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SEISMIC PERFORMANCE OF SHEAR FRAME VERSUS CROSS – BRACING REINFORCED CONCRETE FRAME

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Abstract: *Construction of R.C.C. framed structure has increased day to day. Multistory buildings require the structural system that resists the lateral load due to earthquake and wind. Hence, the study of structural system for R.C.C. framed structure to resist lateral loads is necessary. The structure should have adequate lateral strength, lateral stiffness and sufficient ductility for safety and minimum damage due to lateral load. Among the various structural systems, shear wall frame or braced concrete frame could be the best structural system to resist lateral load. Among various bracing system, X-bracing is best. It is proposed to study the seismic behavior of R.C.C. frame with and without shear wall and concrete braced frame. The purpose of this study is to compare the seismic response of above structural systems. Response spectrum method is used to analyze and the parameters maximum displacement, drift, base shear, story stiffness and overturning moment are compared using software Etabs.*

IndexTerms - **Bare Frame, Bracing, Shear wall, Response Spectrum Method, Etabs etc.**

I. INTRODUCTION

The increase in population and limitation of land space requires the need of high rise structures. The increase in the height of the structure requires more concern to the lateral load due to earthquake and wind. The structural system should have sufficient lateral strength and stiffness. Shear wall frame structure or braced frame structure could be the best structural system to resist lateral load. Bracing members are widely used in steel structures to reduce lateral displacements and dissipate energy during strong ground motion. Tall moment resisting frames are undesirable for wind and earthquake resistant because with the increase in number of stories, the depth of beam required to ensure adequate rigidity become very large, leading to corresponding increase in story height. Large inter-story displacement can cause severe damage to the moment resisting frame. Bracing systems are used to resist lateral forces. The bracing members solely carry tension or alternately tension and compression. Such system reduces bending moment and shear forces in the column.

To bring the center of mass and center of rigidity closer, concrete wall are provided. A shear wall is a wall that is used to resist the shear produced due to lateral forces. These shear walls start at foundation level and extended throughout the building height. The thickness of shear wall may vary form 150 mm to 400 mm. Under the large overturning effects caused by horizontal earthquake forces, edges of shear walls experience high compressive and tensile stresses. To ensure that shear walls behave in a ductile way, concrete wall end regions must be reinforced in a special manner to sustain these loads without losing strength. End regions of a wall with increased confinement are called boundary elements. This special confining transverse reinforcement in boundary elements is similar to that provided in columns of RC frames. Sometimes, the thickness of the shear wall in these boundary elements is also increased. Shear wall with boundary elements are less susceptible to earthquake damage than walls without boundary elements.

I.I. OBJECTIVE OF STUDY

The main objective of this study is to compare the seismic performance of shear wall frame and X – braced RC frame.

I.II. GEOMETRICAL DATA

Type of building: Commercial
Building dimension: 20 m x 20 m
Typical story height: 3m
Structural Member sizes for G+4 and G+5 Building;
Size of column: 450 mm x 450 mm
Size of beam: 300 mm x 425 mm
Slab thickness: 125 mm

Thickness of shear wall: 150 mm.
Bracing size: 300 mm x 300 mm
Structural Member sizes for G+6 and G+7 Building;
Size of column: 500 mm x 500 mm
Size of beam: 300 mm x 475 mm
Slab thickness: 125 mm
Thickness of shear wall: 150 mm.
Bracing size: 300 mm x 300 mm.

I.III. EARTHQUAKE DATA

Based on Indian Seismic code, IS 1893:2016
Seismic Zone: Zone V
Seismic Zone Factor (Z): 0.36
Importance Factor (I): 1.2
Response Reduction Factor (R);
Reinforced Concrete SMRF: 5
Reinforced Concrete Concentrically Braced Frame: 4.5
Reinforced Concrete Special Moment Resisting Frame with Shear Wall (Dual System): 5
Soil Type: Medium (Type II)
Based on Indian Seismic code, IS 1893:2016
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II. MODELING AND ANALYSIS

The Etabs version 19.1.0 software is used to prepare 3D Model and do analysis. The analysis is done by response spectrum method. In this approach, the multiple modes of response of a building to an earthquake are taken into account. The response of the different modes is combined to provide an estimate of total response of the structure using model combination method called complete quadratic combinations (CQC).

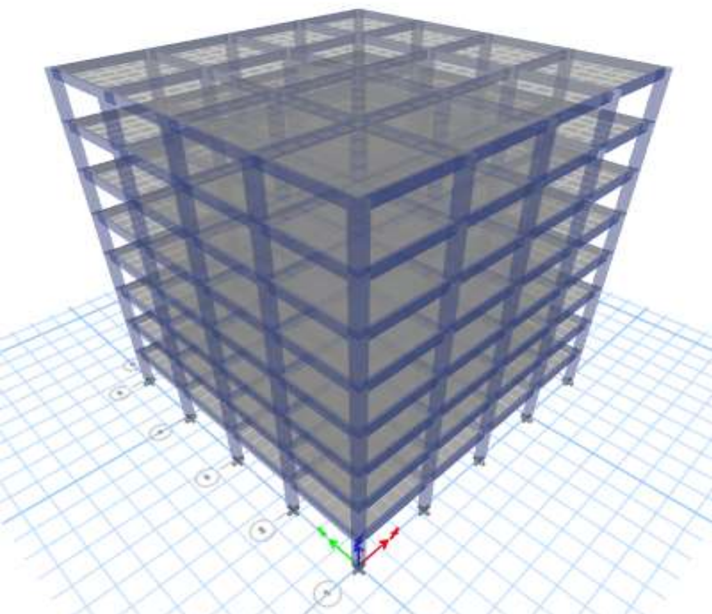


Fig- 1: 3D Model of G+ 7 Bare Frame

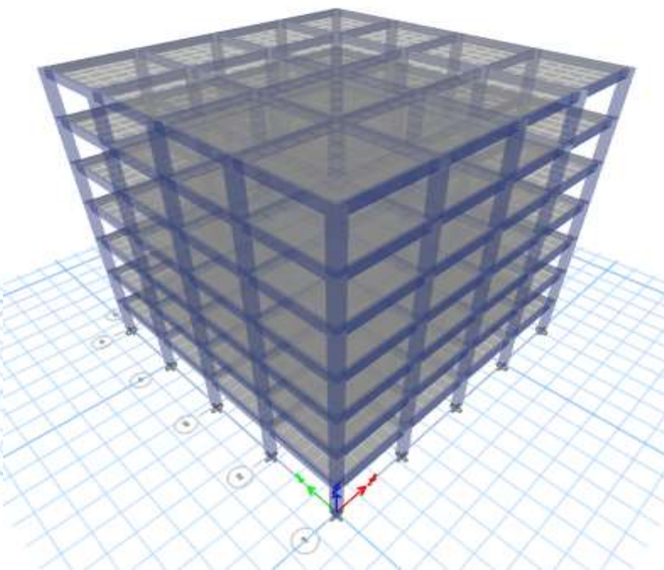


Fig- 2: 3D Model of G+ 6 Bare Frame

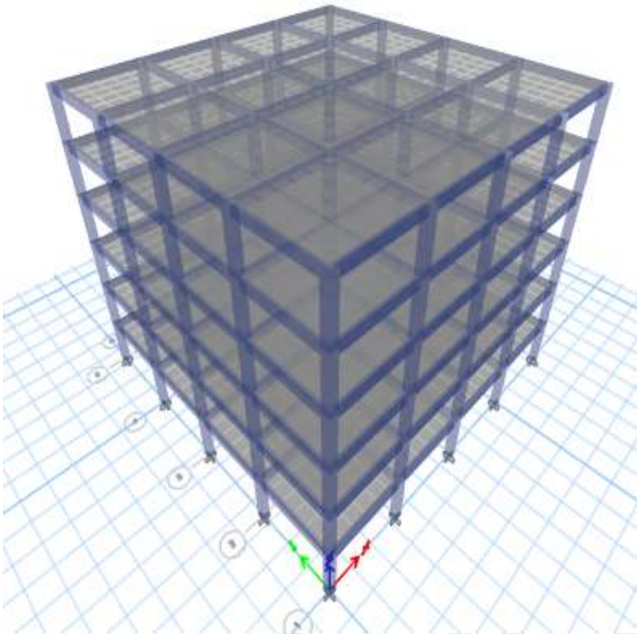


Fig- 3: 3D Model of G+ 5 Bare Frame

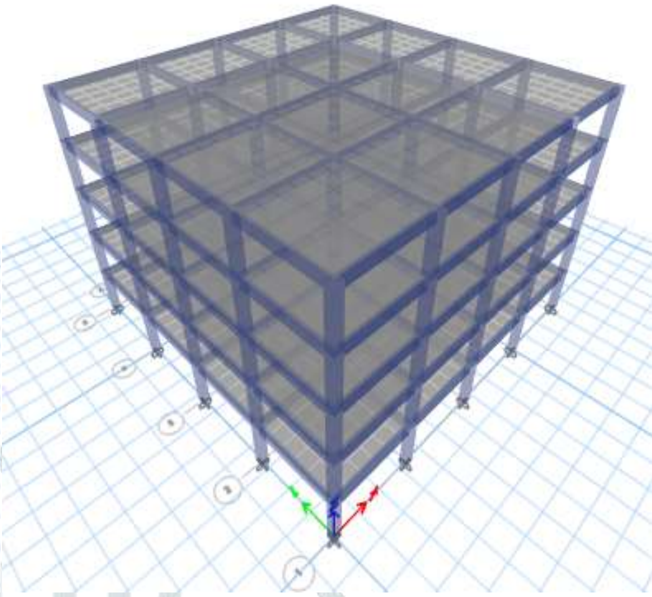


Fig- 4: 3D Model of G+ 4 Bare Frame

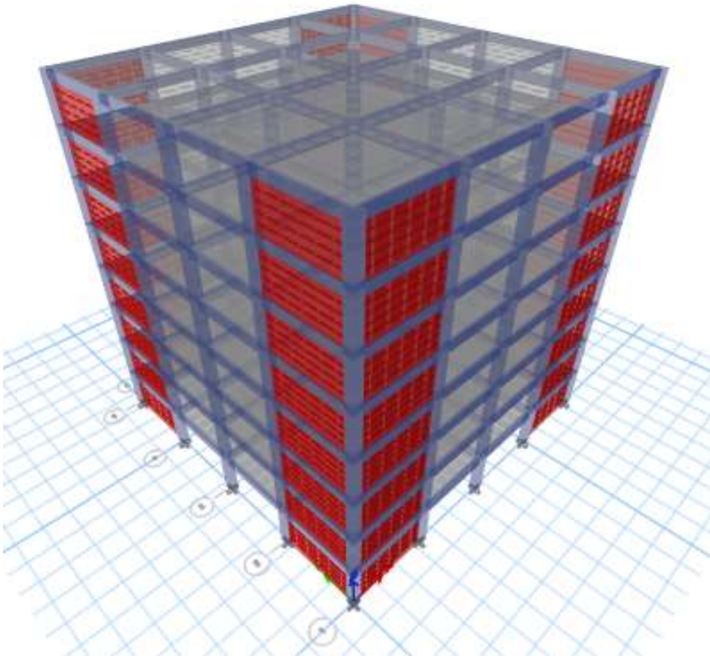


Fig-5: 3D Model of G+7 Shear Frame

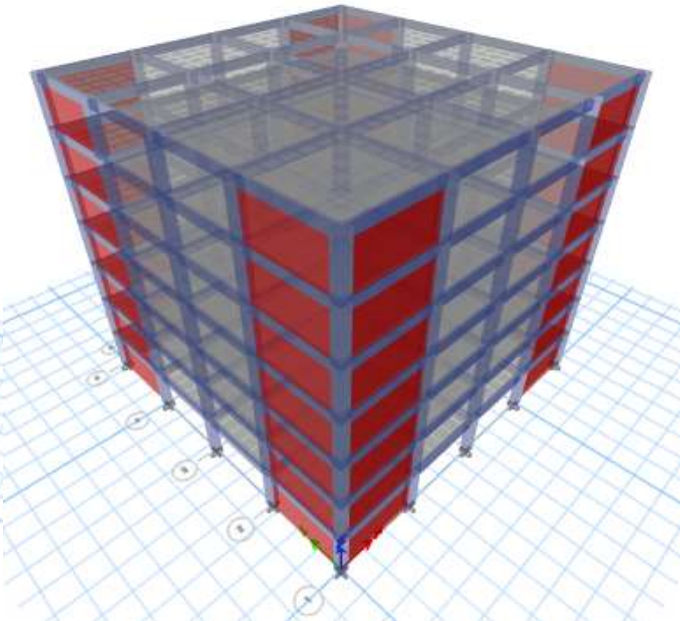


Fig-6: 3D Model of G+6 Shear Frame

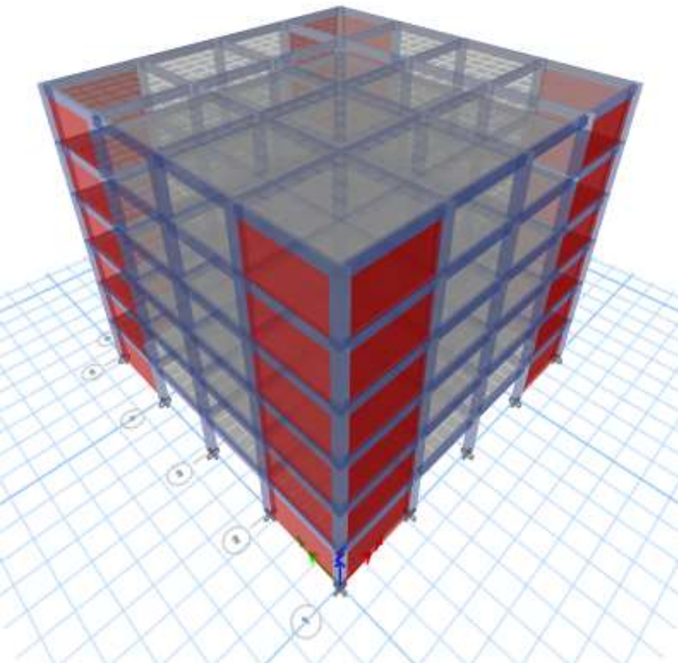


Fig-7: 3D Model of G+5 Shear Frame

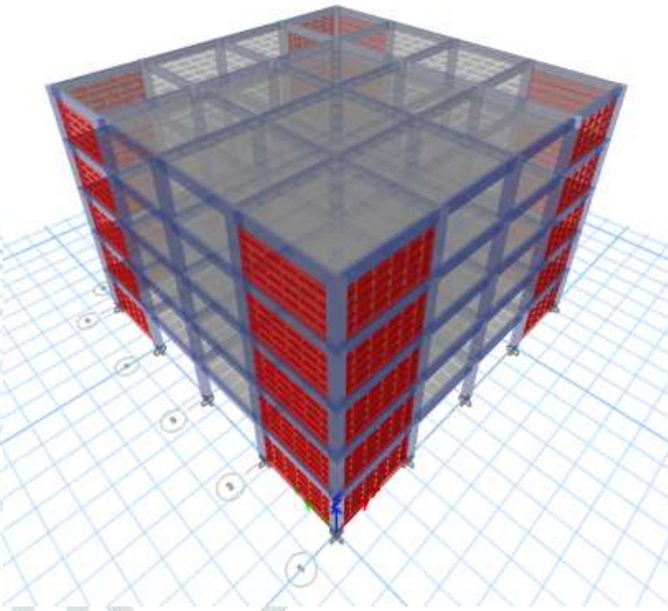


Fig-8: 3D Model of G+4 Shear Frame

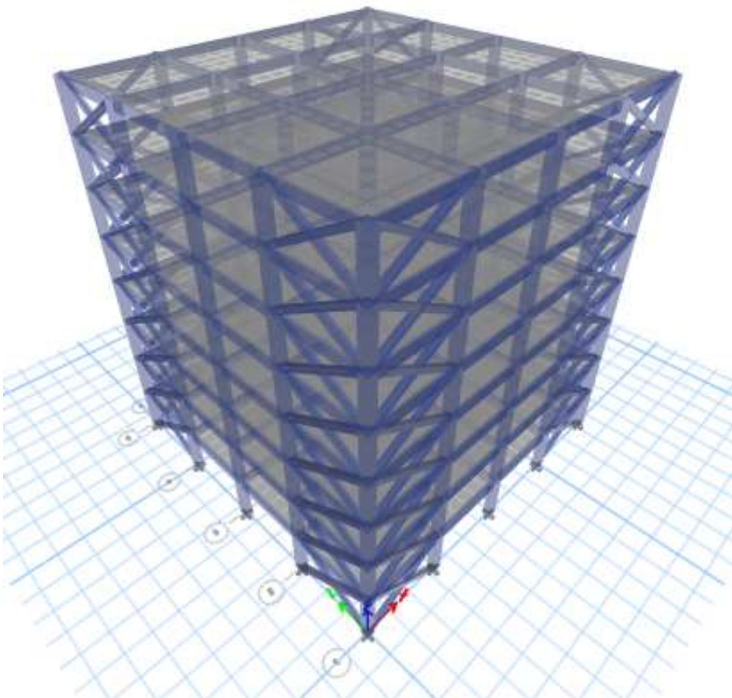


Fig-9: 3D Model of G+7 Brace Frame

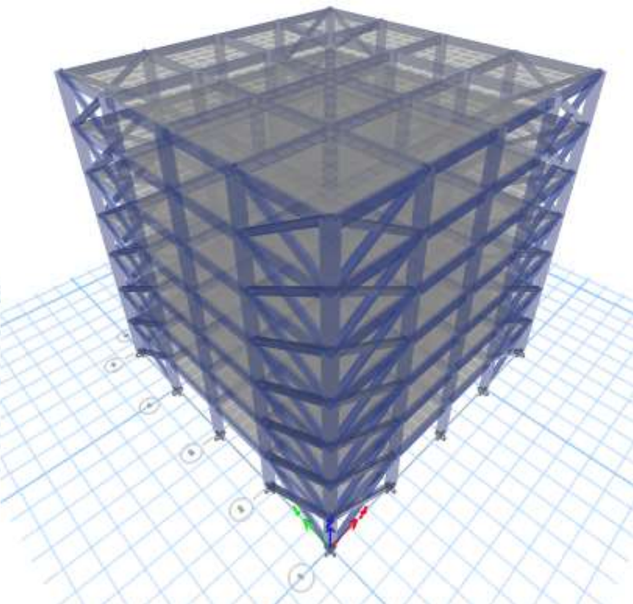


Fig-10: 3D Model of G+6 Brace Frame

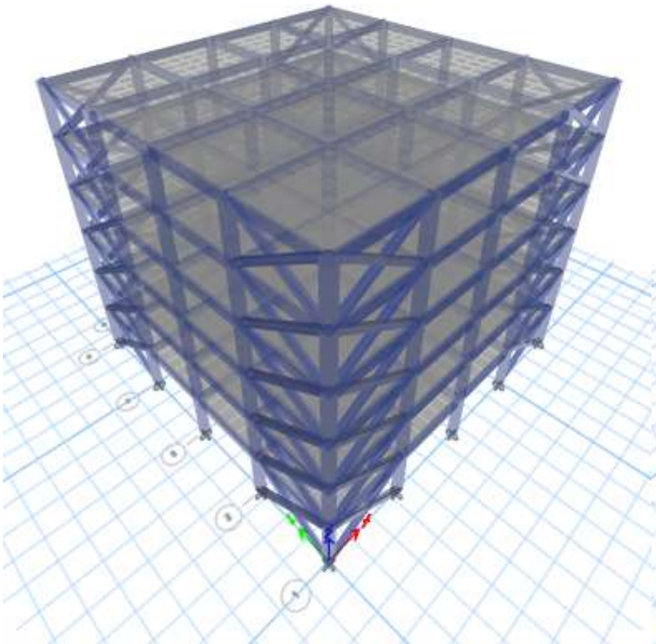


Fig-11: 3D Model of G+5 Brace Frame

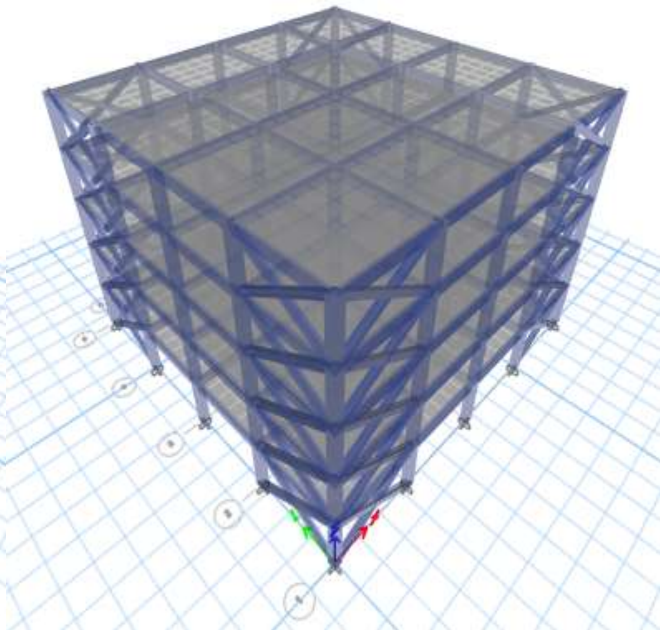


Fig-12: 3D Model of G+4 Brace Frame

III. RESULT AND DISCUSSION

The response spectrum method is used to analyze and the parameters story displacement, story drift, base shear, story stiffness and overturning moments are determined along x and y direction due to application of linear dynamic seismic force. As the building consider for study is symmetric and regular, response along x and y are same and hence only one set of data are presented. Numbers of charts are plotted and comparisons are made.

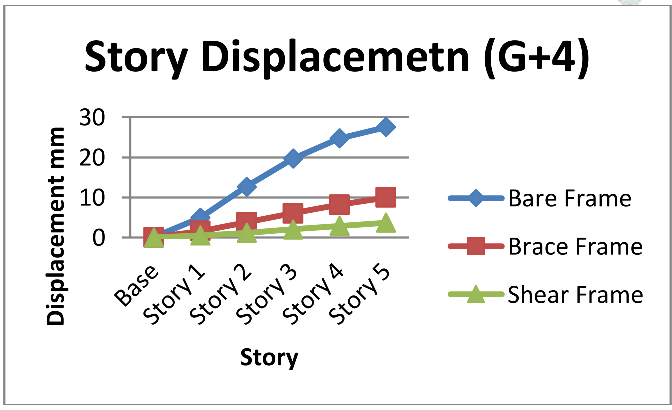


Chart-1:Story Displacement of G+4 Building

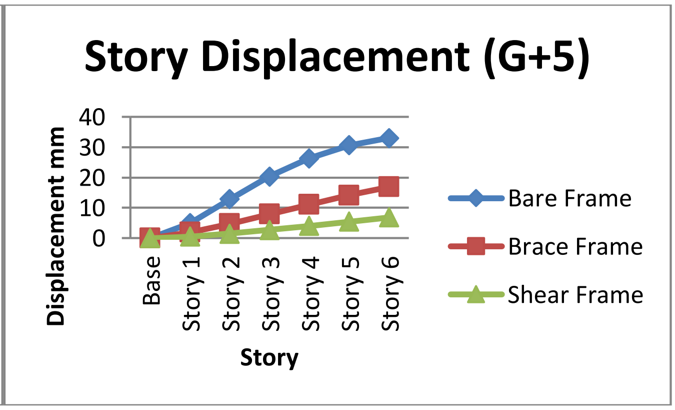
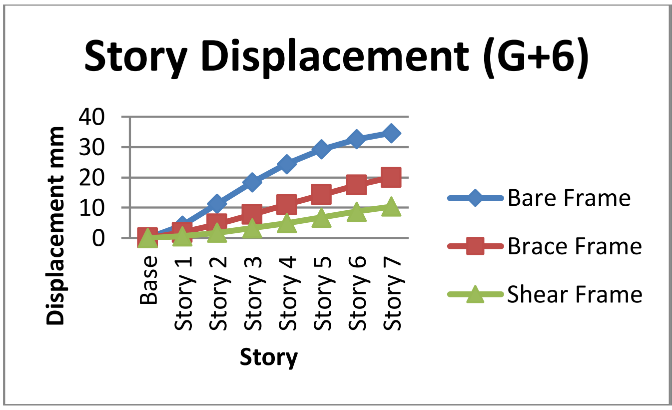


Chart-2:Story Displacement of G+5 Building



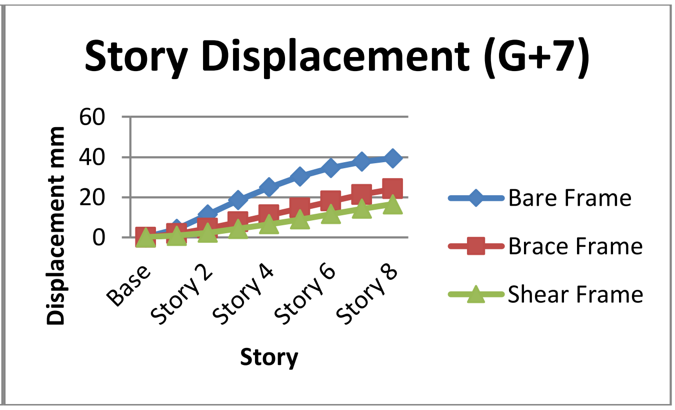
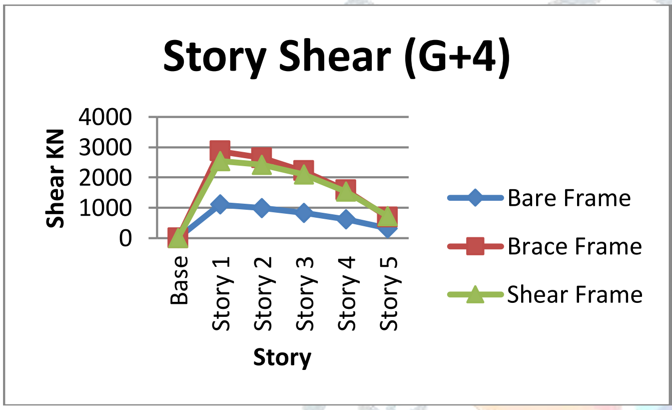


Chart-3:Story Displacement of G+6 Building

Chart-4:Story Displacement of G+7 Building



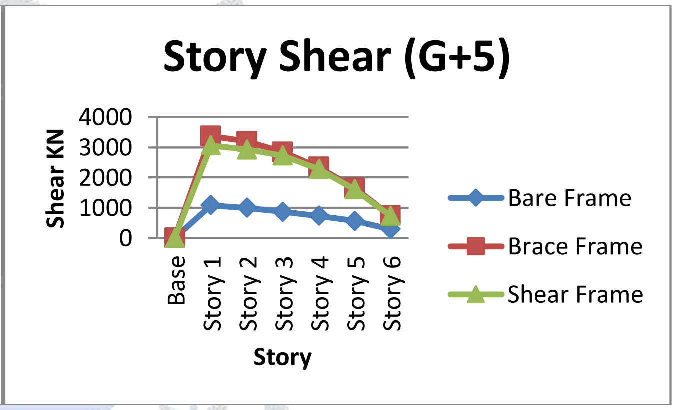
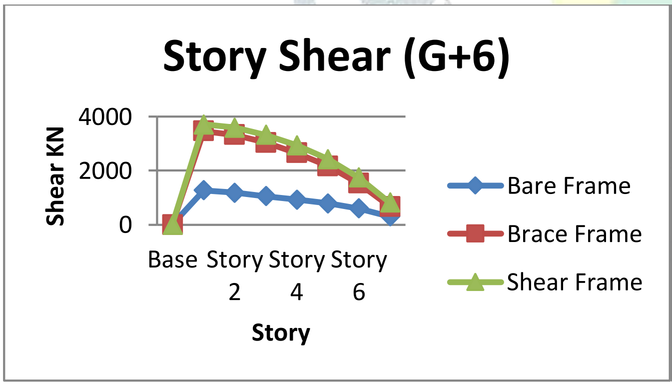


Chart-5:Story Shear of G+4 Building

Chart-6:Story Shear of G+5 Building



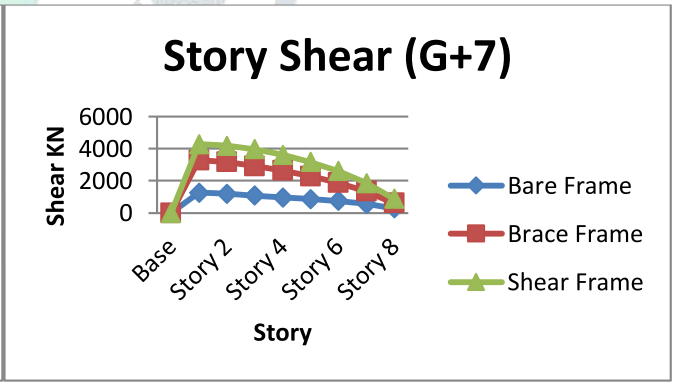
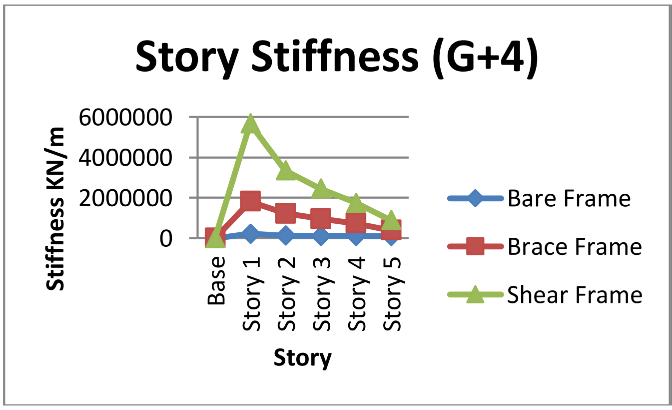


Chart-7:Story Shear of G+6 Building

Chart-8:Story Shear of G+7 Building



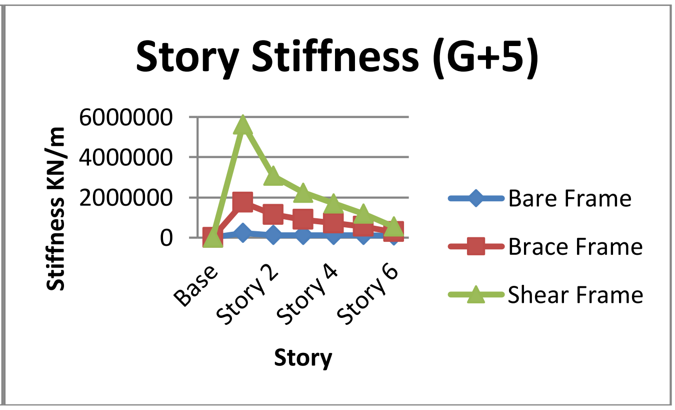


Chart-9:Story Stiffness of G+4 Building

Chart-10:Story Stiffness of G+5 Building

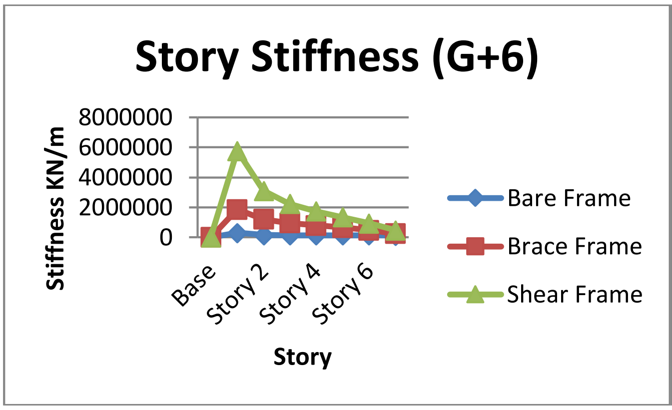


Chart-11:Story Stiffness of G+6 Building

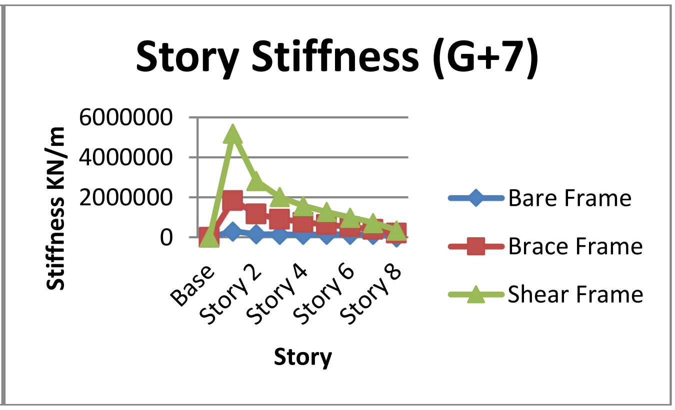


Chart-12:Story Stiffness of G+7 Building

IV. CONCLUSION

The performance of building models (bare frame, brace frame and shear frame) with G+4,G+5,G+6 and G+7 stories when subjected to seismic load, has been studied and result for response of the structure are made from Response Spectrum Analysis. The analysis software used is Etabs 2019. The chart of story displacement, base shear and story stiffness is made in previous section and the following conclusions are made from the result obtained.

1. The maximum displacement of G+ 4 stories, shear frame building is reduced by 62.63% of that brace frame. But in case of G+7 story building, the maximum displacement of shear frame is reduced by 31.3% of that brace frame. This shows that the difference in maximum displacement due to application of shear wall and bracing is decreasing on increasing the number of story of building, indicating braced frame are efficient for high rise buildings.
2. The base shear of shear frame is lesser than that of brace frame for G+4 and G+5 story building. And in case of G+6 and G+7story building brace frame has lesser shear force than shear frame building.
3. The maximum story stiffness of shear frame is higher than that of brace frame for all consider buildings (i.e. G+4, G+5, G+6 and G+7). For G+4 story building the maximum story stiffness of brace frame is 68.02% lesser than that of shear frame and for G+7 story building the maximum story stiffness of brace frame is 64.47% is lesser than that of shear frame

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