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Seismic Analysis of Multi- Storey Building by Providing Flat Slab with Different Types of Bracing System and Shear Wall

Mohammed Asif [a]***, Prof. Nadeem Pasha*** [b]

[a] *Student, Department of Civil Engineering, Khaja Bandanawaz University, Kalaburagi, India.*
[b] *Professor, Department of Civil Engineering, Khaja Bandanawaz University, Kalaburagi, India.*

ABSTRACT

This paper focuses on the effect of earthquake causes a large loss to the building structures, so the important steps to be taken to overcome the damage cause due to earthquake. Seismic analysis performance is carried to know how the structure behaves during the earthquake. nowadays multi-storey building in India have open first storey as an unavoidable feature. This is usually being adopted to accommodate parking or reception lobbies, Also for offices or for any other purpose such as communication hall etc. In present work Seismic Analysis of Multi-storey building by providing Flat Slab with different types of bracing sytem and shear wall. In present construction practice flat slab systems has become widely used in reinforced concrete buildings. In RC buildings flat slab system exhibit several advantages over conventional moment resisting frames. Flat slab system reduces floor height to meet the architectural and economical demand.. Shear walls are used to resist lateral forces parallel to the plane of the wall. Large forces are generated due to seismic action resist by high in plane stiffness and strength of shear wall. Mainly to avoid the total collapse of the buildings under seismic forces, shear wall act as a flexural member. In this paper, study of 12 storey building in zone V and zone II is considered, and it is analyzed with flat slab by changing various shapes of shear wall to determine different parameters like storey shear, storey displacement, storey drift and time period. Analysis is done using ETABS V.17.Software. Response spectrum analysis i.e. linear dynamic analysis is performed on the system to get the seismic behaviour. A Bracing is a system that is provided to minimize the lateral deflection of structure. The members of a braced frame are subjected to tension and compression, so that they are provided to take these forces similar to a truss. The analyses were carried out to assess the structural performance under earthquake ground motions. These models are compared in different aspects such as storey drift, storey displacement and storey shear.

Keywords: Flat Slab, Bracing system, Shear wall, story displacement, story drift, Time Period, base shear, Response Spectrum, Etabs 17

1. Introduction

1.1 Flat Slab

Traditional RCC slabs are w`idely utilised in building construction since long past. Even though it improves the building's shear capability & stiffness, it's being phased out in favour of a newer method of building (flat slab), developed in the United States by C.A.P. Turner in 1906.

These slabs carry their weights to the columns since they lie directly on them. In compared to regular RCC slabs, the price of these "beamless slabs" supposedly drops by 20%. It may be constructed using either traditional RCC methods or post-tensioning. Placing of reinforcement was already simplified in this kind of building because to its many benefits, which include a more aesthetically pleasing look, increased lighting, adaptability in room arrangement, decreased construction time, and simplified formwork. The lack of rafters in a slab ceiling creates a clean, modern look from an architectural perspective.

Due to its rapid and standard method of construction, this form of slab prevents the beam column from being clogged. These slabs are more susceptible to earthquake stress because of their greater flexibility compared to traditional slabs.

There are typically two modes of failure in such a system: flexure failure and punched shear failure. Once total shear force surpasses slab's shear resistance, its driven down to within a few millimetres of the column, causing the punching shear to occur. In order to prevent the column from failing through the encircling slab, designers incorporate components such as drop panels, column heads, shear walls, shear reinforcement, bracings, etc.

A flat slab is a common structural design in which the slab and the supporting column are constructed as one seamless unit, with the slab being reinforced in 2 or many directions without the need of beams. As a result, the weight was carried straight from the flat slab to support column located underneath it. The lack of a beam system in this sort of building results in a smooth ceiling, which is more aesthetically pleasing from an architectural standpoint. The simple ceiling diffuses light better than the typical beam slab design, and it is said to be less sensitive to fire. When compared to other slab types, flat slab is simpler to build and needs less expensive formwork. Since concrete is a more practical material to utilise, the overall cost is reduced when dealing with long spans and high weights.

In the absence of a beam, a flat-slab structure consists of a slab cast in one piece and supported by a series of columns. If there is no beam, a flat ceiling may be achieved. The main characteristics of a flat slab floor are its uniform thickness and level ceiling, for which little formwork is required and the building process is straightforward. High-rise building projects may benefit financially from flat-slab systems. The total height of the building is reduced, which has a knock-on impact on the structure's loading and so reduces the cost of the foundation. A column is said to be of the slender kind if ratio of its unsupported length to its smallest dimension is lesser than 10. When the bottom level or parking floor of a multi-story building is raised, the need for thinner columns arises, either for practical reasons or aesthetic ones. However, current architectural fashion favours higher, slimmer buildings. When two columns have the same cross-sectional area, the longer one may bear less weight than the shorter one. Because of this effect, the long column can only support a negligible fraction of the load of a shorter column. Because they are assessed and developed in accordance with IS code, flat-slab buildings have sustained extensive damage. Therefore, it is necessary to assess the real-world effectiveness of flat-plate structure under seismic stress.

2. Literature Review

Vivek Kumar, Dr. Kailash Narayan(2019) "Seismic Behavior of Flat Slab Building with Steel Bracing System using Pushover Analysis on ETABSv17"[2] Commonplace in the modern day is the use of tried and true RC Frame construction. In this study, three variations of flat slab constructions are examined: (1) flat slab with a drop, (2) flat slab with a 'X' bracing system, and (3) the flat slab with an inverted '/' bracing system. To evaluate nonlinear behaviour of buildings with lateral loads, base shear, displacement relationships, i.e. a capacity curve, may be generated by Pushover analysis, which was used to analyse the performance of all three modalities of flat slab structures. Non-linear static analysis is a sort of analysis that pushes a structure over its elastic limit to see how well it holds up. The ETABSv17 programme is used for analysis. All three versions are G+10 stories tall and 15 x 25 metres in footprint. Base shear, displacement, and storey drift are compared to findings obtained. The major goal of this work was to examine the effects of various lateral force resisting systems, like steel bracings on flat slab buildings, when subjected to seismic excitation, and to determine the nonlinear behaviour of such buildings. The goal of this research is to compare base shear, displacement, storey drift, etc. characteristics of various models according on standards set out in IS-1893:2016.

Javed Ul Islam, et.al (2020)"Earthquake Resistant Design-"[3] This research focuses on analysing the structural performance of metal buildings using a variety of bracing configurations. The efficiency of several types of bracings has been studied. At, we looked at how lateral loads might affect the design and analysis of a 10-story frame building. Different types of bracing systems, such as X bracing, Inverted V-type bracing, K bracing, & single Diagonal bracing, have been studied to see how they affect the structural performance of RC frame buildings. Lateral displacement and beam moments have been compared between braced, story drift, and unbraced structures at different floor levels. The research revealed that the lateral displacement of a braced frame structure would be less than that of an RC frame, & X-Bracing system was more efficient than the others. The highest displacement reduction occurs in the X-bracing frame structure and adds significantly to the overall rigidity of the building. Finally, it can be said that, among all the structures considered here, X-diagonal braced structure implies greater structural overall performance. Bracing mechanisms integrated into the building make it more earthquake-proof. Designing buildings to withstand earthquakes in this way might be practical and economical in certain cases.

Sanjeev et.al (2019)) "**seismic Analysis of Multi Storied Building with and without Shear Wall and Bracing"[4]** An increasing number of structures are being built and developed in accordance with architectural needs and aesthetic preferences. Most structures, whether they are X or V shaped, have axes that are not perpendicular to the structure. The fundamental issue with many modern building configurations is that they are too tall and thin to withstand an earthquake without significant damage. The major purpose of this research is to do a comparison analysis of dynamic behaviour of buildings with diverse layout of structure throughout all seismic zones & different kinds of soils. In this research, a 20-story, 70-meter-tall skyscraper with a 3.5-meter-tall floor plate and Shear walls and bracing at strategic heights throughout the building are taken into account. Building dynamics were analysed in four distinct soil conditions (hard, medium, and soft) and four different seismic zones (II, III, IV, and V). An R.C Shear wall, 200 mm thick, is supported by beams throughout the building's outside edge. The response spectrum study was carried out by utilising software of ETAB's version 9.7.4.

Shahzeb Khan, et.al "Earthquake Resisting Techniques upon A G+10 Storey Building with Help of Shear Walls & Bracings, using Software"[6] Natural disasters have been a major source of loss of life and property for humans almost from beginning of recorded history on Earth. Earthquakes are a significant natural occurrence. Any building still standing after a sudden tremor presents a formidable task. Many structures have fallen and lives have been lost in recent earthquakes because of poor design that lacked seismic resilience. The structures' strength, necessary to resist the earthquake, has been achieved using a variety of designs and materials. There are a variety of methods used to make buildings earthquake proof in the current day. Shear walls, bracings, base isolation, column jacketing, etc., are all examples of these methods used to reinforce a building. Using software, I conduct a comparative examination of several earthquake-resisting approaches applied to a G+10-story structure by using various kinds of Shear walls and Bracings. Unreinforced masonry, parallel masonry, an L-shaped masonry wall, diagonal masonry walls, X-shaped masonry walls, and V-shaped masonry walls are all compared. Shear walls & bracings are used to reinforce the building, making it more resistant to earthquakes. The IS 1893:2002 codified rules for seismic zone III are applied to a G+10 construction. Staad pro v8 is the programme I used to do the analysis. By improving the building's strength and stiffness, shear walls & bracing are discovered to have a significant role in decreasing deflection. The findings from this experiment may be used elsewhere to improve seismic strength of structures by using a wider range of seismic resistance strategies.

Ms. Deepa Telang, et.al (2018)"Comparative Study of Multi-Storey RC Building Having Flat Slab with and without Shear Wall with Conventional Frame Structure Subjected To Earthquake"[7] There has been a dramatic growth in number of skyscrapers in the modern age. Until recently, conventional reinforced concrete (RC) buildings were the norm in the construction business. The flat slab method is often used in the construction of public structures. Poor structural efficiency may be expected from a flat slab building when subjected to seismic loads. It's not really stiff. By including a shear wall as an additional lateral load resisting structure, their stiffness may be increased. This study compares the performance of a G+9 commercial building with a flat slab and a shear wall. That way, we may evaluate variables such as base period, base shear, storey drift, & storey displacements side by side.

3. Objectives of Study

1. To assess G+11 Multi-Storey Commercial building using M30 Grade of concrete as per IS 1893-2016(part 1) code & examine the reaction utilising flat slab with drop panel , various kinds of bracing system and shear wall.

2. Purpose of this research is examining parameters of multi-story structure with flat slab in seismic zones II and V, including storey displacement, storey drift, & foundation shear.

4. Description of the Models

4.1 Geometry of the models.

1. Finalised structures are 12 story moment resisting frame structures.
2. The story height is 3.6m and base 2m.
3. Entire height of structure is 41.6m.
4. Number of Bays in X-direction and Y-direction is 7.
5. Spacing between column in X is 4m and Y direction is 5m.
6. Columns of 600mmx600mm.
7. Size of the building 24mx30m.
8. Section property used as X Bracing: ISMB 200.
9. Thickness of flat slab is 200mm.
10. Size of the drop panel is 2mx2m
11. Thickness of drop panel is 250mm
12. Thickness of shear wall taken: 250mm

4.2 Models Considered in the Study

1. Multi storey building + flat slab + x bracing at corner side of building
2. Multi storey building + flat slab + v bracing at corner side of building
3. Multi storey building + flat slab + x bracing at corner side + at centre of the building
4. Multi storey building + flat slab + L shaped shear wall
5. Multi storey building + flat slab + Box type shear wall
6. Multi storey building + flat slab + straight shear wall

4.3 Loads Applied

1) Gravity loads :

Live load = 4kN/m^2

Dead load = 6.25kN/m^2

2) Earthquake inputs as per IS 1893 (Part 1): 2016

Soil type-Type II (Medium soil)

Importance factor – 1.5

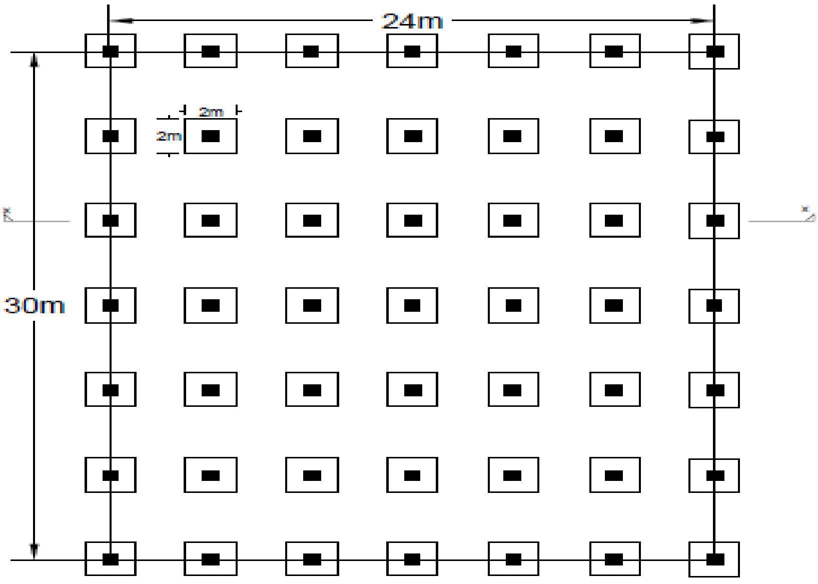
Response reduction factor – 5

Building location:

- Very severe intensity (Zone V).
- less severe intensity (Zone II).

Zone factor:

- Z= 0.36 for (ZONE V).
- Z= 0.10 for (Zone II).



SLAB LAYOUT DETAILS

Model 1:

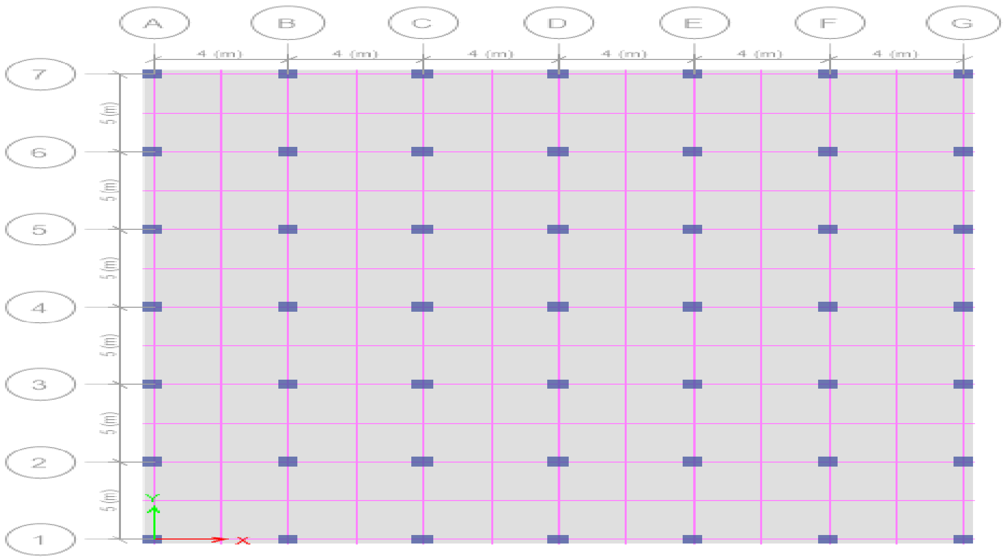


Fig 1 Multi-storey building with Cross bracing at corner side

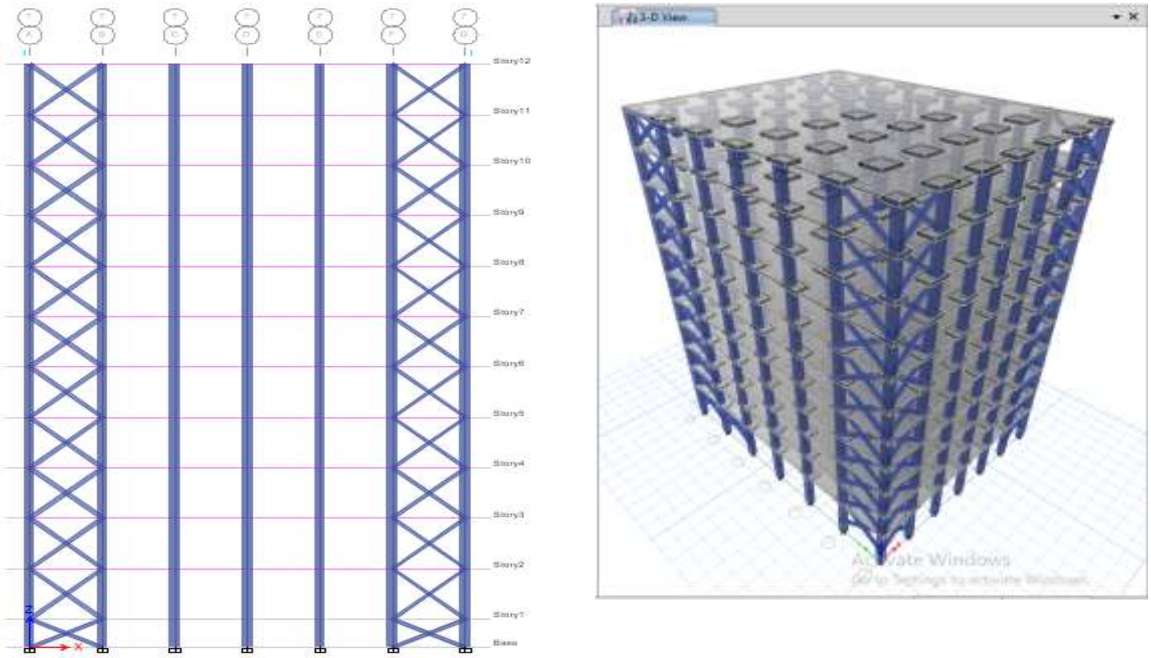


Fig 2 Elevation and 3D view of Multi-storey building with Cross bracing at corner side

Model 2:

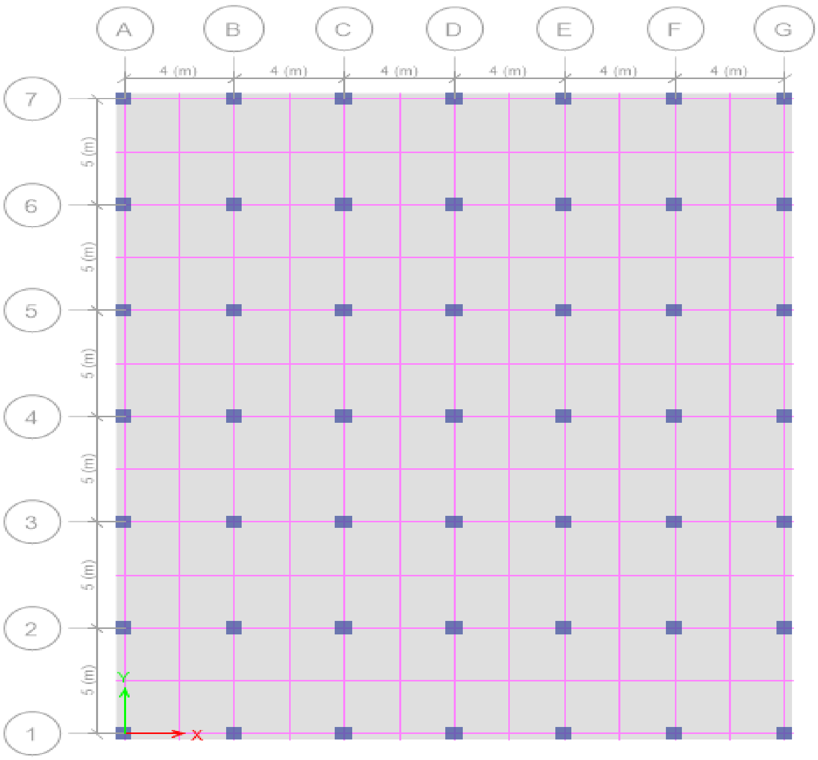


Fig 3 Multi-storey building with V bracing at Corner side

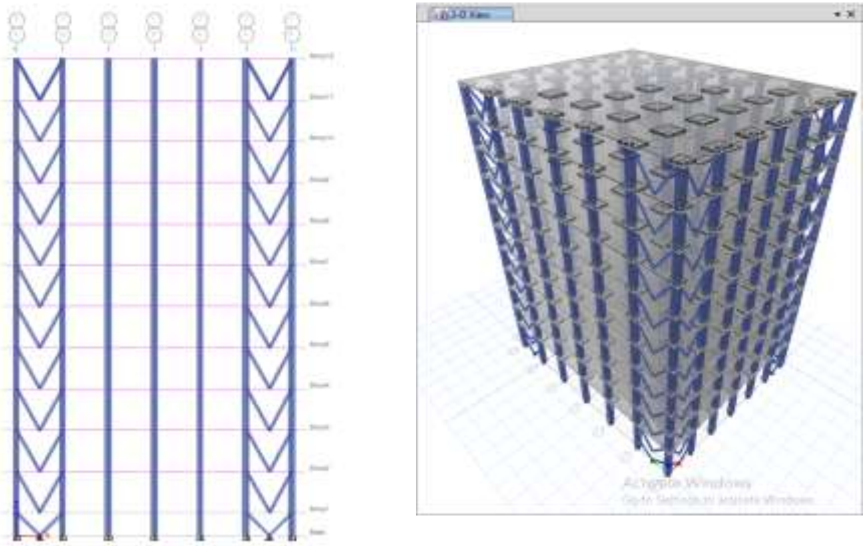


Fig 4 Elevation and 3D view of Multi-storey building with V bracing at Corner side

Model 3:

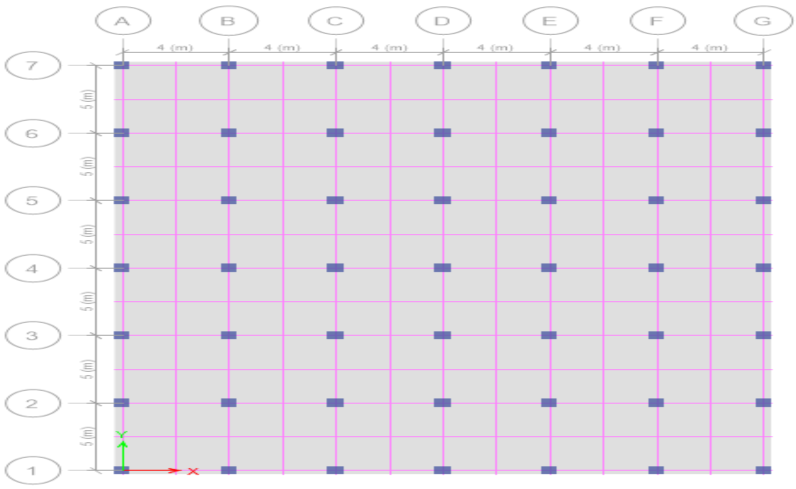


Fig 5 Multi-storey building with cross bracing at corner side and at centre

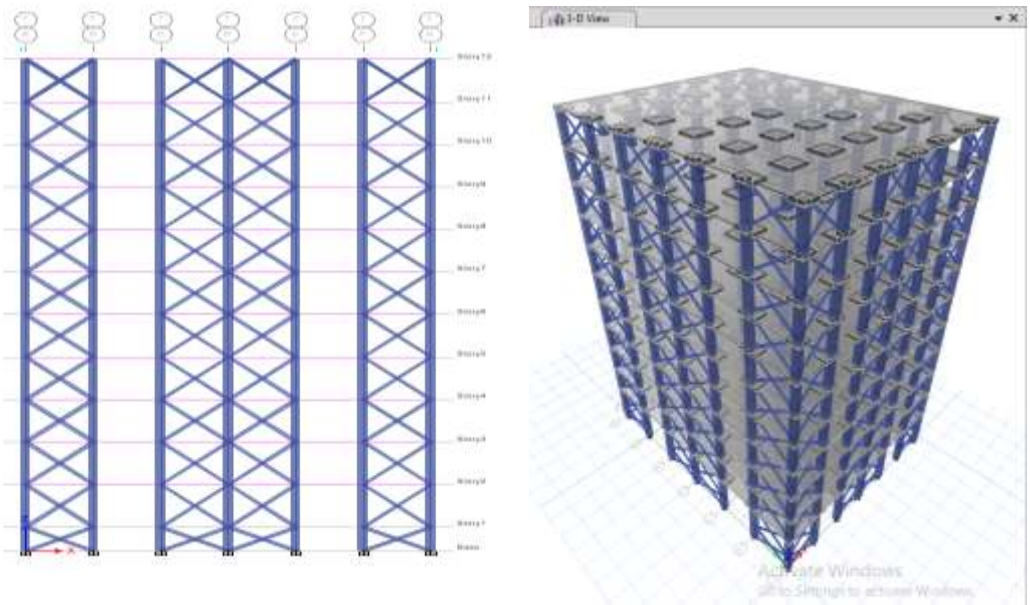


Fig 6 Elevation and 3D view of Multi-storey building with cross bracing at corner and atcentre

Model 4:

Fig 7 Multi – Storey building with L Shaped Shear wall

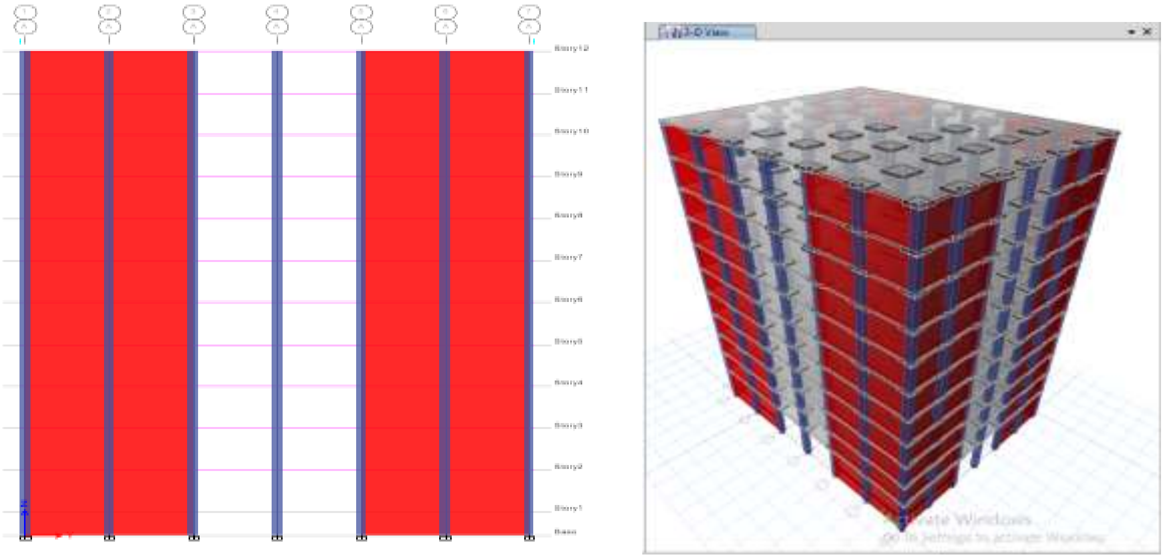


Fig 8 Elevation and 3D view OF L Shaped Shear wall

Model 5:

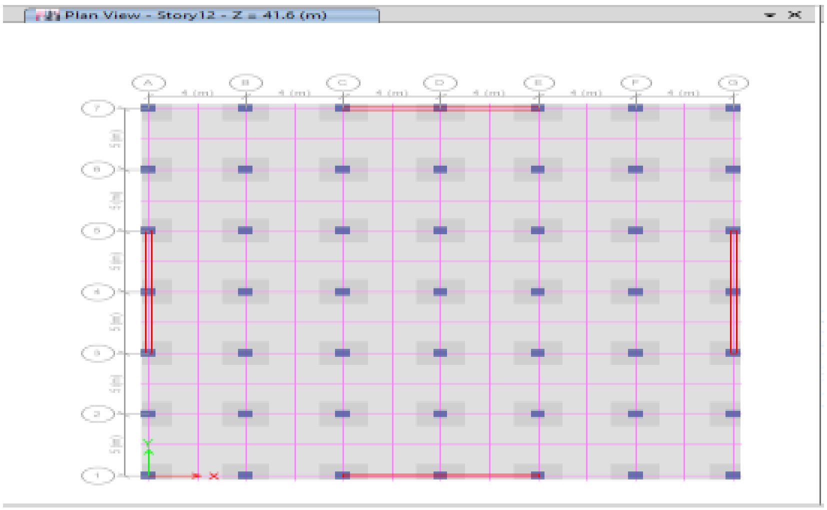


Fig 9 Multi – Storey Building with Straight Shear wall

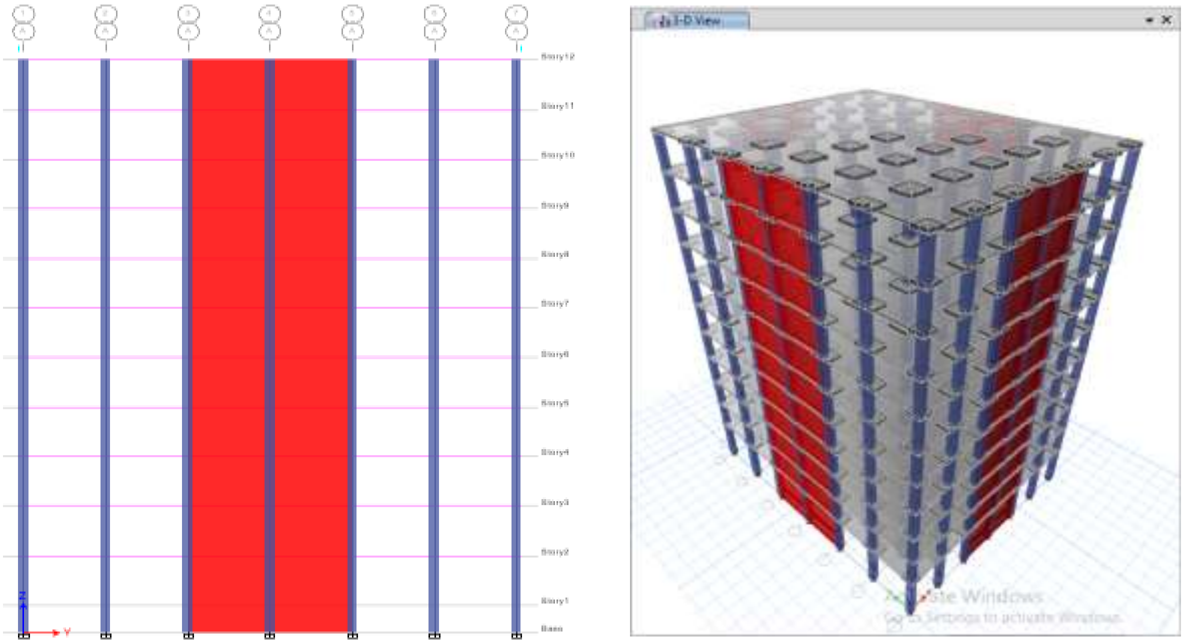


Fig 10 Elevation and 3D view OF Straight Shear wall

Model 6:

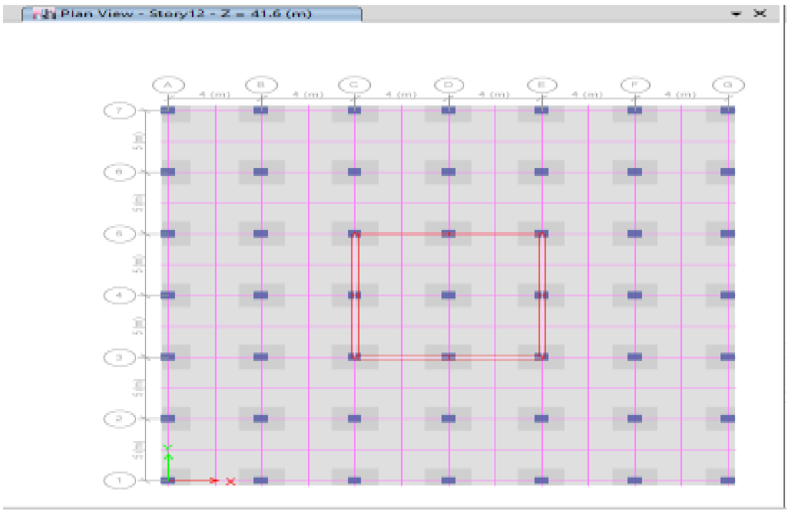


Fig 11 Multi – storey building with box type shear wall

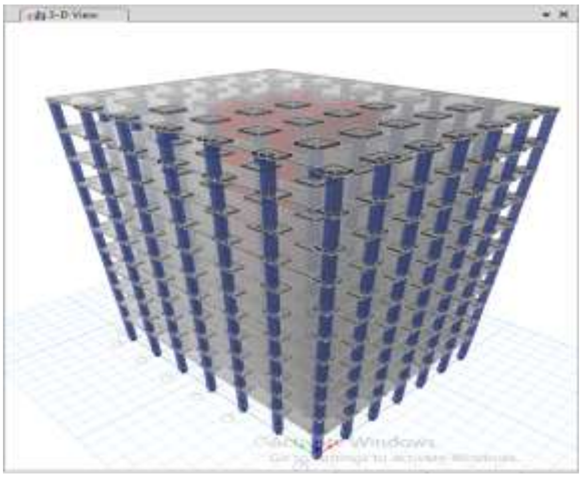


Fig 12 Elevation and 3D view Box Type Shear wall

4.4 Parameters utilized for different framing systems analysis

The plan is kept same for the study of all the framing systems. Story height is kept as 3.6m from bottom to top and base is 2m.

Table 1 Material Properties:

PROPERTIES	VALUES
Concrete Young's modulus	25X106kN/m^2
Reinforced concrete density	25 kN/m^2
Steel density	76.59 kN/m^3
Poisson's ratio of steel	0.3
Concrete Grade	M30
Steel Grade	Fe 500

5. Results and Discussion

The Response Spectrum techniques are used to analyse the many models of structures. The various structural models are analysed with the help of ETABS software. The outcomes of inquiry are presented and analysed, including data like tale displacements & story drifting for each structural model.

5.1.1 Displacement

Models are presented using seismic loads with a focus on their significance so that the audience can grasp the presentation. The expected model-specific displacements under various lateral loads are obtained and summarised.

As per IS codes most displacement into multi storey structure is hs/500,

here hs- Building Height.

Maximum allowable displacement was determined for models tested.

=41.6/500=0.0832m = 83.2mm

5.1.2 Storey Drifts

As per IS 1893-2016 utmost permissible drifting for any structure is =0.004H

H- 1 storey height

For our models greatest permissible drift = 0.004*3.6=0.014m = 14mm

5.1 Parameters studied for all models in Zone V

5.1.1 Maximal time period comparing with every model because of seismic loads into Zone V

TABLE 2 Maximal time period comparing with every model because of seismic loads into Zone V

MODELS	EQX (sec)
Model 1	1.69
Model 2	1.812
Model 3	1.448
Model 4	0.81
Model 5	1.147
Model 6	0.996

1.Time period for Cross bracing is 8% less than the V bracing and time period for V bracing is 55% more than the L shaped shear wall in zone V.

2. Time period for Straight Shear wall is 13% more than Box Type Shear wall in zone V.

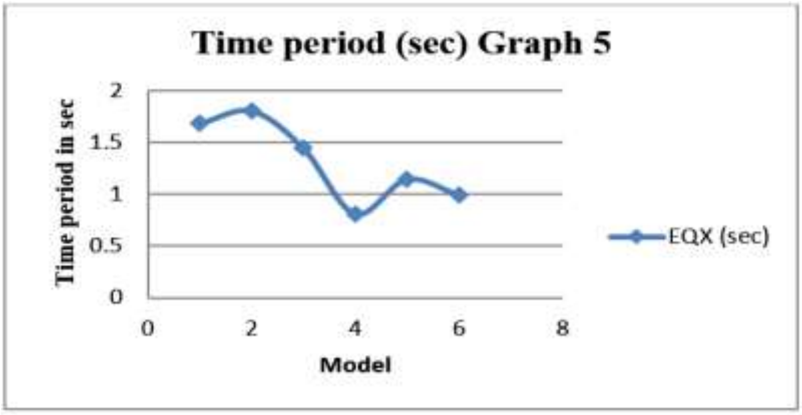


CHART 1: Maximal time period comparing with every model because of seismic loads into Zone V

5.1.2 Maximal base shear comparing with every model because of seismic loads into Zone V

TABLE 3 Maximal base shear comparing with every model because of seismic loads into Zone V

MODELS	EQX (kN)
Model 1	5609.23
Model 2	5230.02
Model 3	6560.86
Model 4	13335.86
Model 5	8830.171
Model 6	10456.77

1. Base shear of Cross bracing is 7% more than the V bracing and base shear of L Shaped shear wall is 51% more than straight shear wall in zone V.

2. Base shear for Box Type shear wall is 19% more as Straight Shear wall in zone V.

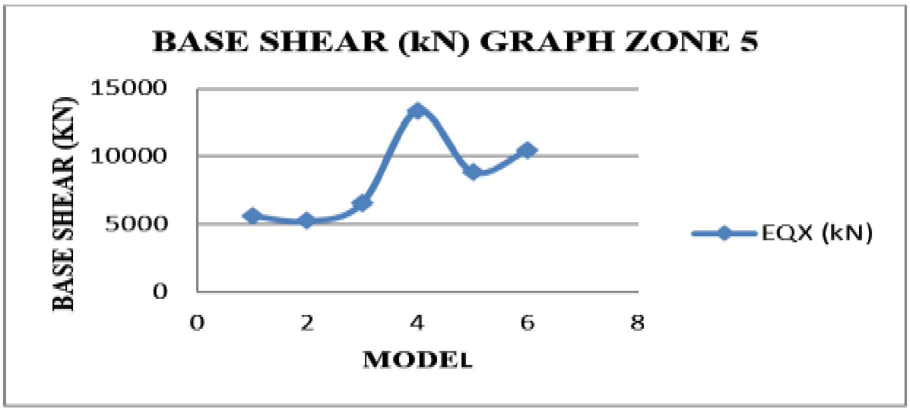


CHART 2: Maximal base shear comparing with every model because seismic loading in ZoneV.

5.1.3 Storey wise displacements into X direction with every model in Zone V

TABLE 4 Storey wise displacements along X-direction in mm.(Response spectrum method)

STOREY	MODEL1(RSX) IN MM	MODEL2 (RSX) IN MM	MODEL3 (RSX) IN MM
Base	0	0	0
Story1	1.77	3.45	1.613
Story2	7.165	9.251	6.027
Story3	12.7	15.445	10.678
Story4	18.459	21.412	15.575
Story5	24.357	27.372	20.628
Story6	30.253	33.25	25.712
Story7	36.002	38.921	30.699
Story8	41.454	44.246	35.459
Story9	46.454	49.071	39.86
Story10	50.848	53.235	43.767
Story11	54.479	56.57	47.05
Story12	57.18	58.941	49.549

1. Storey displacement consistently raising when Cross bracing is providing every floors. From model 1 i,e Cross bracing is 3% less than the V bracing in zone V.

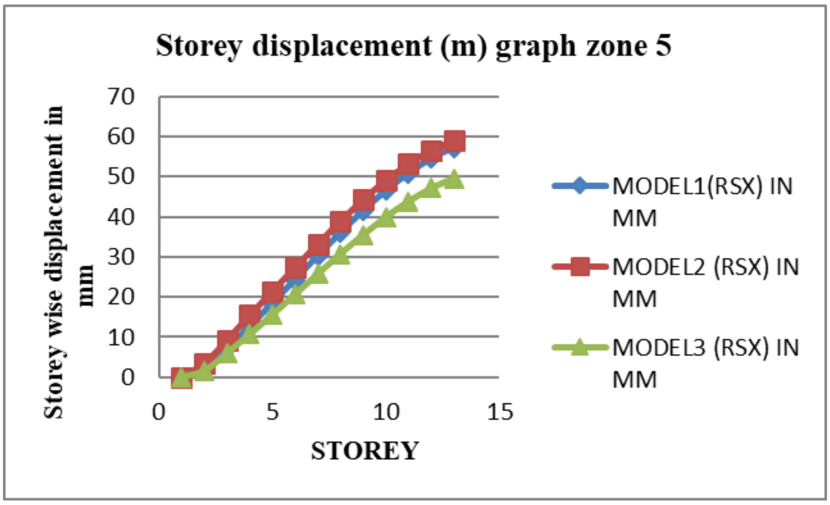


CHART 3: Storey wise displacement for model 1,2 and 3

TABLE 5 Storey wise displacementalong X-direction in mm.(Response spectrum method)

STOREY	MODEL4 (RSX) IN MM	MODEL5 (RSX) IN MM	MODEL6 (RSX) IN MM
Base	0	0	0
Story1	0.49	0.622	0.589
Story2	1.722	2.487	2.198
Story3	3.695	5.387	4.583
Story4	6.19	9.04	7.539
Story5	9.088	13.237	10.949
Story6	12.284	17.799	14.699
Story7	15.682	22.563	18.682
Story8	19.192	27.391	22.797
Story9	22.733	32.167	26.949
Story10	26.239	36.801	31.054
Story11	29.66	41.247	35.048
Story12	32.944	45.426	38.843

1.Storey displacement consistently rising whenever shear wall is provided for every floors. From model 1 i,e Straight Shear wall is 17% more than the Box Type Shear wall in zone V.

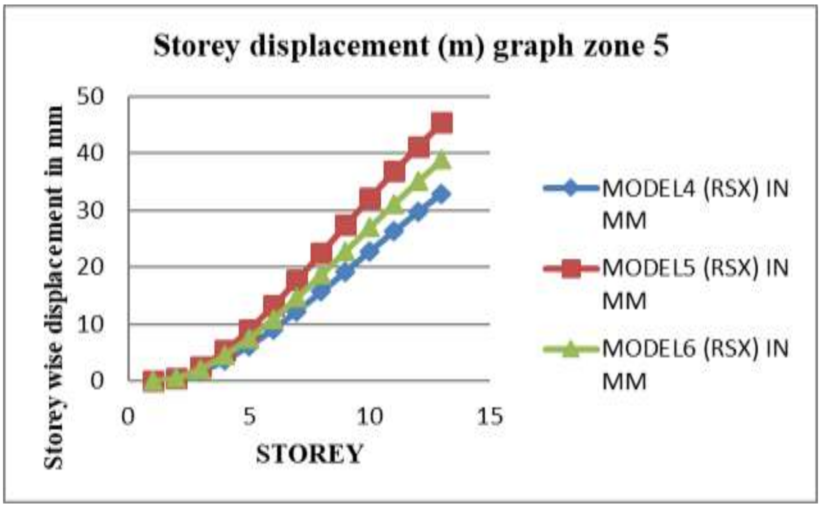


CHART 4: : Storey wise displacements for model 4,5 and 6

5.1.4Storey wise storey drifting proportion disparity in X directionfor all models in Zone V

- TABLE 6 Storey wise storey drift ratio variation along X-direction(Response spectrum method)

STOREY	MODEL 1	MODEL2	MODEL3
Base	0	0	0
Story1	0.000885	0.001053	0.000807
Story2	0.00199	0.00257	0.001674
Story3	0.001538	0.00172	0.001292
Story4	0.0016	0.001658	0.00136
Story5	0.001638	0.001656	0.001404
Story6	0.001638	0.001633	0.001412
Story7	0.001597	0.001575	0.001385
Story8	0.001514	0.001479	0.001322
Story9	0.001389	0.00134	0.00122
Story10	0.001221	0.001157	0.001086
Story11	0.001009	0.000927	0.000912
Story12	0.00075	0.000659	0.000694

CHART 5: Storey wise storey drif for model 1,2 and 3

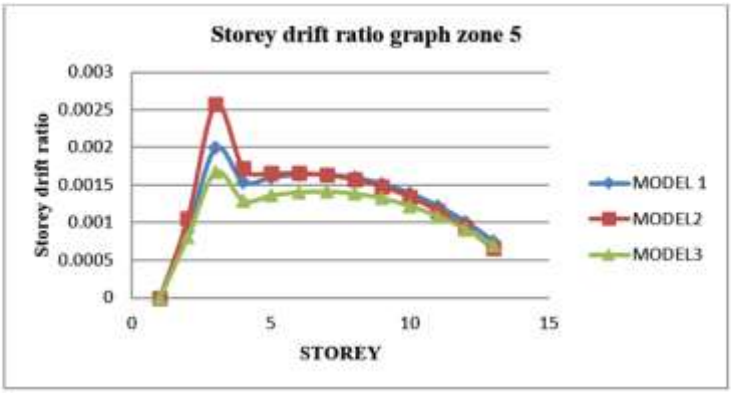


TABLE 7 Storey wise storey drift ratio variation along X-direction(Response spectrum method)

STOREY	MODEL 4	MODEL 5	MODEL 6
Base	0	0	0
Story1	0.000245	0.000311	0.000295
Story2	0.000478	0.000691	0.000505
Story3	0.000548	0.000806	0.000662
Story4	0.000693	0.001015	0.000821
Story5	0.000805	0.001166	0.000947
Story6	0.000888	0.001267	0.001042
Story7	0.000944	0.001323	0.001106
Story8	0.000975	0.001341	0.001143
Story9	0.000984	0.001327	0.001153
Story10	0.000974	0.001287	0.00114
Story11	0.00095	0.001235	0.00111
Story12	0.000912	0.001161	0.001054

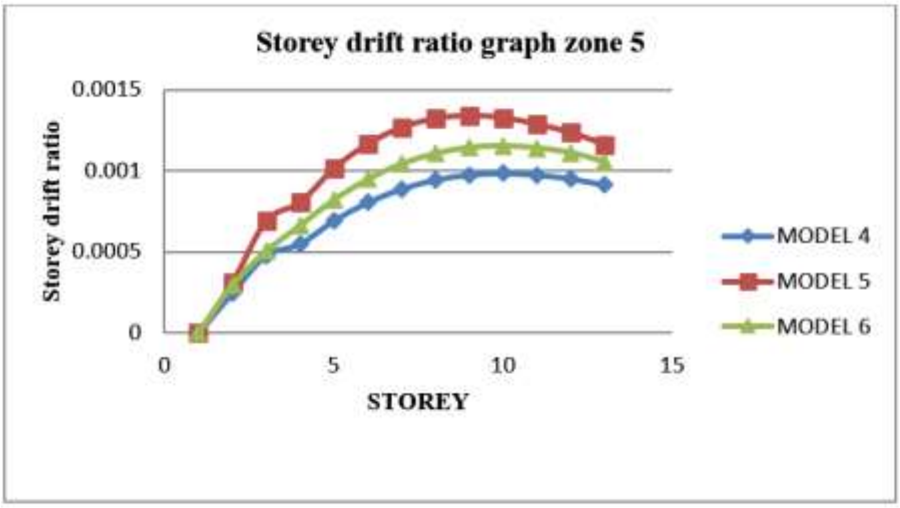


CHART 6: Storey wise storey drift for model 4,5 and 6

5.2 Parameters studied for all models in ZoneII

5.2.1 Maximal time period comparing every models because of seismic loading into Zone II

TABLE 8 Maximal time period comparing every models because of seismic loading into Zone II

MODELS	EQX (sec)
Model 1	1.69
Model 2	1.812
Model 3	1.448
Model 4	0.81
Model 5	1.147
Model 6	0.966

1. Time period for V bracing is 7% more than Cross bracing bracing and time period for straight shear wall is 41% more than L shaped shear wall in zone II .

2. Time period for Straight Shear wall is 19% more than Box Type Shear wall in zone II.

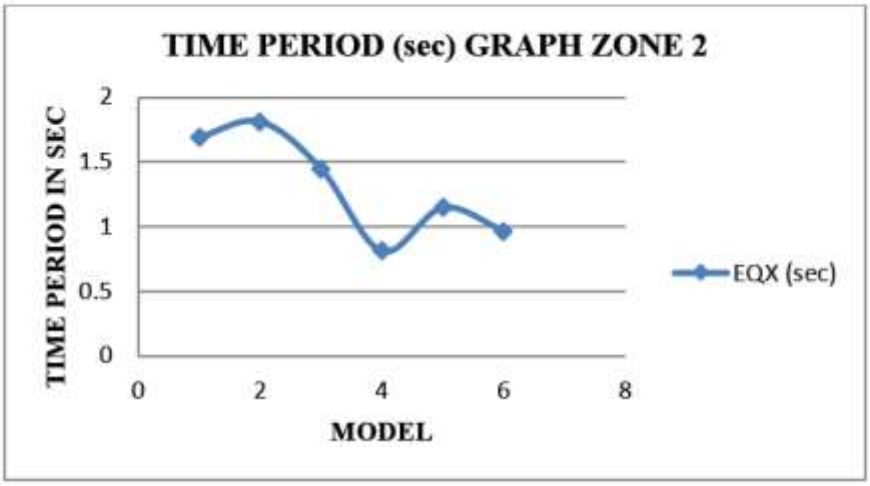


CHART 7: Maximal time period comparing every models because of seismic loading into Zone II

5.2.2 Maximal base shear comparing every models because of seismic loading into Zone II

TABLE 9 Maximal base shear comparing every models because of seismic loading into Zone II

MODELS	EQX (kN)
Model 1	1558.1206
Model 2	1452.7846
Model 3	1822.4638
Model 4	3704.4082
Model 5	2452.8254
Model 6	2904.6587

1. Base shear of Cross bracing is 7% more than the V bracing and base shear of L Shaped shear wall is 51% more than straight shear wall in zone II.

2. Base shear for Box Type shear wall is 19% more as of Straight Shear wall in zone II.

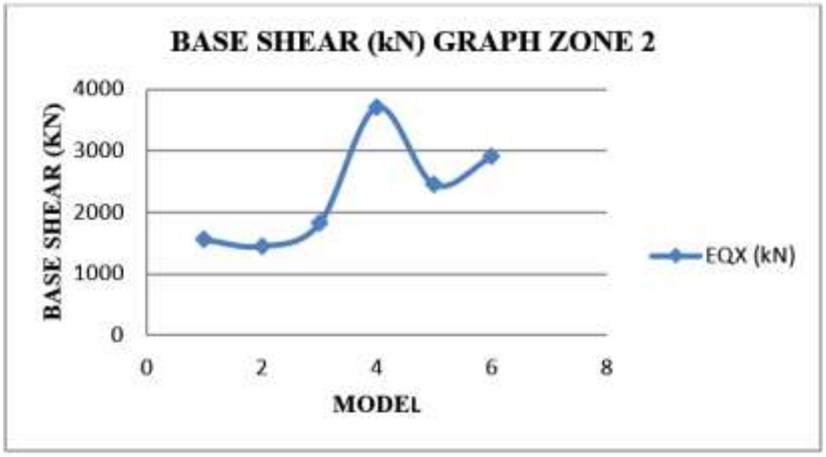


CHART 8: Maximal base shear comparing every models because of seismic loading into Zone II

5.2.3 Storey wise displacements in X direction for every model in Zone II

TABLE 10 Storey wise displacements along X-direction in mm.(Response spectrum method)

STOREY	MODEL1 (RSX) IN MM	MODEL2 (RSX) IN MM	MODEL3 (RSX) IN MM
Base	0	0	0
Story1	0.492	0.785	0.448
Story2	1.99	2.57	1.674
Story3	3.528	4.29	2.966
Story4	5.128	5.948	4.326
Story5	6.766	7.603	5.73
Story6	8.404	9.236	7.142
Story7	10.001	10.811	8.528
Story8	11.515	12.29	9.85
Story9	12.904	13.631	11.072
Story10	14.124	14.787	12.158
Story11	15.133	15.714	13.069
Story12	15.883	16.373	13.763

1. Storey displacement consistently rising when bracing is providing with every floor. From model 1 i,e Cross bracing is 3% less than the V bracing in zone II.

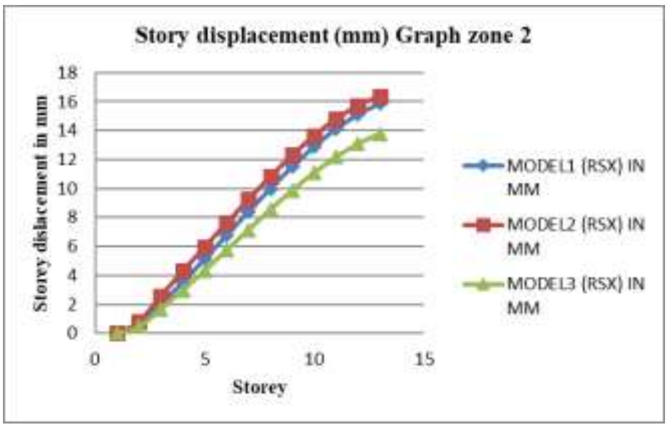


CHART 9: Storey wise displacements for model 1,2 and 3

TABLE 11 Storey wise displacements along X-direction in mm.(Response spectrum method)

STOREY	MODEL4 (RSX)	MODEL5 (RSX)	MODEL6 (RSX)
Base	0	0	0
Story1	0.136	0.173	0.18
Story2	0.478	0.691	0.76
Story3	1.026	1.497	1.531
Story4	1.719	2.511	2.457
Story5	2.524	3.677	3.508
Story6	3.412	4.944	4.649
Story7	4.356	6.267	5.849
Story8	5.331	7.609	7.077
Story9	6.315	8.935	8.305
Story10	7.289	10.222	9.506
Story11	8.239	11.457	10.659
Story12	9.151	12.618	11.737

1. Storey displacement uniformly increasing when Shear wall is provided for all the floors. From model 1 i,e straight shear wall is 8% more than Box type shear wall in zone II.

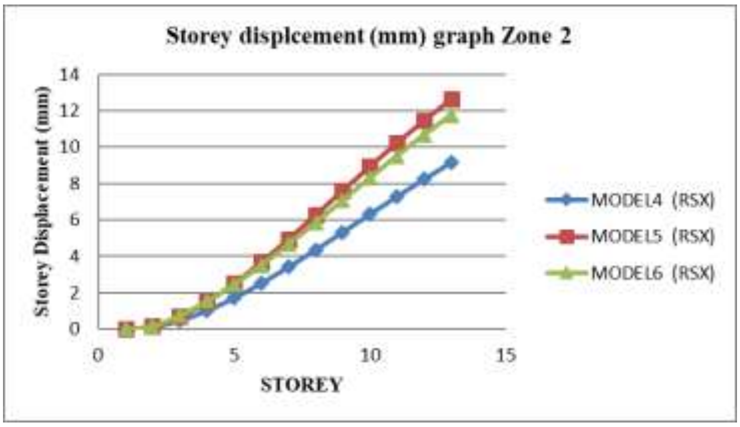


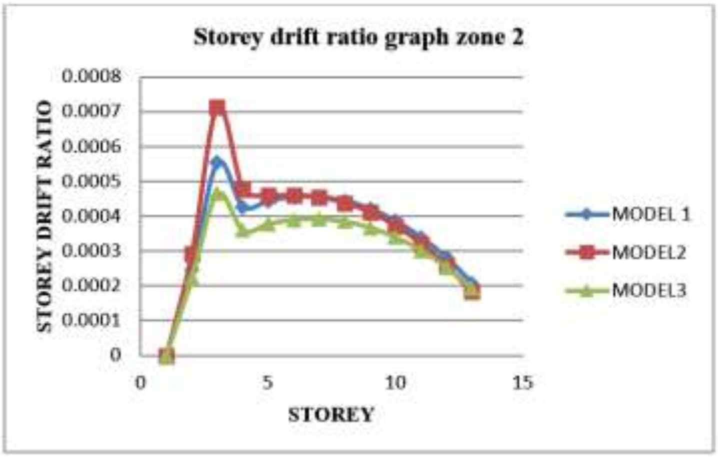
CHART 10: Storey wise displacements for model 4,5 and 6

5.2.4 Storey wise storey drift ratio disparity in X directionfor all models in Zone II

- TABLE 12 Storey wise storey drift ratio disparity along X-direction(Response spectrum method)

STOREY	MODEL 1	MODEL2	MODEL3
Base	0	0	0
Story1	0.000246	0.000292	0.000224
Story2	0.000553	0.000714	0.000465
Story3	0.000427	0.000478	0.000359
Story4	0.000444	0.00046	0.000378
Story5	0.000455	0.00046	0.00039
Story6	0.000455	0.000454	0.000392
Story7	0.000444	0.000438	0.000385
Story8	0.000421	0.000411	0.000367
Story9	0.000386	0.000372	0.00034
Story10	0.000339	0.000321	0.000302
Story11	0.00028	0.000257	0.000253
Story12	0.000208	0.000183	0.000193

CHART 11: Storey wise storey drift for model 1,2 and 3



- TABLE 13 Storey wise storey drift ratio variation along X-direction(Response spectrum method)

STOREY	MODEL 4	MODEL 5	MODEL 6
Base	0	0	0
Story1	0.000068	0.000086	0.00009
Story2	0.000133	0.000192	0.000173
Story3	0.000152	0.000224	0.000214
Story4	0.000192	0.000282	0.000257
Story5	0.000224	0.000324	0.000292
Story6	0.000247	0.000352	0.000317
Story7	0.000262	0.000368	0.000333
Story8	0.000271	0.000373	0.000341
Story9	0.000273	0.000369	0.000341
Story10	0.000271	0.000358	0.000334
Story11	0.000264	0.000343	0.00032
Story12	0.000253	0.000323	0.0003

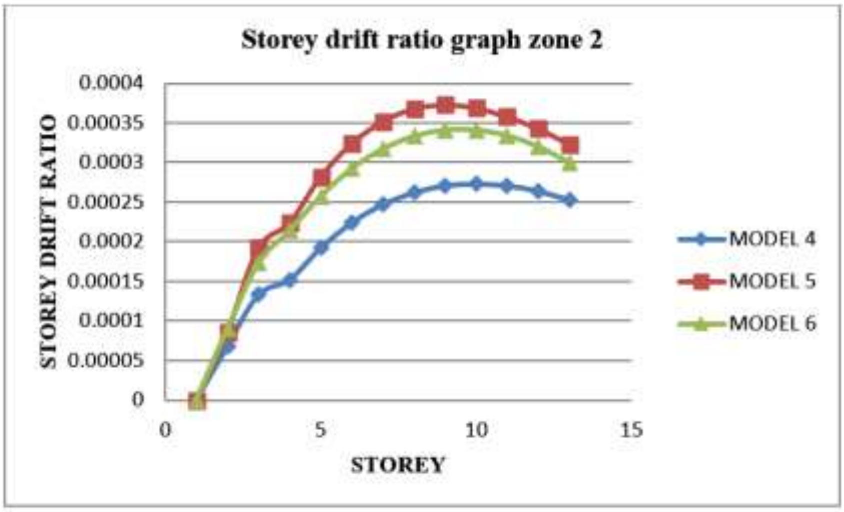


CHART 12: Storey wise storey drift for model 4,5 and 6

5.3 MAXIMAL DISPLACING COMPARING WITH EVERY MODEL BECAUSE OF SEISMIC LOADING IN ZONE V

TABLE 14 Maximum displacements comparison of all models due to seismic loads in Zone V in X-direction in Zone V.

MODEL	MAX DISPLACEMENT IN MM
Model 1	57.18
Model 2	58.941
Model 3	49.549
Model 4	32.944
Model 5	45.426
Model 6	38.843

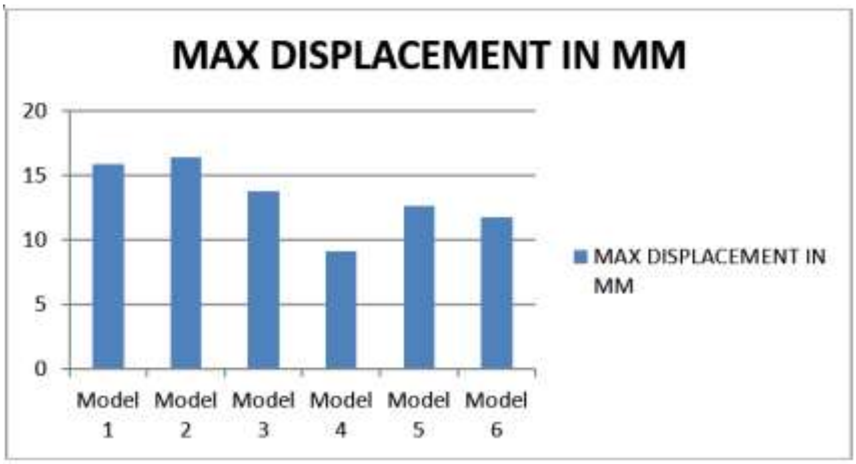


CHART 7.13: Maximum displacements comparison of all models due to seismic loads in Zone V in X-direction in Zone V

The accompanying table details the greatest model-specific displacements caused by zone-5 (RSM) seismic loads. The results suggest that along X-axis,

Comparing model 1 and model 2 The maximum displacement for V bracing is maximum i.e **58.941mm** and for Cross bracing is minimum i.e, **57.18mm**. as shown in chart 13.

In comparison of model 4,5 and 6 maximal displacement for Straight Shear wall is **45.426mm** and for L Shape Shear wall is minimum i.e **32.944mm** as shown in chart 13.

5.4 MAXIMAL DISPLACING COMPARING WITH EVERY MODEL BECAUSE OF SEISMIC LOADING IN ZONE II

TABLE 15 Maximal Displacing Comparing With Every Model Because Of Seismic Loading In Zone II

MODEL	MAX DISPLACEMENT IN MM
Model 1	15.883
Model 2	16.373
Model 3	13.763
Model 4	9.151
Model 5	12.618
Model 6	11.737

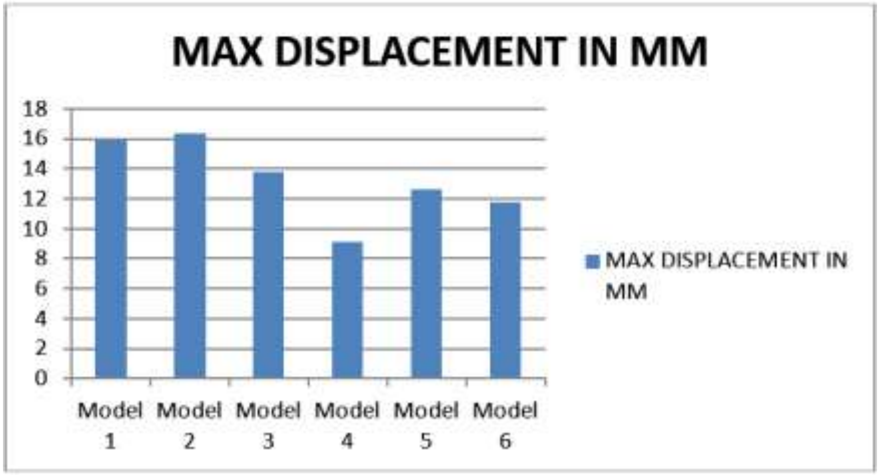


CHART 14: Maximum displacements comparison of case 1 and case 2 models due to seismic loads in X-direction In zone II

The accompanying table details greatest model-averaged displacements caused by zone-2 (RSM) seismic loads. The results suggest that along the X-axis,,

Comparing of model 1 and model 2 The maximum displacement for V bracing is maximum i.e **16.373mm** and for Cross bracing is minimum i.e, **15.883mm**. as shown in chart 14.

In comparison of model 4,5 and 6 maximal displacement for Straight Shear wall is **12.618mm** and for L Shape Shear wall is minimum i.e **9.151mm** as shown in chart 14.

6. Summary & Conclusions

SUMMARY

Seismic analysis of zone V and zone II multi-story buildings is the focus of the current investigation. A flat slab with a bracing system and a shear wall at various locations were modelled, and their responses to various structural and environmental stresses were analysed..

6.1 FOR ZONE V

1. Time period for Cross bracing is 8% less than the V bracing and time period for V bracing is 55% more than the L shaped shear wall in zone V.
2. Time period for Straight Shear wall is 13% more than Box Type Shear wall in zone V.
3. Base shear of Cross bracing is 7% more than V bracing and base shear of L Shaped shear wall is 51% more than the straight shear wall in zone V.
4. Base shear for Box Type shear wall is 19% more than the Straight Shear wall in zone V.
5. Storey displacing consistently rising when Cross bracing is providing with every floors. From model 1 i,e Cross bracing is 3% less than the V bracing in zone V.
6. Storey displacing consistently rising when Cross bracing is providing with every floors. From model 1 i,e Straight Shear wall is 17% more than the Box Type Shear wall in zone V.
7. All of the storey drift values are below the threshold for violation set out by IS 1893:2016 (part 1) in zone V, which is 0.004 times the storey height.

6.2 FOR ZONE II

1. Time period for V bracing is 7% more than Cross bracing bracing and time period for straight shear wall is 41% more than L shaped shear wall in zoneII .
2. Time period for Straight Shear wall is 19% more than Box Type Shear wall into zone II.
3. Base shear of Cross bracing is 7% more than the V bracing and base shear of L Shaped shear wall is 51% more than straight shear wall in zone II.
4. Base shear for Box Type shear wall is 19% more as of Straight Shear wall in zone II.

5. Storey displacement consistently increasing when bracing is provided for all the floors. From model 1 i,e Cross bracing is 3% less than the V bracing in zone II.
6. Storey displacement uniformly increasing whenever Shear wall is provided with every floors. From model 1 i,e straight shear wall is 8% more than the Box type shear wall in zone II.
7. As per IS 1893:2002 (part 1) in zone II, the values of storey drift for all of the stories are determined to be within the allowable limit, i.e. not further than 0.004 time for storey height.

6.3 SCOPE OF STUDY

1. Current research deals with Response spectrum analysis, later in future study can be carried out through time history and push over analysis.
2. The results of all the models in Etabs will be compared. The study undertaken is carried out under seismic zone 5 and zone 2,later in future study can be done in other zones.
3. Research could be performed with diverse dimension.

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