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Seismic Analysis of Plan Irregular Multi-Storied Building with and Without Shear Walls

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ABSTRACT: Selecting the type of structure which will be constructed in seismic zone is very critical as it has to withstand the effects of seismic activities and shouldn't undergo any deformation, damage and should be responsible for any loss of life during the earthquake as the majorities of the damage or the destruction happens during the earthquake activities. The behaviour of the structure located in seismic zone depends on many factors like type of structure, purpose of the structure, its shape, position of structural elements like columns their spacing, orientation and sizes, location and symmetry of shear wall and its strength. Sometimes all these or some of these structural elements will have limitations due to either architectural requirements or may be due to usage point of view. Hence, as a structural engineer one has to design the structure by keeping all this things in mind and yet should be strong enough to resist the worst seismic effect in that area.

KEYWORDS: Shear walls, Time history analysis, Storey displacements, Storey drift, Storey accelerations

I. INTRODUCTION

Shear wall can be considered as one of the structural element which can be used to resist the seismic effect on that structure and thus reducing the damage caused by the earthquake, be it the loss of properties or the loss of lives. Provision of shear wall has to be made by keeping in mind the irregularities due to architectural requirement or due to end use of the structure. The present project explains the need of the shear wall in order to take care of various parameters which need to be accounted during performing the structural design. This is done by comparing various parameters like story drift, story displacement, base shear etc for two similar buildings first one being modelled without any shear wall and the second one by providing shear wall around the lift and staircase

1.1 SHEAR WALL

A Shear wall can be considered as an auxiliary part of the structure which is used to resist the horizontal forces are constraints that is the forces which are perpendicular to the shear wall. Shear wall can be provided at statistical positions in the building in order to take care of lateral forces like earthquake or wind load. Positioning of shear wall has to be carefully planned before doing analysis and design. 2 This is very important as proper placement of shear walls will enhance the strength and rigidity of the entire building in order to resist lateral forces. If an improper positioning of shear walls is done this will have adverse effect on the strength of the building structure. Placement and size of the shear wall also depends on architectural requirement and usage point of the building. However, if the shear wall provided is symmetrical in both X and Y directions then its behaviour will be e same in both directions.

1.2 IRREGULARITIES OF BUILDINGS

Generally latest of buildings can be classified into two groups

- 1) Irregularity in plan
- 2) Vertical irregularity



II. BUILDING DESCRIPTION

In this project we have considered three buildings which are irregular in shape in plan. These buildings consist of G + 9 + terrace. Ground floor is used as parking area whereas first to 9th floor are typical floors. The dimensions of typical floors and terrace floor are shown in subsequent pages. Position of columns is carefully planned so that they won't be expecting the usage of each flat.

This entire frame structure is modelled using design software Etabs. As mentioned earlier six models were created. Three building without shear wall and the same three buildings with shear walls.

Three models consist of solid concrete block as main Wall and around the lift and staircase as well. In remaining three models solid concrete blocks are used as main wall similar to other three models. However around the left and staircase in place of concrete block shear walls are provided. All other parameters like dimensions of the building. Column and beams dimensions, their properties, grade of concrete, imposed load, analysis method are retained same.

After this analysis is performed for all the six models and various parameters like story drift, story displacement, story shear, base reactions etc are tabulated and comparison is made in the form of charts and graphs.

Table 2.1: Different shape models with and without shear wall

Type of model	Without shear wall	With shear wall
PLUS SHAPE	Model 1	Model 2
L SHAPE	Model 3	Model 4
H SHAPE	Model 5	Model 6

Sl.No.	Building details	
1	Type of structure	RCC (Ordinary Moment Resistance Frame)
2	Building shape	Irregular shape Structures
3	Building dimensions	Shown in subsequent pages
4	Total Height of Building from Plinth	(G + 9 + Terrace + Head Room) = 35.38m
5	Height of typical Storey	3.05m
Material properties		
1	Grade of concrete	M25 for all the structural elements
2	Grade of rebar steel	Fe500
3	Density of concrete	25KN/m ³
Section properties		
1	RCC Beam size	200mmx600mm, 200mmx750mm, 600mmx600mm
2	RCC Column	200mmx600mm, 600mmx600mm
3	RCC Slab Thickness	150mm
4	Wall Thickness	200mm, 100mm (Solid concrete wall block)

SEISMIC FACTORS FOR LATERAL LOAD ANALYSIS

- Soil Profile type = Medium
- Seismic Zone Factor = Zone 5
- Response Reduction Factor = 5.0
- Importance Factor = 1.0
- Damping = 5.0%

III .MODEL ANALYSIS

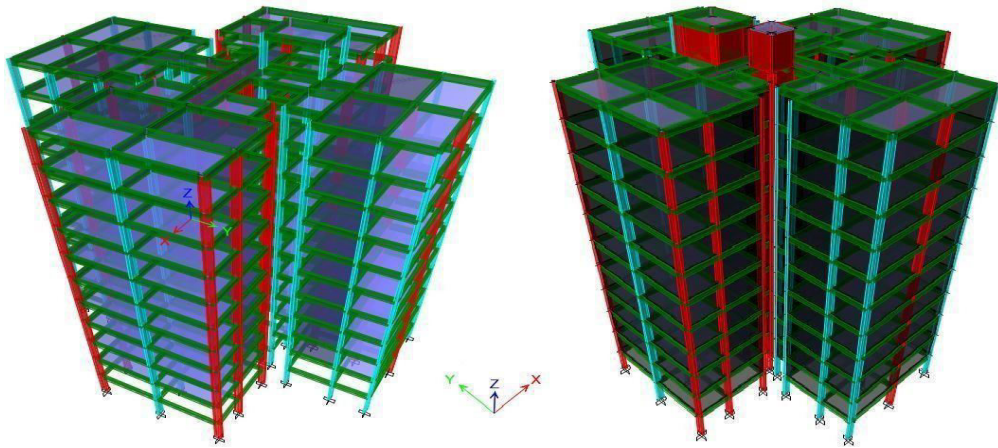


Figure 3.1: 3D VIEW OF MODEL 1 & 2



Figure 3.2: 3D VIEW OF MODEL 3 & 4

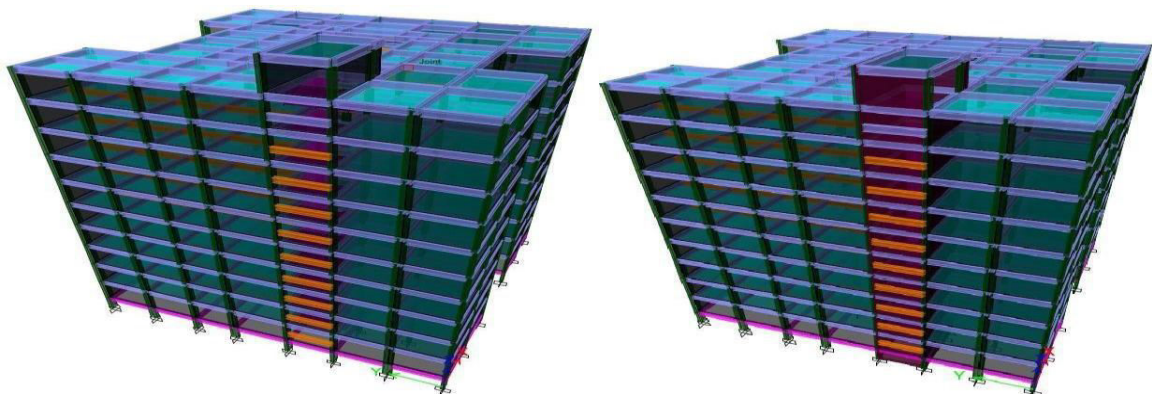


Figure 3.3: 3D VIEW OF MODEL 5 & 6

IV.RESULTS

4.1 BENDING MOMENTS

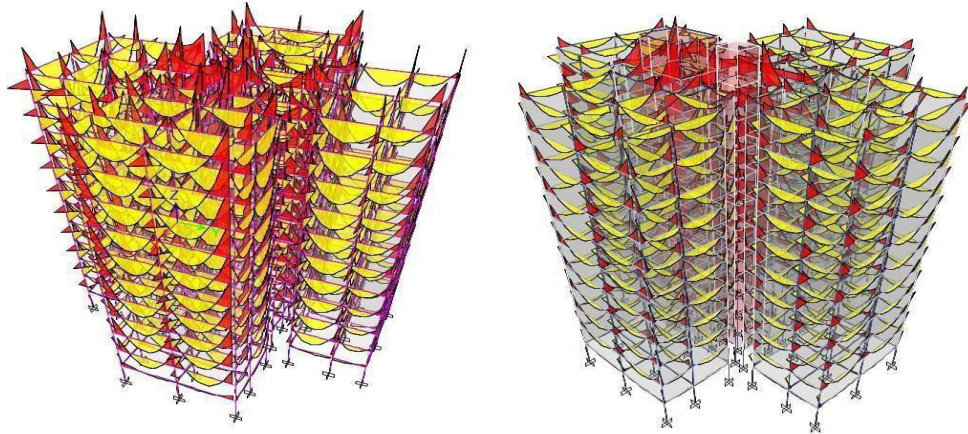


Figure 4.1: BM for Model 1 & 2

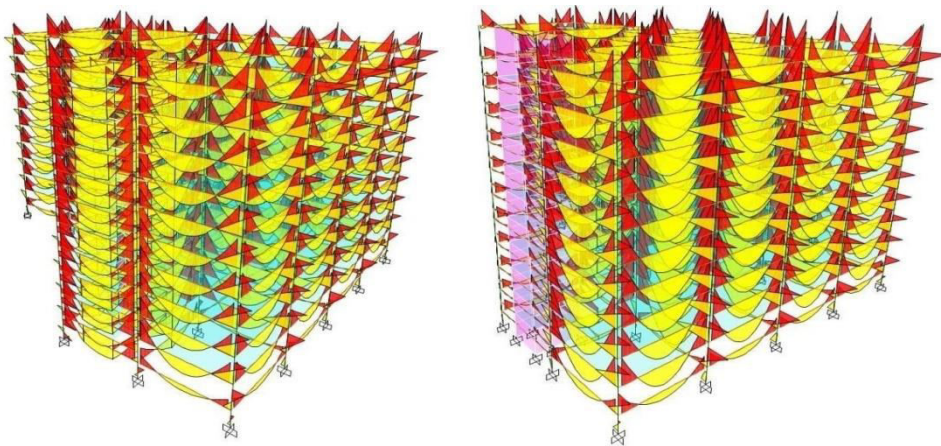


Figure 4.2: BM for Model 3 & 4

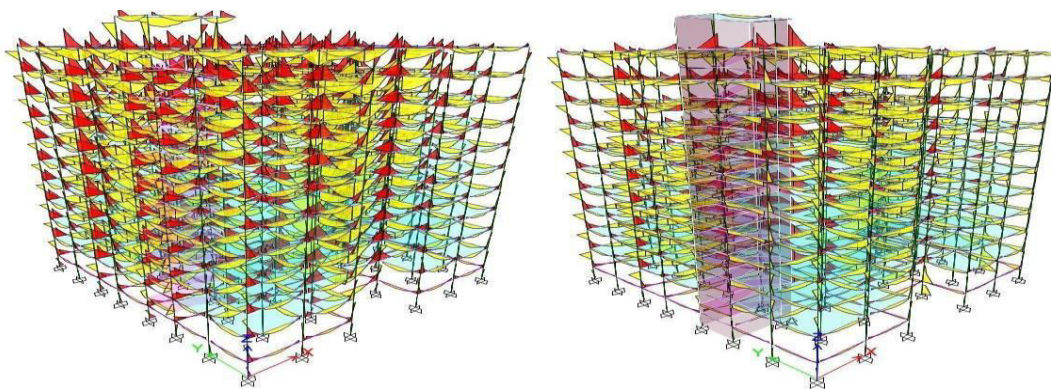


Figure 4.3: BM for Model 5 & 6

4.2 SHEAR FORCE

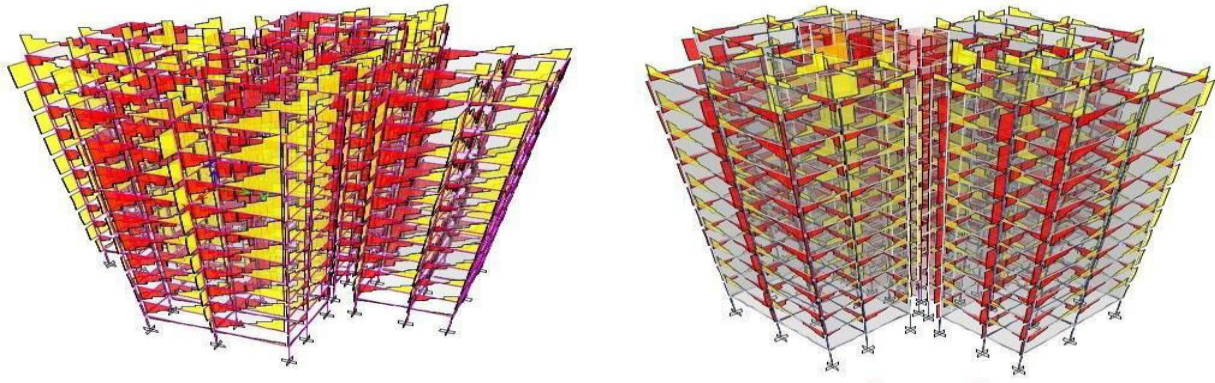


Figure 4.4: SF for Model 1 & 2

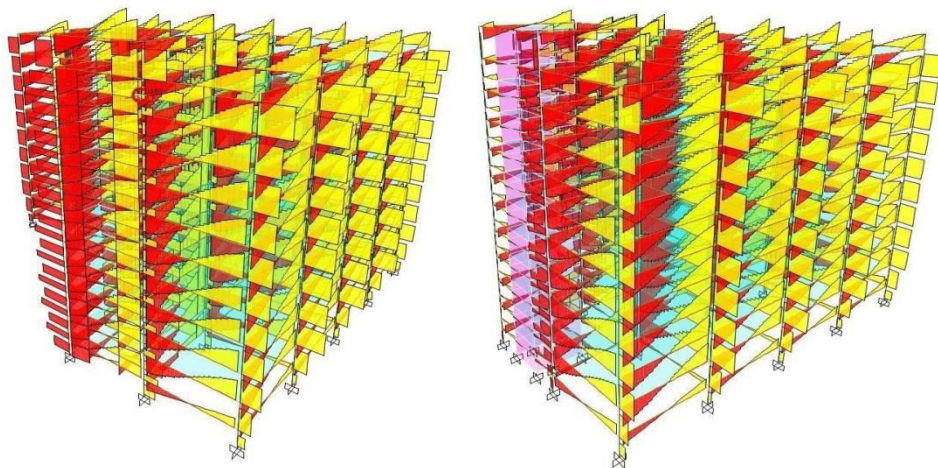


Figure 4.5: SF for Model 3 & 4

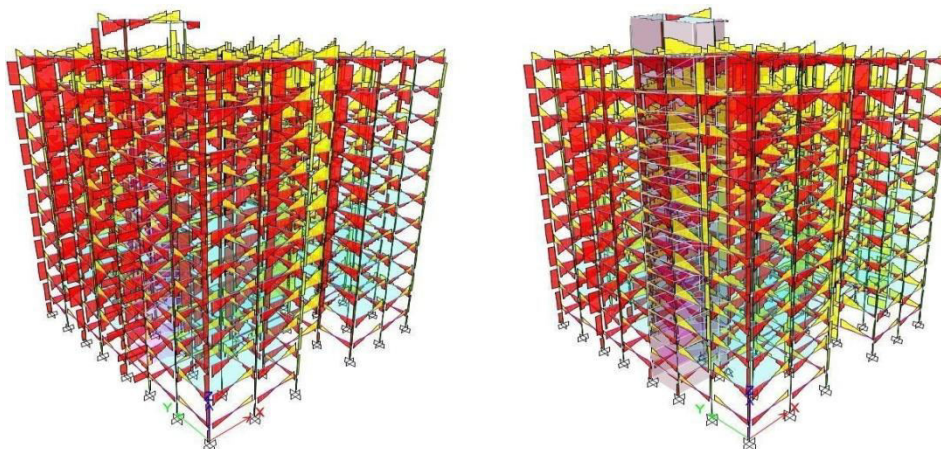
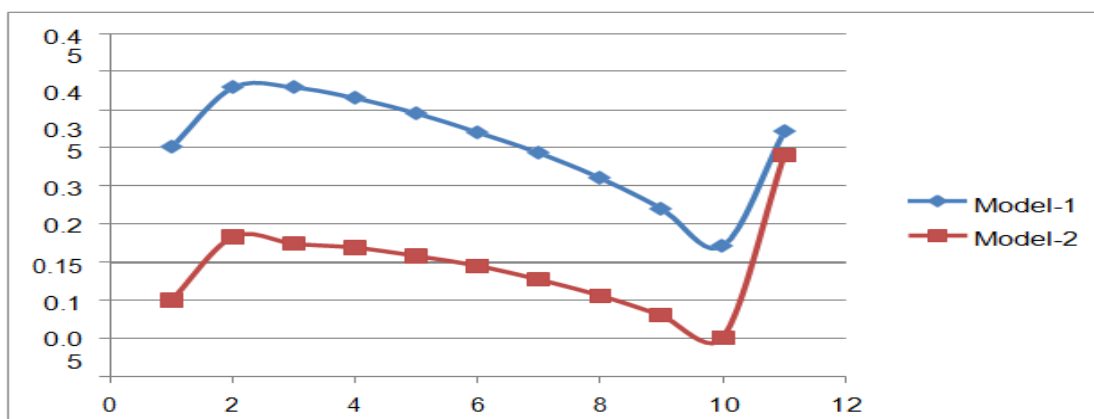
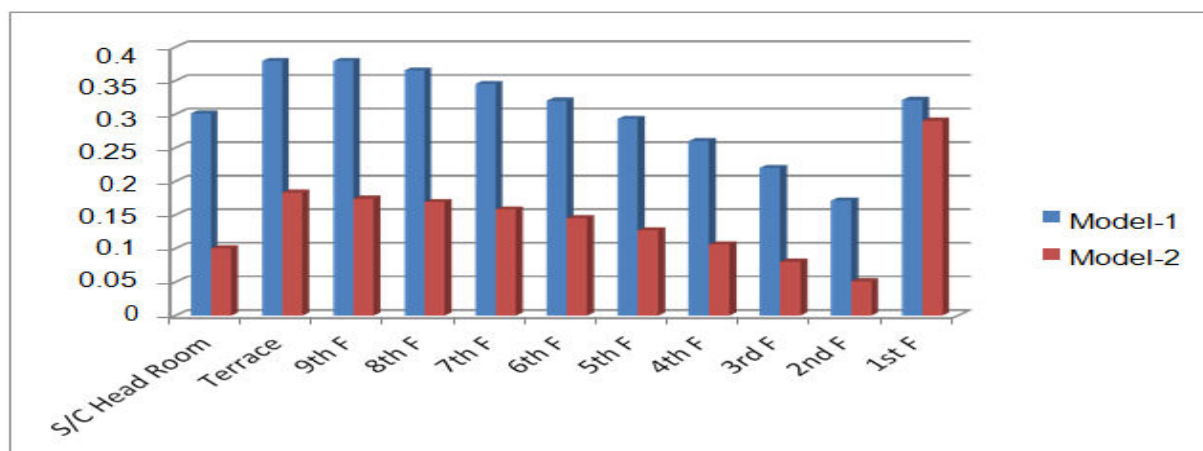


Figure 4.6: SF for Model 5 & 6

4.3 STOREY DRIFT

Storey Max Drift 1.2 (DL+LL+THX) , mm		
Storey	Model-1	Model-2
S/C Head Room	0.301	0.1
Terrace	0.379	0.183
9th F	0.379	0.174
8th F	0.365	0.169
7th F	0.345	0.158
6th F	0.32	0.145
5th F	0.293	0.127
4th F	0.26	0.106
3rd F	0.22	0.08
2nd F	0.171	0.051
1st F	0.321	0.29

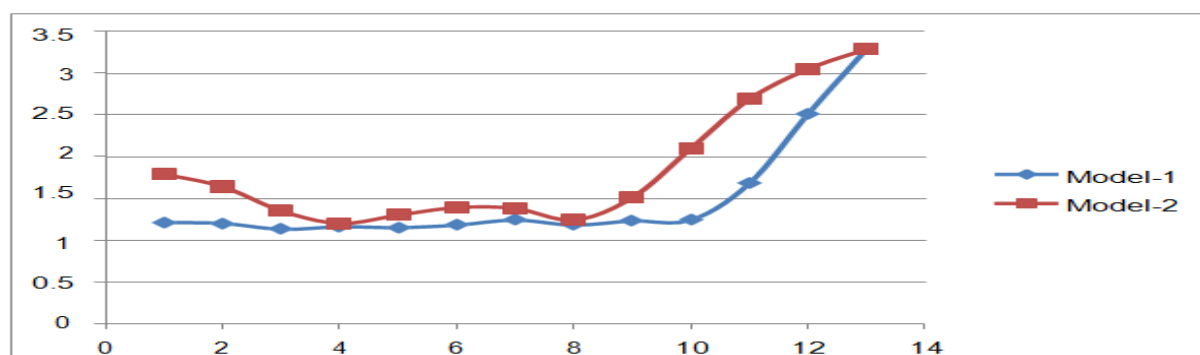
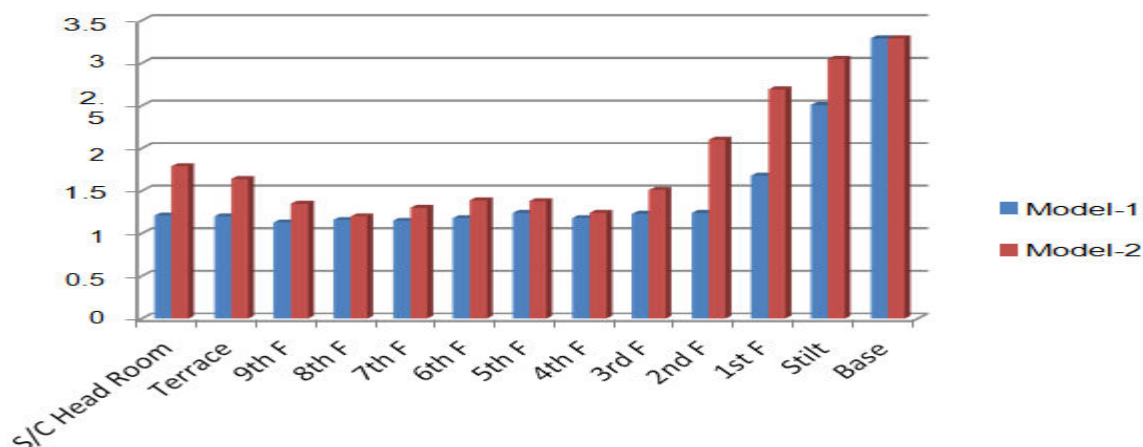
Figure 4.7: Maximum storey drift in X direction



4.4 STOREY ACCLERATION

Storey Accelerations for THX, mm/sec ²		
Storey	Model-1	Model-2
S/C Head Room	1.21	1.79
Terrace	1.2	1.64
9th F	1.13	1.35
8th F	1.16	1.2
7th F	1.15	1.3
6th F	1.18	1.39
5th F	1.24	1.38
4th F	1.18	1.24
3rd F	1.23	1.51
2nd F	1.24	2.1
1st F	1.68	2.69
Stilt	2.51	3.05
Base	3.29	3.29

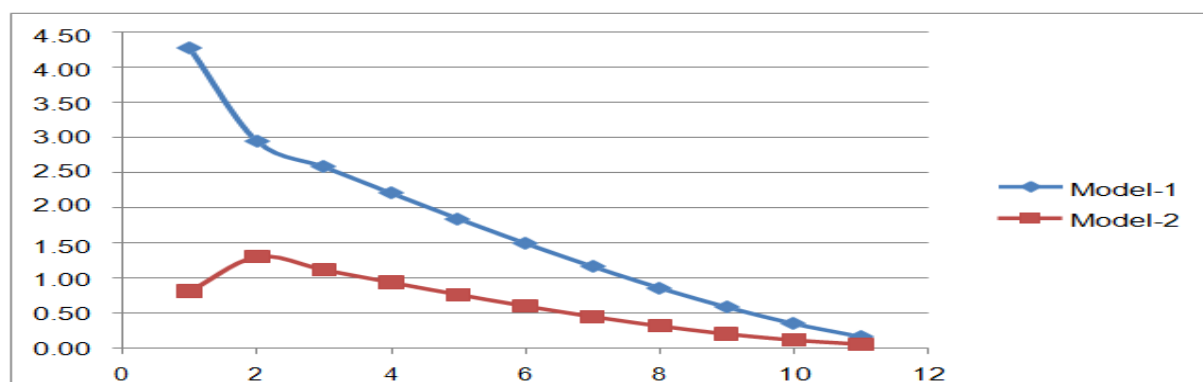
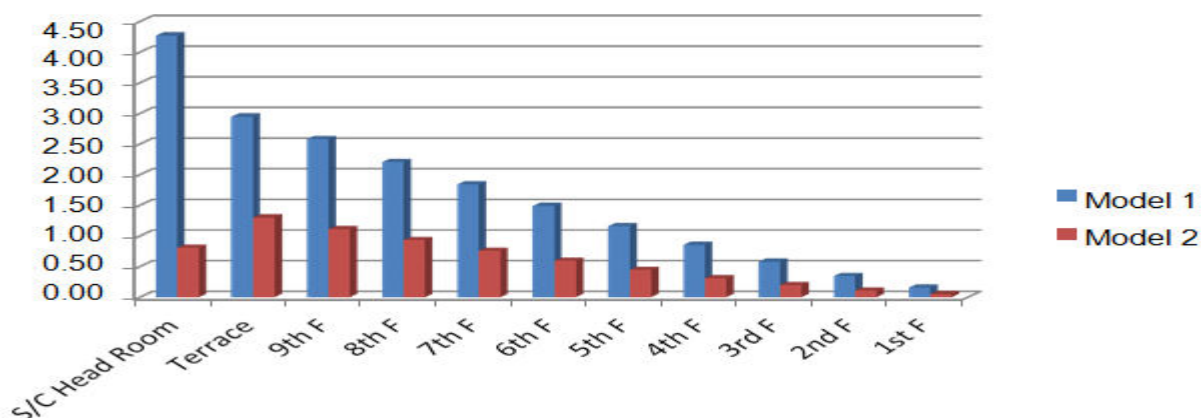
Figure 4.8: Maximum storey acceleration in X direction



4.5 MAXIMUM STOREY DISPALCEMENT

Storey Max Displacement 1.2 (DL+LL+THX) , mm		
Storey	Model-1	Model-2
S/C Head Room	4.27	0.81
Terrace	2.95	1.30
9th F	2.58	1.11
8th F	2.21	0.93
7th F	1.84	0.76
6th F	1.49	0.59
5th F	1.16	0.44
4th F	0.85	0.31
3rd F	0.58	0.20
2nd F	0.34	0.11
1st F	0.16	0.05

Figure 4.9:Maximum storey displacement in X direction



Modelling of 3 buildings was performed all the parameters like floor to floor height, column, beam, slab, stair case etc. Were kept same the only difference was Model 1, Model 3, and Model 5 Shear wall wasn't provided anywhere. Whereas Model 2, Model 4, and Model 6 Shear wall provided around the Stair case and analysis was carried out by ETABS Software. Analysis were carried out comparison of various analysis parameters like Storey drift, Storey displacements, Storey accelerations, Base shear are carried out both in X and Y directions for Model 1 & 2, Model 3 & 4, Model 5 & 6.

V. CONCLUSION

1. Building which is provided with shear wall at appropriate places will help in reducing the displacement and base shear.
2. This also helps in reducing the Storey drift. Reduction in Storey displacement and Storey drift is due to increase in stiffness of the building as a whole.
3. There is increase by 3% average in base shear when compared building with shear wall with that of without shear wall.
4. Storey drift in X direction is decreased by 52%, similarly Storey drift in Y direction is decreased by 31% when compared building with shear wall with that of without shear wall.
5. Storey force in X direction is decreased by 5.91% when compared building with shear wall with that of without shear wall.
6. Storey displacements in X direction are decreased by 39.83%, similarly Storey displacements in Y direction is decreased by 30.83% when compared building with shear wall with that of without shear wall.

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