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Study on Analysis of G+10 Building with Shear Wall Using ETABS

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Abstract: *Shear wall is a structural member designed to counteract the lateral forces acting on a structure. These walls are more important in seismically active zones when shear forces on the structure increases due to earthquakes. Shear walls have more strength, stiffness and resist in-plane loads that are applied along its height. Buildings with shear walls which are properly designed and detailed have shown very good performance in past earthquakes. Various research studies have been conducted on the design of shear wall and its performance to seismic forces. This study used analytical software called E-TABS to provide a full perspective of the equivalent static technique and a high-rise building's reaction spectrum analysis with same model, in different zones. Using software to do the study has been beneficial. The structure has a medium soil type and is approximately G+10 stories tall.*

Keywords: Shear Wall, Seismic Zones, Displacement, Base Shear, Storey Drift.

I. INTRODUCTION

In structural engineering, a shear wall is a vertical component of a seismic force-resisting system that is made to withstand lateral forces acting in-plane, most often caused by wind and seismic loads. A shear wall resists loads that are perpendicular to its plane

Shear walls are often constructed out of masonry or concrete. Shear walls can be built inside buildings or outside of them to form a shear core, which is a structure of shear walls in the middle of a building that frequently encloses a stairwell or elevator shaft. Due to the fact that the shear wall functions as a single unit, lateral pressures frequently result in rotational forces that produce compression forces at one corner and tension forces at the other.

As a result, both types of pressure must be resolved on both sides of the shear wall when the lateral force is applied from the opposite direction. For the building to withstand horizontal earthquake and wind forces and transmit those forces to the base, the shear wall must provide lateral shear strength. Shear Walls significantly increase a building's lateral stiffness in the direction of the building's orientation, reducing lateral sway and minimizing structural damage.

1.1 Seismic Zones

A. Earthquake

- The term "earthquake" is used to describe sudden changes in the earth's tension as a result of volcanic activity, magmatic activity, or other sources, as well as the resulting ground shaking and transmitted seismic energy.

B. Earthquake Resistant Structures

- Earthquake-resistant constructions are ones that were built to withstand earthquakes. Although no structure can be totally protected from earthquake damage, the goal of earthquake resistant construction is to build structures that perform better under seismic activity than their conventional counterparts.

C. Seismic Zones of India

- The earthquake zoning map of India divides the country into four seismic zones, as opposed to its earlier existence, which had five or six zones spread out over the country (Zone 2, 3, 4 and 5). According to this partitioning map, Zone 0 will have the least amount of seismic activity, while Zone 5 will have the most. In order to represent each zone's effects of an earthquake at a specific location and support observations made in the affected areas, the Medvedev-Sponheuer-Karnik scale, a macro unstable intensity scale, may be used. This scale is used to assess the severity of ground shaking based on effects found in a specific area of the earthquake occurrence.

ZONE 2: This area is categorised as a Low Damage Risk Zone because it is susceptible to MSK VI (strong) or less. The zone factor assigned by the IS code is 0.10.

ZONE 3: This area is MSK VII-eligible and classed as a Moderate Damage Risk Zone (very strong). And Zone 3 is given a zone factor of 0.16 under the IS code.

ZONE 4: This area which includes locations subject to MSK VIII, is known as the High Damage Risk Zone (Damaging). Zone 4 in Jammu & Kashmir, Himachal Pradesh, and Uttarakhand has a zone factor of 0.24 according to the IS code.

ZONE 5: Zone 5 includes the regions that are most susceptible to earthquakes with a magnitude of MSK IX (Destructive) or above. Zone 5 has a zone issue of zero.36 according to the IS code. This problem is used by structural designers to create earthquake-resistant buildings in Zone 5. The zone problem of zero.36 is indicative of an earthquake in this zone that is effective (zero periods) level. It is mentioned as being in a zone with an extremely high injury risk.

II. LITERATURE SURVEY

[1] Farjana Khanam, Anik Das AndSharmin Reza Chowdhury "Effective Location Of Shear Wall On Performance Of Building Frame Subjected To Lateral Loading" analyzed the influence of the shear wall's positioning in a building with several stories. Considered is a residential structure with a base plan of 49.25 feet by 49.25 feet and an average floor height of 10 feet. According to the study's results, reinforced concrete frame structures without shear walls do badly under all lateral stresses. Model 3 (a structure with a shear wall at each fourth corner of an L-shaped building) has a stronger shear force at ground level than Model 2 (a structure without a shear wall). Because of this, it may be said that shear walls placed in the middle of a building's four perimeters are more effective than those placed elsewhere. Analysis of additional structures with variable shear wall positions are required

[2] Krishna G S And ChaithraS "Nonlinear Analysis of Frame Shear Wall Building With Different Opening Configurations" examined the behaviour of shear walls with various opening arrangements. Research and comparisons are done. The presence of an aperture reduces strength and stiffness. The top displacement brought on by the staggered aperture resembles that brought on by shear walls without apertures quite a bit. The base shear when adopting staggered layouts is significant. The increase in stresses brought on by staggered opening layout is modest when compared to vertical opening design.

[3] Kollipara V G ManikantaSreeram, Rajendra Prasad Singh AndSripathi Siva Bhanu Sai Kumar "Effective Location Of Shear Walls And Bracings For Multistoried Building"

In comparison to a standard building, a structure with a dual system at the corner will have less lateral displacement at the top 4.84mm. The lateral displacement in the x-direction of the dual system is 86% lower than that of a conventional structure.. The dual system's lateral displacement in the z-direction is 89% less than that of a normal structure. The shear force in a typical construction is 1157.8 kN at its maximum. The dual system has a maximum shear force of 1130.2 kN. The maximum bending moment in a typical construction is 5.042 kNm.

[4] Nitin Choudhary And Prof. Mahendra Wadia "Pushover Analysis Of R.C. Frame Building With Shear Wall"analysed considerable reduction in base shear symmetrical and asymmetrical structures. When a shear wall is put in an L-shaped building, base shear and roof displacement are reduced by 4.3% and 58.15%, respectively; when it is installed on the smaller side, base shear and roof displacement are reduced by 7.97% and 55.43%, respectively. The smaller side of an asymmetrical structure must thus have a shear wall erected. The aforementioned procedure results in a performance-based seismic design of earthquake intensities.

III. METHODOLOGY

A 10 storey RCC lateral load resisting structure with and without shear wall are modelled using ETABS software. Each floor height is taken as 3.15m.The following cases are considered in this study

- Case 1: Building without shear wall
- Case 2: Building with shear wall in seismic zone II
- Case 3: Building with shear wall in seismic zone III
- Case 4: Building with shear wall in seismic zone IV
- Case 5: Building with shear wall in seismic zone V

3.1 Building Detail

Plan is prepared in AUTOCAD 2016, G+10 building with and without shear wall with area (43 x 17)m.

3.1.1 Material Properties:

- Grade of concrete (M30)
- Grade of steel (fe500)
- Density of concrete (25KN/m^3)
- Density of Floor finishing material (24KN/m^3)
- Density of blocks (20KN/m3)

3.1.2 Member Properties:

- Thickness of RC slab (150mm)
- Thickness of Shear wall (200mm)

Column Size

- C – 300mm X 600mm

Beam Size

- B – (300 X 450) mm

3.1.3 Thickness of brick masonry wall

- Outer wall (0.2m)
- Inner wall (0.1m)

3.1.4 Storey height

- 3.15m

3.1.5 Loads

- Outer Wall load = 0.2x(3.15 – 0.45) x 20 = 10.8 KN/m
- Inner wall load = 0.1x(3.15 – 0.45) x 20 = 5.4 KN/m
- Floor finishing (1.2KN/m2)
- Live load on slab (2KN/m) (IS 875 part 2)
- Live load on stairs (3KN/m) (IS 875 part 2)

3.2 Models

3.2.1 3D view of all models

1. **Model 1 :**Building without shear wall
2. **Model 2 :**Building with shear wall in seismic zone II
3. **Model 3 :**Building with shear wall in seismic zone II
4. **Model 4 :**Building with shear wall in seismic zone II
5. **Model 5 :**Building with shear wall in seismic zone II

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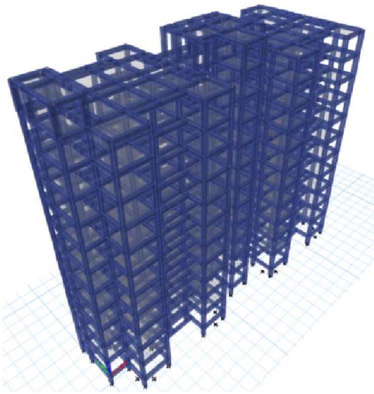

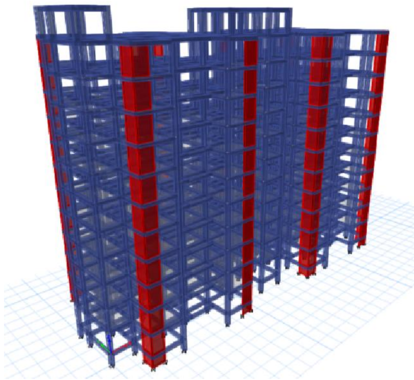

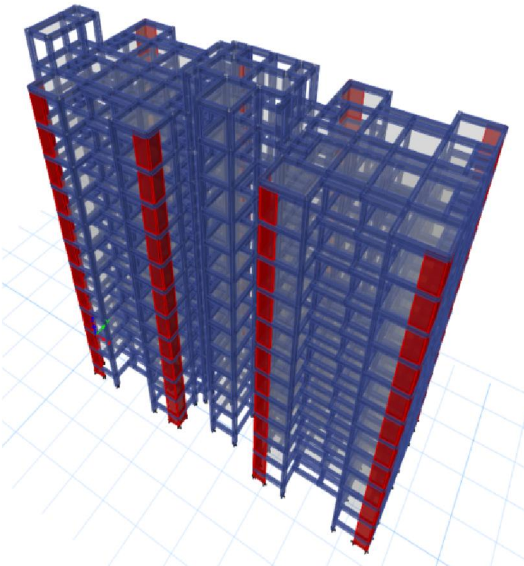

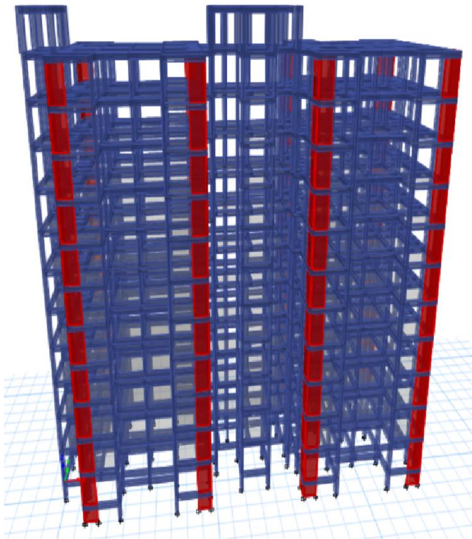

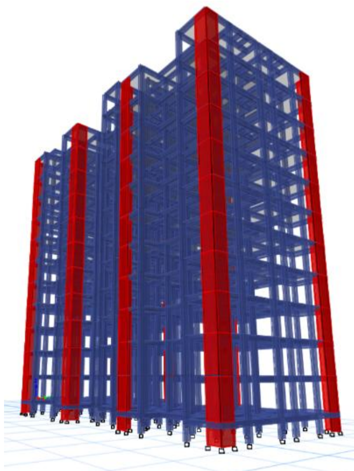

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IV. EXPERIMENTAL RESULTS

4.1 Linear Static Analysis

4.1.1 Time Period

Time period (SEC)	Model no
1.94	1
1.63	2
1.113	3
1.072	4
1.051	5

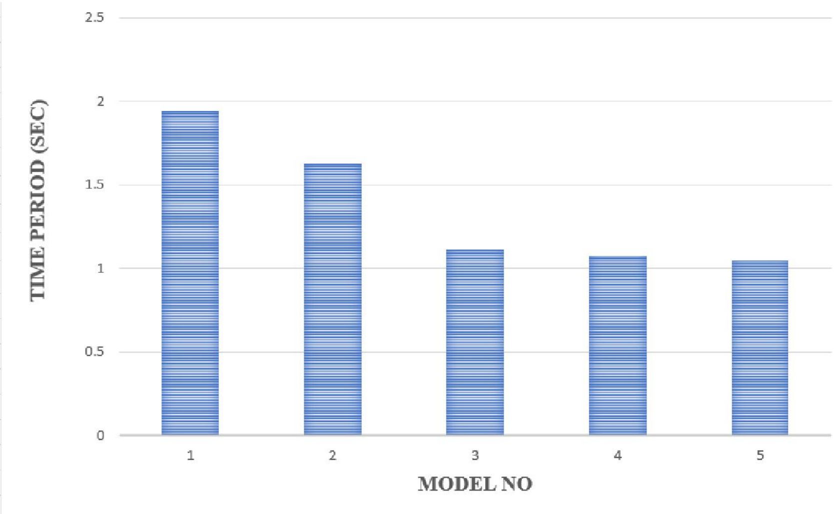


Fig.4.1.1 -Time Period(SEC)

- The time period for model 1 in zone 2 is 1.63sec
- It is recorded that model 2 time period is less than 31.7% when compared to model 1
- It is also calculated that the time period of model 3 is less than 34.2% when compared to model 1

Similarly, it is also calculated that the time period of model 4 is less than 35.52 % when compared to model 1

4.1.2 Base Shear

BASE SHEAR (KN)	NO OF MODEL
9251.529	1
5731.47	2
6530.55	3
9906.3	4
11250.65	5

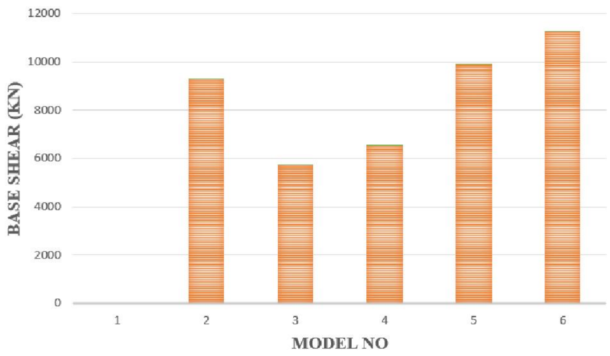


Fig. - 4.1.2 Base Shear (KN)

- The base shear for model 1 in zone 2 is 5731.47 kN
- It is recorded that model 2 base shear is more than 13.94% when compared to model 1
- It is calculated that model 3 base shear is more than 72.84% when compared to model 1

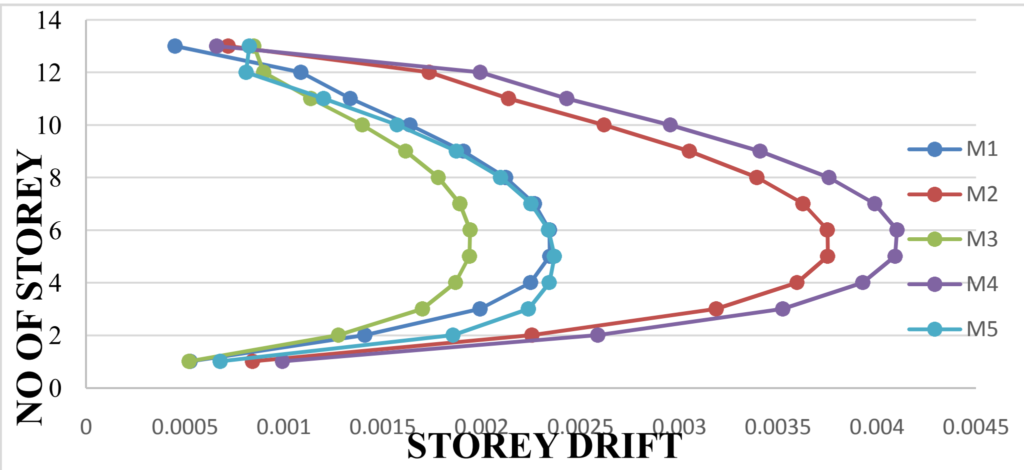
Similarly, it is also calculated that model 4 base shear is more than 96.30% when compared to model 1

4.1.3 Storey Drift

NO OF STOREY	STOREY DRIFT				
	M1	M2	M3	M4	M5
1	0.00053	0.00084	0.00052	0.00099	0.00068
2	0.00141	0.00225	0.00128	0.00259	0.00186
3	0.00199	0.00319	0.0017	0.00352	0.00224
4	0.00225	0.0036	0.00187	0.00393	0.00234
5	0.00234	0.00375	0.00194	0.00409	0.00237
6	0.00234	0.00375	0.00194	0.0041	0.00234
7	0.00227	0.00363	0.00189	0.00399	0.00225
8	0.00212	0.00339	0.00178	0.00376	0.0021
9	0.00191	0.00305	0.00162	0.00341	0.00187
10	0.00164	0.00262	0.0014	0.00295	0.00157
11	0.00134	0.00214	0.00114	0.00243	0.0012
12	0.00109	0.00174	0.0009	0.00199	0.00081
13	0.00045	0.00072	0.00085	0.00066	0.00083

Table 4.1.3 Storey Drift

Fig. 5.1.3 -Storey Drift



5.1.4 Storey Displacement

Storey displacement without shear wall

NO OF STOREY	STOREY DISPLACEMENT (mm)				
	M1	M2	M3	M4	M5
1	2.6	1.2	4.8	4.4	7
2	5.7	9.1	10.2	9.2	14
3	9.1	14.5	16.1	14.5	21.4
4	12.6	20.2	22.2	20	28.8
5	16.2	25.9	28.3	25.5	36.2
6	19.6	31.4	34.3	30.8	43.3
7	22.9	36.6	39.9	35.9	49.9
8	25.8	41.2	45	40.5	55.8
9	28.3	45.2	49.4	44.4	60.7
10	30.3	48.4	52.9	47.6	64.5
11	31.9	51	55.8	50.2	67.1
12	29.3	46.9	51.5	46.4	60.6

Table 5.1.4 Storey Displacement (mm)

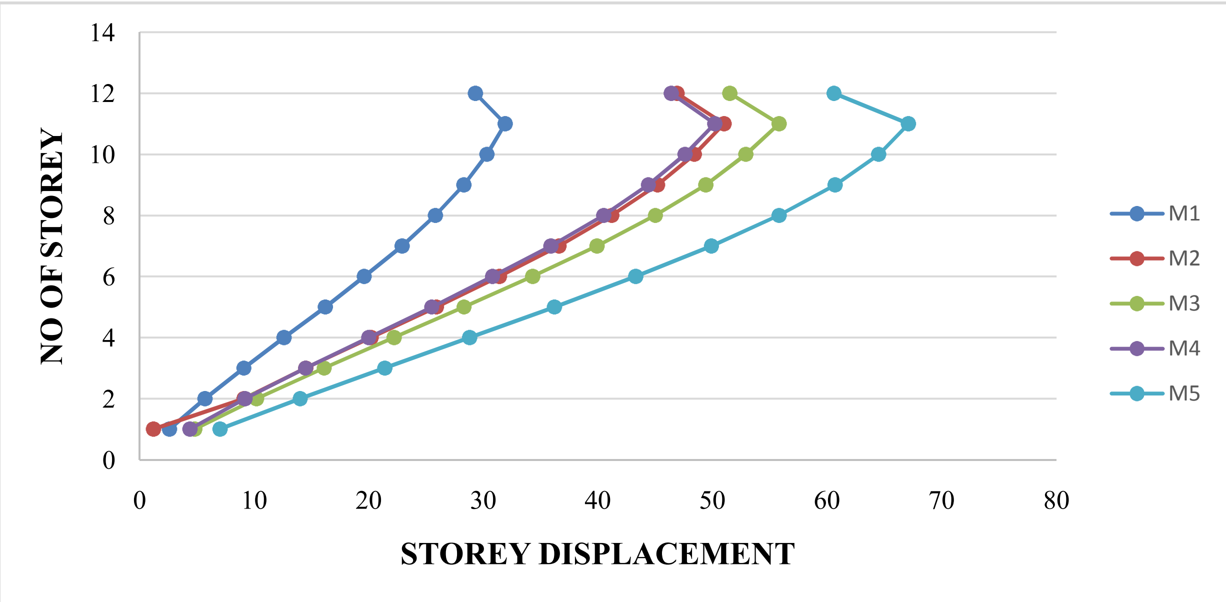


Fig. 5.1.4 Storey Displacement (mm)

V. CONCLUSION AND FUTURE WORK

- The time period was highest for model 1 when compared to model 2, model 3 and model 4
- There was a slight variation in time period of model 2, model 3 and model 4 when compared with model 1
- It is observed that the base shear is increasing from model 1 to model 4
- Model 1 base shear is found to be the least, whereas the base shear for model 4 is found to be the highest
- At the 6^{th} storey, there was maximum storey drift found for all the models
- Model 3 was having the least storey drift, whereas model 4 was having the highest storey drift.
- The highest storey displacement was found to be for model 3, whereas the least for model 1
- It is noted that there is a very slight variation in the storey displacement of model 2 and model 4

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