
23. Thickness of shear wall : 250 mm

2.2Plan area

Length of building : 12 m
Width of building : 12 m
Height of building : 35 m

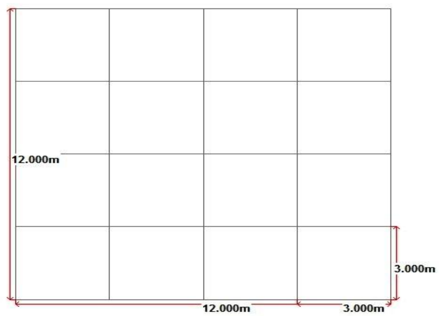


Fig 1 Plan

24. Width of shear wall : 6 m
25. Height of shear wall : 35 m

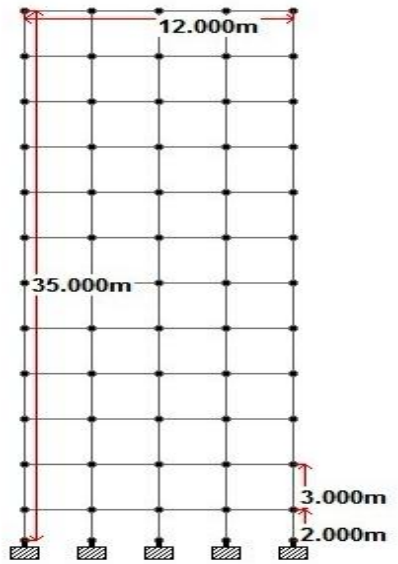


Fig 2 Elevation

2.3 TYPES OF SEIMIC ANALYSIS

2.3.1Response spectrum analysis

This method is applicable for those structures where other than the fundamental one affect significantly the response of the structure. The response of the structure can be defined as the combination of modes. The modes of structure can be analyzed by any software. A response of mode can be analyzed from design spectrum, based on modal mass and modal frequency. Magnitude of forces in all directions is calculated based upon the different combinations as follows:

- Absolute – peak values
- Square root of sum of the squares (SRSS)
- Complete quadratic combination (CQC) – for closely spaced modes,

a method improved on Square root of sum of the squares

In this case structures are too tall, too irregular or of significance to a community in disaster management, and more complex analysis are required, such as non-linear static or dynamic analysis.

2.3.2 Elastic time history analysis

A linear time history overcomes all the drawbacks of modal response spectrum analysis, provided non-linear behavior is not involved. It requires greater computational efforts for calculating the response at discrete intervals. One interesting advantage of such procedure is that the relative signs of response quantities are preserved in the response histories. This is important when interaction effects are considered in design among stress resultants.

2.4 SHEAR WALL

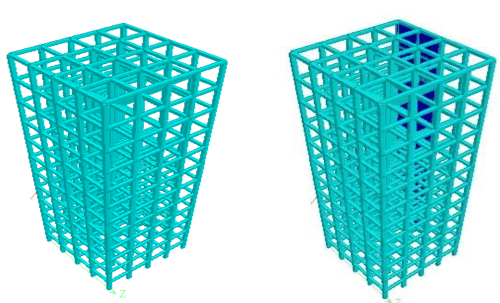
In structural engineering, a shear wall is a structural system composed of braced panels (also known as shear panels) to counter the effects of lateral load acting on a structure. Wind and seismic loads are the most common loads that shear walls are designed to carry. Shear walls are vertical members that resist pseudo static (seismic) forces. These are provided along the height to resist the in-plane loads. Shear wall mainly experience the seismic and wind loads. Generally, the loads are transferred to walls by Diaphragm (The structural element which transverse the lateral load to the vertical resisting elements of a structure. These are mainly in horizontal, but can be in sloped in special case like ramp for parking the vehicle). They may be wood, concrete and masonry. Shear walls have high strength and stiffness to resist the lateral forces. Shear wall are very important in high rise buildings in the seismic prone areas. Lateral displacement can be reduced by these shear wall. These are designed to resist both self-weight of the structure (gravity loads) and lateral forces.

Natural calamities (Earthquakes, wind forces) force causes several kinds of stresses such as shear, tension, and torsion etc., the structure may experience Storey displacement or may collapse suddenly. Shear wall reduces the severity of lateral displacement of the structure and indicate the failure of the structure.

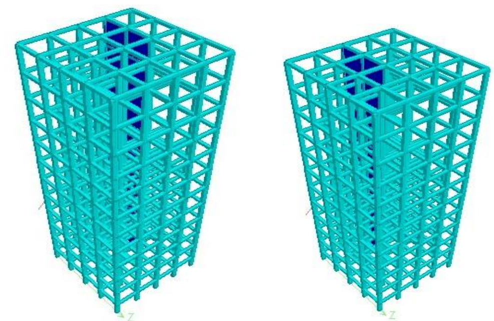
2.5 BUILDING MODALS

Different locations or positions of shear wall was placed for the structure as follows

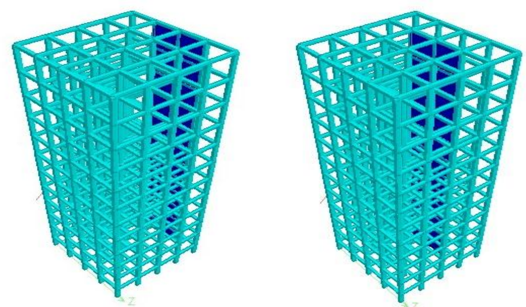
Sl. No	Frame	Description
1	Normal	RC frame structure without shear wall
2	SW at 12 m T	RC frame structure with shear wall at 12 m Top in YZ plane
3	SW at 9 m T	RC frame structure with shear wall at 9 m Top in YZ plane
4	SW at 6 m T	RC frame structure with shear wall at 6 m Top in YZ plane
5	SW at 12 m C	RC frame structure with shear wall at 12 m Centre in YZ plane
6	SW at 9 m C	RC frame structure with shear wall at 9 m Centre in YZ plane
7	SW at 6 m C	RC frame structure with shear wall at 6 m Centre in YZ plane
8	SW at 12 m B	RC frame structure with shear wall at 12 m bottom in YZ plane
9	SW at 9 m B	RC frame structure with shear wall at 9 m bottom in YZ plane
10	SW at 6 m B	RC frame structure with shear wall at 6 m bottom in YZ plane



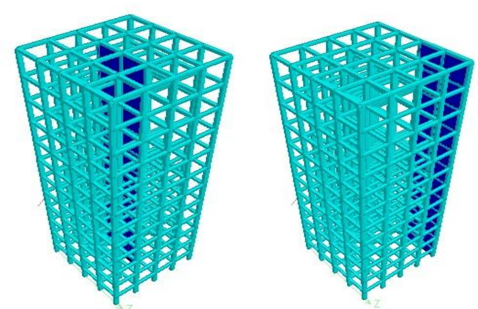
1) Normal 2) Sw at 12 m T



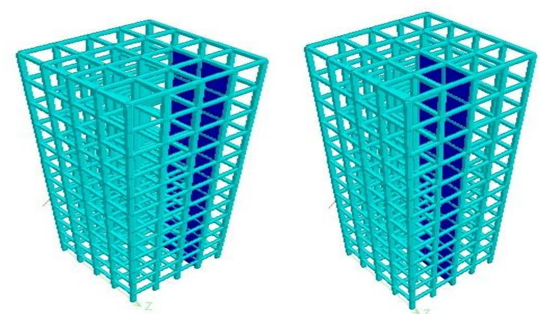
3) SW at 9 m T 4) SW at 6 m T



5) SW at 12 m C 6) SW at 9 m C



7) SW at 6m C 8) SW at 12 m B



9) SW at 9 m 10) SW at 6 m B

Fig1Different locations of shear wall

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3 RESULTS AND DISCUSSION

3.1 TIME HISTROY ANALYSIS

3.1.1 Nodal displacements

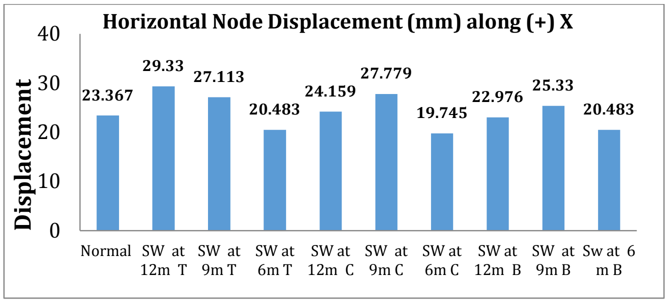

Fig 4 Horizontal nodal Displacement along (+) X

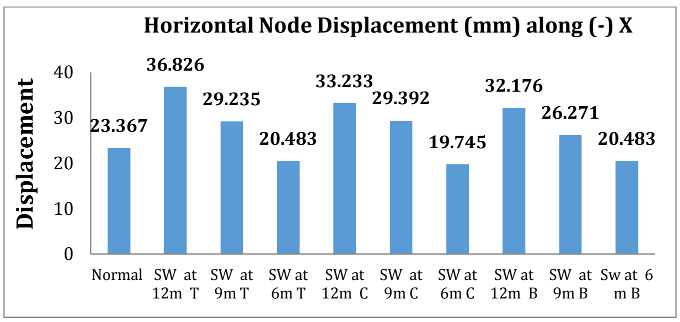

Fig 5 Horizontal nodal Displacement along (-) X

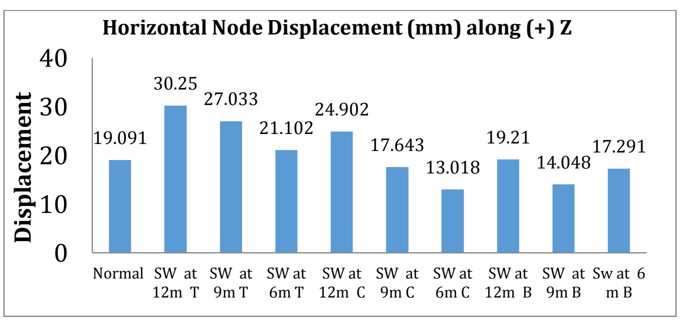

Fig 6 Horizontal nodal Displacement along (+) Z

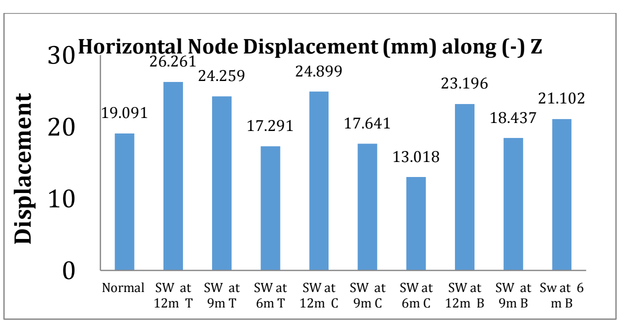

Fig 7 Horizontal nodal Displacement along (-) Z

In the nodal displacement, out of these modals shear wall at 6 m Centre gave lower displacement when compared to other models in both positive and negative X and Z directions.

3.1.2 Support reaction

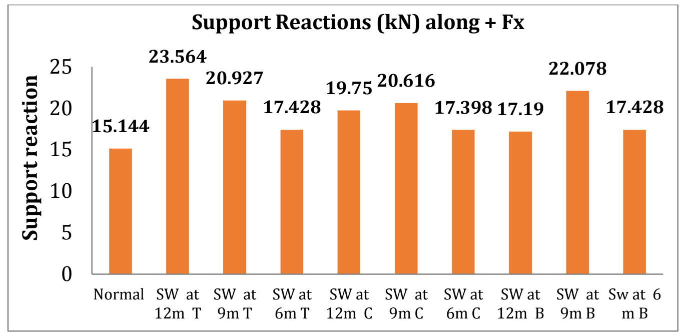

Fig 8 Support reaction along (+) Fx

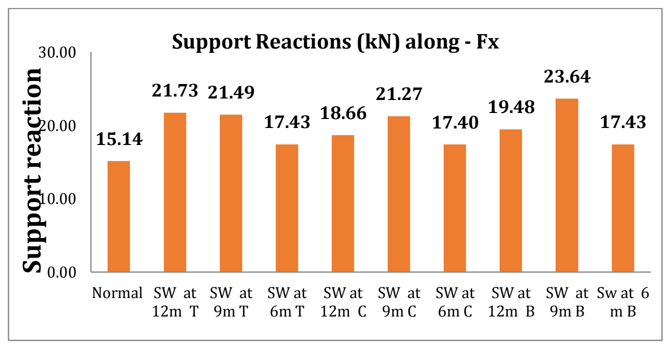

Fig 9 Support reactionalong (-) Fx

In the Support reaction, out of these modals shear wall at 6 m Centre gave lower Support reaction when compared to other models in both positive and negative X and Z directions.

3.1.3 Bending moments

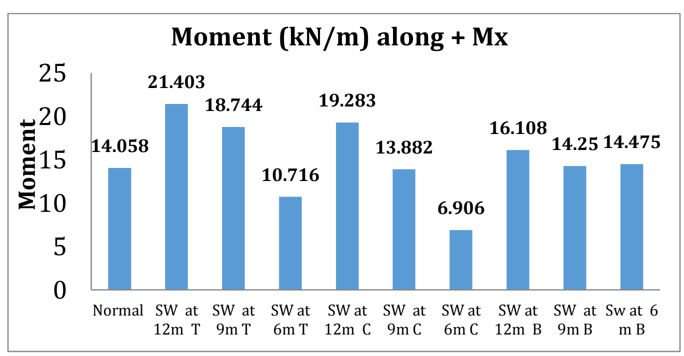

Fig 10 Bending moment along (+) Mx

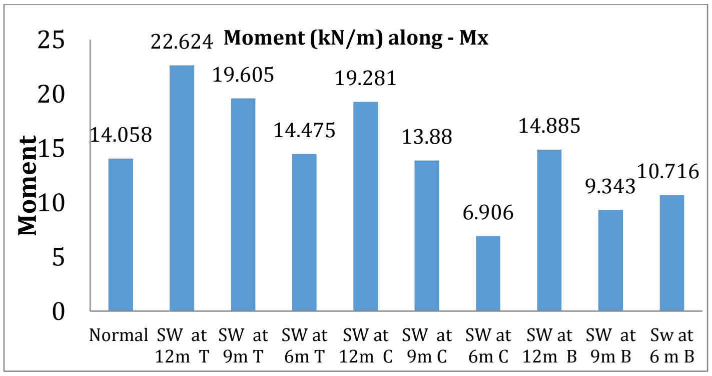

Fig2 Bending moment along (-) Mx

In the Moment, out of these modals shear wall at 6 m Centre gave lower moment when compared to other models in both positive and negative X and Z directions.

3.1.4 Steel quantities

The quantities of steel are in tons. Here we can see the quantities of steel for different models in Figure 12.

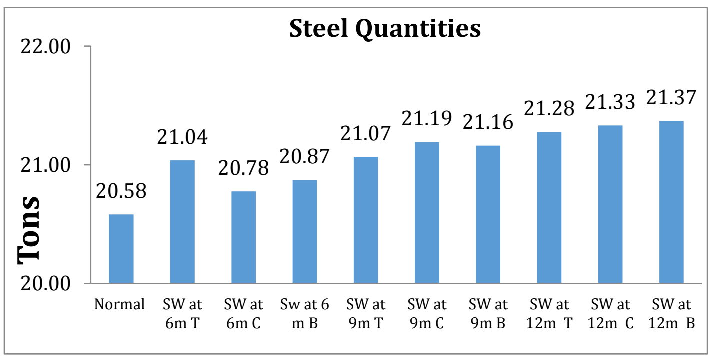

Fig 12Steel quantities

3.2 RESPONSE SPECTRUM

3.2.1 Nodal displacements

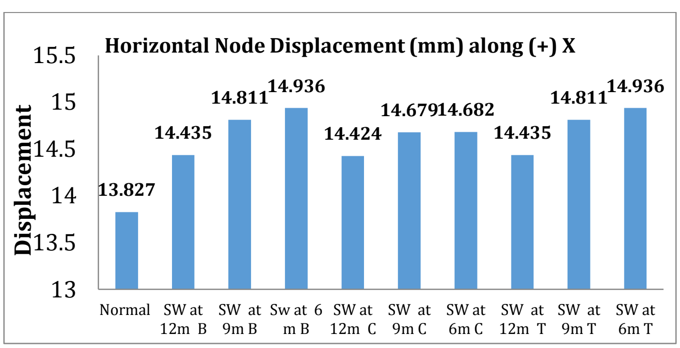

Fig 13 Horizontal nodal Displacement along (+) X

Out of these models normal building has very less nodal displacements when compared to shear wall provided models.

3.2.2 Support reaction

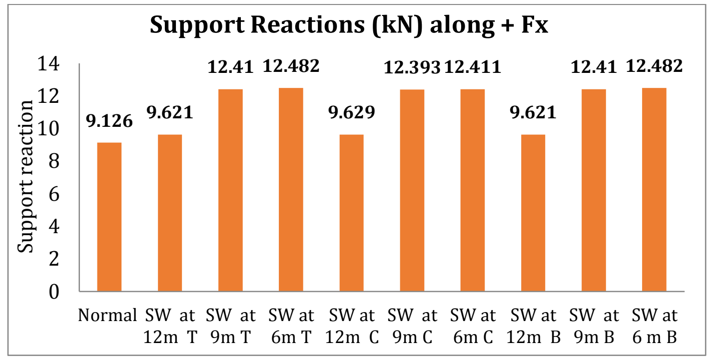

Fig 143 Support reaction along (+) Fx

Out of these models normal building has very less support reaction when compared to shear wall provided models.

3.2.3 Moment

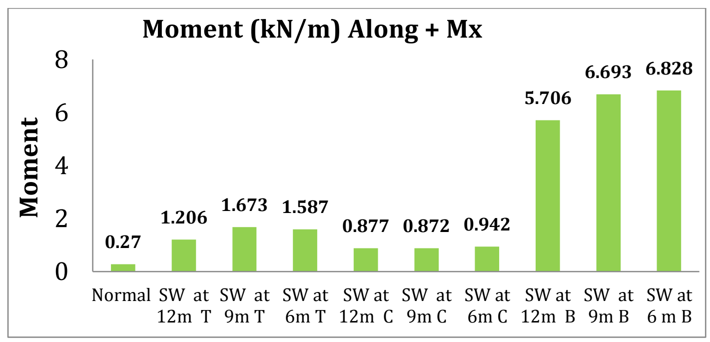

Fig 15 Bending moment along (+) Mx

Out of these models normal building has very less moment when compared to shear wall provided models.

3.2.4 Steel quantities

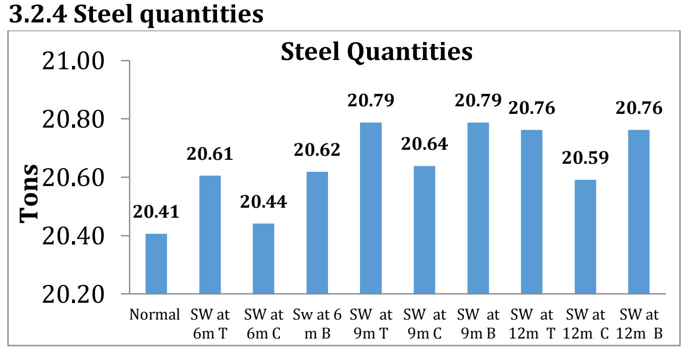

Fig 16 Steel quantities

4 CONCLUSIONS

4.1 TIME HISTROY ANALYSIS

1. We can see the nodal displacement (+X) in RC frame structure with shear wall at 12 m and 9 m Top, Centre and Bottom in YZ plane has increased some percentages but the shear wall at 6 m Top, Centre and Bottom in YZ plane has decreased by 12.3%, 15.5% and 12.3% respectively when compared to normal building.
2. By placing the shear wall at 6 m Centre in YZ plane has decreased by 15.5% of nodal displacement when compared to normal building.
3. The shear wall at 6 m Top, Centre and Bottom in YZ plane has increased by around 15% of support reaction but 12 m and 9 m Top, Centre and Bottom in YZ plane has increased by more percentages when compared to normal building.
4. The provision of shear wall at 6 m Centre gave lower bending moment when compared to other models. So provision of shear wall at 6 m Centre gives rigidity to structure.
5. The steel quantities (tons) in RC frame structure with shear wall in YZ plane at 6 m Top has increased by 2.21%, 6 m Centre has increased by 0.94 %, 6 m Bottom has increased by 1.41%, 9 m Top has increased by 2.35%, 9 m Centre has increased by 2.96%, 9 m Bottom has increased by 2.81%, 12 m Top has increased by 3.86%, 12 m Centre has increased by 3.64% and 12 m Bottom has increased by 3.82% when compared to normal building.
6. From the above cases the shear wall at 6 m Centre has required lower quantity of steel when compared to other models.

4.2 RESPONSE SPECTRUM

1. When compared to normal building, provision of shear wall at any location (modals developed in the thesis) has increased the nodal displacement. But out of these shear wall at 12 m Centre gave lower displacement.
2. The shear wall at 12 m Top, Centre and Bottom in YZ plane has increased lower percentages of support reaction when are compared to The shear wall at 6 m and 9 m Top, Centre and Bottom.
3. Provision of shear wall at 12 m, 9 m and 6 m Centre in YZ plane has increased lower percentages of support reaction when are compared to the shear wall at 12 m, 9 m and 6 m Top and Bottom.
4. The steel quantities (tons) in RC frame structure with shear wall in YZ plane at 6 m Top has increased by 0.98%, 6 m Centre has increased by 0.17%, 6 m Bottom has increased by 1.04%, 9 m Top has increased by 1.87%, 9 m Centre has increased by 1.14%, 9 m Bottom has increased by 1.87%, 12 m Top has increased by 1.75%, 12 m Centre has increased by 0.91% and 12 m Bottom has increased by 1.75% when compared to normal building.
5. From the above cases the shear wall at 6 m Centre has required lower quantity of steel when compared to other models.

However, it is evident that Response spectrum method has been wrong method in seismic analysis and it is also proven in this thesis.

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