COMPARATIVE STUDY ON ANALYSIS OF STEEL-CONCRETE COMPOSITE STRUCTURE WITH DIFFERENT SHEAR WALL POSITIONS

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Abstract - *Steel- Concrete composite systems have become quite popular in recent times because of their advantages against reduction in self-weight. Composite construction combines the better properties of the both i.e. concrete and steel and results in speedy construction. In this study we have analyzed the G+8 storey steel-concrete composite building without shear wall and with shear wall at different positions. The overall dimension of the building is 25m X 25m The 3D analysis has been carried out using structural analysis software ETABS and the results are compared; and it is found that composite structure with shear walls at corners has minimum displacement, storey drift and time period.*

***Key Words*: Composite column, Composite beam, Shear connector, Displacement, Storey drift, Time period, Base shear.**

1.INTRODUCTION

Structures in which composite sections made up of two different types of materials such as steel and concrete are used for beams, and columns is called as composite structures. Steel- Concrete composite systems have become quite popular in recent times because of their advantages against reduction in self-weight. In this paper we have compared the G+8 storey steel-concrete composite building without shear wall with shear wall at different positions, which is situated in seismic zone V as per IS 1893-2016. For analysis we have used equivalent static and response spectrum method. *The parameters considered are lateral displacements, storey drift, time period and base shear.* The analysis involves the load calculation, analysing it by 3D modelling using software ETABS. Analysis has been done for various load combinations as per the Indian Standard Code of Practice. The results such as maximum values of displacements, storey drift, time period and base shear are found out by analysis.

2 LITERATURE REVIEW

This [11] study evaluates four various multi-storeyed commercial buildings i.e. G+12, G+16, G+20, G+24 are analysed by using ETABS 2013 software. It was concluded that the Composite structure is nearly double than that of R.C.C structure but within permissible limit. The Shear force and Axial force in R.C.C structure is on higher side than that of composite structure. [12] This paper analyze steel concrete composite, steel and R.C.C. options are considered for comparative study of G+30 storey commercial building which is situated in earthquake zone IV. Equivalent Static Method of Analysis is used. For modelling of Composite, Steel and R.C.C. structures. The reduction in the dead weight of the Steel framed structure is 32 % with respect to R.C.C. frame Structure and Composite framed structure is 30 % with respect to R.C.C. framed structure.

3 OBJECTIVES

The salient objectives of the present study have been identified as follows:

- To study the behaviour of composite structure against dead load, live load, seismic load and their various combinations.
- To perform the static and response spectrum analysis on composite structure with different shear wall positions.
- To analyse and compare the lateral displacement, storey drift, base shear and time period of different models.

4 COMPOSITE CONSTRUCTION

4.1 Definition

In structural engineering, composite construction exists when two different materials are bound together so strongly that they act together as a single unit from a structural point of view.

Composite members are constructed such that the structural steel shape and the concrete act together to resist axial compression and bending.

4.2 Components of Composite Construction

The Composite construction consist of following elements:

1. Composite deck slab

2. Composite beam

3. Composite column

4. Shear connector

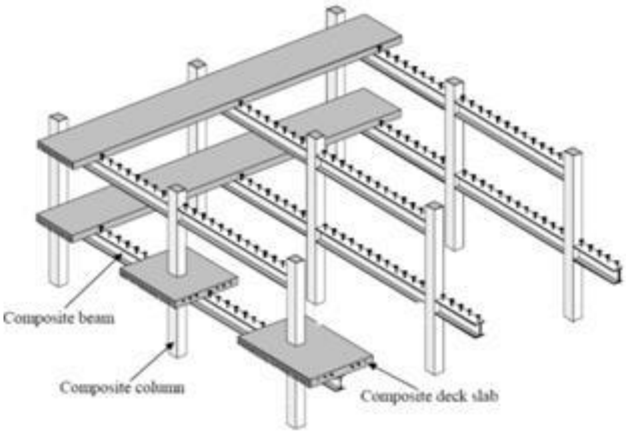


Figure 1: Steel-concrete composite frame

4.3 Composite Deck Slab

Steel beams, metal decking, and concrete make up the composite floor system. They are blended in such a manner that the greatest qualities of each material may be exploited to improve construction methods. In composite floor systems, the most common structure is a rolled or built-up steel beam linked to a formed steel deck and concrete slab. The metal deck usually extends between steel elements unsupported, providing a working platform for concrete operations. By creating a robust horizontal diaphragm and dispersing wind and seismic shears to the lateral load-resisting systems, the composite floor system ensures overall building system stability.

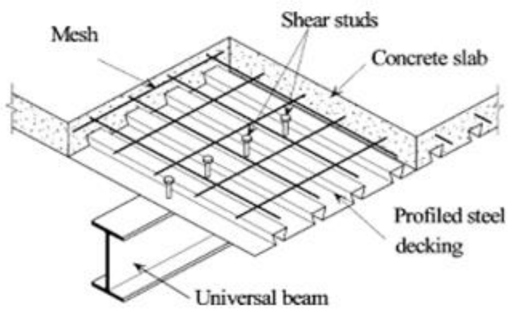


Figure 2: Composite deck slab components

4.4 Composite Beam

When a concrete slab is put over an I-section or steel beam under in-situ circumstances, a composite beam is created. Both of these aspects tend to operate independently under the effect of loading, and there is a relative slippage between them. An I-section steel beam with a concrete slab will act like a monolithic beam if they are properly connected and there is no relative slip between them.

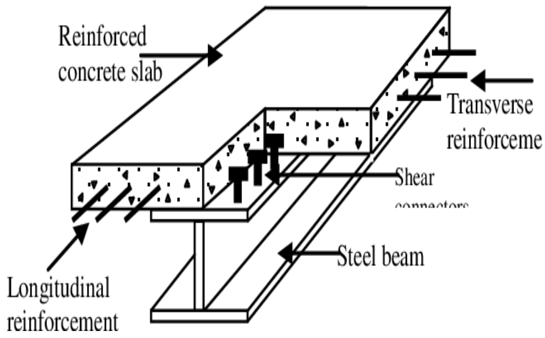


Figure 3: Composite beam components

4.5 Composite Column

A compression member is made out of a concrete-encased hot rolled steel section or a concrete-filled hollow hot rolled steel section with a steel concrete composite column. It is typically employed as a load bearing element in composite framed structures. Compression and bending are the most common stresses on composite elements. There is currently no Indian standard code that covers composite column design. Friction and bonding are used to interact between the concrete and the steel. In a building that is made up of many columns. As a result, they are resistant to external loading. The principal construction loads are often carried and supported by bare steel columns in composite construction.

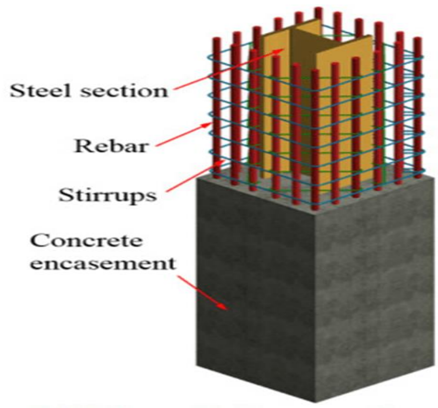


Figure 4: Composite column components

4.6 Shear Connectors

Shear connections are critical in steel-concrete construction because they combine the compression capacity of the supported concrete slab with the load bearing capacity and overall stiffness of the supporting steel beams / girders. Despite the fact that the steel-to-concrete connection may aid shear transmission between the two to some level, it is ignored by the codes due to its ambiguity. As a result, all codes require positive couplings at the steel-concrete contact. All codes therefore, specify positive connectors at the interface of steel and concrete. The shear connectors are designed to transmit longitudinal shear along the interface and horizontal shear between steel beam and concrete slab, ignoring the effect of any bond between the two. Shear connectors prevent separation of steel beam and concrete slab at the interface and also resist uplift force at the steel concrete interface.

Figure 4: Shear connectors

5 BUILDING DETAILS

The Building assumed as residential building. The plan dimension of building is 25m x 25m.

Table 1: Structural data

Plan dimensions	25m x 25m
Total height of building	27m
Height of each storey	3m
Height of parapet wall	1m
Type of beam	Size of beam
Main beam	ISMB 500
Secondary beam	ISMB 300
Column size	300x600mm with ISMB 500 encased
Thickness of slab	150mm
Thickness of wall	200mm
Seismic zone	V
Zone factor	0.36
Importance factor	1.2
Soil condition	Medium soil
Floor finish	1.5 KN/m2
Grade of concrete for slab	M25
Grade of concrete for columns	M30
Grade of steel	Fe 550

6 MODELLING

The modelling is done using ETABS 2016 software:

1. **Model 1 (without shear wall)**

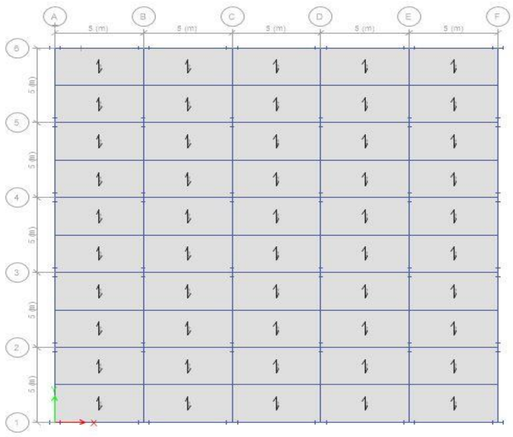


Figure 5: Plan of model 1

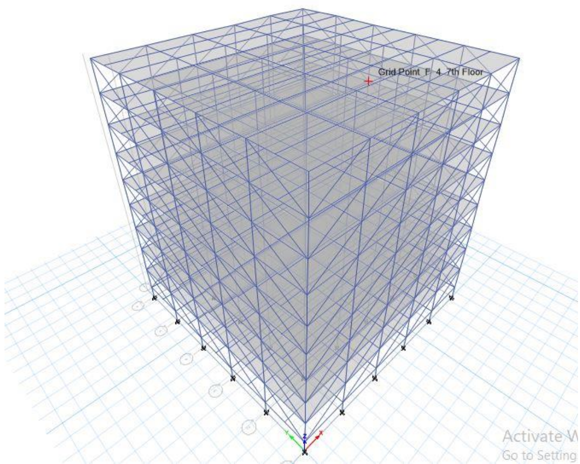


Figure 6: 3D view of model 1

2. Model 2 (with shear wall at center)

Figure 7: Plan of model 2

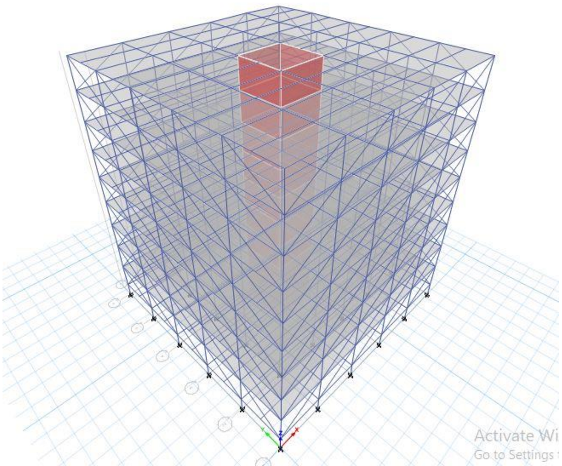


Figure 8: 3D view of model 2

3. Model 3 (with shear wall in X-direc)

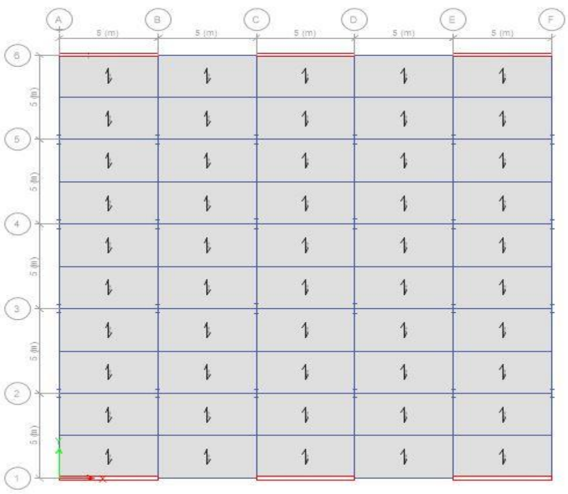


Figure 9: Plan of model 3

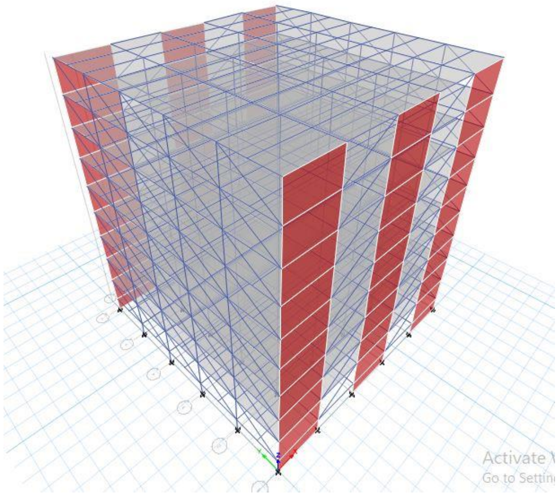


Figure 10: 3D view of model 3

4. Model 4 (with shear wall in Y-direc)

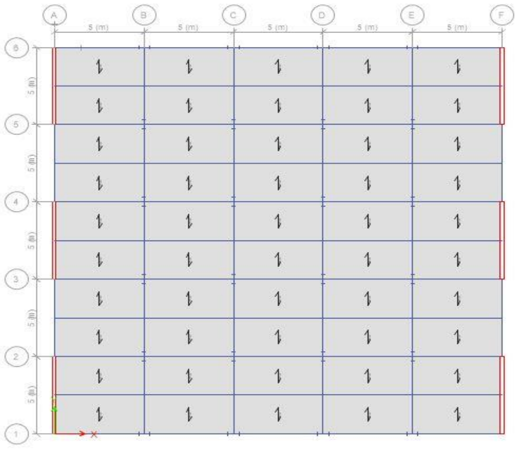


Figure 11: Plan of model 4

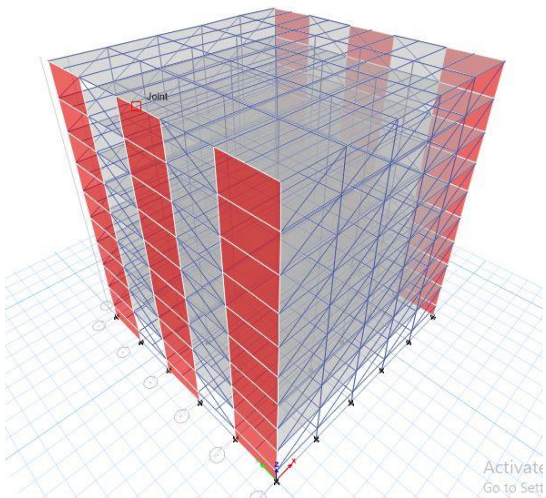


Figure 12: 3D view of model 4

5. **Model 5 (with shear wall at corners)**

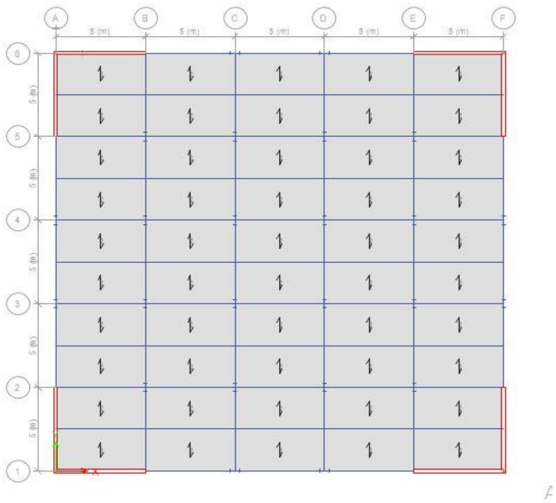


Figure 13: Plan of model 5

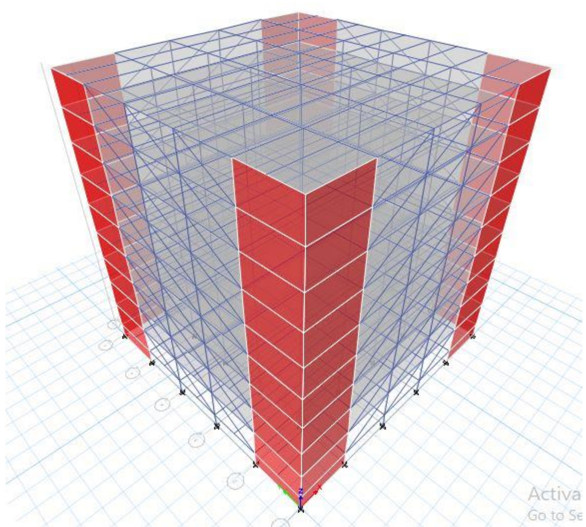


Figure 14: 3D view of model 5

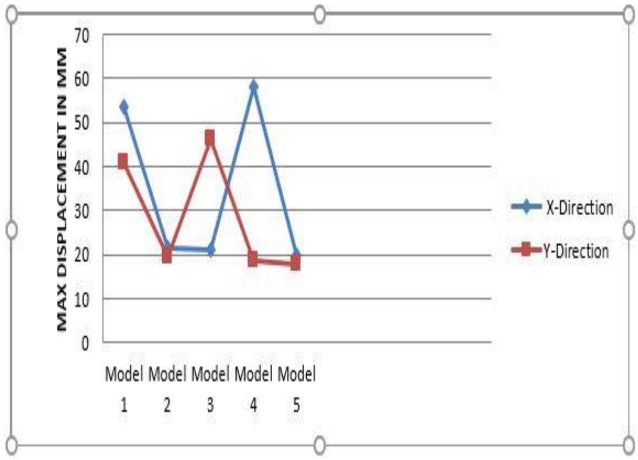
7 RESULTS AND DISCUSSIONS

From the analysis the parameters such as displacement, storey drift, time period and base shear is considered and their variation plotted in the form of graph as shown below.

7.1 Displacement

Table 2: Displacement for static analysis in x-y direc

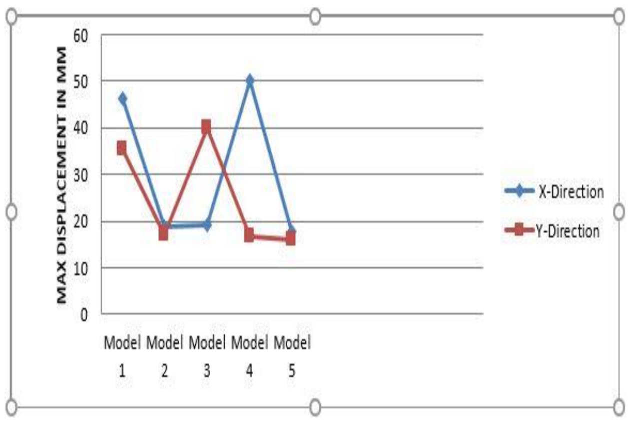
Models	X-direc (mm)	Y-direc (mm)
Model 1	53.525	40.917
Model 2	21.37	19.372
Model 3	21.307	46.189
Model 4	58.273	18.717
Model 5	20.009	17.942



Graph 1: Displacement for static analysis in x-y direc

Table 3: Displacement for dynamic analysis in x-y direc

Models	X-direc (mm)	Y-direc (mm)
Model 1	46.277	35.467
Model 2	18.944	17.157
Model 3	19.043	39.89
Model 4	50.269	16.702
Model 5	17.796	15.964



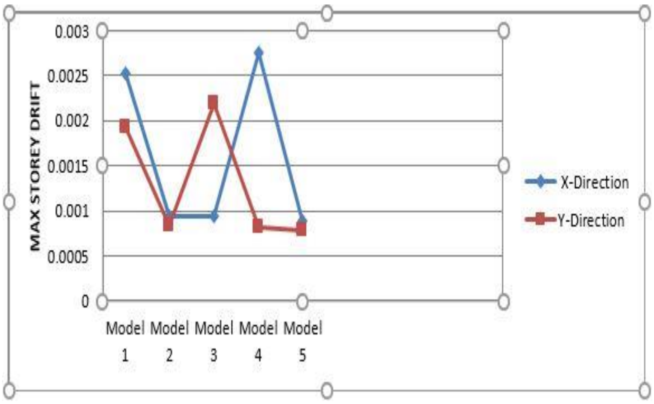
Graph 2: Displacement for dynamic analysis in x-y direc

From table 2&3 and graph 1&2 it is observed that Model 5 shows less displacement along x & y direction.

7.2 Storey Drift

Table 4: Storey drift for static analysis in x-y direc

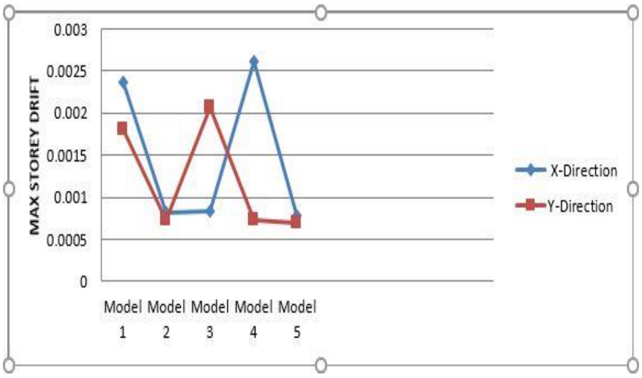
Models	X-direc	Y-direc
Model 1	0.002527	0.001933
Model 2	0.000933	0.000841
Model 3	0.000939	0.002186
Model 4	0.002754	0.000822
Model 5	0.000884	0.00079



Graph 3: Storey Drift for static analysis in x-y direc

Table 5: Storey drift for dynamic analysis in x-y direc

Models	X-direc	Y-direc
Model 1	0.002365	0.001806
Model 2	0.000817	0.000736
Model 3	0.000833	0.002064
Model 4	0.002619	0.000726
Model 5	0.000778	0.000696



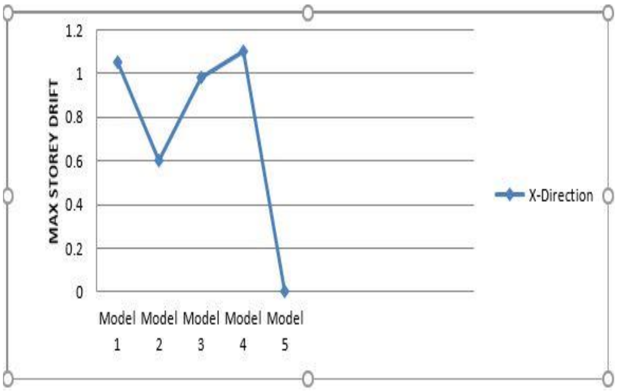
Graph 4: Storey Drift for dynamic analysis in x-y direc

From table 4&5 and graph 3&4 it is observed that Model 5 shows less storey drift along x & y direction.

7.3 Time Period

Table 6: Time period

Models	Time period (sec)
Model 1	1.051
Model 2	0.605
Model 3	0.979
Model 4	1.1
Model 5	0.581



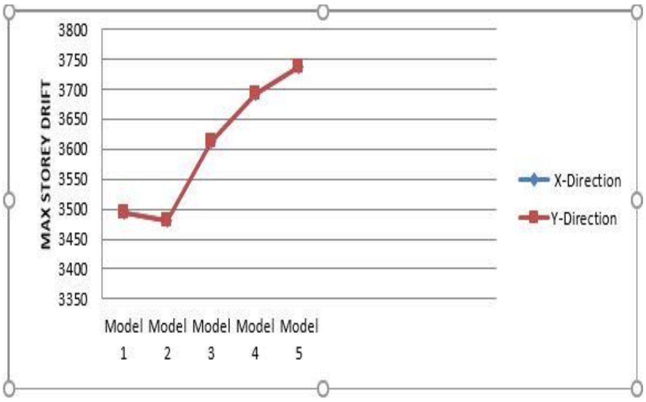
Graph 4: Time period of all models

From table 6 and graph 4 it is observed that Model 5 shows less time period value.

7.4 Base Shear

Table 7: Base Shear for static and dynamic analysis in x-y direc

Models	X-direc (KN)	Y-direc (KN)
Model 1	3492.5125	3492.5125
Model 2	3480.3446	3480.3446
Model 3	3612.9358	3612.9358
Model 4	3691.6954	3691.6954
Model 5	3737.8342	3737.8342



Graph 5: Base Shear for static and dynamic analysis in x-y direc

8 CONCLUSIONS

From the analysis done on G+8 structure in zone V the following conclusions are made:

1. From the results of displacement, it is noted that the maximum lateral displacement is seen in Model 4 for static analysis along X-direction, Model 3 for static analysis along Y-direction.

2. From the results of displacement, it is noted that the maximum lateral displacement is seen in Model 4 for response spectrum analysis along X-direction and Model 3 for response spectrum analysis along Y-direction.

3. From the results of displacement, it is noted that the minimum lateral displacement is seen in Model 5 for static and response spectrum analysis along X and Y direction.

4. The reduction of lateral displacement along X direction for static and response spectrum analysis is 34.33% and 35.40%. The reduction of lateral displacement along Y direction for static and response spectrum analysis is 38.84% and 40.02%.

5. From the results of storey drift, it is noted that the maximum lateral storey drift is seen in Model 4 for static analysis along X-direction, Model 3 for static analysis along Y-direction.

6. From the results of storey drift, it is noted that the maximum lateral storey drift is seen in Model 4 for response spectrum analysis along X-direction and Model 3 for response spectrum analysis along Y-direction.

7. From the results of storey drift, it is noted that the minimum storey drift is seen in Model 5 for static and response spectrum analysis along X and Y direction.

8. The reduction of storey drift for static and response spectrum analysis along X-direction is 32.09% and 29.70%. The reduction of storey drift for static and response spectrum analysis along Y-direction is 36.13% and 33.72%.

9. From the graphs and tables of time period in the results section it is clearly observed that the Model 4 has maximum time period and Model 5 has minimum time period.

10. The reduction in time period is 52.81% when compared between maximum and minimum values of time period.

11. From the graphs and tables of base shear in the results section it is clearly observed that the maximum base shear is seen in Model 5 for static and response spectrum analysis along X and Y direction.

12. From the graphs and tables of base shear in the results section it is clearly observed that the minimum base shear is seen in Model 2 and Model 8 for static and response spectrum analysis along X and Y direction. The reduction in base shear is 9.17% when compared between maximum and minimum values of base shear.

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