ANALYSIS OF BUILDING WITH SHEAR WALL OF DIFFERENT HEIGHT UNDER SEISMIC LOAD

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Abstract: Many high-rise buildings are constructed as framed structures with shear walls capable of withstanding horizontal stresses. Lateral forces created by wind blowing against the building or inertia forces caused by ground movement tend to shatter the structure in shear and push it over in bending.
In this paper study of G+24 stories building in zone-V is presented with some investigations which is analyzed by changing the height of shear wall at interval of each five story in same building for determining the parameters like displacement, story drift, Time period, and Base shear is done by using ETAB software. In this paper the positions of shear walls are fixed which are provided at the corners of building.

1. INTRODUCTION

Fundamental function of every building's architectural system is to bear weight of the earth. Three most prevalent types of weights caused by gravity are dead load, living load, and snow load. In addition to these vertical stresses, structures may also experience lateral loads from things like earthquakes, blasts, or wind. When applied laterally, loads may induce vibration, sway movement, or excessive stresses. So, the structure has to be strong enough to withstand vertical loads and stiff enough to withstand lateral stresses. Horizontal force resisting system consists of shear walls, which are vertical components. One way to protect a building from the damaging consequences of lateral loads is to build shear walls. These walls are responsible for providing the structure with all of its lateral support. A correctly planned and built shear wall will be strong and rigid enough to withstand horizontal forces. In the event of an earthquake, shear walls are among the most efficient structural components for mitigating lateral forces. One way to lessen the impact of lateral stresses caused by earthquakes and strong winds is to build shear walls. Increased rigidity that results from the construction of shear walls lessens likelihood of damage to both the building itself and its contents. Horizontal force resisting system consists of shear walls, which are vertical components of the structure. Lateral resistance which a structure receives from its structural systems is provided by shear walls. Wind and seismic loads are two examples of in-plane lateral forces that shear walls are designed to withstand. High in-plane stiffness is a property of reinforced shear walls. When installed properly, a shear wall can withstand stresses that run perpendicular to its surface. In most cases, shear walls begin at the base of the structure and continue uninterrupted as they rise. Column axial load and bending moments are at their highest when shear walls are not there. Based upon structural stress, the shear wall thickness might range from 150 to 400 mm. Reinforcing bars used in shear walls typically range in thickness from one tenth to one hundredth of the wall's thickness. Concrete, steel plate, plywood, and many more forms of shear walls are available. Structures with a reinforced concrete frame can withstand loads in both the vertical and horizontal directions. Because of these real-world issues, shear walls are now standard in multi-story structures. An element of a structure that is utilized to withstand lateral, horizontal, or shear forces that are perpendicular to the wall's plane is known as a shear wall. Cantilever action is used by shear walls to resist horizontal or lateral forces on thin walls, whereas truss action is used by short walls to resist horizontal or lateral forces on shear walls.

Seismic Zones of India: The probability of destructive earthquakes occurring at various areas is variable throughout the nation due to diverse geology. Therefore, in order to locate these areas, a seismic zone map is necessary. India was split into five zones (I, II, III, IV, and V) according to intensities of previous destructive earthquakes in 1970 edition of zone map. Updates to seismic zone maps are made periodically to reflect new knowledge about the country's geology, seismology, and seismic activity. After two revisions in 1967 and 1970, the Indian Standards finally produced a seismic zone map in 1962. Seismic zones II, III, IV, and V are the only ones remaining on the 2002 updated map. Seismic Codes for India: Each nation and area has its own set of seismic codes. Seismicity in the area, the generally acknowledged seismic risk level, building types, and construction materials and techniques are all factors that are considered. Additionally, they show how far a nation has come in terms of earthquake engineering. Publication of IS 1893, India's first codified seismic code, occurred in 1962.

2. LITERATURE REVIEW

1.P.Kalpana, et.al: For several models, this study investigates analytical parameters for structural shear walls of varying heights. Load variations are evaluated in line with requirements of IS 1893 (Part-1):2002. Several model buildings are compared based on findings expressed as axial forces, lateral displacement, and bending moment in structural shear walls of varying heights. Two conventional buildings with reinforced concrete frames and different shear wall locations in seismic zones III and V were also examined in this research. Both five-story structures with and without shear walls were photographed. Utilizing the technique known as extended 3D analysis of structures (STAAD), the design for this comparable structure has been validated.

2.Praveen Gupta, Aditya Lakhera: This article presents results of some early study into analysis of G+ 5 struture in zone-III, which involves examining the effects of altering height of shear wall at the corners. Using the STAAD-pro program, the displacement of nodes, maximum shear force, maximum moment, and base shear are computed in this article. With seven bays spaced every 4 meters along the 28-meter span and six bays spaced every 3 meters along the 18-meter span, building's floor area is 28 by 18 meters. One level is three meters high. STAAD-pro program is used to do the analysis. An analysis and comparison have been made on placement of shear wall at different building heights in corner.

3.Pankaj Yadav, et.al: A G+5-story structure in Zone III with different shear wall positions was subjected to wind and seismic loading in this research. The consequences of these loadings were compared. 12 models were developed and tested for +X seismic and wind loads using STAAD.Pro v8i software. In addition to several full-height shear wall placements, such models also provide partial shear walls at different floor levels. Both bending moment and lateral displacement measurements were within acceptable ranges, and the results were accurate. Results showed that structures with shear walls had lower bending moments and lateral nodal displacements than ones without. Furthermore, shear walls make structures more resistant to wind and earthquakes than ones without them.

4.Dr. S. B. Shinde et.al: This article presents a study of a G+25 storey building in the Aurangabad area, zone III, as well as other experiments that examine the impacts of different shear wall thicknesses at five-story intervals inside the same building. Goal is to analyze the data using ETAB software and get values for factors such tale drift, story shear, and deflection. To enable vertical lift, shear walls in this study are fixedly placed at building's corners and in middle.

5. Gulam Hyder et.al: Building structures must be designed with shear walls in mind so that they can withstand lateral loads with sufficient strength and deform capacity, while yet leaving room for safety. Effects of shear walls upon RC structures of varying heights are investigated in this study. This was accomplished by analyzing five models with different heights & aspect ratios: 15.33, 30., 45, 60, and 75 meters. Seismic zone V was the target of each model's development. For this investigation, we followed the guidelines in IS: 1893-2002 and used response spectrum approach. tale stiffness, base shear, tale displacement, and story drift have all been compared. When shear walls are positioned at the corners of low- aspect ratio buildings, they are far more efficient in high-rise structures than in low-rise structures with a larger aspect ratio. This is because they maximize base shear and minimize displacement. Incorporating shear walls at structure's corners also significantly reduces story drift and boosts story stiffness.

6. Dr. S. Shinde, et.al: To resist horizontal pressures that run perpendicular to wall's surface, structural engineers create shear walls. They are essential in avoiding total building collapse in the case of a seismic catastrophe and are often seen in tall buildings. Keeping same locations constant, this research compared shear wall thicknesses at different heights inside the same structure. Using shear wall thickness variations at five-story intervals inside same structure, this research analyzes a G+24 storey building in zone III Aurangabad area. Drift story, story shear, and deflection are some of the characteristics that are determined using S AP2000 and ETab.

7.Deepak Tokriya, et.al: After analyzing the structural analysis of multistory frames with and without shear walls, the paper utilizes Staad Pro to estimate lateral displacement, & storey stiffness. Examining the interplay among a shear wall and a moment-resisting frame, this study analyzes performance of a dual structural design. Upon the presence of a shear wall, the moment-resisting frame exhibits altered behavior. Frames on lower stories transfer the weight to the shear wall, while shear walls in upper stories are supported by the frames.

3. Objectives of the Study

3.1 Objectives:

1. Using zone-V seismic forces, we will compare the behavior of structures with and without shear walls.
2. Utilizing Etabs program, we will compare impact of structures with and without corner shear walls of varying heights.
3. Goal is to find out how seismic force affects a number of variables, such as base shear, maximum displacements, time period, and maximum narrative drift.
4. Find the optimal model using a height-specific shear wall.

3.2 Scope of work:

1. Building's reinforced concrete structure constituted the basis for the models.
2. The brick wall was not modeled. Nevertheless, the brick wall's weight was taken into account.
3. When considering varying shear wall heights, it is important to apply the seismic zone factor and compare the base shear, time period, displacement, and narrative drift results.
4. Different shear wall heights in seismic zone V are highlighted in the research.

4. Methodology

Finding the ideal shear wall height to minimize building's lateral displacement is the primary objective of this thesis. In order to achieve the goal, following approach was used.

1. The impact of shear walls at varying heights has been the subject of several studies in the literature.
2. In order to understand how buildings of varying heights react to seismic loads, researchers have chosen to focus on medium-sized structures.
3. There have been several model analyses, some with shear walls and others without. Finding the optimal height to limit the structure's lateral displacement involves positioning the shear walls at various heights in structure, such as center core and corners.

4.1 Description of Models:

For the purpose of seismic analysis, six models of standard RC buildings were created.

1. Model-1: A RC framed building without shear wall.
2. Model-2: A RC framed building with shear wall at corner up to 5 storey.(From base to 5th story).
3. Model-3: A RC framed building with shear wall at corner up to 10 storey.(From base to 10th story).
4. Model-4: A RC framed building with shear wall at corner up to 15 storey.(From base to 15th story).
5. Model-5: A RC framed building with shear wall at corner up to 20 storey.(From base to 20th story).
6. Model-6: A RC framed building with shear wall at corner up to 25 storey.(From base to 25th story).

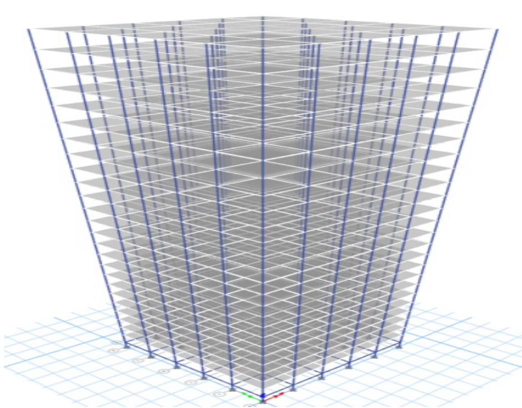


Fig-3D View of RC framed
with Structure without shear wall with

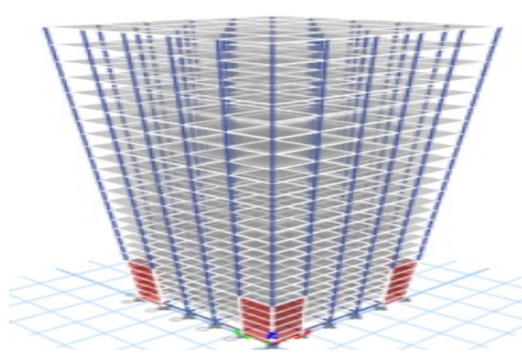


Fig-3D View of RC framed structure
shear wall (From base to 5th story)

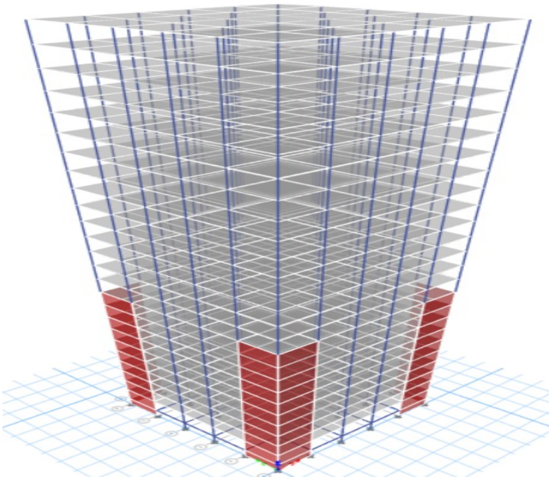


Fig-3D View of RC framed structure with shear wall (From base to 10th story)

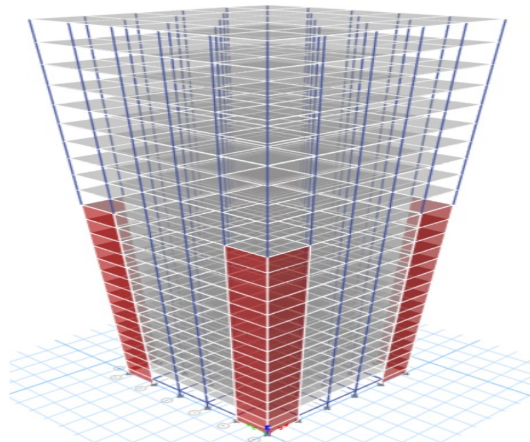


Fig-3D View of RC framed structure with shear wall (From base to 15th story)

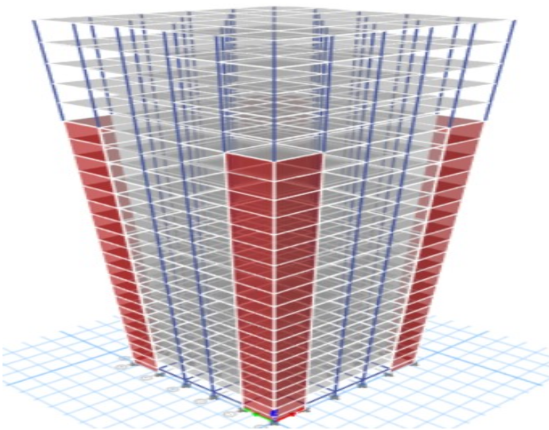


Fig-3D View of RC framed building with shear wall (From base to 20th story)

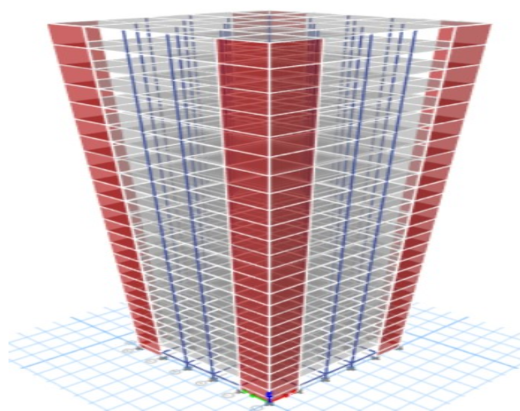


Fig-3D View of RC framed building with shear wall (From base to 25th story)

4.2 Details of Structure:

Building type	Commercial Building
Frame type	Special moment resisting frame
Total storeys	25 (G+24)
Each storey height	3.35m
Bottom storey height	2.0m
Full height of building	85.75 m
Wall thickness	230mm
LL (live load)	3KN/m^2
FF(floor finish)	1.0 KN/m^2
Concrete grade	M40
Steel grade	500 N/mm^2
Density of Brick masonry	18 KN/m^3
Size of column	800mm x 1100 mm

Size of Beam	300mm x 600mmm
Thickness of slab	150mm
Seismic zone	V
Response Reduction Factor	5.0
Type of soil	Medium
Size of Building: 1. 25mx25m without shear wall 2. 25mx25m with shear wall from base to 5th story 3. 25mx25m with shear wall from base to 10th story 4. 25mx25m with shear wall from base to 15th story 5. 25mx25m with shear wall from base to 20th story 6. 25mx25m with shear wall from base to 25th story	

4.3 LOAD ANALYSIS:

Following loads are considered by all models when they do their analysis.
1. Dead load according to IS-875(part I) - 1987
2. Imposed load (LL) as per IS 875(part II) - 1987
3. Seismic load as per IS 1893(part I) - 2002

5. METHODS OF SEISMIC ANALYSIS

There are both linear and non-linear approaches to seismic analysis.

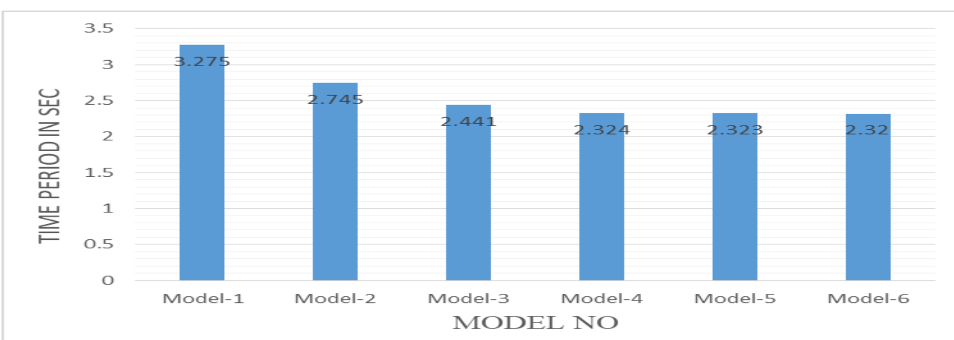
Linear dynamic and response spectrum techniques, as well as the corresponding static force technique and linear static method, are all instances of linear processes. Some examples of this are as follows:
1. Equivalent static method.
2. Response spectrum method.
3. Pushover analysis.
4. Time history analysis.

6. RESULT AND DISCUSSION

6.1 GENERAL:

Six RC building models were created and tested using the seismic load equivalent static approach. We compare findings of studying effects of shear walls of varying heights with respect to displacements, storey drifts, time period, and base shear.

6.2 Time period: It is the amount of time it takes for a single vibrational cycle to pass through a certain spot.



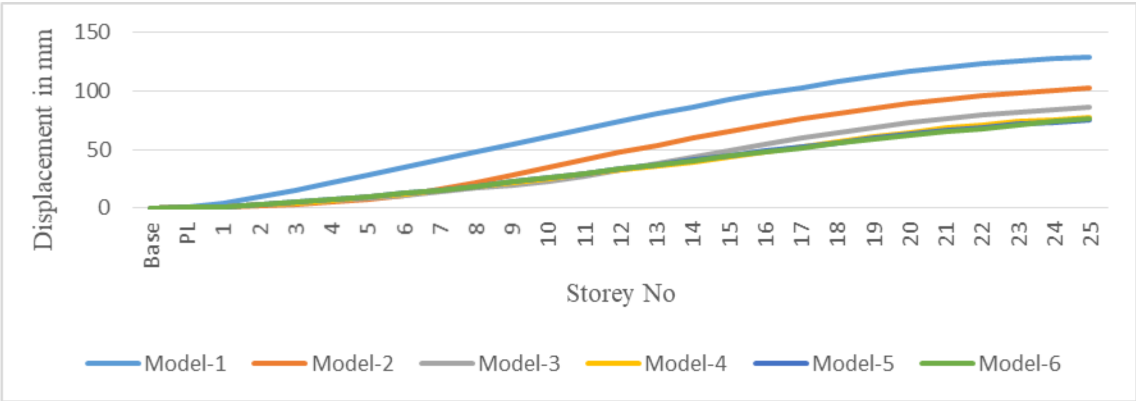
Graph 6.1: Time period in seconds

As we go towards model-2 with the shear wall from base to the fifth story, time period falls by 16.18%, as can be seen in the preceding graph, which peaks for model-1. Following that, time period decreases by 25.46% when moving towards Model-3 with a shear wall from base to story 10. Moving towards Model-4 with shear wall from base to story 15 results in a 29.03% decrease. Moving towards Model-5 with a shear wall from base to 20th story yields a 29.068% decrease. Finally, moving towards Model-6 with a shear wall from base to 25th story results in a 29.16% decrease if contrasted with Model-1.

6.3 Displacement:

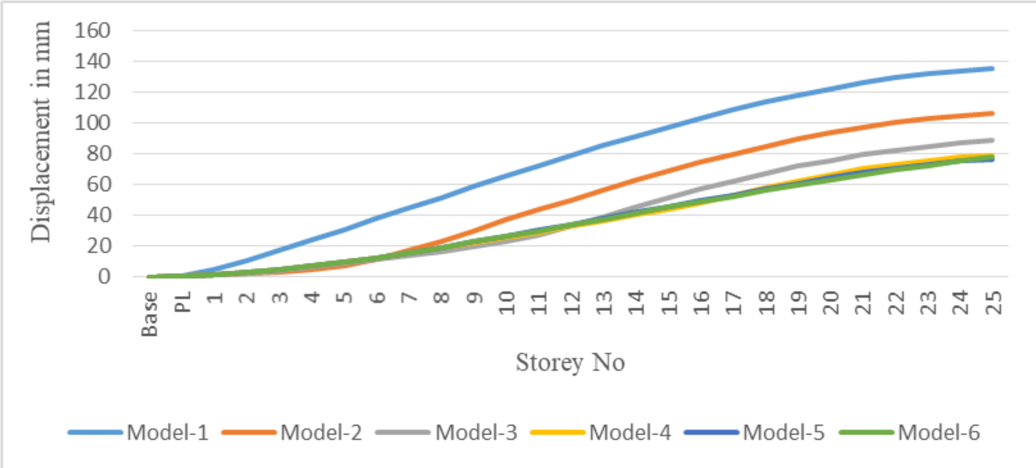
Displacement of a storey is the movement of one level relative to the base of a structure, which is often the ground.

According to clause 7.11.1.2 of IS 1893 Part 1, the maximum permitted displacement in a multi-storey building is hs/500, where hs is the height of the structure. There is a maximum allowable deviation of 171.50 mm, which is calculated as 85.75/500 or 0.1715 miles.



Graph- 6.2: Displacement in mm of all models due to ESM along-X direction

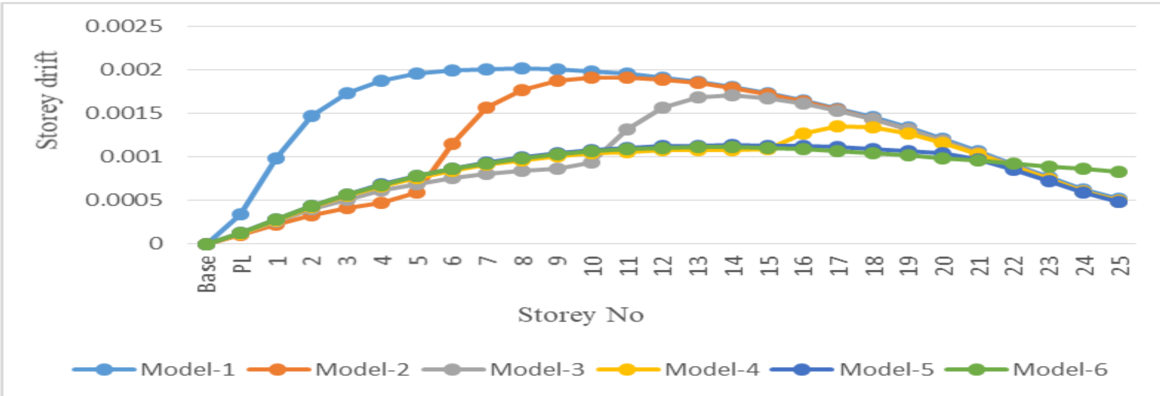
From the above graph it is noticed that the displacement is maximum for model-1 (without shear wall). As we move towards model-2 (shear wall from base to 5th story) the displacement gets decreases by 21.10%. When we have the shear wall from base to 10th story i.e, model-3 the displacement gets decreases by 33.78%, and when we have the shear wall from base to 15th story i.e, model-4 the displacement gets decreases by 40.32%. When we have the shear wall from base to 20th story i.e, model-5 the displacement gets decreases by 41.98%, and when we have the position of shear wall from base to 25th story, then the displacement gets decreases by 40.69% compared to model-1 along X-direction.



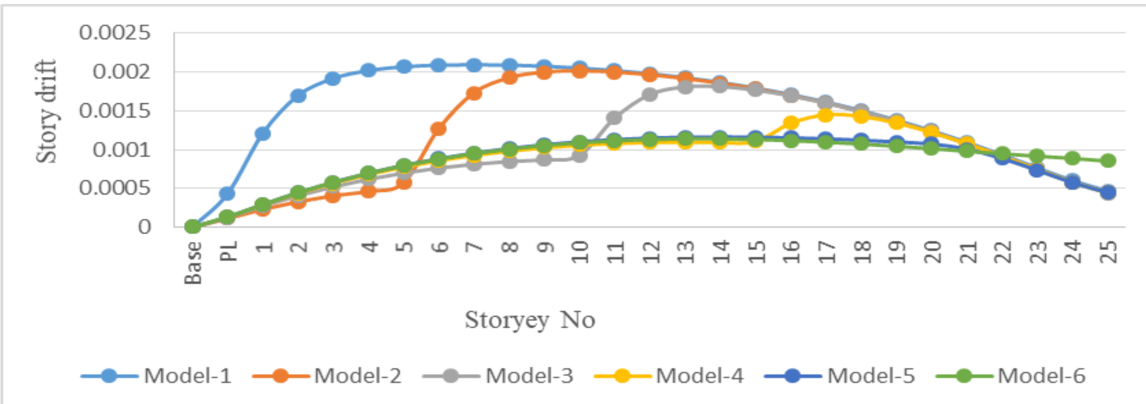
Graph -6.3: Displacement in mm of all models due to ESM along-Y direction

Displacement is greatest for model-1 (no shear wall) as shown in the accompanying graph. Model 2 (shear wall from base to 5th storey) results in a 21.70% reduction in displacement. Model-3, which includes a shear wall from the basement to the tenth story, reduces displacement by 34.70%; model-4, which includes a shear wall from the basement to the fifteenth story, reduces displacement by 41.54%. Displacement falls by 43.44% while shear wall is located from base to 20th story (model 5), and by 42.13% while shear wall is located from base to the 25th story (model 6) in comparison to model 1 along the Y-axis.

6.4 Storey drift: Term "storey drift" refers to the horizontal displacement of one floor in relation to another, & "storey drift ratio" is deliberated with dividing this displacement by height of storey.

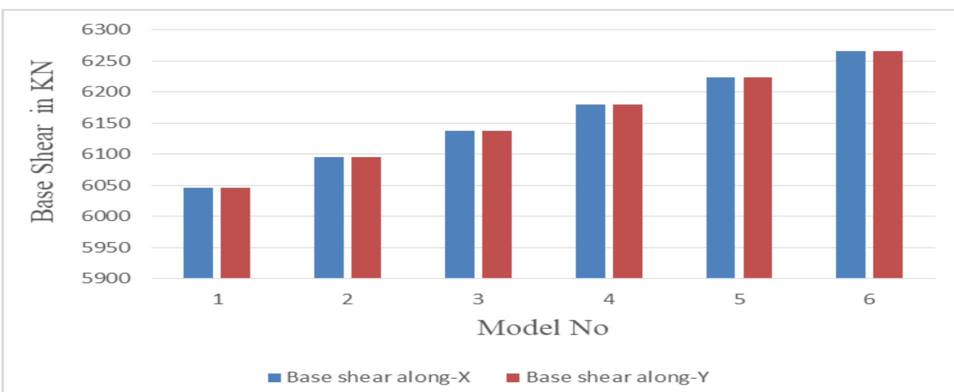


Graph-6.4: Storey drifts of all models due to ESM along X-direction



Graph-6.5: Storey drifts of all models due to ESM along Y-direction

6.5 Base Shear: It's a prediction of the greatest lateral forces that might occur at a building's foundation as a result of seismic activity.



Graph-6.6: Base shear of all models due to ESM along X and Y direction

From the above graph it is observed that the base shear is minimum for model-1 without shear wall. As we move towards model-2 where shear wall is provided from base to 5th story the base shear gets increases by 0.80%

compared to model-1. As we move towards model-3 here Position of shear wall from base to 10th story the base shear gets increases by 1.49%, as we move towards model-4 where shear wall from base to 15th story the base shear gets increases by 2.17%, similarly for model-5 the shear wall from base to 20th story the base shear gets increases by 2.85%, as we move towards model-6 where shear wall from base to 25th story the base shear gets increases by 3.51% compared to model-1 along X and Y direction.

7. OBSERVATION AND CONCLUSION

7.1 Observations:

- For buildings without a shear wall, the displacement is found to be highest.
- From model 5 to model 6, there is a little increase in displacement when the shear wall is supplied from base to the 25th storey, whereas if shear wall is provided from the base to the 20th storey, the displacement reduces.
- It is clear that model-1 has the longest time span.
- Time period grows shorter when the construction incorporates the shear wall.
- The storey drift is within the specified limit.
- Model 2 shows a maximum storey drift at storey-11, while model 1 shows a maximum storey drift at storey-8. Why? Because model-2 has a shear wall that runs from the basement all the way up to the fifth floor.
- The base shear is lowest for model-1, as has been noted.
- Models 2, 3, 4, 5, and 6 all show an increase in base shear when we include a shear wall.

7.2 Conclusions:

- Upon inspection with h/500, every storey displacement was found to be within the acceptable limit as per IS 1893.
- Creating a shear wall reduces displacement.
- Offering a shear wall shortens the time duration.
- Base shear is seen to grow with the addition of the shear wall.
- According to IS: 1893:2002, every story drift is within the allowed range.

7.3 Scope for further study:

- Seismic forces are taken into account in this study. Wind loading may need more research.
- Medium soil is being used for this task. Consideration of soft soil may be useful for future work.
- This project is being executed throughout a 25-story building. Adding more stories allows for more space to be used for future projects.
- Time history analysis and push over analysis may be used to do more work.

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