Evaluation of Seismic Response of Three Different High-Rise Multistorey Bare Frame Versus Braced Steel Frames Under Seismic Condition

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ABSTRACT

Present work, the analysis has been attempts in the bare and braced frame are presented. Models of the frame are developed for multi-storey RC buildings with and without bracing systems to carry out comparative analysis of structural parameters such as base shear, lateral deformation, storey displacement, storey drift, bending moment and frequency under seismic excitation. In this work, G+10, G+15 and G+20 multistorey regular structure with six bays in the X-direction and four bays in the Z-direction has been considered. Additionally, the different types of bracing system have been considered to achieved the effect of structures. In the structure of the building the length, width and height of plan is 24 m x 16 m and 3.5 m taken for each of the storey. To obtained the accuracy and adequacy of results, initially the Seismic coefficient method has been applied in first two (bare and X-type bracing structure) case and these results compared with Response spectrum method in STAAD.Pro. Later cases are calculated from STAAD.Pro software and compared with each other.

Keywords*: Multistorey Structure, Seismic Response, Bracing, Stiffness, Finite Element Analysis.*

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1. INTRODUCTION

Seismic analysis is a subset of structural analysis and is the calculation of the response of a building and other structure to earthquakes. It is part of the process of structural design, earthquake engineering or structural assessment and retrofit in regions where earthquakes are prevalent. The earliest provisions for seismic resistance were the requirement to design for a lateral force equal to a proportion of the building weight (applied at each floor level). Earthquake engineering has developed a lot since the early days, and some of the more complex designs now use special earthquake protective elements either just in the foundation (base isolation) or distributed throughout the structure. Analyzing these types of structures requires specialized explicit finite element computer code, which divides time into very small slices and models the actual physics, much like common video games often have "physics engines". Very large and complex buildings can be modeled in this way (such as the Osaka International Convention Center).

Lateral forces due to wind or seismic loading must be considered for tall buildings with forces of gravity. Very often the design of tall buildings is controlled by the requirement of resistance to lateral loading with gravity loading. High air pressure at the edges of tall buildings produces shear and tipping moments of the base. These forces cause horizontal deflection in a multi-story building. This horizontal deviation at the top of a building is called drift. The drift is measured by the drift rate, D / H, where, D is the horizontal deflection at the top of the building and 'H' is the height of the building. The lateral drift of a typical moment resistor frame is shown in Figure 1.1.

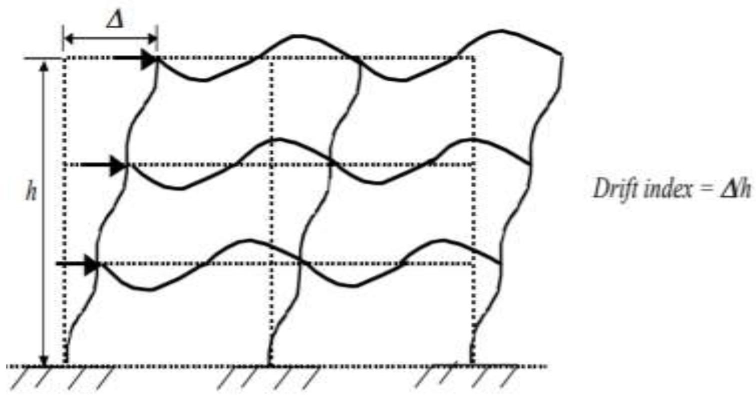


Figure 1. Lateral drift

2. PROBLEM FORMULATION

In present work, with the introduction of various multistorey with and without different bracing frame structure (diagonal, cross (X), V-type and Chevron type), three different types of high rise multistorey structure have been considered. In the structure of the area, storey height, column size, beam size and slab thickness of the building has been taken as 3.5m, 24x16m^2 0.6x0.3m, 0.23x0.45 and 0.15m. The depth of the foundation 1.5 m is considered. The work is analyzed in Zone -III consideration. For analysing both bare and bracing frames are presented and STAAD.Pro software has been used as an analysis tool and the Response Spectrum Method has been taken as a seismic analysis method.

3. METHODOLOGY

The dynamic response of a structure against the ground speed of an earthquake is controlled by the natural duration and coefficient of the structure, and the major components of ground movement. Reaction spectrum analysis is a dynamic method of analysis. Multi-Story Floor Investigations Using STAAD.Pro programming as opposed to systematic linings in Zone III for exceptional minutes. It is one of the effective software structural engineers use for the analysis and design of structures. STAAD.Pro provides more accurate and accurate results than manual techniques and is more flexible than any other software. The details of data specification used in present work is as shown in Table 1.

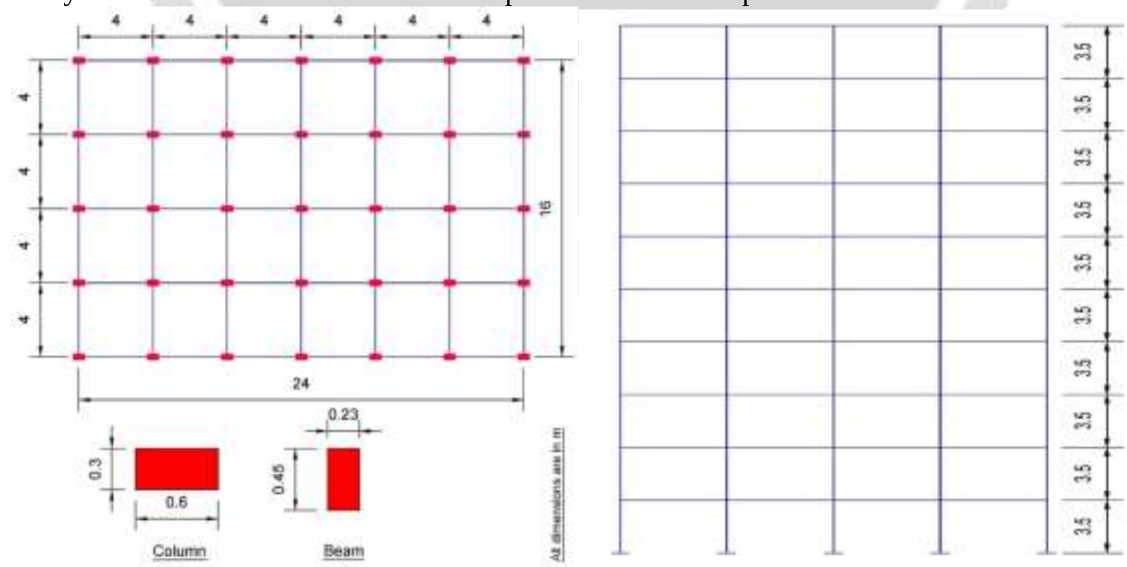


Figure 2. 2D layout and front elevation plane of proposed model with column and beam cross-section

The analysis of G+10, G+15 and G+20 floors is carried out using STAAD V8i software for special moment resisting frame situated in zone III. The RCC G+10, G+15 and G+20 structure is analysed bare frame and with different bracing systems.

4. RESULTS AND DISCUSSION

The work base shear, lateral displacement, lateral force, transverse forces, bending moment, storey displacement and storey drift are calculated for G+10, G+15 and G+20 without and with bracing system from STAAD.Pro software for the building under consideration for Zone-III of Indian seismic code Response Spectrum Method (RSM). The results of analysis for different structure are as follows

Table 2. Verification of Seismic Coefficient Method (theoretically) and Response Spectrum Method (FEA) base shear (kN) for G+10 bare frame structure

Storey	Height	SCM	RSM	% Error
11	38.5	755.66	755.2058	0.06%
10	35.0	1640.99	1639.679	0.08%
9	31.5	2358.11	2356.225	0.08%
8	28.0	2924.72	2922.092	0.09%
7	24.5	3358.54	3355.515	0.09%
6	21.0	3677.26	3673.948	0.09%
5	17.5	3898.59	3895.472	0.08%
4	14	4040.24	4036.204	0.10%
3	10.5	4119.92	4117.04	0.07%
2	7.0	4155.34	4152.957	0.06%
1	3.5	4164.19	4160.443	0.09%

Table 3. Verification of Seismic Coefficient Method (theoretically) and Response Spectrum Method (FEA) base shear (kN) for G+10 X- type bracing frame structure

Storey	Height	SCM	RSM	% Error
11	38.5	882.81	882.1039	0.08%
10	35.0	1871.86	1870.548	0.07%
9	31.5	2672.99	2670.849	0.08%
8	28.0	3305.98	3303.334	0.08%
7	24.5	3790.61	3788.338	0.06%
6	21.0	4146.67	4142.937	0.09%
5	17.5	4393.93	4389.977	0.09%
4	14	4552.18	4548.082	0.09%
3	10.5	4641.19	4637.481	0.08%
2	7.0	4680.76	4677.479	0.07%
1	3.5	4690.65	4687.363	0.07%

After validation of the model and method, and the effects of bare frames and several types bracing frame structure are analyzed and compared.

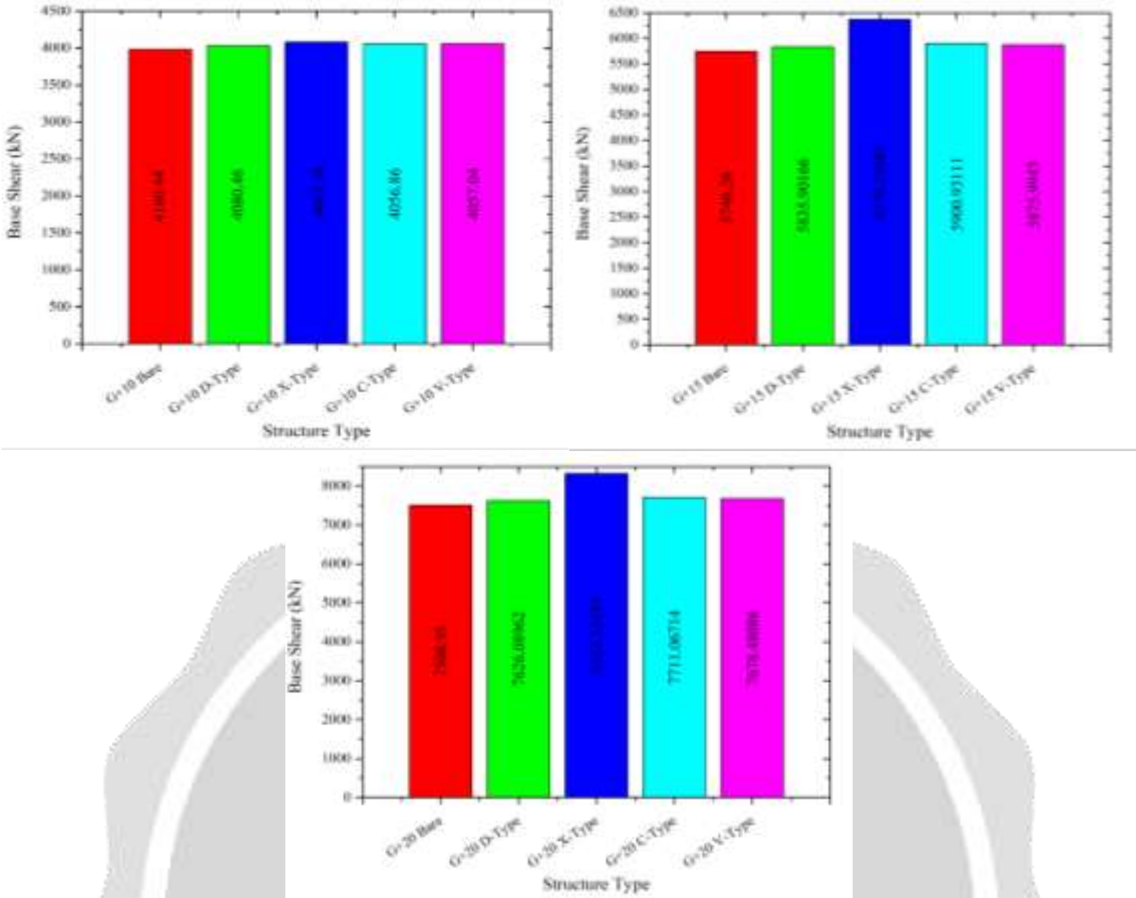
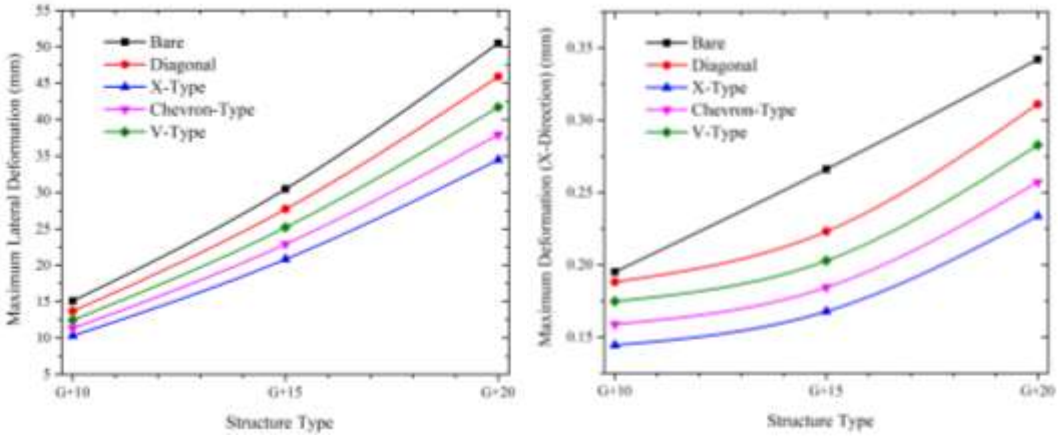


Figure 3. Comparison of base shear (kN) in G+10, G+15 and G+20 multistorey structure with and without different types of bracing frame

4.1 Effect of Bracing in Different Multistorey Structure

After validation of the model and method, and the effects of bare frames and several types bracing frame structure are analyzed and compared.



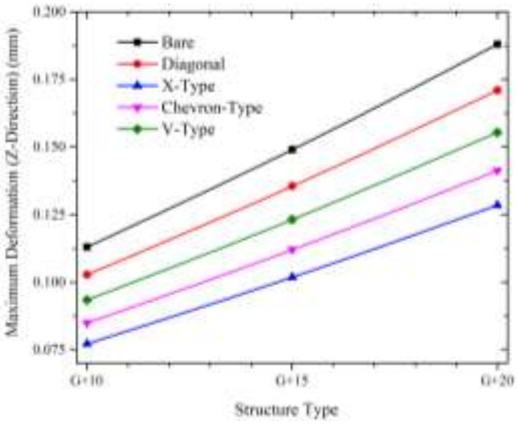


Figure 4. Variation of maximum lateral deformation, X-direction and Z-deformation as a function of different structure type (G+10, G+15 and G+20) with and without bracing frame

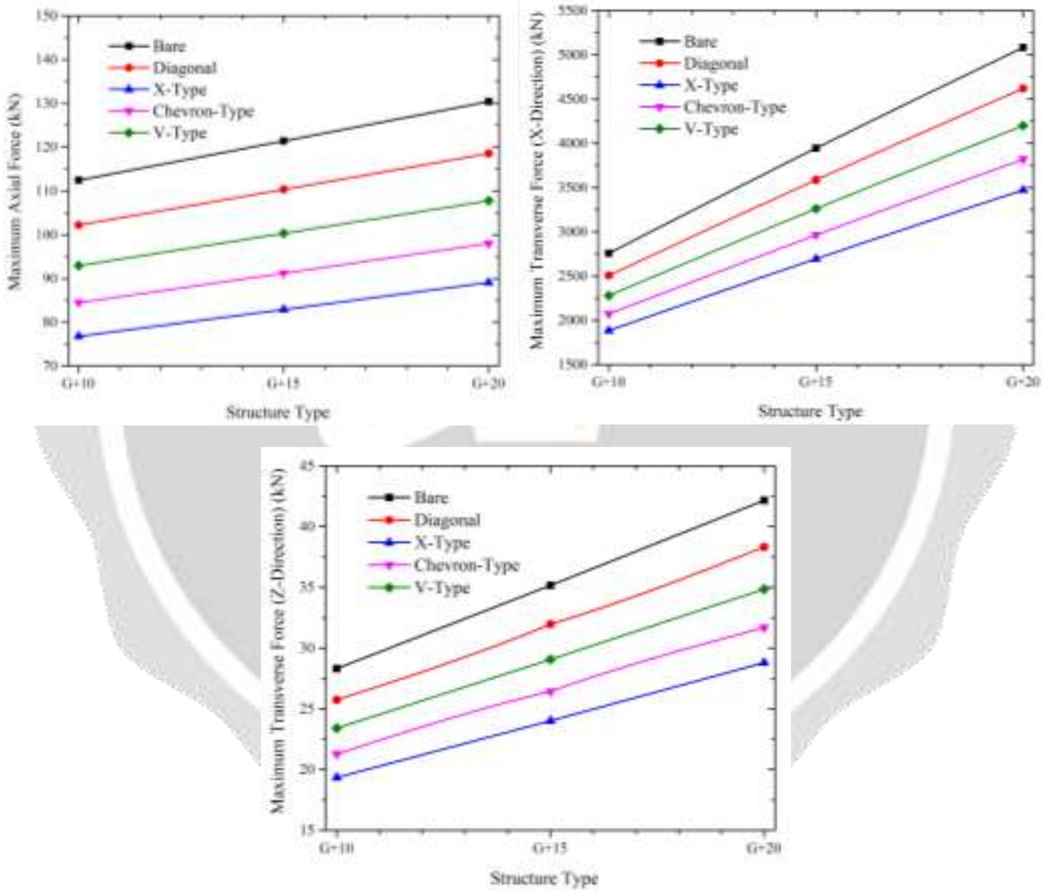


Figure 5. Variation of maximum axial force, X-direction and Z-direction as a function of different structure type (G+10, G+15 and G+20) with and without bracing frame

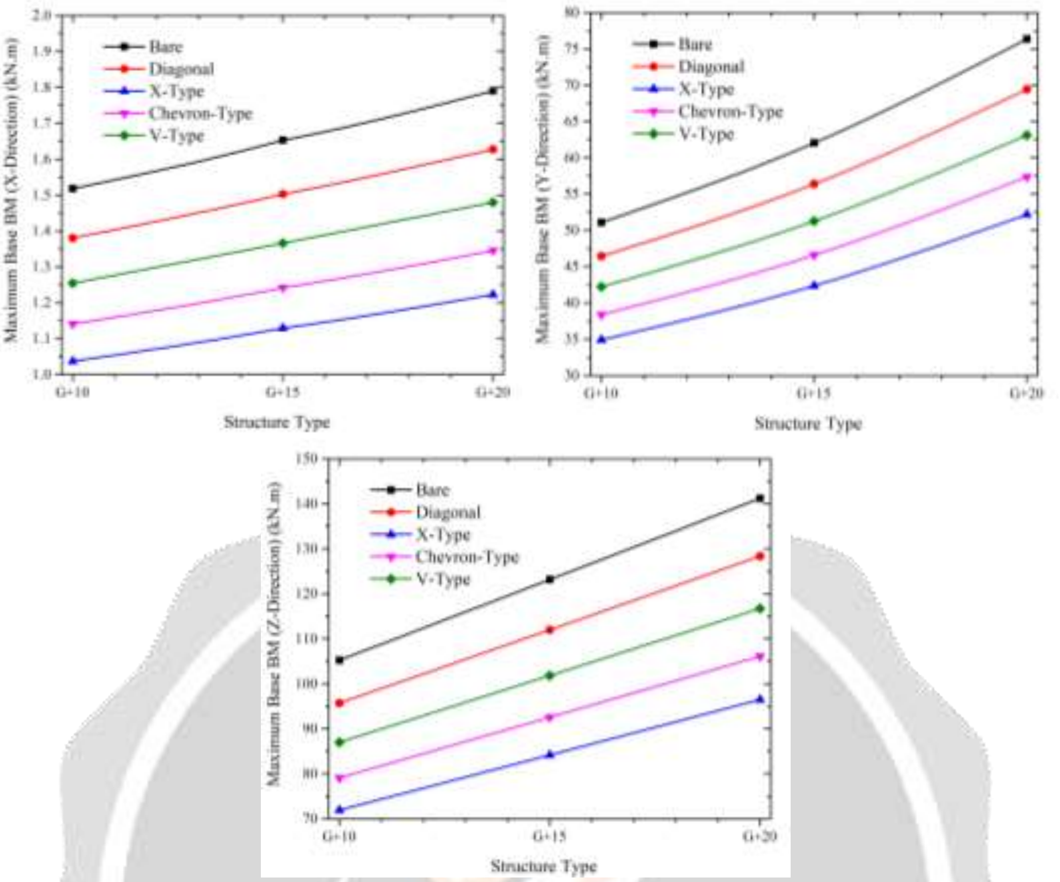


Figure 6. Variation of maximum BM in X-direction, Y-direction and Z-direction as a function of different structure type (G+10, G+15 and G+20) with and without bracing

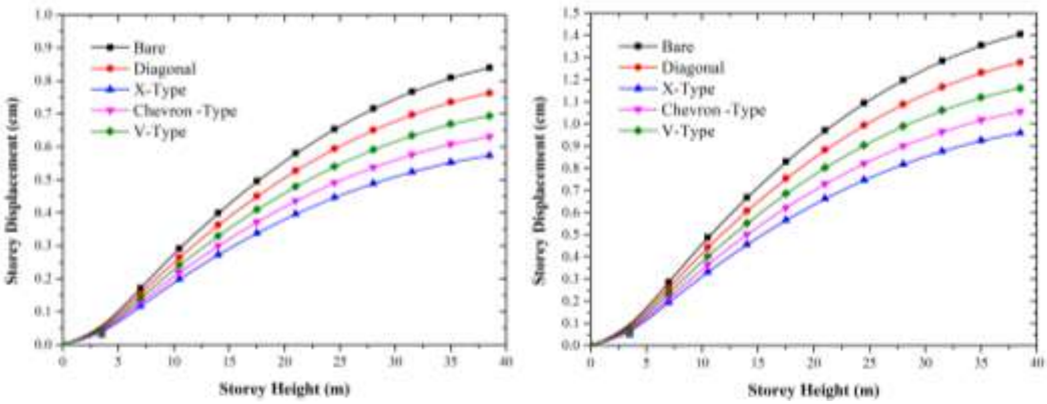


Figure 7. Variation of storey displacement in X-direction and Z-direction as a function of storey height in G+10 multistorey structure with and without bracing frame

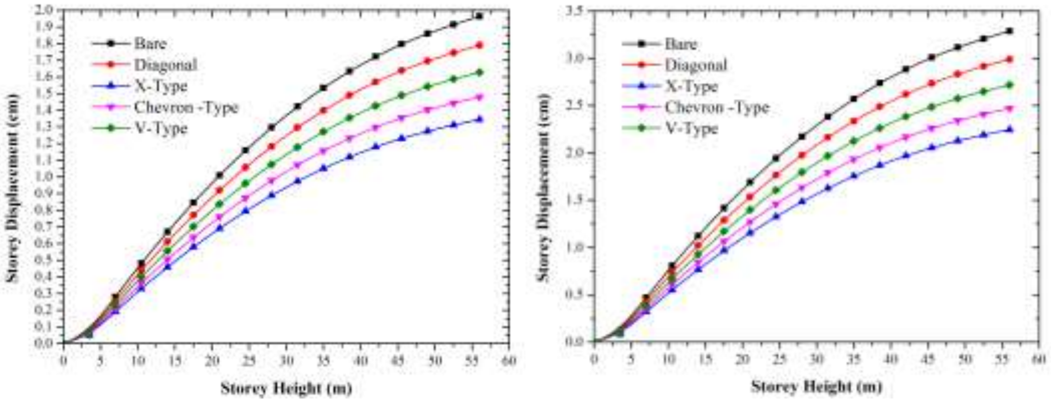


Figure 8. Variation of storey displacement in X-direction and Z-direction as a function of storey height in G+15 multistorey structure with and without bracing frame

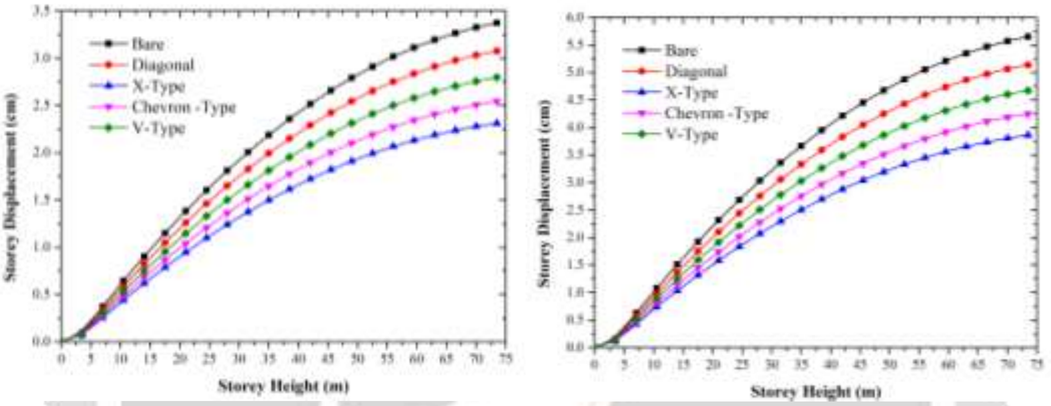


Figure 9. Variation of storey displacement in X-direction and Z-direction as a function of storey height in G+20 multistorey structure with and without bracing frame

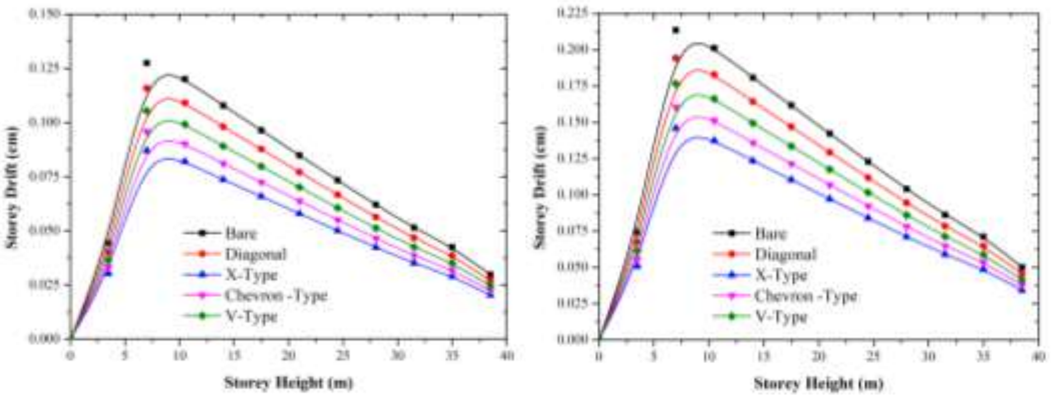


Figure 10. Variation of storey drift in X-direction and Z-direction as a function of storey height in G+10 multistorey structure with and without bracing frame

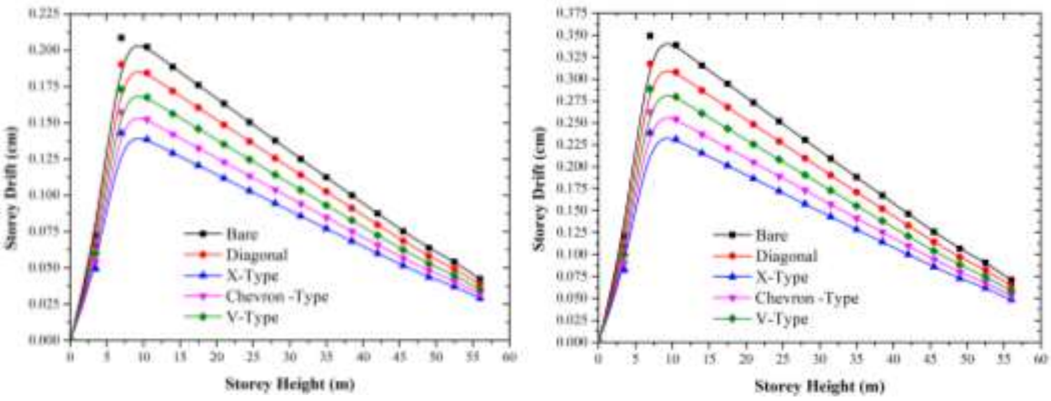


Figure 11. Variation of storey drift X-direction and Z-direction as a function of storey height in G+15 multistorey structure with and without bracing frame

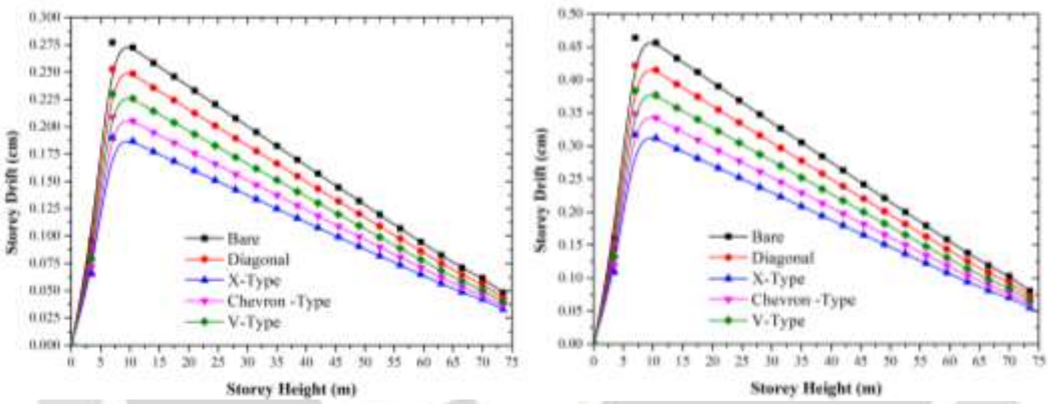


Figure 12. Variation of storey drift in X-direction and Z-direction as a function of storey height in G+20 multistorey structure with and without bracing frame

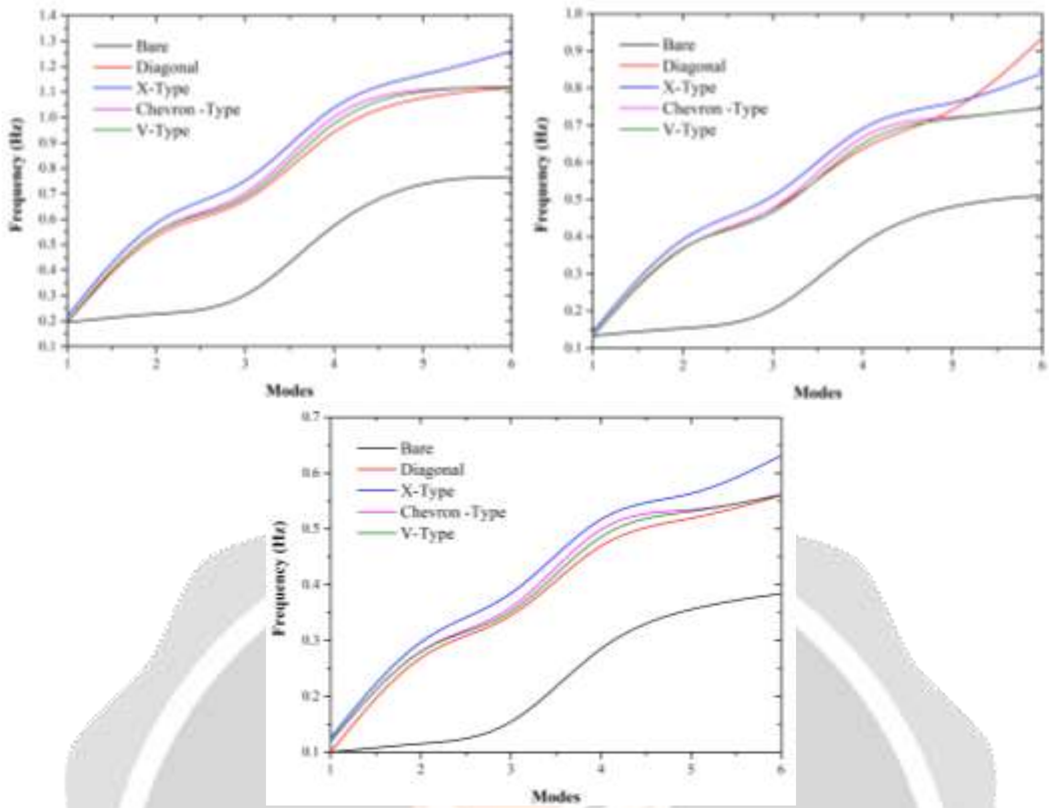


Figure 13. Variation of natural frequency as a function of mode shapes in G+10, G+15 and G+20 multistorey structure with and without bracing frame

5. CONCLUSION

From analysis the major conclusion has been drawn:

- In this work it is observed that the maximum base shear is found in cross (X) bracing frame as compared to other in all G+10, G+15 and G+20 high-rise building.
- It is observed in these works is to increasing the floor of the building progressively the maximum deformation, axial force and bending moment is also increasing. And the use of the brace frame is reducing the deformation of the structure, which is the minimum found in the X-type brace frame.
- Also form present work, the minimum average displacement has been found in cross (X) bracing frame type in all considered G+10, G+15 and G+20 high-rise building as compared to other types of structure.
- Present work also perform effect of storey drift in all types of structure and found the minimum storey drift in cross (X) bracing frame type.
- It has been also observed that the fundamental frequency is more in case of cross (X) type bracing system and less in bare frame structure.
- The work has been concluded that, many literatures it is clear that there is a possibility to enhance the quality of structure with the help of present structures. There is a good agreement to the Response spectrum analysis was carried out to gives effect of bare and braced frame structure on seismic behaviour of building and find the response.

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