A Comparative Seismic Analysis of Steel Frame with and Without Bracings using Software Sap-2000

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***Abstract*:- In General, the structure in high seismic areas may be susceptible to the severe damage. Along with gravity load structure has to withstand to lateral load which can develop high stresses. Steel is by far most useful material for building construction in the world and in last decades steel structure has played an important role in construction industry. Bracing system is one such structural system which forms an integral part of the frame. Such structure has to be analysed before arriving at the best type or effective arrangement of bracing.**

In this paper static linear analysis is carried out for high rise steel frame building with different pattern of bracing system. The shear capacity of the structure can be increased by introducing Steel bracings in the structural system. There are 'n' numbers of possibilities to arrange steel bracings such as Diagonal, X, K, Inverted V bracings. A typical 14th- story regular steel frame building is analyzed for various types of concentric bracings like Diagonal, X, inverted V and K-type and Performance of each frame is carried out through static linear analysis ie. equivalent static force method. Three types of sections i.e. ISMB, ISMC and ISA sections are used to compare for same patterns of bracing with different position.

Key Word*: *Static Analysis, Steel Frames with Different Types of Bracings linear

I.INTRODUCTION:

Earthquake is a natural phenomenon, which is generated in earth's crust. Duration of earthquake is usually rather short, lasting from few seconds to more than a minute or so. But thousands of people lose their lives due to earthquakes in different parts of the world. Building collapse or damages are the major loss due to earthquake ground motion. Lateral stability has always been a major problem of structures especially in the areas with high earthquake hazard this issue has been studied and concentric, eccentric and knee bracing systems have been suggested and consequently used by civil engineers. The bracing system that has a more plastic deformation before collapse can absorb more energy during the earthquake[1].

The primary purpose of all kinds of structural systems used in the building type of structures is to transfer gravity loads effectively. The most common loads resulting from the effect of gravity are dead load, live load and snow load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces[9]. Bracing is a highly efficient and economical method to laterally stiffen the frame structures against earthquake and wind loads. A braced bent consists of usual columns and girders whose primary purpose is to support the gravity loading, and diagonal bracing members that are connected so that total set of members forms a vertical cantilever truss to resist the horizontal forces. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing the stiffness and strength against horizontal shear[4].

Generally, the use of bracings instead of Shear walls provides lower stiffness and resistance for a structure but it should not be forgotten that such a system has lower weight and more useful for architectural purposes. Use of braces for seismic rehabilitation of structures should not cause any torsion disorder and designers should be aware of increasing the axial loads of columns in bracing panels[5]. The most effective and practical method of enhancing the seismic resistance is to increase the energy absorption capacity of structures by combining bracing elements in the frame. The braced frame can absorb a greater degree of energy exerted by earthquakes. In braced frame reduces the column and girder bending moments. Bracing members are widely used in steel structures to reduce lateral displacements and dissipate energy during strong ground motions[6]. The braces are usually placed in vertically aligned spans. This system allows obtaining a great increase of stiffness with a minimal added weight,

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and so it is very effective for existing structure for which the poor lateral stiffness is the main problem. The concentric bracings increase the lateral stiffness of the frame, thus increasing the natural frequency and also usually decreasing the lateral drift. However, increase in the stiffness may attract a larger inertia force due to earthquake. Further, while the bracings decrease the bending moments and shear forces in columns, they increase the axial compression in the columns to which they are connected[9].

II. OBJECTIVES OF THE PROJECT:

- To compare response of braced and unbraced building subjected to lateral loads.
- To identify the suitable bracing systems for resisting the seismic loads efficiently.
- To analyses the response of unsymmetrical building with braces subjected to seismic loading using SAP-2000 Vr. 14 or improve year.

III. STRUCTURAL MODELING:

For this analysis work, five models of high rise steel frame building (G+13) floors are made to know the realistic behavior of building during earthquake. The length of the building is 15m and width is 9m.The columns are assumed to be fixed at the ground level. Linear static analysis is used to find out realistic behavior of steel frame building according to IS 1893-2002(part -I). The SAP-2000 Vr. 14 software is utilized to create 3D model and carry out the analysis.

3.1. STUDIED CONFIGURATION:

In this research following two types of structural configuration is studied.

1. G+15 Steel Framed structure without bracing (MRF)
2. G+15 Steel Framed structure with different bracing patterns.

Note:- Same pattern of bracings i.e.(Diagonal, X,Inverted –V, K-type) are used for study.

3.2. BUILDING DESCRIPTION:

Table 1. Building Modeling Description

Sr.no.	Building Description		Sr.no	Building Description	
1	zone	III	12	Thickness of slab	150 mm
2	Zone factor (IS 1893-2002)	0.16	13	Grade of concrete	M 20
3	Responce Reduction Factor (IS 1893-2002)	5.0	14	Grade of steel	Fe 415
4	Importance factors(IS 1893-2002)	1.0	15	Floor finished load(IS 875)	1.0 kN/m^2
5	Height of building	46.80 M	16	Live load (IS 875 –P-II)	3.0 kN/m^2
6	floor to floor height	3.20 m	17	Live load at roof	1.5 kN/m^2
7	Types of building used	Residential	18	Density of brick(IS 875P-I)	20 kN/m^3
8	Length of bays @ x & y direction	3.0 m	19	Thickness of outer wall	230 mm
9	Column details	ISMB 550	20	Thickness of inner wall	150 mm
10	Beam details	ISMB 450	21	Density of concrete	25 kN/m^3
11	Bracing Type	ISMB 175	22	Types of bracings provided	X, Diagonal, Inverted V,K-types

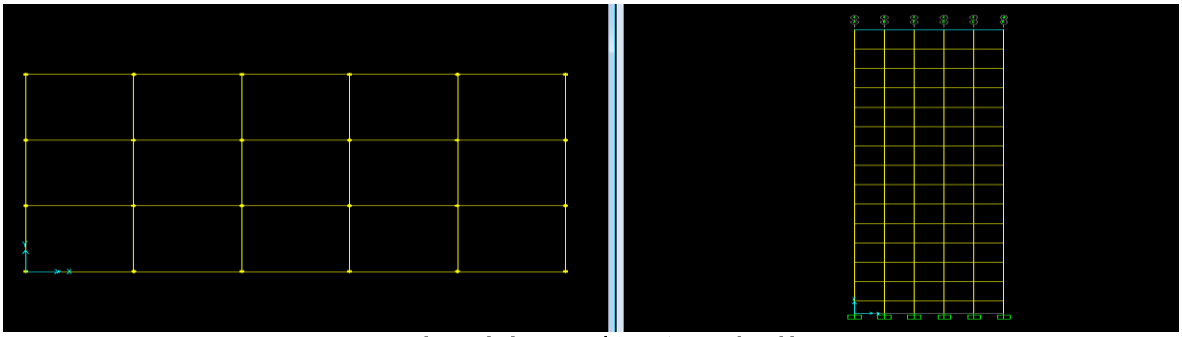

Fig. 1.Plan And Elevation Of (G+13) Storied Building

3.4 BRACING PATTERNS USED IN THE STUDY:

Different types of bracing pattern used in the study are shown in below figures.

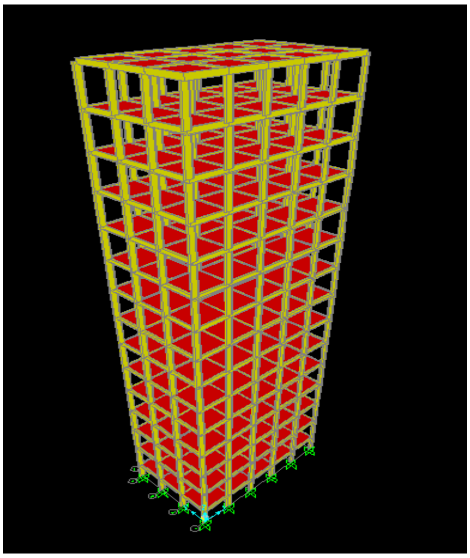

Fig. 2. 3D View Of Bare Frame

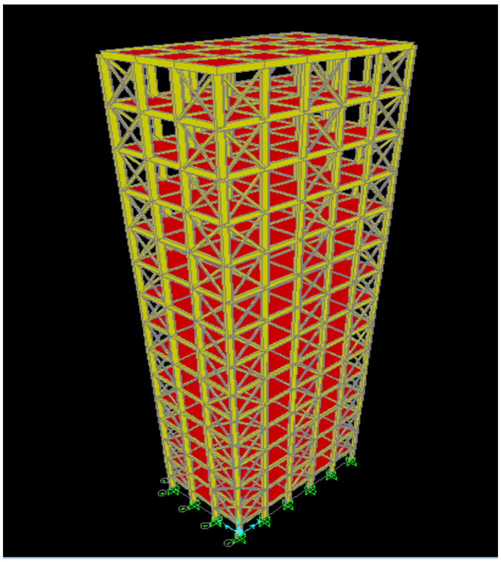

Fig. 3. 3D View Of X-Type Bracing

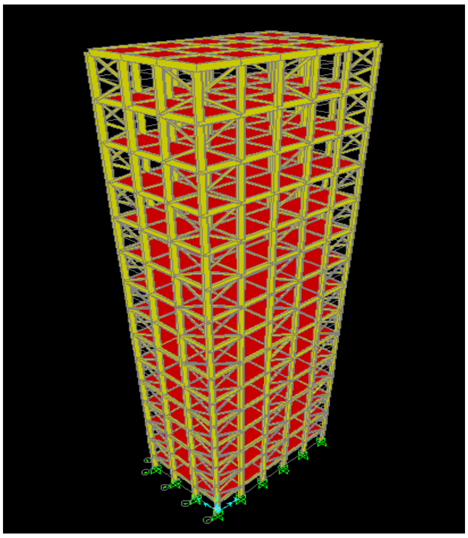

Fig. 3. 3D View Of K-Type Bracing

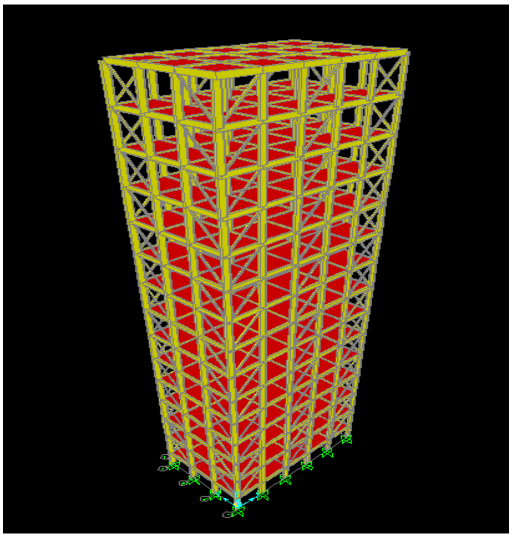

Fig. 4. 3D View Of Diagonal Type Bracing

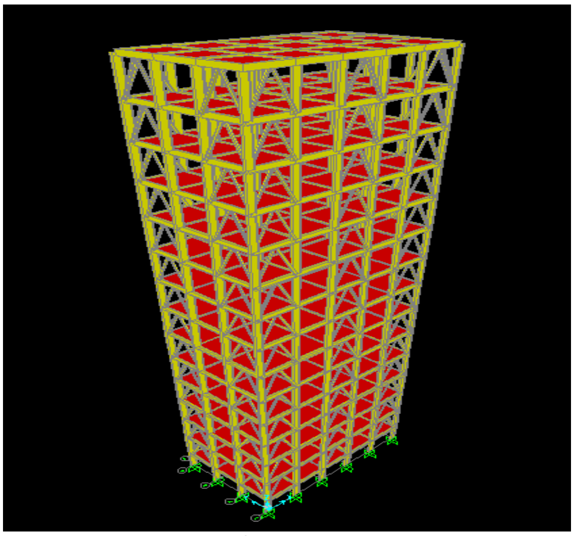

Fig. 5. 3D view Of Inverted-V Type Bracing

IV. RESULT AND DISCUSION:

4.1. LATERAL DISPLACEMENT:

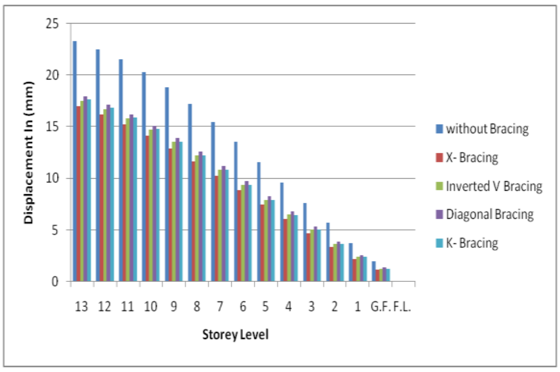

Fig.6. Lateral Displacement Along X-Direction

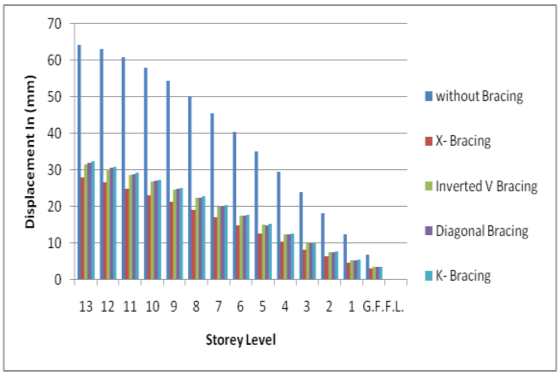

Fig.7. Lateral Displacement Along Y-Direction

From fig.6 and fig.7 it can be seen that lateral displacement in braced building in both X and Y direction are reduced in comparison with the unbraced building. The maximum displacement at the 13th storey in X direction reduces by 26.84%, 24.73%, 22.87%, & 24.12% and in Y direction by 56.25%, 50.77%, 50.06% & 49.47% for X bracing, inverted V bracing, diagonal bracing & K bracing respectively.

4.2. STOREY DRIFT:

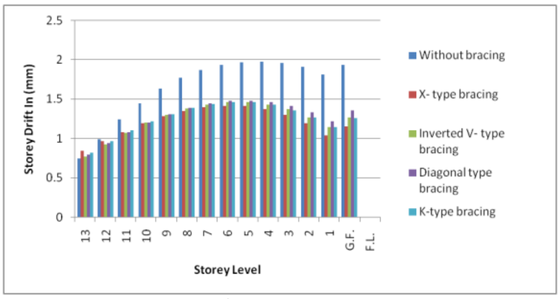

Fig.8. Storey Drift In (mm) Along X-Direction

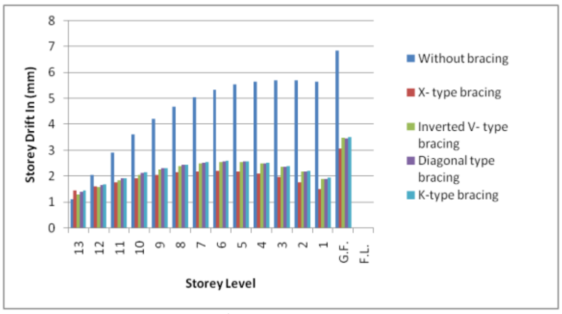

Fig.9. Storey Drift In (mm) Along Y-Direction

From fig.8 and fig.9 it can be seen that storey drift in braced building in both X and Y direction are reduced in comparison with the unbraced building. The maximum storey drift at the 4th storey in X direction reduces by 30.80%, 27.77%, 26.26%, & 27.77% and at G.f. storey in Y direction reduced by 55.18%, 48.90%, 49.49% & 48.46% for X bracing, inverted V bracing, diagonal bracing & K bracing respectively.

4.3.AXIAL FORCES:

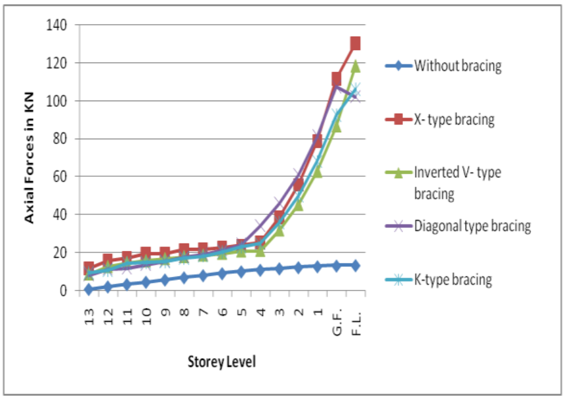

Fig.10. Axial Forces In (KN) Along X-Direction

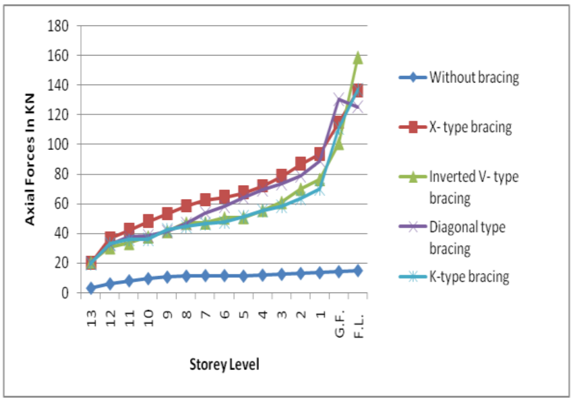

Fig.11. Axial Forces In (KN) Along Y-Direction

From fig.10 and fig.11 it can be seen that the axial forces in braced building in both X and Y direction are increased in comparison with the unbraced building. The maximum axial forces at foundation level in X direction increased by 89.75%, 88.75%, 86.95%, & 87.42% and in Y direction increased by 89.02%, 90.56%, 88.04% & 89.07% for X bracing, inverted V bracing, diagonal bracing & K bracing respectively.

4.4. SHEAR FORCES:

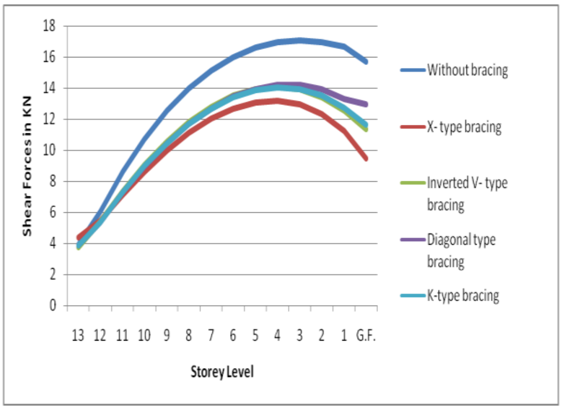

Fig.12. Shear Forces In (KN) Along X-Direction

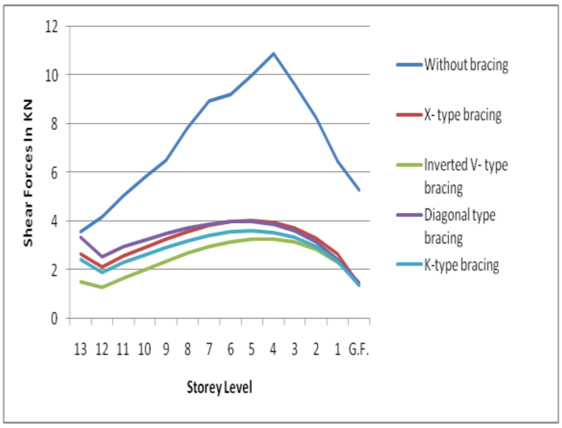

Fig.13. Shear Forces In (KN) Along Y-Direction

From fig.12 and fig.13 it can be seen that the shear forces in braced building in both X and Y direction are reduced in comparison with the unbraced building. The maximum axial forces at 3rd storey in X direction reduced by 24.00%, 18.25%, 16.80%, & 18.37% and at 4th storey in Y direction reduced by 63.54%, 69.88%, 64.46% & 67.30% for X bracing, inverted V bracing, diagonal bracing & K bracing respectively.

4.5. BENDING MOMENT:

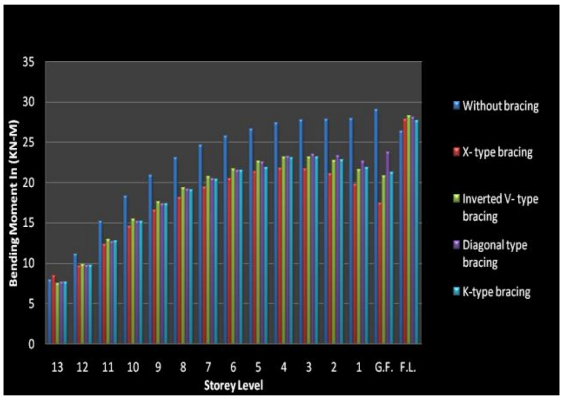

Fig.14. Bending Moment Along X-Direction

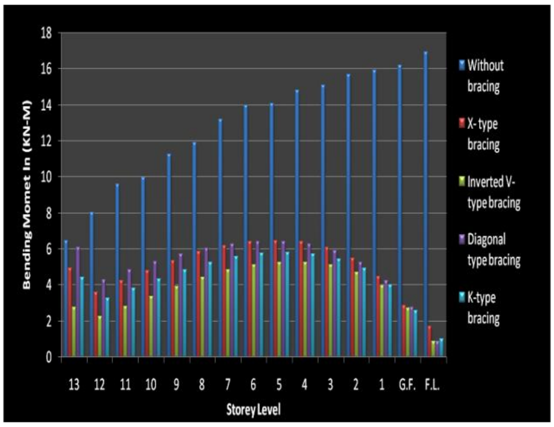

Fig.15. Bending Moment Along Y-Direction

From fig.14 and fig.15 it can be seen that the bending moment in braced building in both X and Y direction are reduced in comparison with the unbraced building. The maximum bending momentat ground floor in X direction reduced by 40.02%, 28.38%, 18.27%, & 26.84% and in Y direction reduced by 90.15%, 90.67%, 90.58% & 91.08% for X bracing, inverted V bracing, diagonal bracing & K bracing respectively.

4.6.BASE SHEAR:

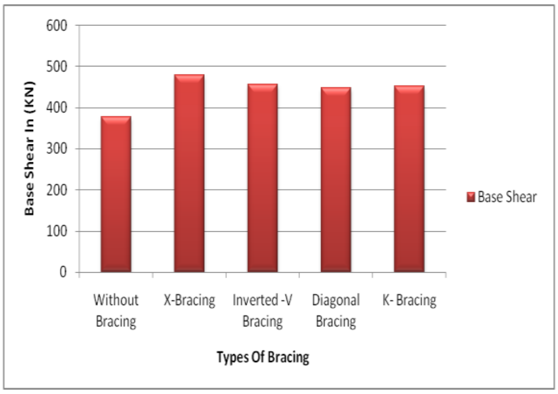

Fig.16. Base Shear In (KN) Along X-Direction

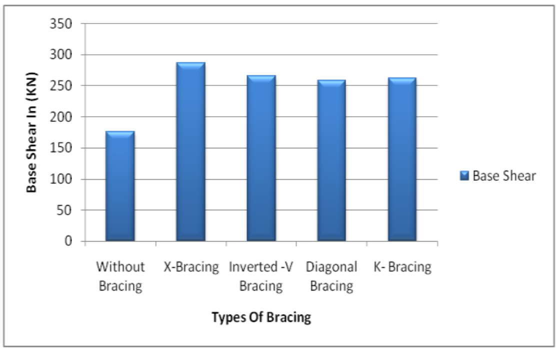

Fig.17. Base Shear In (KN) Along Y-Direction

From fig.16 and fig.17 it can be seen that the base shear in braced building in both X and Y direction are increased in comparison with the unbraced building. The maximum base shear at foundation level in X direction increased by 21.18%, 17.24%, 15.90%, & 16.62% and in Y direction increased by 38.70%, 33.75%, 32.05% & 32.90% for X bracing, inverted V bracing, diagonal bracing & K bracing respectively.

V. CONCLUSION:

Do most of your work on analysis results following conclusion are their face looks as below :-

1):- The concept of using steel bracing is one of the advantageous concepts which can be used to strengthen or retrofit the existing & new structures.

3):- Steel bracings reduce flexure and shear demands on beams and columns and transfer the lateral loads through axial load mechanism.

3):- Using Steel Bracing the total weight on the existing building will not change significantly.

4):-The braced building of the lateral displacement decreases as compared to the unbraced building,. The max. percentage of x bracing decreased 30.80% & 55.18% along X & Y direction.

5):- The braced building of the storey drift decreases as compared to the unbraced building,. The max. percentage of x bracing decreased 30.80% & 55.18% along X & Y direction.

6):- The braced building of the axial forces increased as compared to the unbraced building,. The max. percentage of x bracing increased 89.75% & 89.02% along X & Y direction.

7):- The braced building of the shear forces decreased as compared to the unbraced building,. The max. percentage of x bracing decreased 24.00% & 63.54% along X & Y direction.

8):- The braced building of the shear bending moment decreased as compared to the unbraced building,. The max. percentage of x bracing decreased 40.02% & 90.15% along X & Y direction.

9):- The braced building of the base shear increased as compared to the unbraced building,. The max. percentage of x bracing increased 21.18% & 38.60% along X & Y direction.

10):- From above result concluded that the overall performance of braced building reduced by unbraced building and X- bracing reduced the all seismic parameters to large extent than other type of bracing.

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