"PARAMETRIC STUDY OF SEISMIC BEHAVIOUR OF MULTISTOREY BUILDING WITH L, PLUS AND RECTANGULAR ARRANGEMENT OF SHEAR WALLS"

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Abstract: Shear walls are one of the best ways to make multi-story reinforced concrete buildings earthquake resistant. Shear walls are specially engineered concrete walls used in buildings to withstand horizontal forces caused in the wall's plane by wind, earthquakes, and other forces. Shear walls have a high in-plane stiffness and strength, allowing them to withstand significant horizontal loads while still supporting gravity loads. Because of the destructive effects of earthquakes in the last decade, it is now necessary to consider earthquake effects when designing medium to high-rise buildings. Before assessing the structural stability of a system, earthquake forces should be considered. Shear walls can be very effective in resisting lateral loads caused by wind or earthquakes when they are placed in advantageous locations in a house. The present study is carried out to address better understanding and improved usage of shear wall with different shapes and different location. In this project, various models of 11 storeyed building in zone IV are analysed by changing locations of shear walls for determining parameters like lateral displacement and storey drift. Different models have been drawn by adopting different locations and configurations of shear walls. Linear static, linear dynamic (response spectrum analysis) methods of analysis have been used following IS: 1893 (Part l)-2002. The seismic analysis of all the frame models has been done for various load combinations according to IS: 1893 (Part-l)-2002 has been done by using software STAADPRO V8i.

Keywords: Seismic Analysis, Shear Wall, Response Spectrum, Seismic Effect, Story Drift, Multi-storey Building.

1. INTRODUCTION

Shear wall are one of the excellent means of providing earthquake resistance to multi storeyed reinforced concrete building. In high-rise buildings, beam and column dimensions are wide, and heavy reinforcement at beam-column joins is very heavy, resulting in a lot of clogging at these joints, making it difficult to position and vibrate concrete, which does not add to the buildings' protection. These functional issues necessitate the use of shear walls in high-rise buildings. From the standpoint of economy and control of horizontal displacement, a shear wall can become essential. During earthquakes, the foundation is still weakened for several reasons. The distribution of weight, stiffness, and strength in both horizontal and vertical planes of the system determines how it behaves during earthquake motion. The Building uses reinforced concrete shear walls to mitigate the effects of earthquakes. These can be used to improve

a building's seismic response. The primary issue in structural architecture for seismic loading is structural stability during major earthquakes. It is critical to ensure sufficient lateral stiffness in tall buildings to resist lateral loads.
Reinforced concrete shear walls are used in building to resist lateral force due to wind and earthquakes. They are usually provided between column lines, in stair wells, lift wells, in shafts that house other utilities. Shear wall provide lateral load resisting by transferring the wind or earthquake load to foundation. Besides, they impart lateral stiffness to the system and also carry gravity loads. When shear wall are situated in advantageous positions in the building, they can form an efficient lateral force resisting system. The taller and more the slender a structure, the more important the structural factors become and the more necessary it is to choose an appropriate structural form or the lateral loading system for the building. In high rise buildings which are designed for a similar purpose and of the same height and material, the efficiency of the structures can be compared by their weight per unit floor area.

1.1Functions of shear wall

- To withstand horizontal earthquake forces, shear walls must have sufficient lateral strength. Shear walls will pass these horizontal forces to the next feature in the load path below them if they are high enough.
- Shear walls can have lateral stiffness to prevent undue side sway in the roof or floor above.
- Shear walls that are sufficiently stiff will prohibit floor and roof framing members from shifting off their supports. Non structural loss is normally less in structures that are sufficiently stiff.
- Shear walls give buildings a lot of strength and stiffness in the direction of their orientation, which decreases lateral sway dramatically. As a result, damage to the building and its contents is reduced. the details Shear walls hold a lot of lateral force.earthquake powers, and the consequences of overturning on them are very big.

1.2Objectives of present work

i) To analyse an R.C. building frame using staad.pro Software setup.

ii) To analyze the storey drift pattern in various types of frames.

iii) To find out the configuration which has least lateral displacement and storey drift i.e. best location of shear walls with shapes in a building for earthquake prone area.

iv) To study the results of base shear, storey drift, nodal displacement, maximum reaction for seven different models.

Table 1.Structural properties of building

S NO	Properties	Dimensions
1	Shear wall thickness	200 mm
2	Total depth of slab	150 mm
3	Spacing b/w frame along X direction	4m
4	Spacing b/w frame along Y direction	3m
5	Size of beam	(350 x 400)mm
6	Size of column	(450 x 500)mm
7	No of storey	11
8	Density of concrete	25 KN/m^3
9	Floor hieght	4 m
10	Zone factor (Z)	0.24
11	Importance factor (I)	1.5
12	Response reduction factor (R)	5
13	Live load of the building at floor level	3.5KN/m^2
14	Soil type	Medium
15	Damping	5%
16	Grade of Concrete and steel	M30 and Fe 415
17	Support condition	Fixed

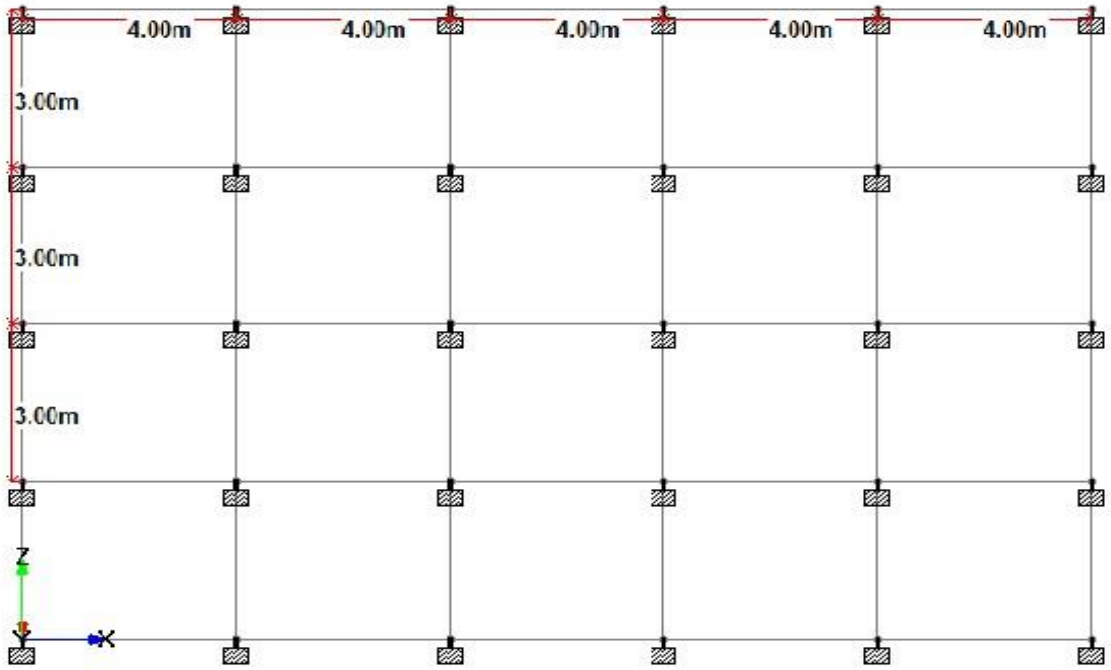

Figure 1. Floor plan of the building

2. LITERATURE REVIEW

A literature review is carried out to define the objectives of the paper. The literature review is discussed briefly summarized as follows:

Sanisha Santhosh et. al.(2017) studied on the improvement shape of shear walls in symmetrical high rise building. The multi storey with G+14 and G+29 storey's are analyzed for its storey drift and base shear using ETABS software. For the analysis of the building for seismic loading with two different Zones (Zone- III & Zone-V) is considered

Vijit Sahu et. al.(2018) explained the main focus is to determine the solution for shear wall location in multistory building. A study has been carried out to determine the strength of RC shear wall of a multistoried building with different arrangements, with or without central cross shear wall. Six different cases of shear wall position for a 5 storey building have been analyzed.

Mindala Rohini et. al.(2019) Studied An earthquake occurs in the form of seismic waves due to sudden release of energy and results in ground shaking. the analysis is carried out for seismic response of (G+15) residential building for zone-III and Zone-V regions through response spectrum method and time history method in ETABS. The parameters like storey displacement, storey drift and storey shear are observed for specified zones.

Ashish Raghuwanshi et. al.(2020) coupled shear wall in combination with steel x bracing provided in bare frame at an outer portion of the building with R.C.C beam and the slab and this frame is analyzed and compared with bare frame. For present research analysis a regular 13 storey RCC frame having square plan of size 25 m × 25 m which is located in seismic zone V is considered. For the analysis of structure STAAD.Pro software is used and the Seismic zone consideration is as per IS 1893(Part 1): 2002**.**

3. METHODOLOGY

The 11-storeyed building frames consists of beams, columns, slabs and shear wall are modeled for analysis using software Staadpro v8i. Four separate models were investigated of various shear wall placements in order to determine parameters such as storey drift and displacement in order to determine the best shear wall location in buildings. In this project 4 types of structures in which shear walls at different locations are taken for comparison Type 2 and 4 are the structures without central cross shear wall and type 2 are the structures in which central cross shear walls are provided at the center.

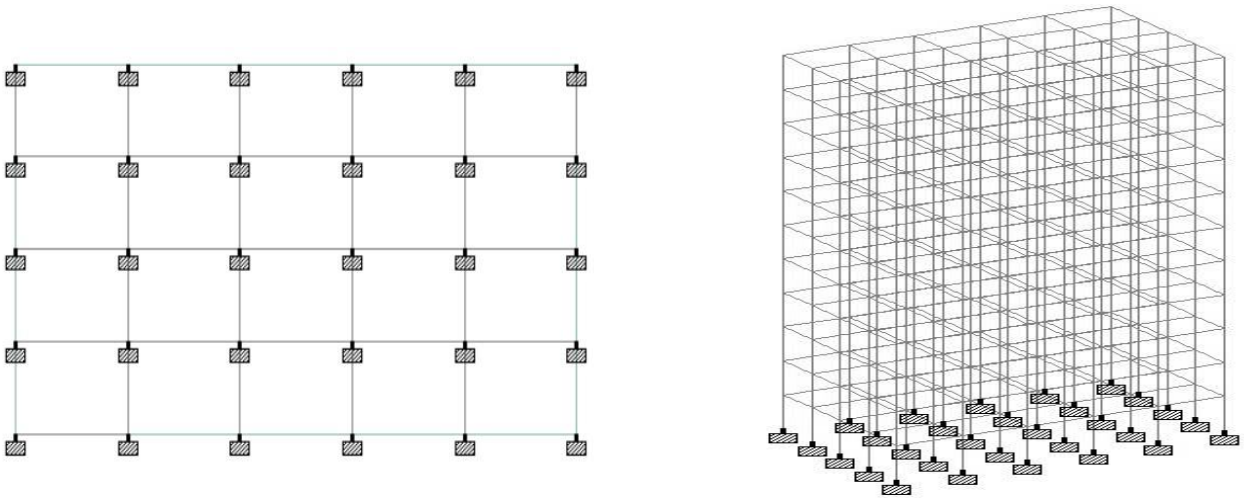

Figure 2.structure without shear wall

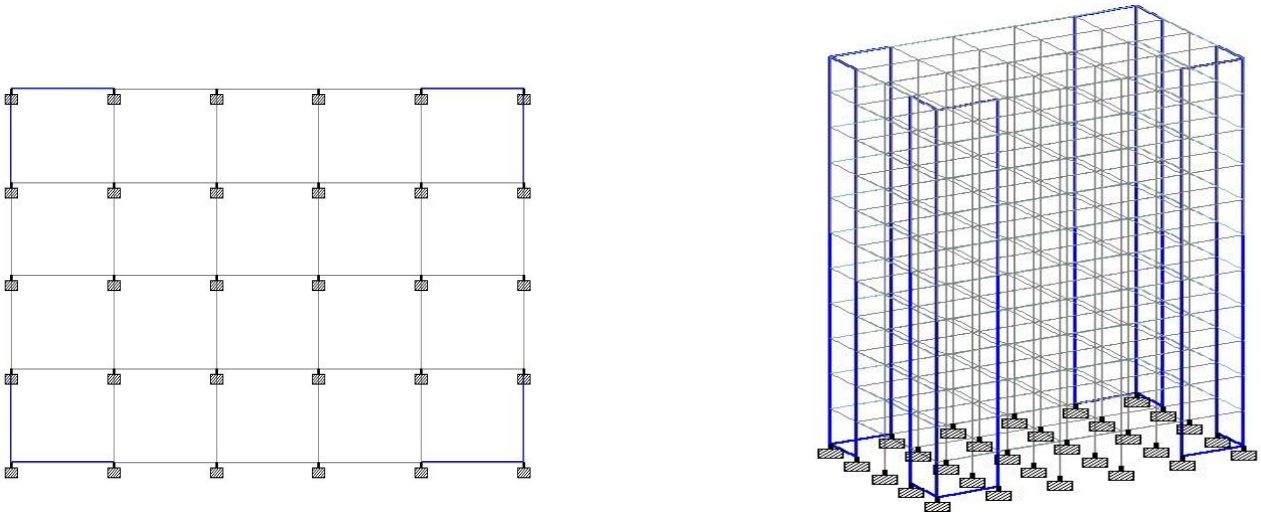

Figure 3.Shear Wall at corners

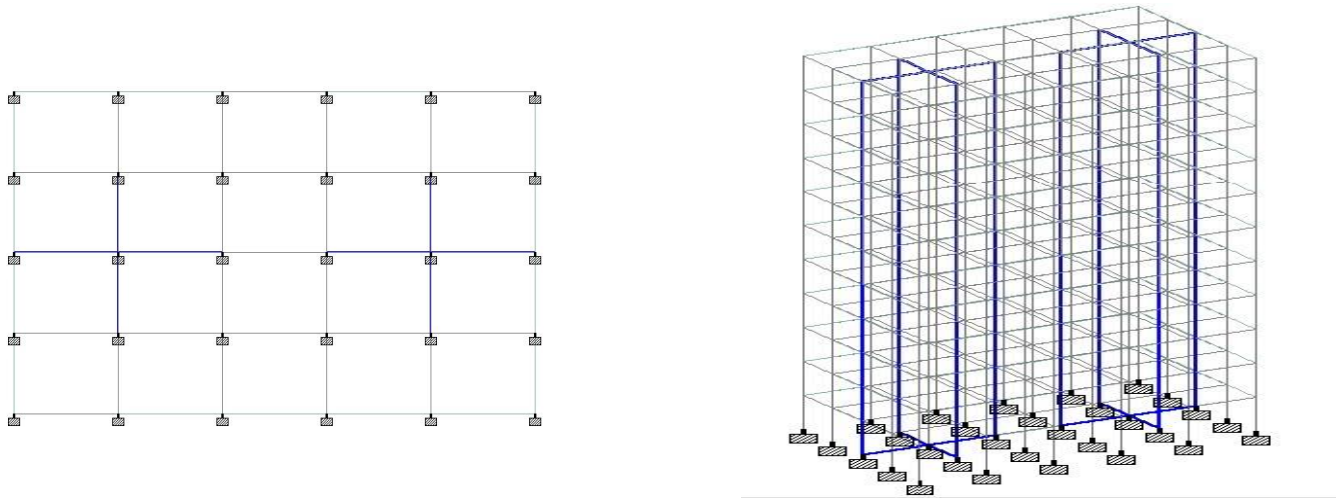

Figure 4.Shear wall in middle

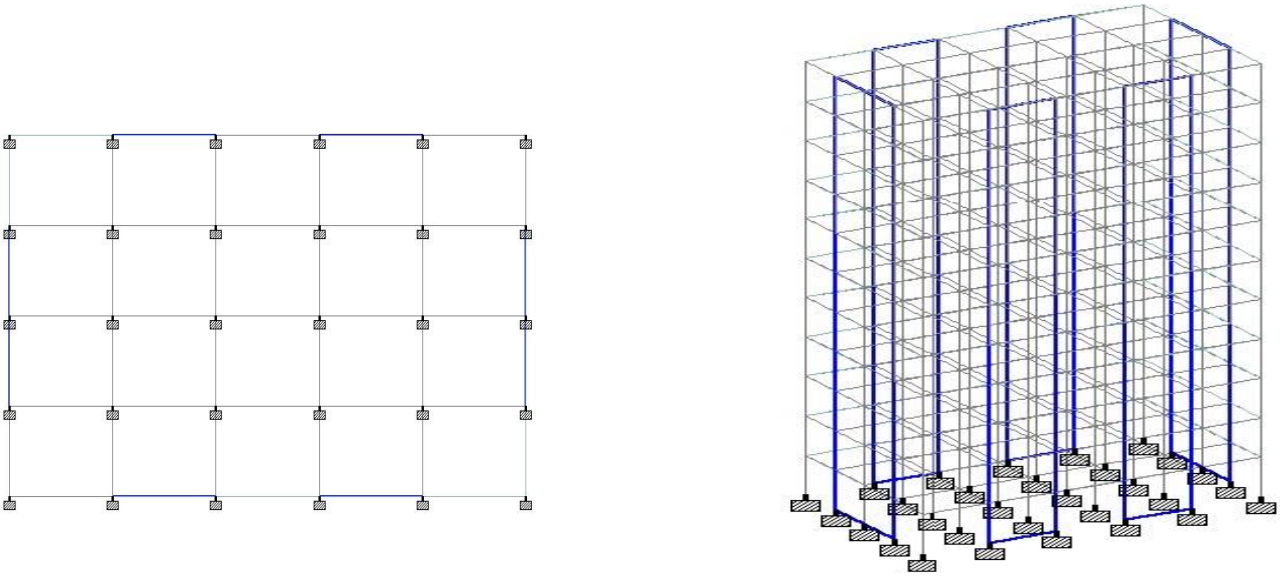

Figure 5.shear wall along periphery

3.1 Result and discussion

3.1.1 Lateral displacement

Among all the load combination, the load combination of 1.5DL+1.5EQ is found to be the most critical combination in both X and Y directions for all the models. So all the results are for load combination of 1.5DL+1.5EQ, where DL= Dead load including floor finish load and wall load, and EQ= Earthquake load in corresponding direction.
Obtained results have been presented in form of graphs, indicating the trends and pattern of variables such as lateral displacement, storey drift.

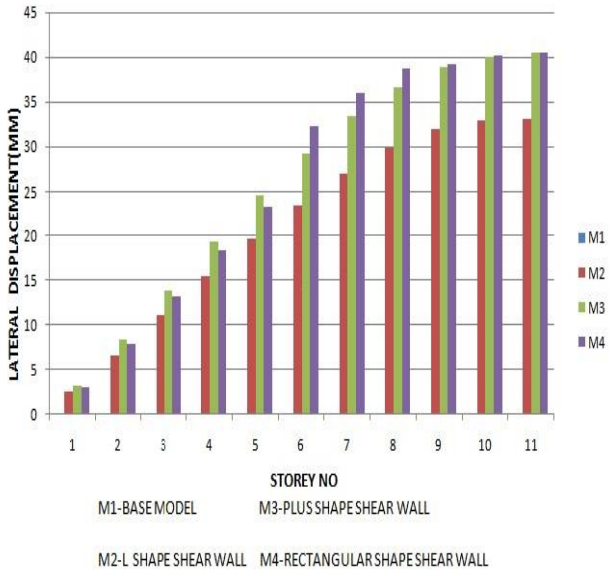

Figure 6.Lateral displacement along X-direction (Equivalent static method)

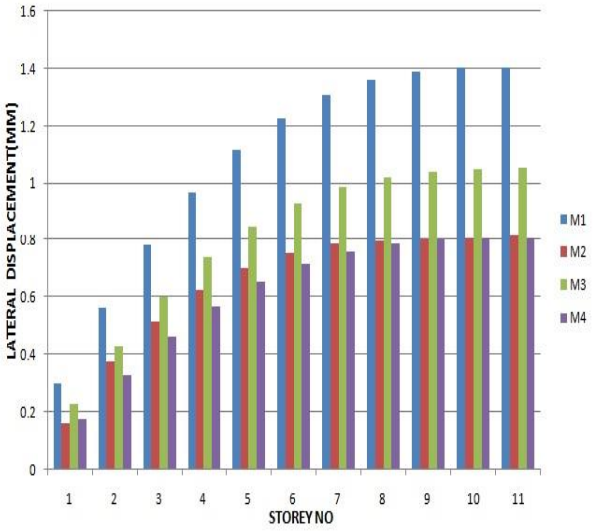

Figure 7.Lateral displacement along Y- direction (Equivalent static method)

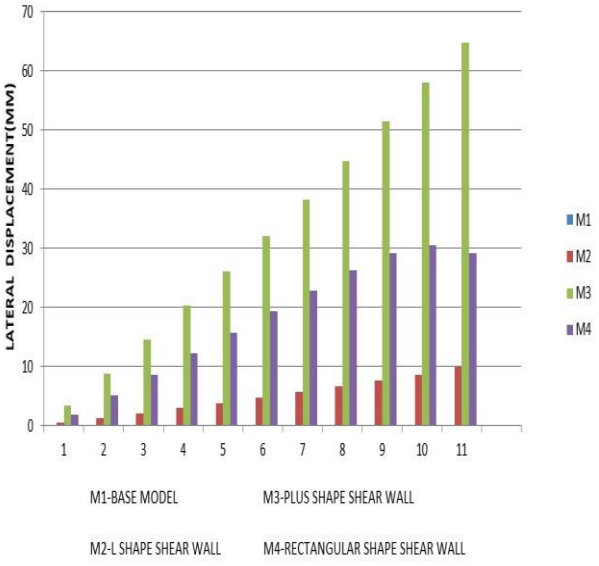

Figure 8.Lateral displacement along X-direction (Response spectrum method)

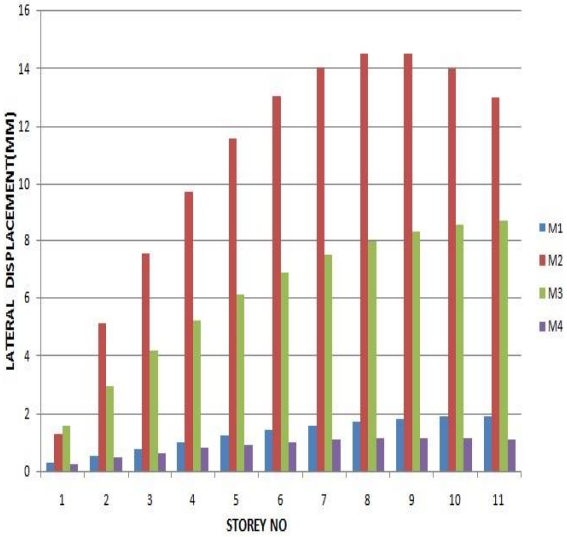

Figure 9.Lateral displacement along Y direction (Response spectrum method)

3.1.2 Storey drift

In case of drift, as the height of the building increases, the drift also increases up to a certain height and after that it decreases. From the graph it is observed that the maximum value of storey drift is for the structure type 4 which is shear wall along periphery and the minimum value is for the model type 1 which is shear wall not provide (base model).

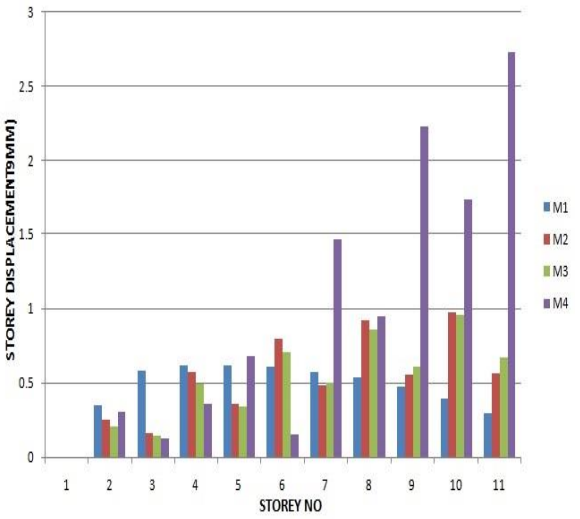

Figure 10.Storey drifts along X-direction (Equivalent static method)

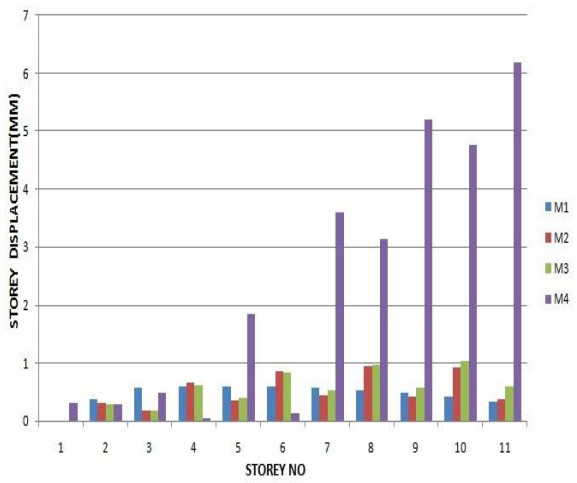

Figure 11.Storey drifts along Y-direction (Equivalent static method)

3.1.3 Maximum nodal displacement due to earthquake load

The reaction at supports implies that the rigidness of support and to ensure that the capability of a column to transfer the load without settlement of support. From the Figures it has been observed that maximum nodal reaction for M1 (Base model) which is structure without shear wall is minimum And nodal reaction is maximum for M4 model which is shear wall along periphery.

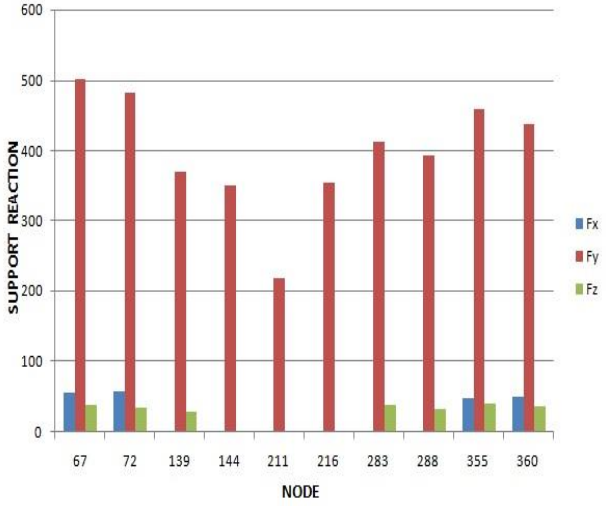

Figure 12.NODAL SUPPORT REACTION (Shear wall at Corner)

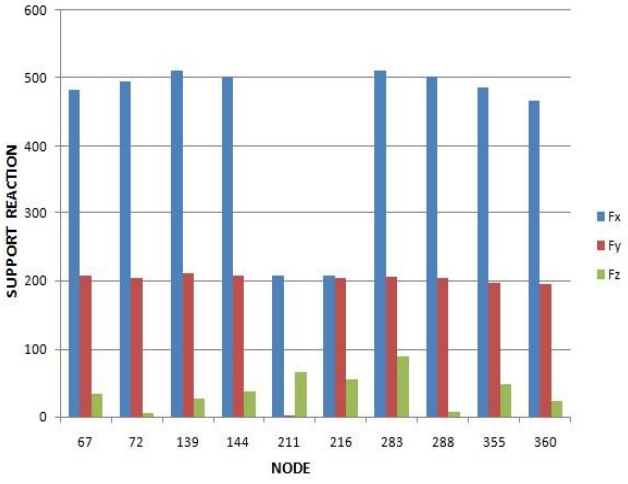

Figure 13.NODAL SUPPORT REACTION (Shear wall at middle)

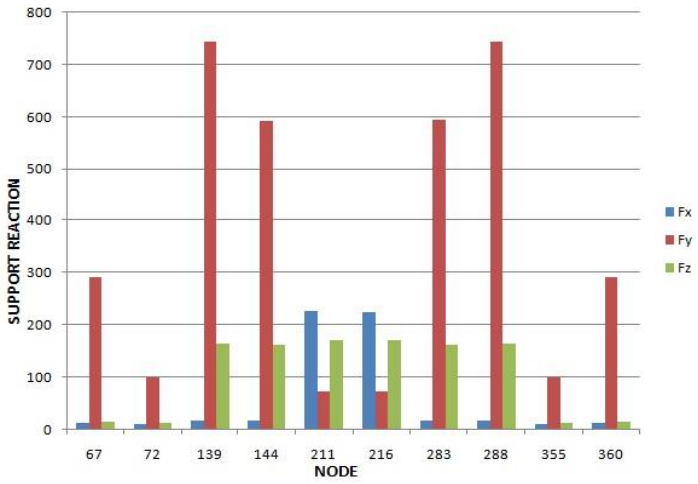

Figure 14.NODAL SUPPORT REACTION (Shear wall along Periphery)

3.1.4 Base shear

Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of the structure. Base shear and mass participation factors in percent for both the buildings at plain and slope are shown below. The total design lateral force or design seismic base shear Vb along any principal direction is determined by the STAAD. Participation factor Sum-X on 50th mode is calculated to be 93.21 for building at plain. Seismic weight has been achieved using the first three mode shapes. As per clause 7.8.4.2 in IS 1893, the number of modes to be used in the analysis should be such that the sum of total of modal masses of all modes considered as 90% of total seismic mass. The summation has come to be about 90% in STAAD Pro V8i, hence we can conclude that clause 7.8.4.2 has been satisfied.

Table 2.Value of base shear for all types of structure

TYPE	STRUCTURE TYPE	BASE SHEAR
1	Structure without shearwall	862.15
2	Shearwall at corner	1083.92
3	Shearwall in middle	1083.92
4	Rectangular shearwall along periphery	1083.92

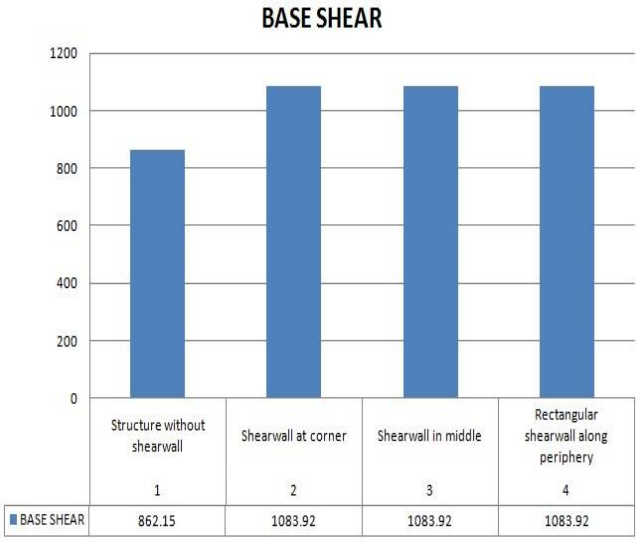

Figure 15.base shear of structure with shear wall

4. CONCLUSIONS

The key goal of this project was to investigate the impact of shear walls at various locations within a multistory structure. Storey drift, base shear, maximum nodal displacement, and maximum nodal reaction were the reference parameters.
Among all the load combination, the load combination of 1.5DL+1.5EQ is found to be the most critical combination in both X and Y direction for all the models. In both equivalent static and response spectrum analysis it has been found that model having shear walls at the corner of the building (L Shape) in shows the least lateral displacement and M2(L Shape) and M3(+ Shape) shows the least storey drift in X and Z direction but model having shear walls at the along periphery of the building in (rectangular shape) shows lesser lateral displacement and storey drift in both X and Z directions as compared to other models.
The reaction at supports refers to the rigidity of the pillar and the capacity of a column to move weight without support settlement. Model type 4 (Shear wall around periphery) has the greatest nodal reaction. Shear walls become inefficient when a building reaches 80 percent height, according to this report.
In column force, maximum axial force is calculated and it is observed that maximum load is in base columns because it resist complete load of residential building.
Maximum bending moment and maximum shear force are measured in beam forces, and it is discovered that the ground floor is more effective due to close interaction with the earth and base. In contrast to long Beams, the Torsion effect is observed to be greater in short Beams. The displacement of the lower components of a structure on plain land is less than the displacement of beams 51, 46, and 41.

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