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Comparative Analysis of Flat Slab, Grid Slab and Conventional Slab with C-Type & L-Type Shear Wall

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ABSTRACT

In the past few years there was use of conventional slab in most of the buildings but now a days there is an efficient use of flat slab being provided in most of the buildings, the construction of flat slab provides many advantages over conventional slab structure in terms easier reinforcement, ease of framework installation, flexibility in layout, easier auto sprinkler and less construction time. Similarly, from the beginning the conventional slab has been quite often in providing features like better stiffness, High load carrying capacity, economical safe too. In this project G+14 storey building is taken with the same plinth area i.e. (35 m X 50 m)The main objective of the present study is to study the seismic behavior of the structure by finding the parameters such as Storey Displacement, Bending moment, story drift , shear Force, torsion etc. Thus to compare these parameters with seismic analysis for the different cases i.e. Model 1 with Flat slab with C-type shear wall, Model -2 with Flat slab with L-type shear wall, Model -3 with Conventional slab with C-type shear wall, Model -4 with Conventional slab with L-type shear wall, Model -5 with Grid slab with C-type shear wall, Model -6 with Grid slab with L-type shear wall respectively.

Keywords: Flat Slab, Conventional Slab, Grid Slab, L-Type Shear wall, C-Type Shear wall.

INTRODUCTION

Metropolitan area sowing to the shortage of land, erect building shave urbanized such a slow rise, medium–rise and high rise structures. These forms of structures exploit frame buildings as Conventional RC slab buildings and Flat slab building. Conventional RC slab building consists of Conventional slab worn forth e-construction that carry out a system in which a slab rests on a beam and beam rests on a column. This can be denoted as Beam–Slab Load transmit technique, a method that's regular put into practice all over the world

Flat Slab System

In universal framework, the system possesses columns, beams and slab. However the same building structure without beams, the frame structure consists of slab and columns merely. This form of slabs known as Flat Slab.

Conventional Slab System

Slab resting on walls or beams known as Conventional Slab. Conventional slabs are in general rectangular shape, but they are also present in any irregular shape like triangular, circular, trapezoidal etc.

Grid Slab System: -

Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement.

METHODOLOGY

The modeling part consists of modeling of G+14 Storey building on Staad.pro software. The total 6 models are created on the staad.pro. The model 1 and model 2 are having Flat slab building with C-type shear wall & L-type shear wall respectively. While from model 3 to 6 are modeled having building with Conventional slab System & Grid slab system with C-type shear wall & L-type shear wall respectively. The model description is tabulated on table no. 1 are as follows:

Table 1: Model Description

S. No.	Models	Descriptions
1.	**Model 1**	Building with Flat slab system with C-type shear wall.
2.	**Model 2**	Building with Flat slab system with L-type shear wall.
3.	**Model 3**	Building with Conventional slab system with C-type shear wall.
4.	**Model 4**	Building with Conventional slab system with L-type shear wall.
5.	**Model 5**	Building with Grid slab system with C-type shear wall.
6	**Model 6**	Building with Grid slab system with L-type shear wall.

MODELING AND ANALYSIS

G+14 storey's building with different Slab System is taken into account for the analysis. Six various types of building models with bay width of 5m in X-direction, 5m in Z-direction and storey height of 3.5m were taken into consideration for this analysis. The structure was modeled using STAAD.PROV8i computer software. All the selected models were designed with M-30 grade of concrete being used and Fe-500 grade of reinforcing steel as per IS code of practice. The building with Flat slab system, Conventional slab system & Grid slab system with C-type shear wall & L-type shear wall respectively is modeled to study the various parameters. These Six models are modeled in Staad.pro software by taking different Slab system in the RCC framed building. The plan, elevation & 3DView are as follows from Fig1 to Fig 8.

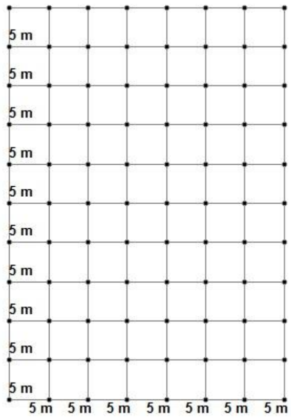
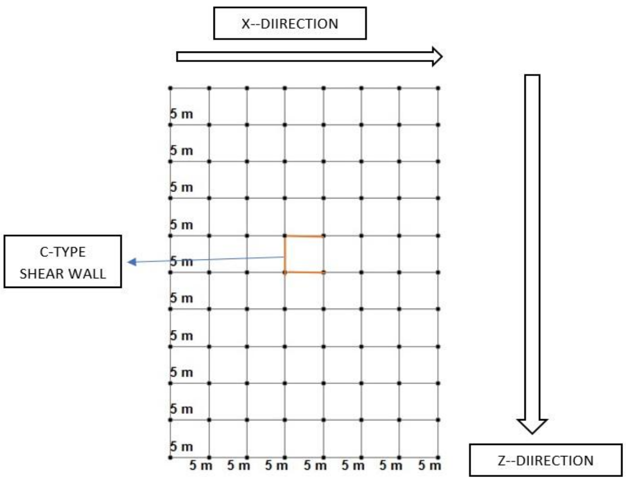
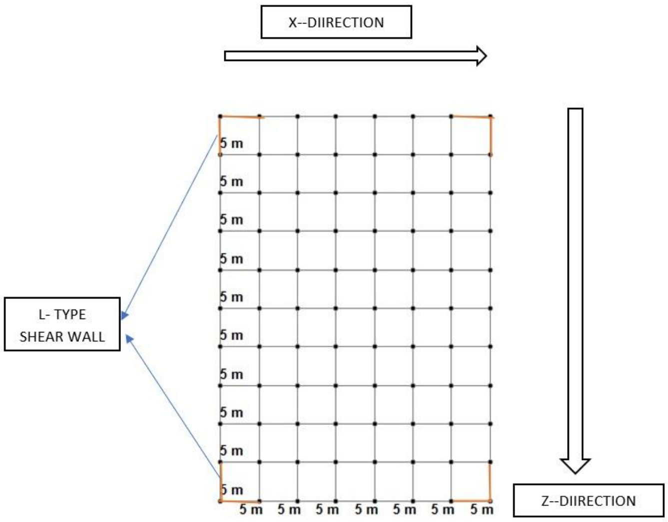


Fig. 1: Grid Plan View



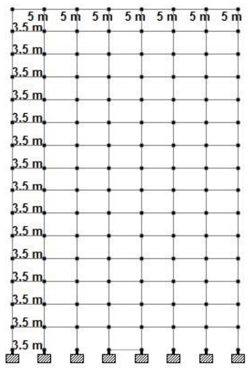
a) Position of C-Type Shear wall

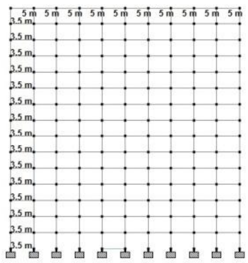


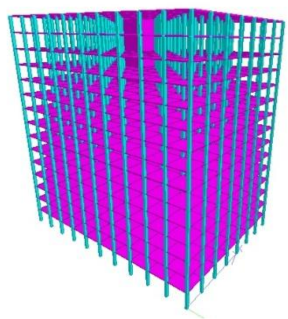
b) Position of L-Type Shear wall

Fig. 2 Plan view with position of C-type & L-type shear wall

Model 1: G+14 Storey Building with Flat slab system having C-type shear wall.



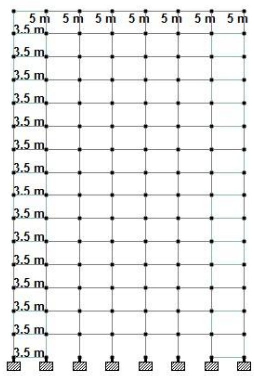


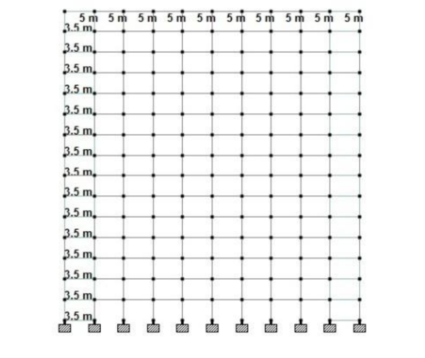


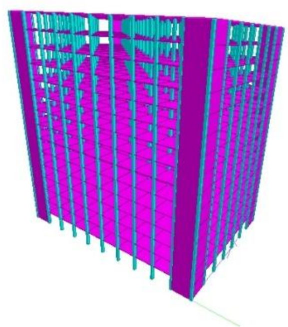
a) Elevation@ X direction **b) Elevation @ Z direction** **c) 3D view**

Fig. 3: Model 1- G+14 Storey Building with Flat slab system having C-type shear wall.

Model 2: G+14 Storey Building with Flat slab system having L-type shear wall.



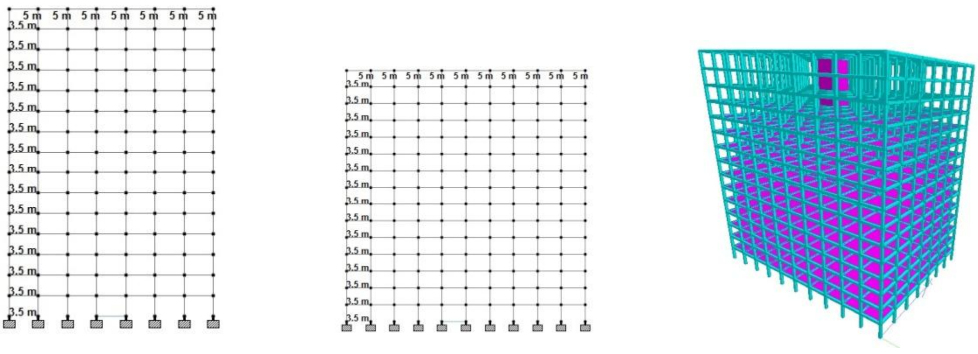




a) Elevation@ X direction **b) Elevation@ Z direction** **c) 3D view**

Fig.4: Model 2- G+14 Storey Building with Flat slab system having L-type shear wall.

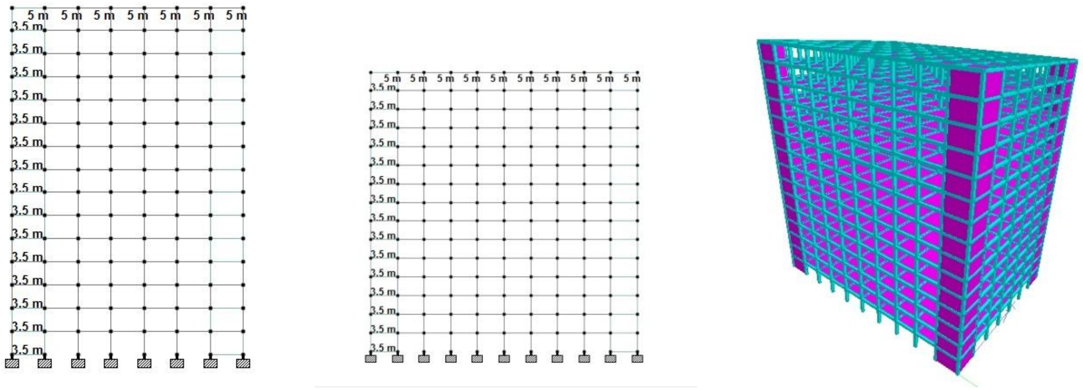
Model 3: G+14 Storey Building with Conventional slab system having C-type shear wall.



a) Elevation@ X direction **b) Elevation@ Z direction** **c) 3D view**

Fig. 5: Model3: G+14 Storey Building with Conventional slab system having C-type shear wall

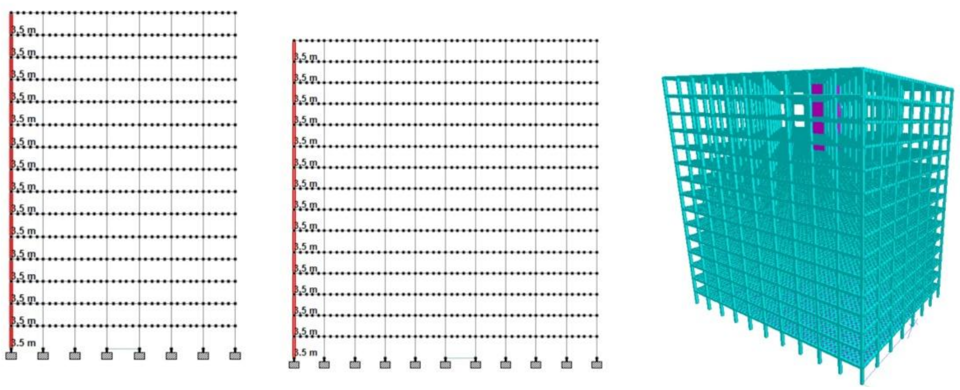
Model 4: G+14 Storey Building with Conventional slab system having L-type shear wall.



a) Elevation @ X direction **b) Elevation@ Z direction** **c) 3D view**

Fig. 6: Model 4 -G+14 Storey Building with Conventional slab system having C-type shear wall.

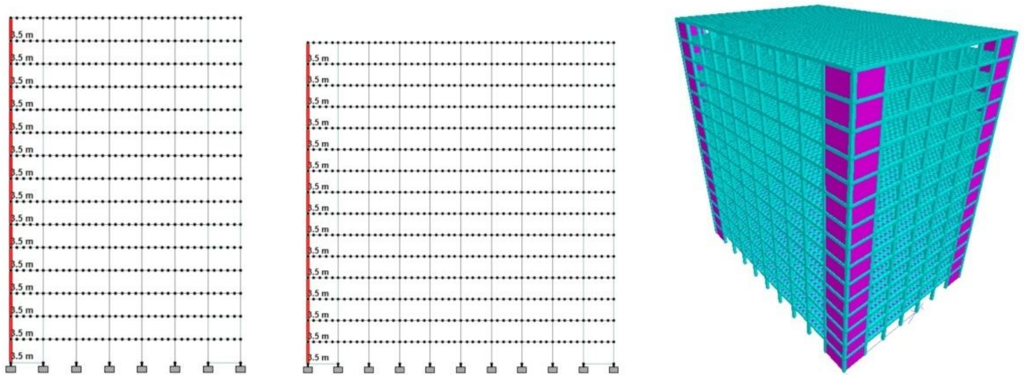
Model 5: G+14 Storey Building with Grid slab system having C-type shear wall.



a) Elevation @ X direction **b) Elevation @ Z direction** **c) 3D view**

Fig. 7: Model 5- G+14 Storey Building with Grid slab system having C-type shear wall.

Model 6: G+14 Storey Building with Grid slab system having L-type shear wall.



a) Elevation @ X direction **b) Elevation @ Z direction** **c) 3D view**

Fig. 8: Model 6- G+14 Storey Building with Grid slab system having L-type shear wall.

Material & Geometrical properties

Table 2: Material properties of elements of Structural

Descriptions of Elements used	**Material Grade**
Column	M-30
Beam	M-30
Equivalent shear wall	M-30
Slab Thickness	M-30
Reinforcement	HYSD-500

Table 3 Structural elements Details of Building.

Particulars	Details
Plinth Area(m^2)	1750 m^2
No. of bay in X-direction	7 no. @ 5m c/c
No. of bay in Z-direction	7 no. @ 5m c/c
No. of floors	G+14
Storey height	3.5meach
Beam Size in X-direction	500 mm x 450 mm
Beam Size in Z[-direction	450 mm x 500 mm
Column Size	450 mmx500mm
Slab Thickness	180mm
Shear wall Thickness	180mm

Earthquake Data

Table 4:Earthquake Data

Earthquake Zone	III
Importance Factor	1
Types of Soil	Medium Soil
Response Reduction Factor	4
Time period both X & Z Direction	1.53533
Damping	0.05
Method of Analysis	Response Spectrum Analysis

CONCLUSION

The results are evaluated based on modeling and analysis of the RCC Building frames having Six different models. The model 1 to model 6 is based on different concrete truss belt system located at different storey in RCC building.

Maximum Storey Displacement: - The maximum displacement value will be taken for all 6 models which is obtained on the top storey of each model. Table 5 tabulated the results of maximum storey displacements. The fig. 9 shows the bar chart representation of maximum displacement of all models.

Table 5 Maximum Storey Displacement Results

Maximum Storey Displacement (mm)			
S. No.	**Models**	**X - Direction**	**Z -Direction**
1	**Model 1**	57.115	58.36
2	**Model 2**	47.873	48.59
3	**Model 3**	95.769	101.345
4	**Model 4**	87.845	92.771
5	**Model 5**	67.125	72.015
6	**Model 6**	60.025	63.095

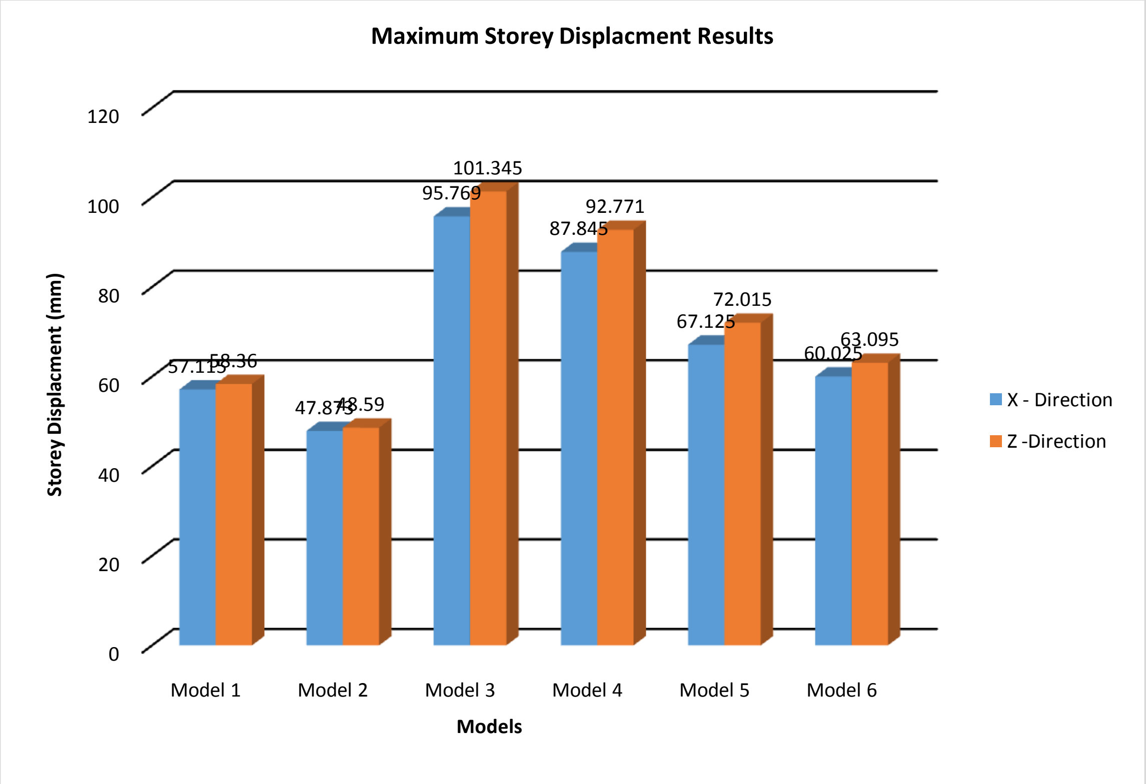


Fig. 9: Bar chart Representations of Max. Storey Displacement Results

Maximum Shear Force in Building: The Maximum Shear Force in Building value will be taken for all 6 models, one by one for each model. Table 6 tabulated the results of Maximum Shear Force in Building. The fig. 10 shows the bar chart representation of Maximum Shear Force in Building of all models.

Table 6 Maximum Shear Force in Building

Maximum Shear Force in Building (KN)			
S. No.	**Model Description**	**X-Direction**	**Z-Direction**
1	**Model 1**	93.797	87.375
2	**Model 2**	90.588	84.195
3	**Model 3**	150.412	147.344
4	**Model 4**	139.899	127.573
5	**Model 5**	170.015	165.235
6	**Model 6**	160.023	155.015

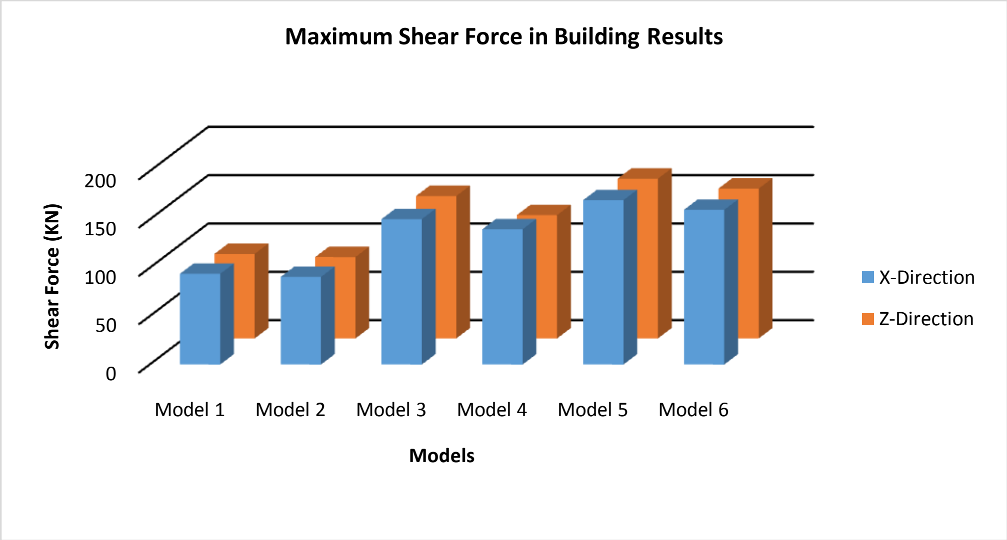


Fig. 10: Bar chart Representation of Maximum Shear Force in Building

Maximum Bending Moment in Building: The Maximum Bending Moment in Building value will be taken for all 6 models, one by one for each model. Table 7 tabulated the results of Maximum Bending Moment in Building. The fig. 11 shows the bar chart representation of Maximum Bending Moment in Building of all models.

Table 7: Maximum Bending Moment in Building

Maximum Bending Moment in Building(KN)			
S.No.	**Model Description**	**X-Direction**	**Z-Direction**
1	**Model 1**	168.679	185.824
2	**Model 2**	161.808	177.605
3	**Model 3**	269.297	335.403
4	**Model 4**	234.272	299.629
5	**Model 5**	355.015	401.552
6	**Model 6**	300.125	360.152

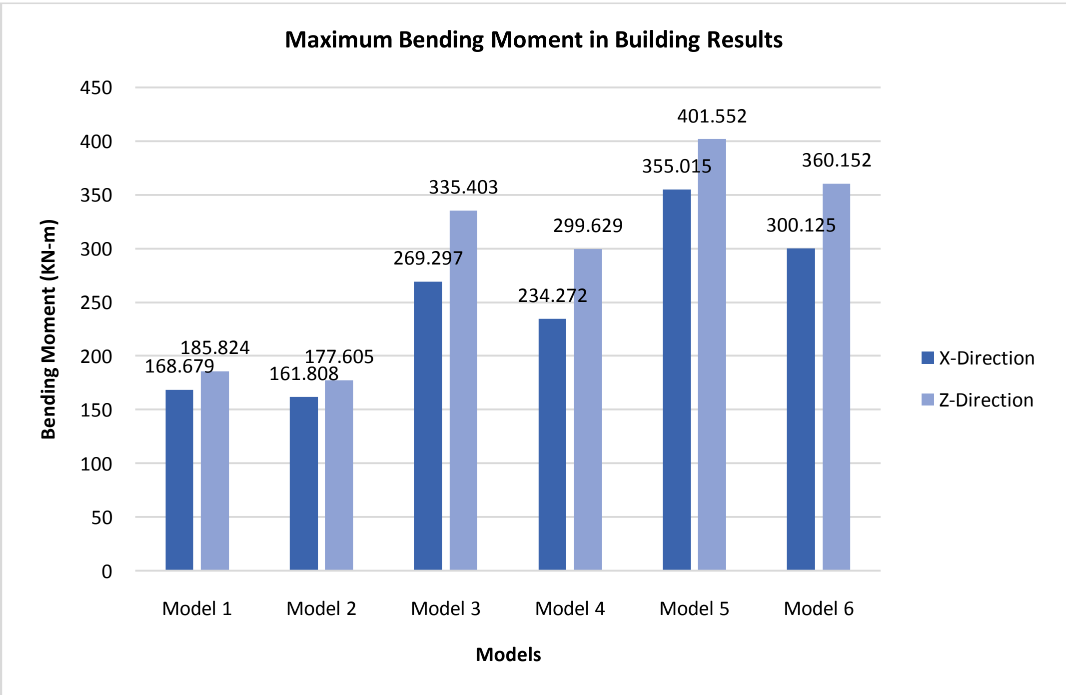


Fig. 11: Bar chart Representations of Maximum Bending Moment in Building

Column Axial Force Results

Table 8:Column Axial Force Results

Column Axial Force (KN)		
S. No.	**Model Description**	**Axial Force(KN)**
1	**Model 1**	4992.4
2	**Model 2**	5043.915
3	**Model 3**	6117.135
4	**Model 4**	6224.426
5	**Model 5**	7545.525
6	**Model 6**	7775.645

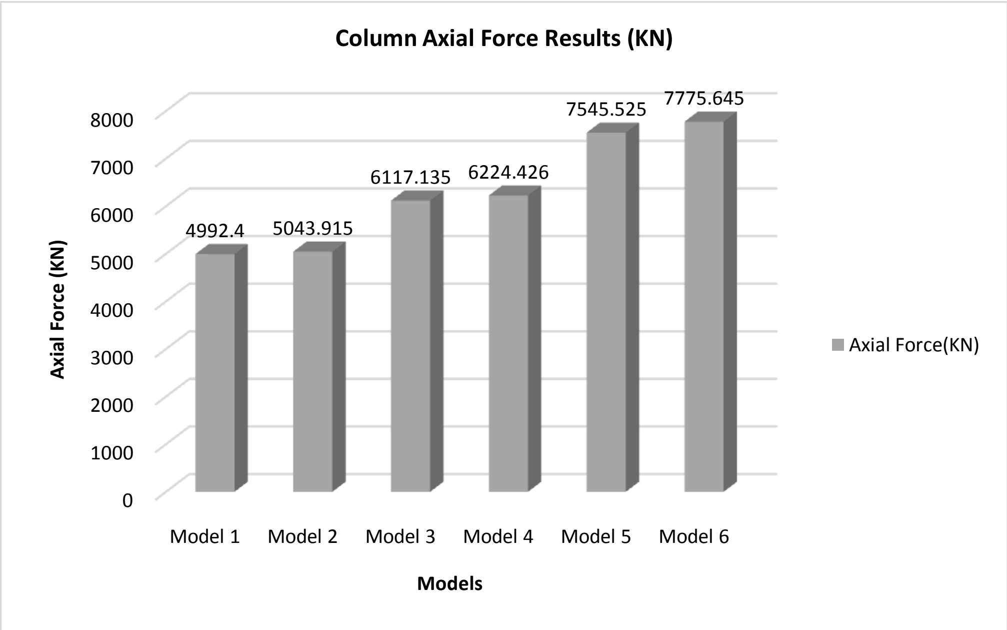


Fig. 12 Bar chart Representations of Column Axial Force

Base Shear Result

Table 9:Base Shear Results

Base Shear Result (KN)			
S.No.	**Model Description**	**X-Direction**	**Z-Direction**
1	**Model 1**	5222.56	5076.94
2	**Model 2**	5976.7	5921.16
3	**Model 3**	7477.97	7206.89
4	**Model 4**	8443.23	8436.7
5	**Model 5**	10815.5	10406.5
6	**Model 6**	11555.52	11305.8

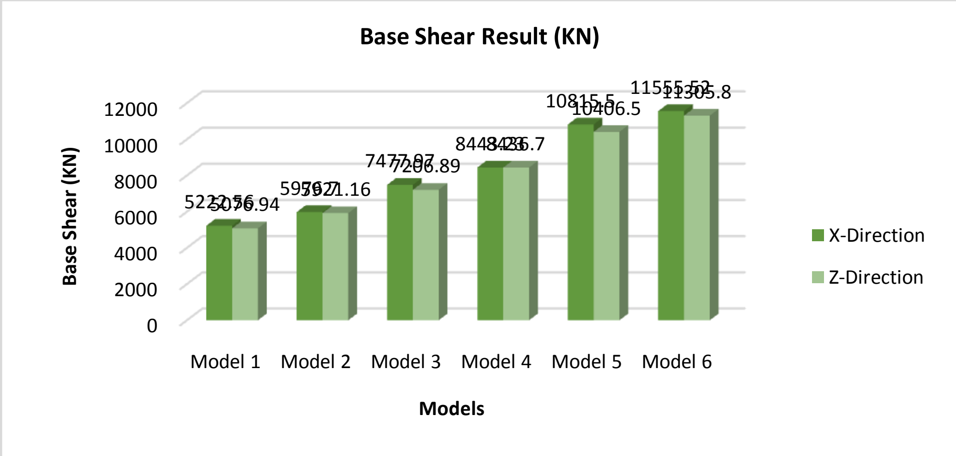


Fig. 13 Bar chart Representations of Base Shear Results

Maximum Beam Torsion

Table 10: Maximum Beam Torsion Results

Maximum Beam Torsion (KN)		
S. No.	**Model Description**	**Torsion (KN)**
1	**Model 1**	1.646
2	**Model 2**	1.883
3	**Model 3**	15.187
4	**Model 4**	17.822
5	**Model 5**	25.655
6	**Model 6**	30.255

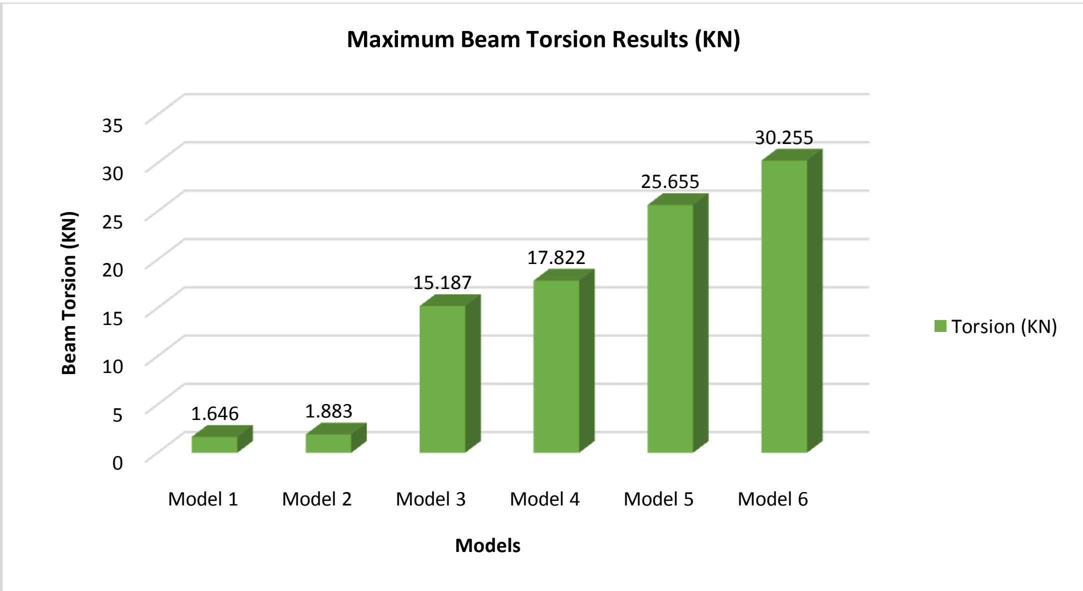


Fig. 14: Bar chart Representations of Maximum Beam Torsion

Maximum Stresses developed

Three types of stresses are to be considered in this project. The stresses are Von Mis Top, Tresca Top and Max. Top., the obtained results are tabulated by table 11 and bar chart plot are shown on fig. 15.

Table 11 Maximum Stresses developed Results

Maximum Stresses developed (N/mm2)				
S. No.	**Models**	**VON MIS TOP (N/mm2)**	**TRESCA TOP (N/mm2)**	**Max. Absolute (N/mm2)**
1	**Model 1**	13.6806	14.8683	5.43059
2	**Model 2**	8.05516	8.74491	3.05084
3	**Model 3**	16.5528	17.9852	5.8048
4	**Model 4**	10.4043	11.2909	3.61026
5	**Model 5**	20.2568	18.2345	6.2058
6	**Model 6**	15.6452	16.9235	4.5427

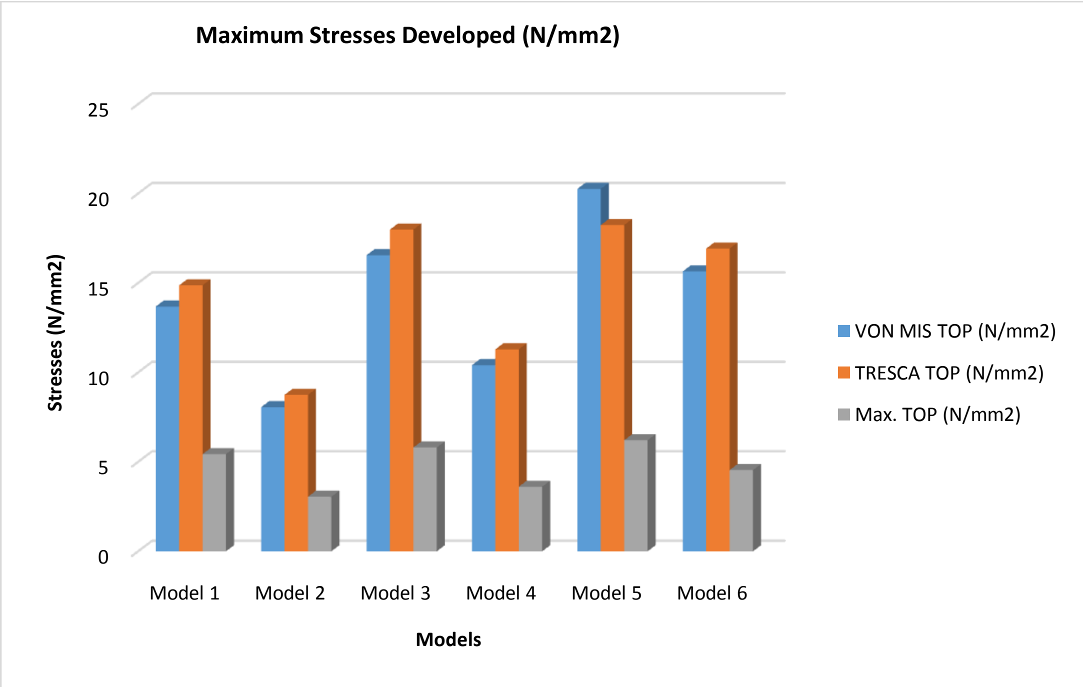


Fig. 15: Bar chart Representations of Maximum Stresses developed

CONCLUSIONS

The following conclusions are drawn from the research which is given below:

- The Storey displacement will be increased when Building with Flat slab is changed to either Conventional Slab or Grid Slab System. The maximum story displacement occurs in building with Conventional slab with C-type Shear wall and minimum storey displacement occur in building with Flat slab with L-type Shear wall in X-direction. Similarly, maximum storey displacement occurs in building with Conventional slab with C-type Shear wall and minimum storey displacement occur in building with Flat slab with L-type Shear wall in Z-direction.
- The shear force of all models shows increment in value when Building with Flat slab is changed to either Conventional Slab or Grid Slab System. The maximum shear force occurs in building with Grid slab with C-type Shear wall and minimum shear force occur in building with Flat slab with L-type Shear wall in X-direction. Similarly in Z direction, the maximum shear force occurs in building with Grid slab with C-type Shear wall and minimum shear force occur in building with Flat slab with L-type Shear wall.
- There is increment in bending moment value also being observed when Building with Flat slab is changed to either Conventional Slab or Grid Slab System. In X direction, the maximum bending moment occurs in building with Grid slab with C-type Shear wall and minimum bending moment occur in building with Flat slab with L-type Shear wall. In Z direction, the maximum bending moment occurs in building with Grid slab with C-type Shear wall and minimum bending moment occur in building with Flat slab with L-type Shear wall.
- The column axial forces value from model 2 to model 6 with reference to model 1 shows increment of 1.03%, 22.53%, 24.68%, 51.14% & 55.75% respectively.
- The use of Grid Slab or Conventional slab in building shows increment in base shear value with respect to Model 1(Building with Flat Slab having C-type shear wall). The maximum base shear occurs in building with Grid slab with L-type Shear wall and minimum base shear occur in building with Flat slab with C-type Shear wall in X-direction. Similarly, maximum base shear occurs in building with Grid slab with L-type Shear wall and minimum base shear occur in building with Flat slab with C-type Shear wall in Z-direction.

- The Grid Slab or Conventional slab Building also increases the beam Torsion in the building. The increment is being observed from model 2 to model 6with respect to model 1(Building with Flat Slab having C-type shear wall).
- There is increment in stresses being observed when Building with Flat slab is changed to either Conventional Slab or Grid Slab System.

As overall it concluded that by using Conventional or Grid Slab system in building, deformation is increased as compared to Flat slab system. Thus, building with Flat Slab should be preferred. In G+14 Storey Building the Model 2 Building with Flat slab system with L-type shear wall performs very well as compared to other remaining models. Also, it is being observed that as overall comparison the Building with Conventional slab system with C-type shear wall is very much vulnerable to seismic forces than all the other building models.

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