Seismic Performance of Flat slab Multistory Building with Varying slab Span

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Abstract: *The necessity of a large headroom is now the essential point of view for any architecture and for that, the only way to solve this as per the structural point of view is to provide a flat slab. The elimination of the beam could show the drastic effect in a different component of the structure. It has been examining from various findings that the stresses generated in the flat slab analysis, its intensity should lessen in order to provide stability to the structure. In this paper we take four cases i.e simple flat slab providing shear wall at lift core, simple flat slab providing shear wall at lift core and at highly Stressed Section, flat slab with drop providing shear wall at lift core and flat slab with drop providing shear wall at lift core and at highly Stressed Section on 12 storied residential building located at Seismic Zone four and vary the flat slab panel L/B ratio from 0.2 , 0.8, 1.2,1.5 and 2. Using dynamic analysis method with the help of STAAD Pro V8i, to evaluate analysis parameters such as Node Displacement, Shear forces in the column, Compressive and tensile stresses, storey drift, von mis stress along with principle stress values, find out the optimum case of structure from this analysis.*

Keywords – *Flat slab, Shear wall, Dynamic Analysis, Stresses on flat slab.*

1. INTRODUCTION

The demand for residential houses increased drastically day by day in the constructional sector. The multistoried building should be economical and should have less building components for architectural point of view. For that flat slab construction would be preferred. The Flat Slab is a slab which does not have beam component and it directly transfers its load to the soil through vertical columns. Slabs are generally of two types which are R.C.C slab and Flat slab. If the beam is present with the slab, then it is called R.C.C slab and if the beam is not present then it called a flat slab. Need more headroom, the flat slab is used in a multistoried building to decrease the overall cost of building construction. Also, the construction process of the flat slab is almost unsophisticated as compared to R.C.C slab. In flat slab, the loading patterns are almost the same as R.C.C slab, but the distribution of load is different in both slabs. Generally, Flat slab is distinguished based on drop panel and column capital. The construction of the flat slab is generally used with drop panel or column head and vice versa depends upon the loading condition. If loading is less, than a simple flat slab is used, otherwise, the rest of three types of the flat slab will be considered. If loading is much higher at the junction of column and slab, a shear phenomenon has occurred is called punching shear that will develop near the support due to the occurrence of the higher-end moment.

2. OBJECTIVE

- In this paper the main purpose is to find out the optimum building Model of flat slab against seismic loading in zone four. And flat slab interaction with shear wall.
- Also, analyses of behaviour of flat slab with varying span in multi storey buildings. L/B ratio consider for analysis is ***0.2, 0.8, 1.2,1.5 and 2.***

- structure is analyzed with response spectrum for seismic loading in STAAD Pro software. After analyzing the different building plan and comparing all the result parameters which are stresses on flat slab i.e principal stresses, von mis stresses, storey shear, storey drift etc.
- The 12 storey building design for the flat slab's analysis. The all panel number is divided according to plan area which is fulfil our objective of varying span, so that it is design separately for roof, external wall as well as internal wall.

3. METHODOLOGY & STRUCTURAL MODELING

1. In this chapter, design the flat slab with the help of Equivalent frame method using the different data related to flat slab with the help of IS 456-2000. The all data extracted from the manual design to software design like thickness of flat slab, roof, external wall and as well as thickness of internal wall.
2. The flat slab is designed firstly with the manual approach with the help of Equivalent frame method for different panels. The panels are divided into different panel numbers. In this research work, considering 12 storied building case and every storey of this building is divided into block number.
3. Equivalent Frame Method for different panels used for analysis, development of models in Staad pro and details of models such as construction configuration, its geometry etc. square root of sum of square method use for dynamic analysis.

4. FLAT SLAB DESIGN DATA

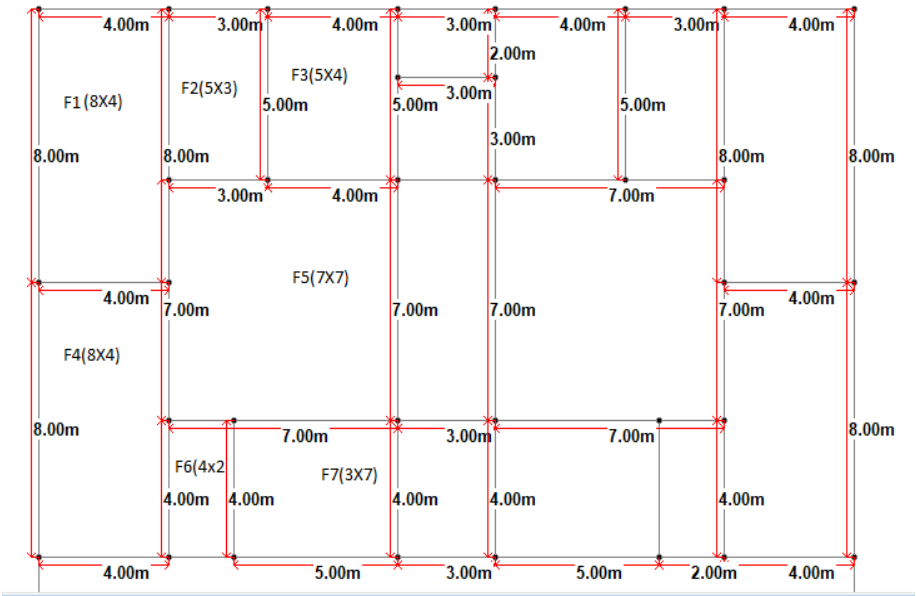


Figure 1 Panel Detail

Table 1 Panel Size Detail

Panel Size	L/B	Thickness (Longer Direction)	Thickness (Shorter Direction)
3X7	0.4	234	224
3X4	0.8	135	125
3x3	1	135	125
7X7	1	234	224
5X4	1.3	175	165
5x3	1.7	175	165
4X2	2	135	125
8X4	2	264	254

Table 2 Reinforcement Detail Due to Negative Moment

Reinforcement in Longer Direction				**Reinforcement in Shorter direction**	
Panel	L/B	Ast/m in Column Strip Due to Negative Moment (mm^2)	Ast/m in Middle Strip Due to Negative Moment (mm^2)	Ast/m in Column Strip Due to Negative Moment (mm^2)	Ast/m in Middle Strip Due to Negative Moment (mm^2)
3X7	0.4	850	290	340	270
3X4	0.8	300	170	240	150
3x3	1	162	162	175	150
7X7	1	850	281	381	291
5X4	1.3	440	210	370	200
5x3	1.7	440	212	265	200
4X2	2	311	162	150	150
8X4	2	1083	345	533	305

Table 3 Reinforcement Due to Positive Moment

Reinforcement in Longer Direction				**Reinforcement in Shorter direction**	
Panel	L/B	Ast/m in Column Strip Due to Positive Moment (mm^2)	Ast/m in Middle Strip Due to Positive Moment (mm^2)	Ast/m in Column Strip Due to Positive Moment (mm2)	Ast/m in Middle Strip Due to Positive Moment (mm^2)
3X7	0.4	350	290	270	270
3X4	0.8	170	170	150	150
3x3	1.0	162	162	150	150
7X7	1.0	350	281	270	270
5X4	1.3	210	210	200	200
5x3	1.7	212	212	200	200
4X2	2.0	162	162	150	150
8X4	2.0	450	320	305	305

5. TYPES OF CASES USED FOR ANALYSIS OF STRUCTURE

Following Building Cases used for design by using actual design data of flat sab design

Table 4 Model Description

Model 1	12 storey Flat Slab building having shear wall at lift core.
Model 2	12 storey Flat Slab building having shear wall at lift core and higher stress location.
Model 3	12 storey Flat Slab with drop building having shear wall at lift core.
Model 4	12 storey Flat Slab with drop building having shear wall at lift core and higher stress location.

Table 5 Design parameters

S.No	Particulars	Dimension/Size/Value
1	Model	12 Storied includes Ground floor
2	Seismic Zones	IVth
3	Floor height	3.8m
4	Depth of foundation	3m
5	Building height	46m
6	Plan size	$25X35m^2$
7	Size of columns	500mmX550mm
8	Earthquake load	As per IS1893-2002(part-I)
9	Type of soil	Medium soil Type-II
10	Live load	$1.5KN/M^2$ Roof & $2.5KN/M^2$ Floor
11	Material used	Grade of Concrete **M30**& Steel **Fe415**
12	Dynamic Analysis	**Response Spectrum Analysis**
13	Fundamental natural period of building	$Ta = 0.075\ h^{0.75}$
14	Zone factor Z	0.24
15	Response Reduction factor (RF)	4
16	Importance factor (I)	1
17	Rock and soil factor (SS)	II
18	Type of structures	1
19	Damping ratio (DM)	0.05

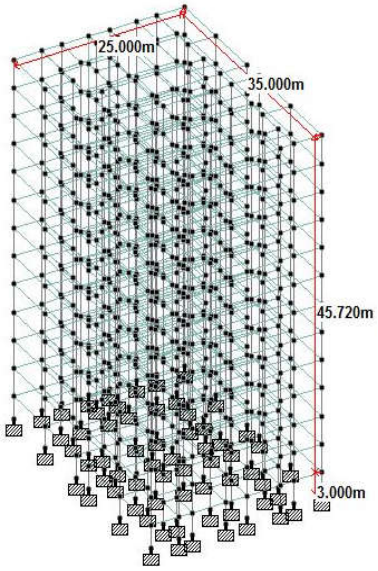


Figure 2 Model Dimensions

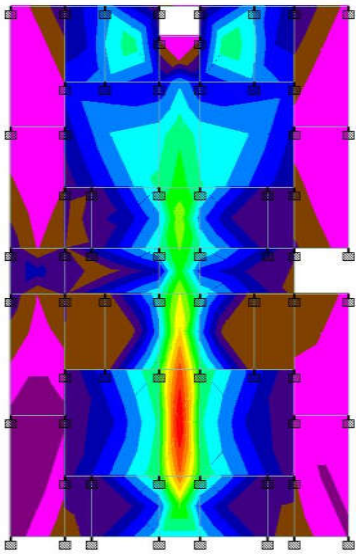


Figure 3 Stresses on Slab

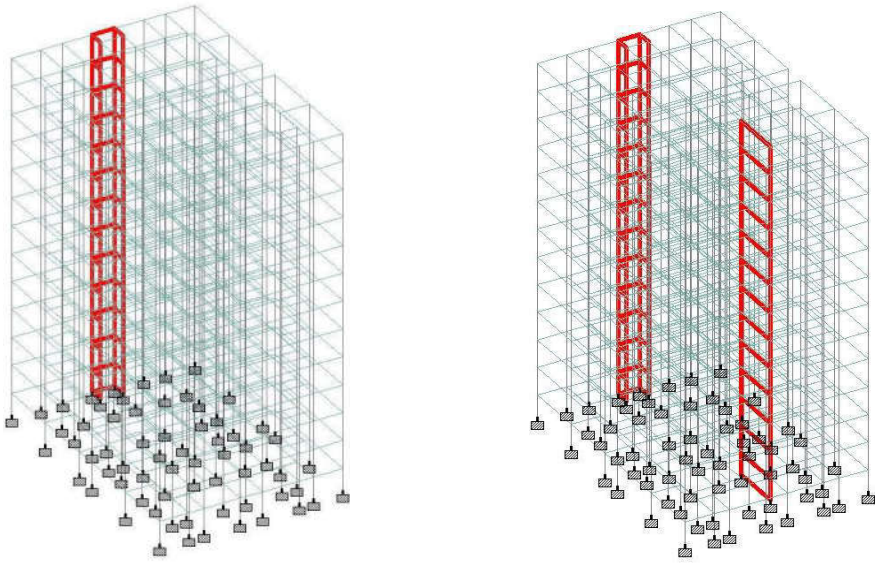
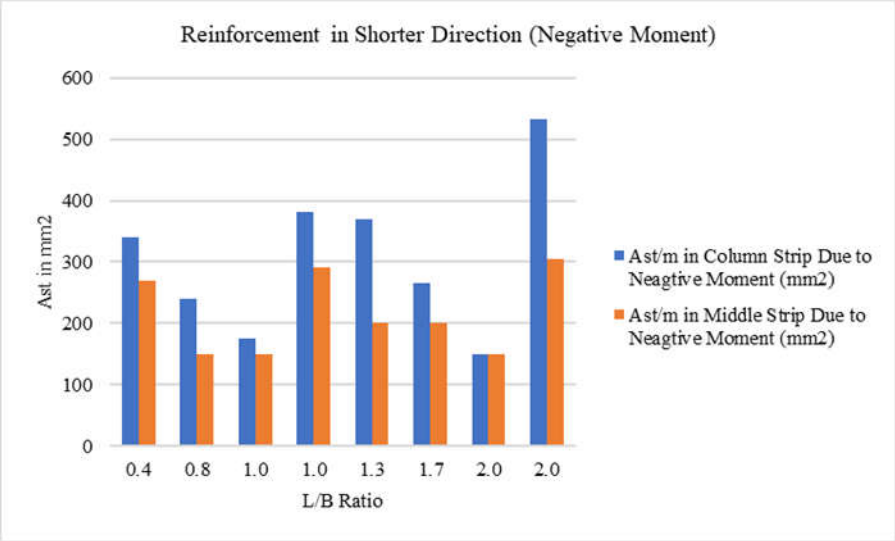


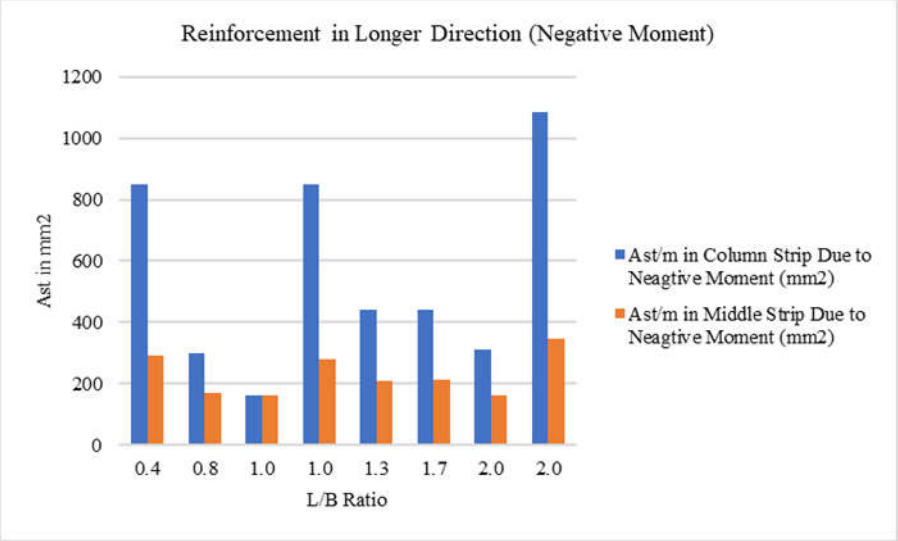
Figure 2 Shear Wall Locations

6. Results

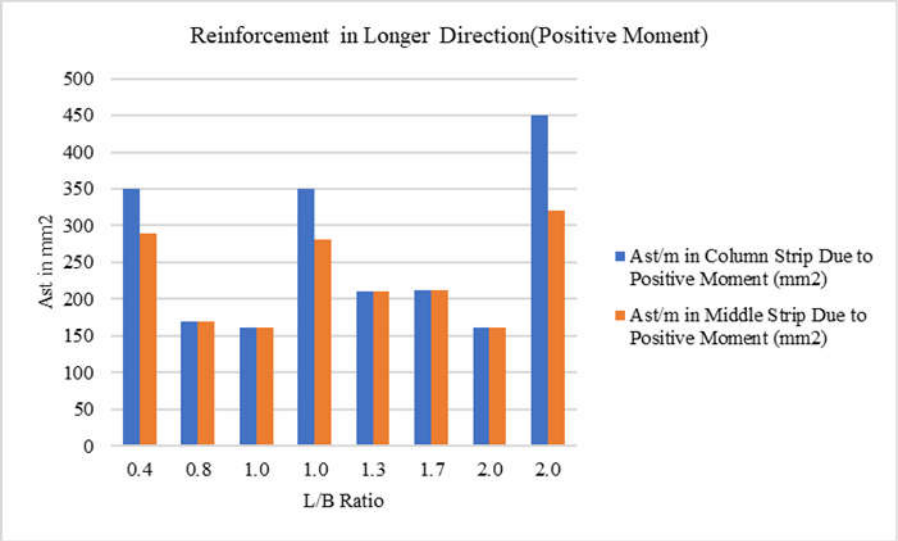
When building analyzed under the seismic forces, the four different building Model's result parameters are compared to find the most economical model therefore as per the objective of this work, the results obtained are shown in graphical form



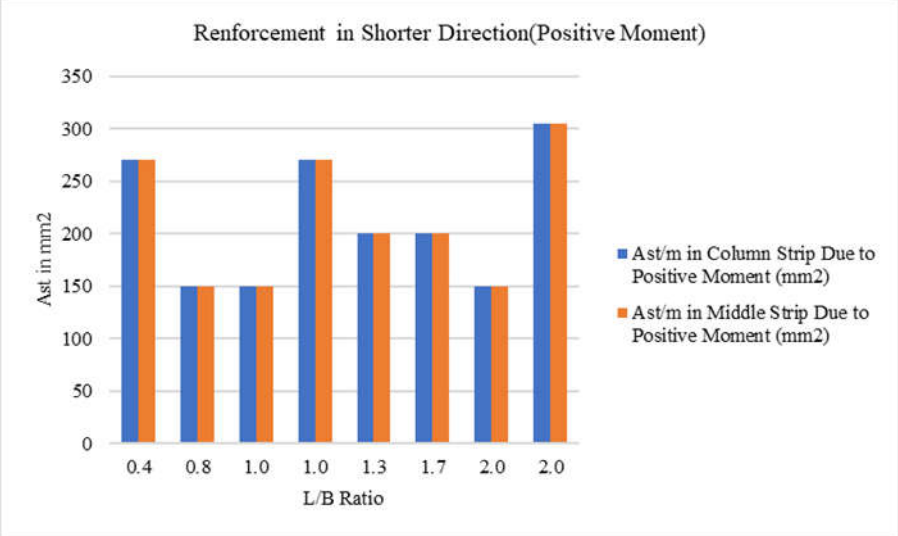
Graph 1 L/B Vs Ast/m



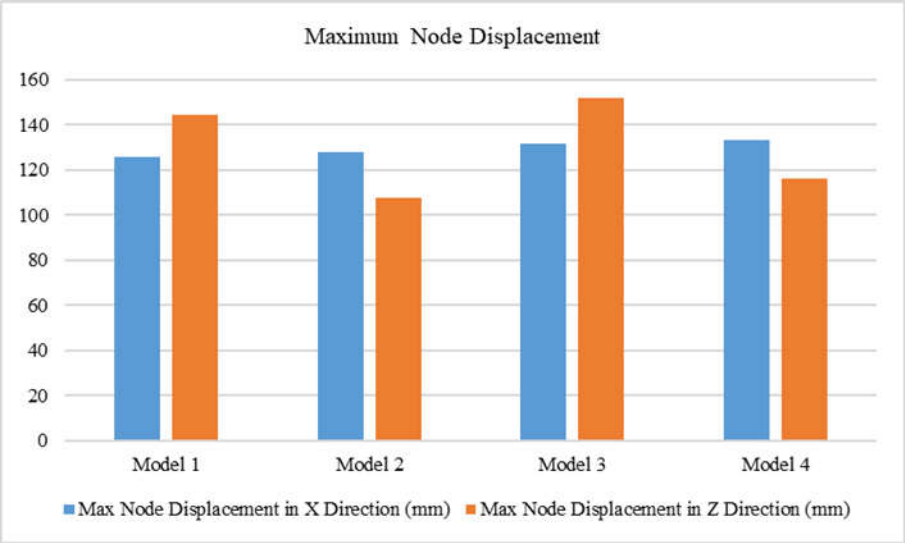
Graph 2 L/B Vs Ast/m



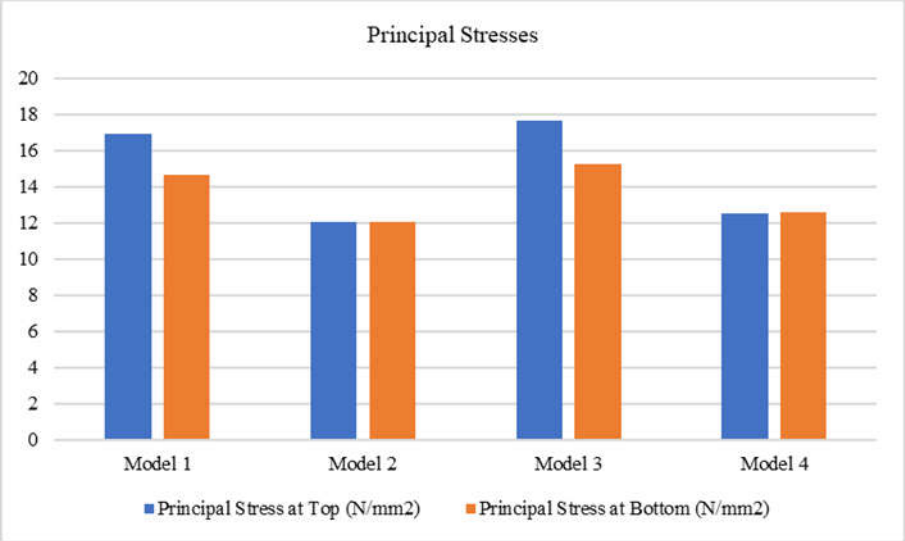
Graph 3 L/B Vs Ast/m



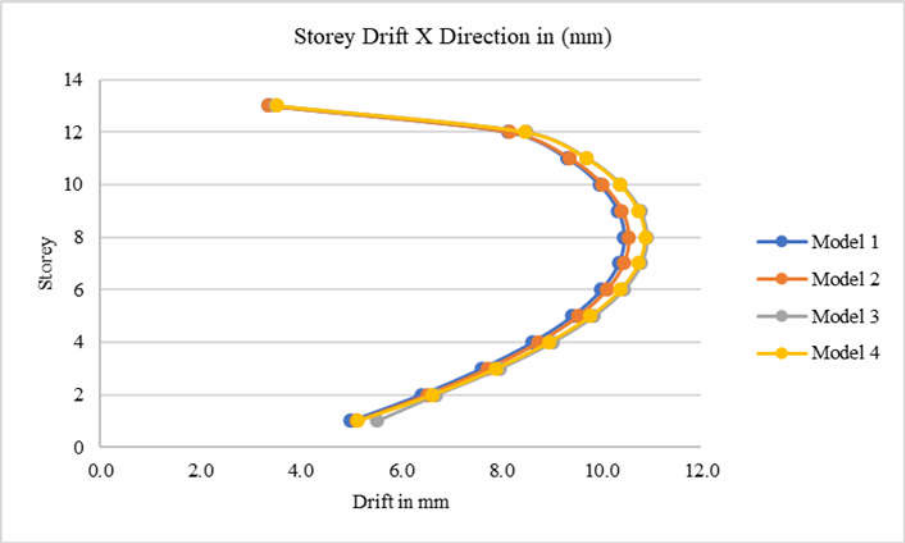
Graph 4 L/B Vs Ast/m



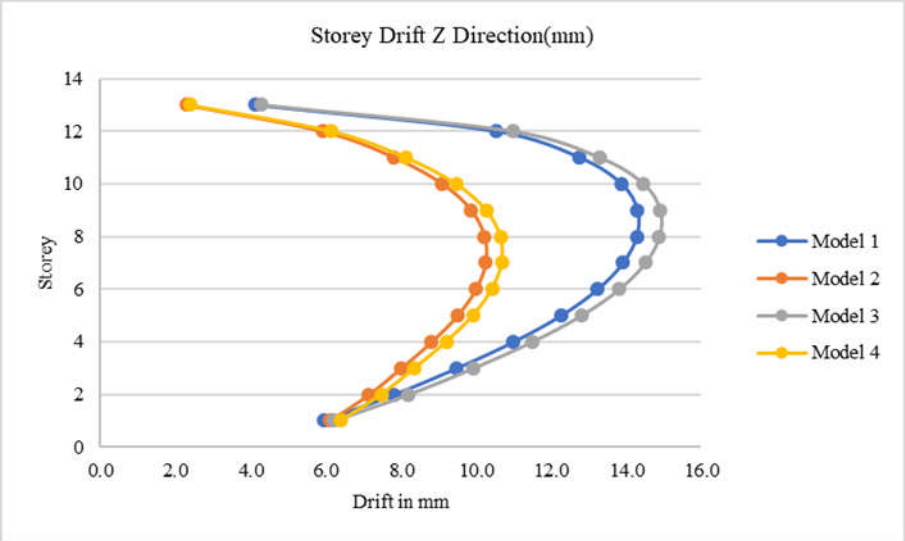
Graph 5 Maximum Node Displacement



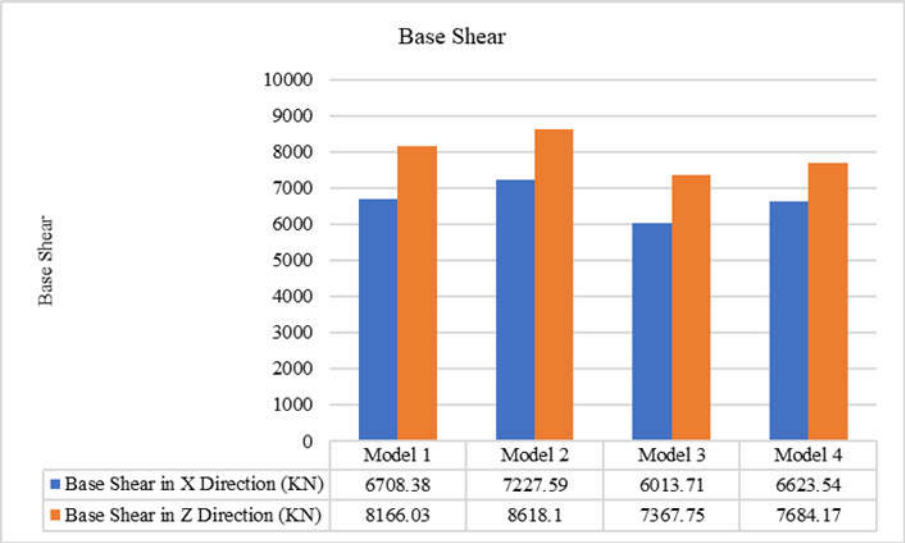
Graph 6 Principal Stresses



Graph 7 Storey Drift in X direction



Graph 8 Storey Drift in Z Direction



Graph 9 Base Shear

4. Conclusions

- Building Model 2 is an optimum building Model in terms of Nodal Displacement in X & Z direction showing its minimum value as compare to all other Models.
- Base shear in X & Z direction is seems to be lesser in Building Model 3 as Compare to all the other Models.
- Max Von Mis Stresses at Top and Bottom is found satisfactory in Model 2 as comparison on all other model consider for this study.
- Similarly, Principal Stresses at Top and Bottom is found satisfactory in Model 2 as comparison on all other model consider for this study.
- Storey Drift in X & Z direction, the observation clearly state that the building Model 2 is an optimum Model with a minimum value of 102 mm. Hence the efficient Model will be building Model 2.
- Its Seem that the area of steel required per meter is more in L/B ratio 0.4, 1.0 And 2.0 as compare to other size of panel.
- Concluding the research work, 12 storey Flat Slab building having shear wall at lift core and higher stress location should be preferred in terms of comparative results of various parameters i.e building Model 2.

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