International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 07, July-2019

Dynamic Seismic Analysis of Multi Storey Buildings (High-Rise) with and without Struts in Seismic Zone V

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***Abstract*:- As high rise buildings are being evaluated in terms of its lateral swing and ability to resist lateral loads. The complexity in the design of such high rise buildings is very high and all the loads parameters as well as other design parameters have to be considered. Therefore, in order to understand the concept of analysis, design and behavior of high rise building when subjected to zone V seismic forces. In order to evaluate and present the current research work, 16 storey building and 20 storey building were modeled in the Bentley's design software STAAD.PRO. various modeling's as well as design parameters were considered and dynamic seismic analysis by response spectrum analysis was carried out as per IS: 1893-2016. The buildings were introduced with typical single and double cross bracing (struts) at the edges. The performance of the afore-mentioned structures was evaluated by recording the results from the post-processing and output file of Staad.Pro and comparison was carried out between the same storied buildings. The conclusion reveals that the maximum displacement of RCC building can be reduced up to 54 % and 67 % when the single cross strut and double cross strut is used with central core respectively.**

Keywords: Dynamic Seismic Analysis, Staad.Pro, Struts, Bracing.

1. INTRODUCTION

Structural analysis is very important process for any structure as it ensures the stability, durability and economy of the structure. It is mainly concerned with the behavior of structure when it is subjected to external and internal forces. Frame structures (such as Concrete frame structures and Steel frame structures) entail various structural components such as stairs, ramp, beams, slabs, columns, foundation etc. vertical loads are the loads which act throughout the life span of buildings but horizontal loads may or may not act on the building. These loads are transferred from slabs to beams and then to columns. Then from columns, these loads are transferred to foundations and then ultimately to the soil. Soil must have enough bearing capacity to withstand the total load of the building without any deformations. Various tests are conducted on the soil in order to get the bearing capacity of the strata. Once the bearing capacity is known, then the type of foundation is decided. There are different types of foundations, shown in Figure 1. Which are being used according to the soil strata.

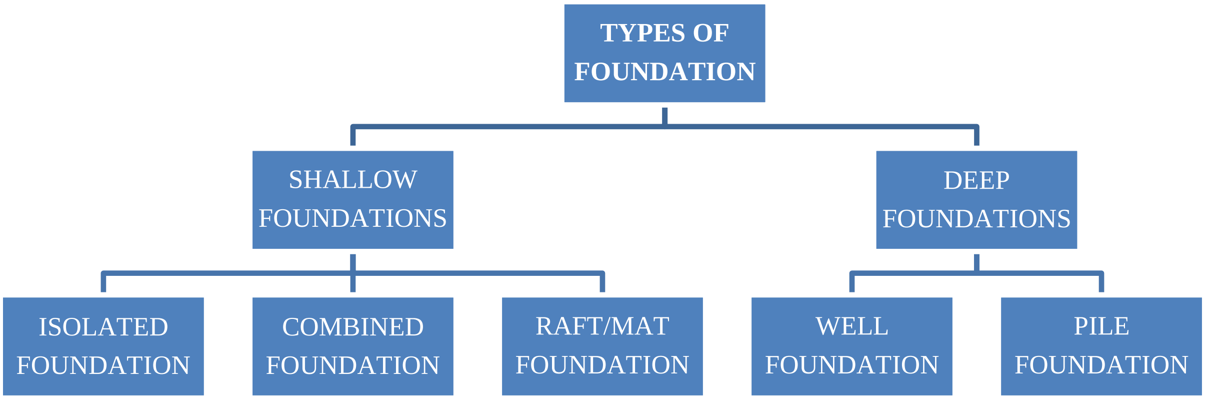

Figure 1. Types of Foundations.

Struts and columns, they both are basically the compression structural components which can resist compressive forces as well as lateral forces generating within the structure. Struts, unlike column, are an inclined member. Conventionally, struts were used in steel structures such as buildings, bridges etc but now they are being used in RCC frame structures also. This imparts large strength to the structure and helps in making it safe and economical. A strut can collapse due to buckling not by crushing. In simple words, a strut may be defined as a long, inclined column.

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2. METHODOLOGY

Phase I: Modeling

For performing the current research work, total 6 models were prepared using Staad.Pro Software and they are mentioned as under:

Table 1. Description of Various Models

Type	Storey	Struts (bracing)
Type A	16 storey Building	None
Type B	16 storey Building	Single Cross Bracing
Type C	16 storey Building	Double Cross Bracing
Type D	20 storey Building	None
Type E	20 storey Building	Single Cross Bracing
Type F	20 storey Building	Double Cross Bracing

Other parameters of modeling are being represented in the table given below:

- Height of each storey = 3.3 m
- No. of bays in X-direction = 8
- No. of bays in Z-direction = 6
- Panel of each bay = 5.5 m x 6.5 m

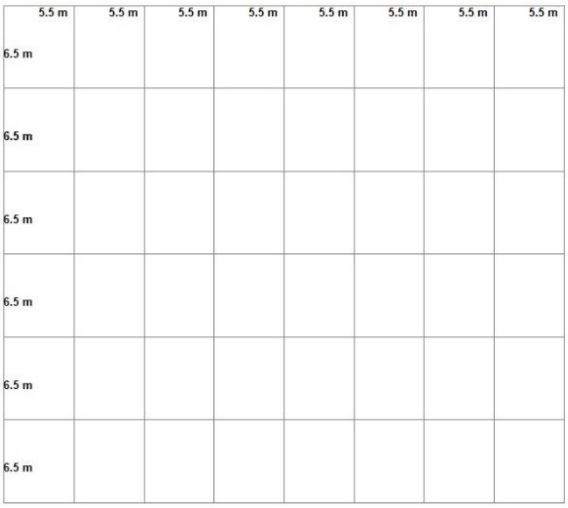

Figure 2. Plan of Building.

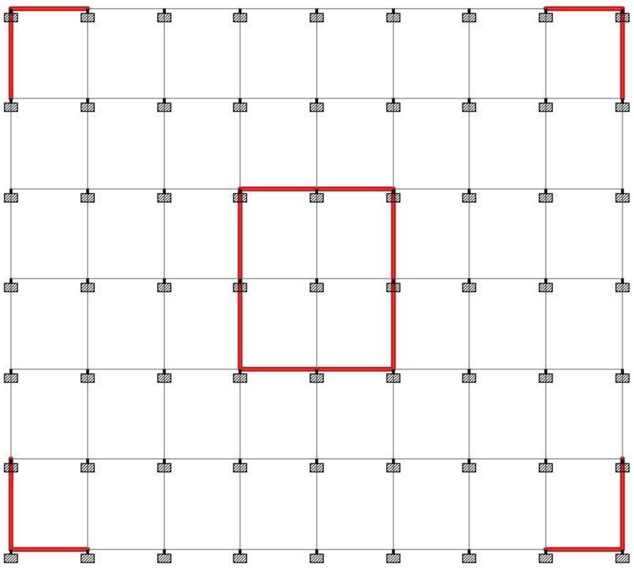

Figure 3. Location of Struts (Single Cross-Strut) in Plan.

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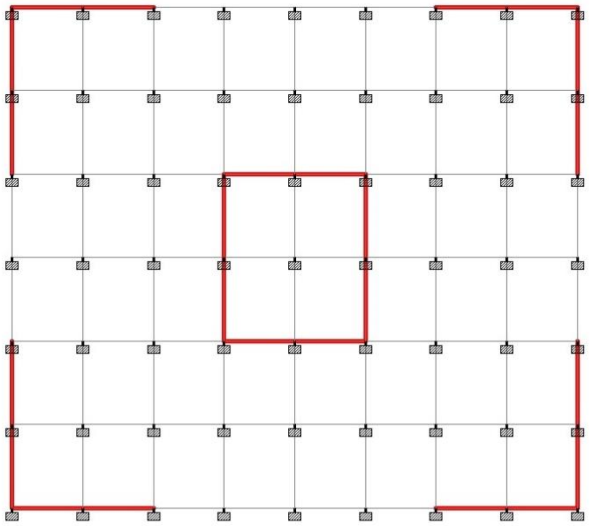

Figure 4. Location of Struts (Double Cross-Strut) in Plan.

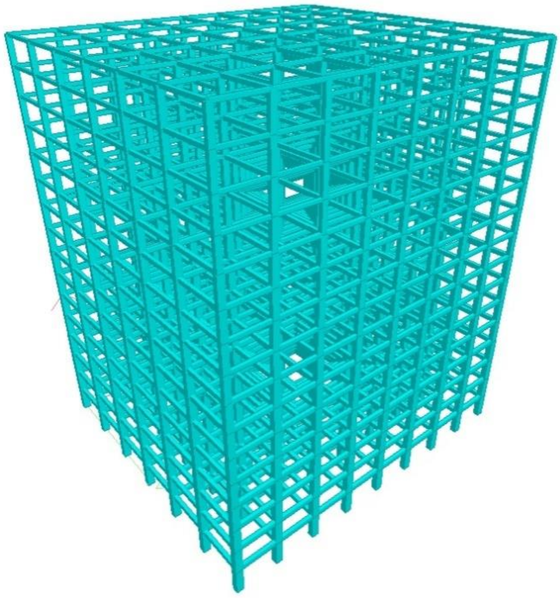

Figure 5. Rendered View of Type A Building.

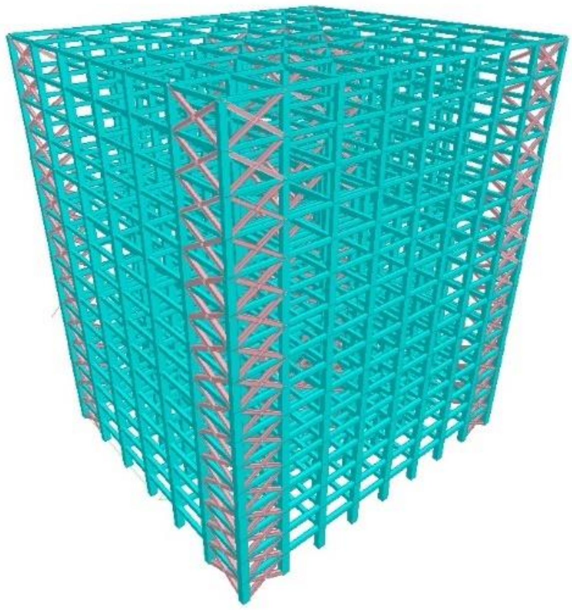

Figure 6. Rendered View of Type B Building.

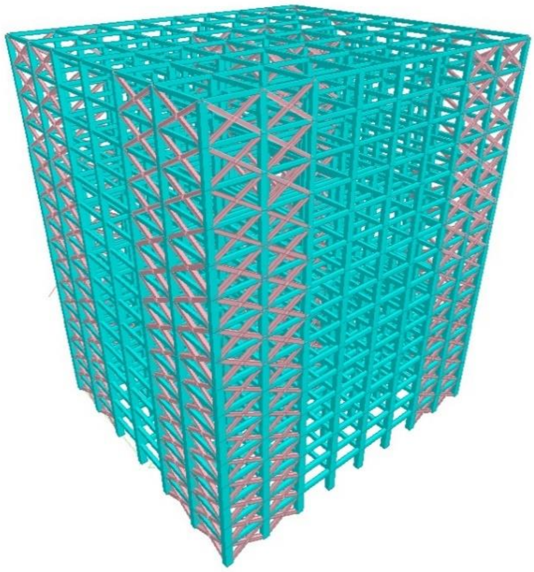

Figure 7. Rendered View of Type C Building.

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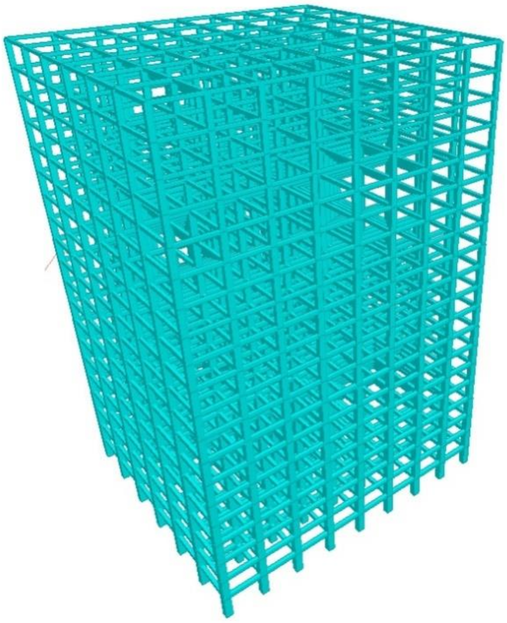

Figure 8. Rendered View of Type D Building.

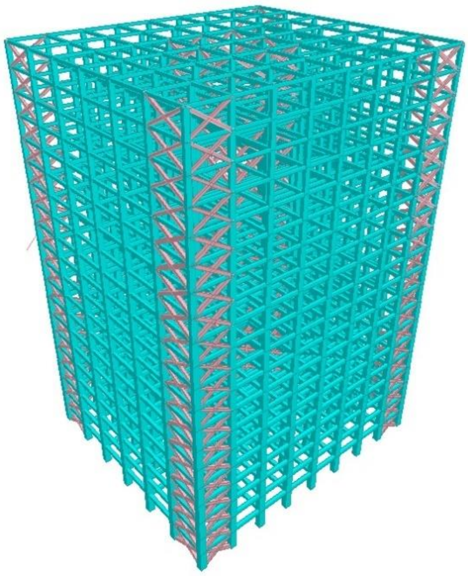

Figure 9. Rendered View of Type E Building.

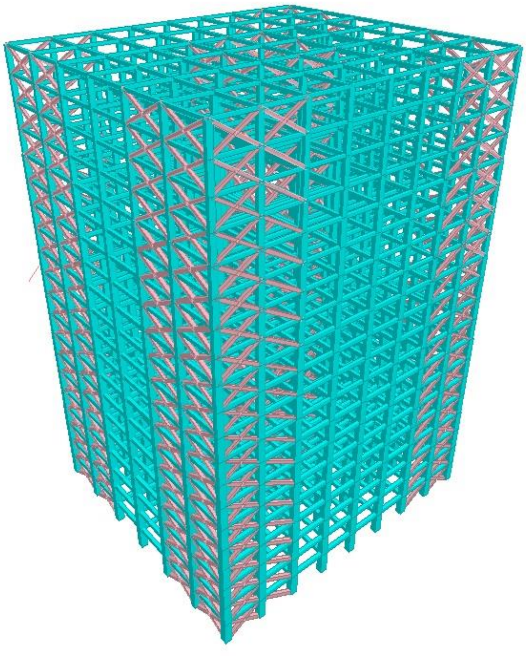

Figure 10. Rendered View of Type F Building.

Material properties which were assigned to different storey buildings are mentioned in table 2.

Table 2. Material Properties of Columns and Beams

Type of building	**Floors**	**Column size (mm)**	**Beam size (mm)**	**Strut Size (mm)**
Type A, B & C	1st to 4th floor	900 x 750 mm	600 x 450 mm	450 x 450 x 12 mm
	5th to 8th floor	825 x 650 mm	575 x 380 mm	350 x 350 x 12 mm
	9th to 12th floor	750 x 525 mm	450 x 380 mm	450 x 450 x 8 mm
	13th to 16th floor	600 x 380 mm	380 x 300 mm	350 x 350 x 8 mm
Type D, E & F	1st to 4th floor	980 x 875 mm	600 x 500 mm	500 x 500 x 12 mm
	5th to 8th floor	900 x 750 mm	600 x 450 mm	450 x 450 x 12 mm
	9th to 12th floor	825 x 600 mm	575 x 380 mm	350 x 350 x 12 mm
	13th to 16th floor	750 x 525 mm	450 x 380 mm	450 x 450 x 8 mm
	17th to 20th floor	600 x 450 mm	380 x 300 mm	350 x 350 x 8 mm

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Phase II: Seismic Analysis

Total 6 models (3 for 16 storey building and other 3 for 20 storey building) were prepared in Staad.Pro software using new seismic code IS: 1893-2016 with dynamic seismic analysis. Relative seismic parameters were considered such as seismic zone, type of structure, importance factor etc. Seismic zone V was taken for the present study. After the analysis, all the results were recovered from various sources of software.

3. RESULTS AND DISCUSSION

The so obtained results have been collected from the staad.pro are now represented in various forms such as tables and figures. With the help of such representations, the results were compared between the same storey building having different bracings. Displacement, being the main factor which was used to evaluate the structure's lateral stability, was recorded at three different locations (displacement of corner columns, edge columns and central column) as shown in the figure below.

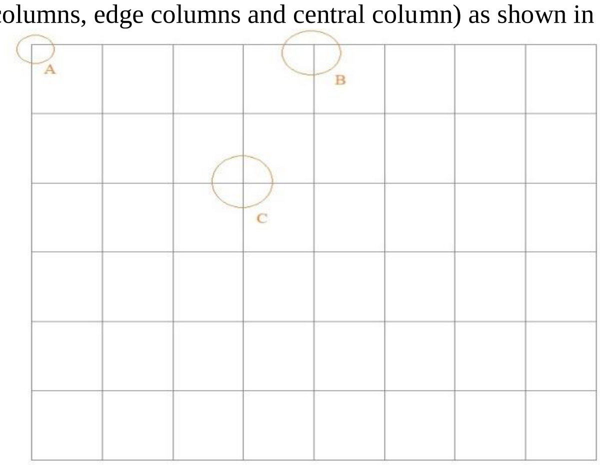

Figure 11. Location of Columns for Displacement Results.

Results of 16 Storey Building and 20 Storey Building.

Figure 12. Displacement of Type A Building.

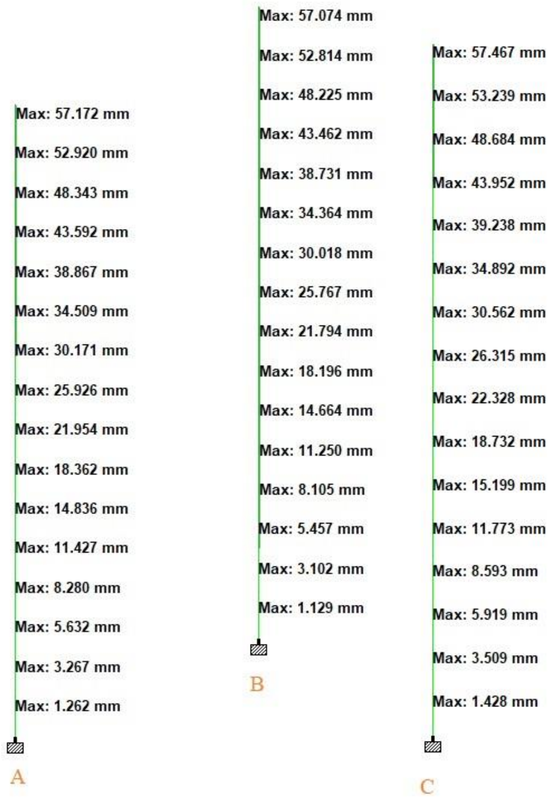

Figure 13. Displacement of Type B Building.

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Figure 14. Displacement of Type C Building.

Figure 15. Displacement of Type D Building.

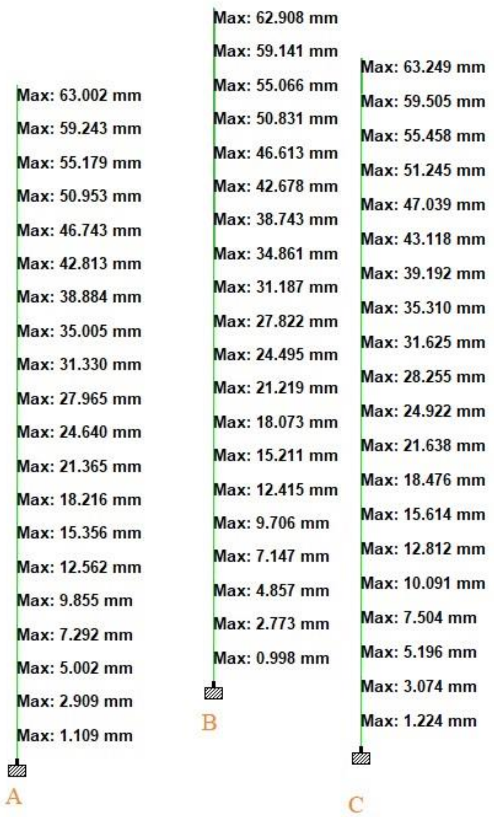

Figure 16. Displacement of Type E Building.

Figure 17. Displacement of Type F Building.

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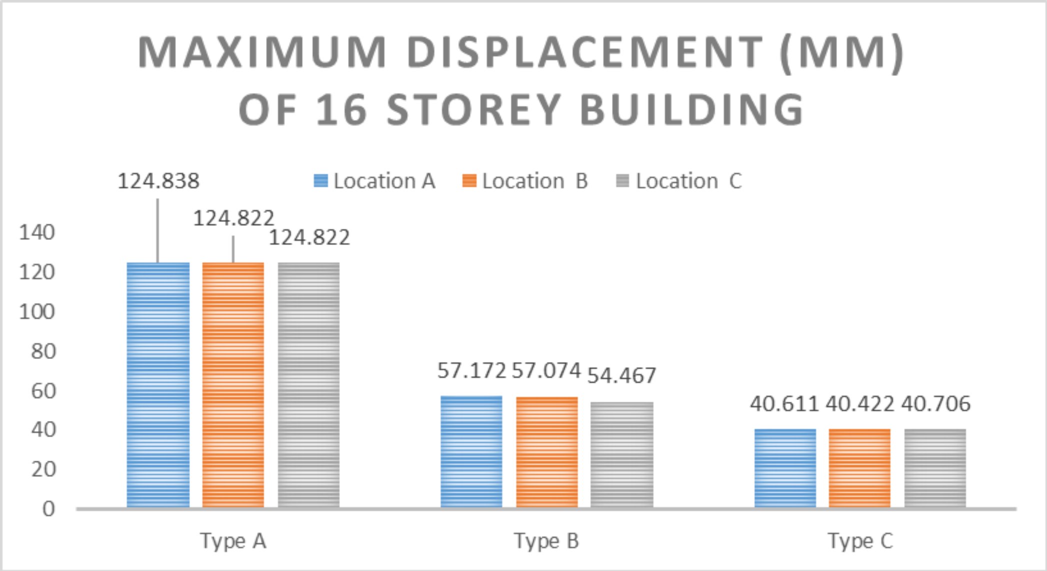

Figure 18. Maximum Displacement of 16 Storey Building.

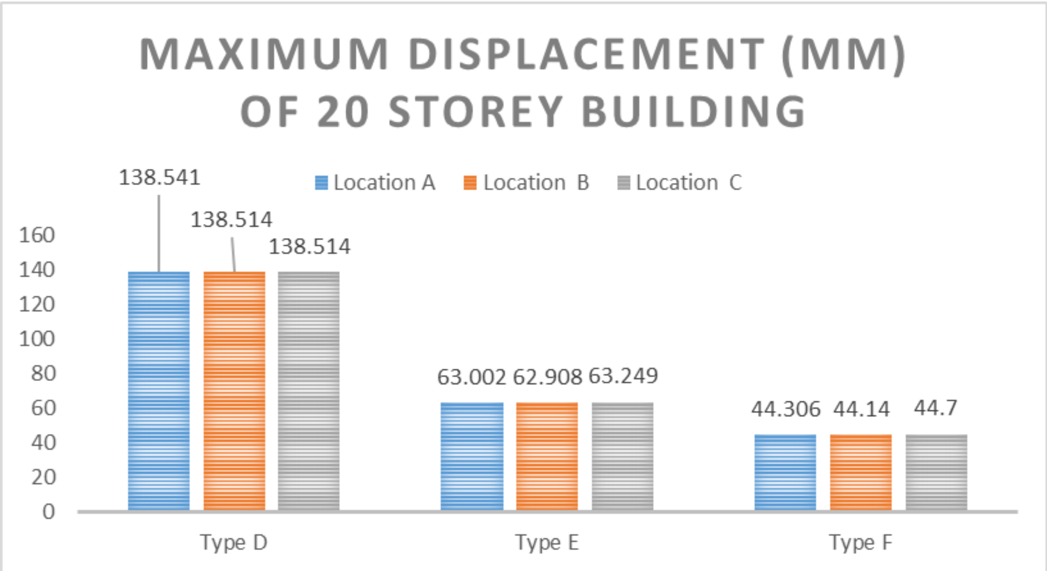

Figure 19. Maximum Displacement of 20 Storey Building.

Table 3. Material Quantity of 16 Storey Building.

	Concrete (m3)	Reinforcement Steel Kn	Steel Section(Kn)
Type A	3580.8	3764.36	-
Type B	3580.8	2461.04	4199.82
Type C	3580.8	2293.34	6299.73

Table 4. Material Quantity of 20 Storey Building.

	Concrete (m3)	Reinforcement Steel (Kn)	Steel Section (Kn)
Type D	5046.8	5151.55	-
Type E	5046.8	3736.36	5777.98
Type F	5046.8	3174.66	8339.71

4. CONCLUSION

The present investigational study evaluates the high-rise building with and without struts as well as central core, the obtained results were studied carefully. From the represented results, following are the conclusions drawn for this current study:

- For 16 storey building, the maximum displacement of column in Type A building, Type B and Type C building is 124.838 mm, 57.152 mm and 40.702 mm respectively. Therefore, the ratio of displacement of type B to type A is 0.46 and the ratio of displacement of type C to type A is 0.33.
- For 20 storey building, the maximum displacement of column in Type D building, Type E and Type F building is 138.514 mm, 63.250 mm and 44.70 mm respectively. Therefore, the ratio of displacement of type E to type D is 0.46 and the ratio of displacement of type F to type D is 0.32.

Therefore, from the above observations it can be finally concluded that there was a reduction of 54 % in maximum displacement when single cross strut bracing was provided in 16 Storey Building and 20 Storey Building. But with the addition of double cross strut bracing, there was a huge reduction of 67 % in maximum displacement of 16 Storey and 20 Storey Building. Therefore, evaluation of both the buildings reflects that the utilization of cross type strut can be done effectively.

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