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COMPARATIVE ANALYSIS OF A TALL STRUCTURE WITH OR WITHOUT BRACINGS CONSIDERING SEISMIC LOAD

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ABSTRACT

Multistory buildings are mostly affected by earthquake force in seismic prone area. The major concern in the design of multistory building is the structure mainly to have enough lateral stability to resist lateral forces and to control the lateral drift of the buildings. The steel bracing system in reinforced concrete frames is viable for resisting lateral forces, steel bracing is easy to erect occupies less space and has flexibility in design for meeting the required strength and stiffness. The resistance to the lateral loads from wind or from an earthquake is the reason for the evolution of various structural systems. Bracing system is one such structural system which forms an integral part of the frame. Such a structure has to be analysed before arriving at the best type or effective arrangement of bracing. A braced frame is a structural system which is designed primarily to resist wind and earthquake forces. Members in a braced frame are not allowed to sway laterally

In this study they are preparing a comparative study on a G+20 tall structure. In this structure they will compare bare frame with frames having X-type bracings at the corners. A three dimensional structure is taken, 20 stories is taken with storey height of 3m. The beams and columns are designed to withstand dead and live load only. Earthquake loads are taken by bracings. The bracings are provided only on the peripheral columns. Here structural modelling and analysis is done using analysis software Staad.pro which is a finite element based programming tool.

KEYWORDS: Structural analysis, staad, displacement, bracing system, forces, support reactions.

1. INTRODUCTION

The magnitude and intensities of earthquakes are varies from place to place causing low to severe destructive powers on engineered properties as well as giving rise to great economic losses and life threat. Steel bracing of RC frames has received some attention in recent years both as a retrofitting measure to increase the shear capacity of existing RC buildings and as a shear resisting element in the seismic design of new buildings. Earlier investigators focused on the retrofitting aspect of bracing and studied external bracing of buildings as well as internal indirect bracing of individual bays of the RC frames. Lately, the direct bracing of RC frames has attracted more attention since it is less costly and can be adopted not only for retrofitting purposes, but also as a viable alternative to RC shear walls at pre-construction design level. Experimental works, as well as analytical investigations have studied the capabilities of the direct bracing system of RC frames with encouraging results.

The main objective of the present study are :

1) To evaluate and compare the effectiveness of steel braced reinforced concrete structure for different storied RC buildings by different types of seismic zones under soft soil.

2) To identify the most efficient and suitable lateral loads resistant X-type steel bracing which give the minimum lateral displacements, minimum story drift and which increase shear capacity of RC frame from the selected groups of bracings types.

3) To suggest the better strengthened and retrofitting option for reinforced concrete structure frame design for seismic load resistance.

2. LITERATURE REVIEW

The conventional arrangements of stabilizing elements used in low-rise buildings may be extended for use in buildings up to 20 to 25 stories in height (Allen and Iano 1995). The same considerations that apply to low-rise buildings apply to taller buildings as well. Stabilizing elements should be arranged so as to resist lateral forces along all major axes of the building. These elements should be arranged in a balanced manner either within the building or at the perimeter and such elements must be integrated with the building plan of elevation.

In 1999, the direct internal use of steel bracing system in concrete frame was studied in laboratory. Experiments were carried out on five one-span one-story frame samples with a scale of 1: 2.5. Two of them had no bracing system but the other three samples were strengthened by X-bracing systems with different component connectors including bolt and nut, cover of RC column, and plates placed in concrete. The prepared frames were exposed to constant gravity and lateral cyclic loadings. Results showed, depending upon various component connectors, the bracing system considerably increases the equivalent stiffness of the frame and notably changes its behavior. When the bracing connector is implanted inside concrete, the performance of frame gets even better and further energy is absorbed.

Recent works by Ghaffarzadeh and Maheri (2006) have shown further that the directly-connected internal bracing systems can be used effectively in retrofitting of existing concrete frames as well as shear resisting elements for construction of new RC structures. In this study, the use of X-shaped concentric internal steel bracing for new construction was investigated experimentally. An important consideration in the design of steel braced RC frames is the level of interaction between the strength capacities of the RC frame and the bracing system. And on the experiment the level of interaction between bracing steel and RC frame is investigated.

Madhusudan et al. (2014) had studied on the effect of a provision of concentric bracings on the seismic performance of the steel frames and in the study they considered the two different types of concentric bracings (viz. X and inverted-V type bracing) for the different story levels.

Nauman Mohammed et al (2013) studied on Behavior of Multistory RCC Structure with Different Type of Bracing System (A Software Approach). They aims to evaluate the response of braced and unbraced structure subjected to seismic loads and to identify the suitable bracing system for resisting the seismic load efficiently. A G+14 floors building were analyzed using STAAD V8i software for special moment resisting frame situated in zone 4.The RCC G+14 structure was analyzed for both without bracings and with different types of bracings system. For all type of structural systems i.e. braced and unbraced structural system bending moments, shear forces, story shears, story drifts and axial forces was compared. They had been concluded that the displacement of the structure decreased after the application of the bracing system. After the application of cross bracing system the maximum reduction in the lateral displacement occurs. In the columns bracing system reduces bending moments and shear forces. The paper also states that the execution of cross bracing system was better than the other specified bracing systems. To retrofit the existing structure steel bracings were used. Significantly after the application of the bracings, total weight of the existing structure will not be changed.

3. PROBLEM FORMULATION AND METHODOLOGY

A rectangular building considered for analysis has symmetric in plan and elevation. Plan dimension of building to be modeled is 28 m x 40 m. It consists of seven bays of 4m with ten bays of 4m in longer and shorter side respectively and height is G+20.

Eight cases of various types of earthquake zone for comparison:

Structural frame with or without bracings are considered in this study considering all the four seismic zones.

Staad.pro is a Computer aided structural analysis and design program which is very useful in preparing drawing and analyze and rapidly used in market by engineers Is staad.pro. Design any type of structure and share your synchronized model data with confidence among your entire design team, using STAAD.Pro. Ensure on time and on budget completion of your steel, concrete, timber, aluminum, and cold-formed steel projects, regardless of complexity. You can confidently design structures anywhere in the world using over 80 international codes, reducing your team's need to learn multiple software applications.

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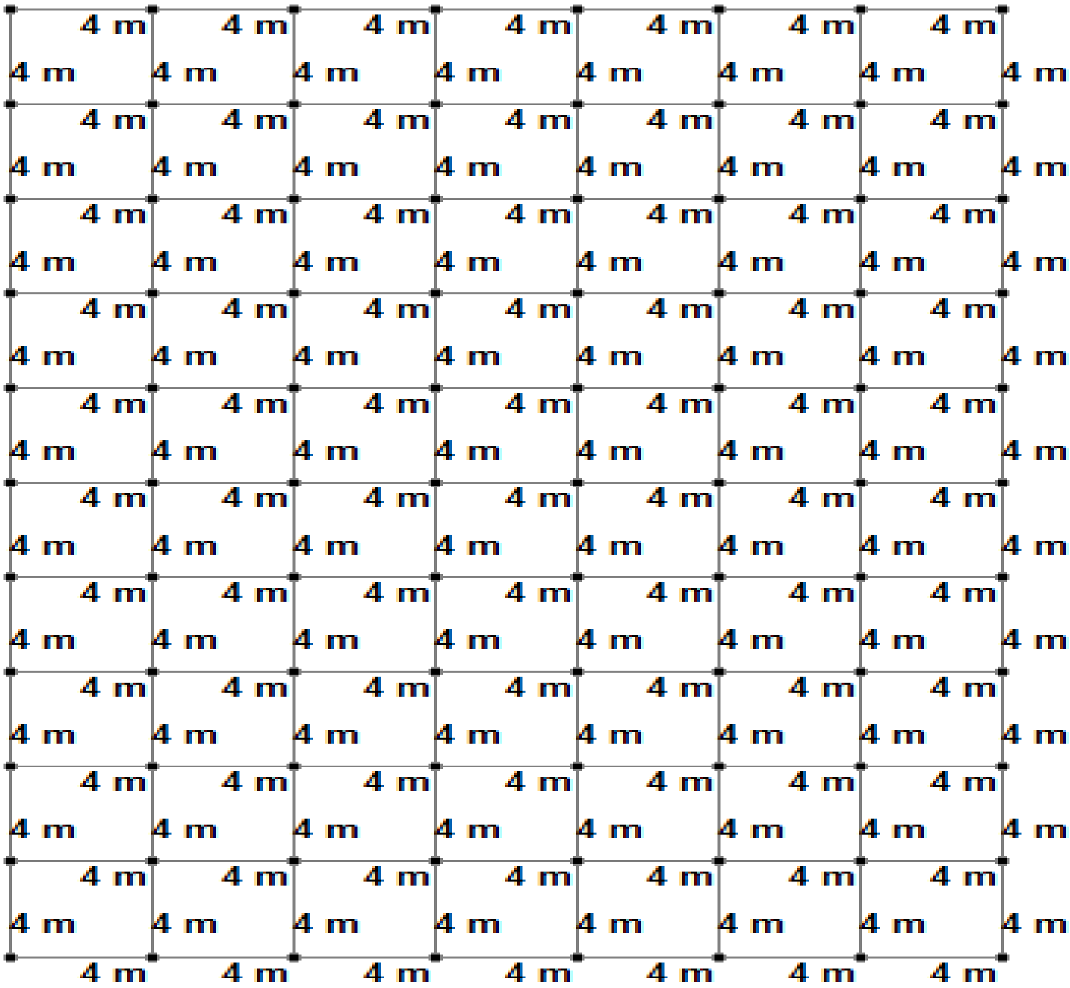

Fig:1 plan

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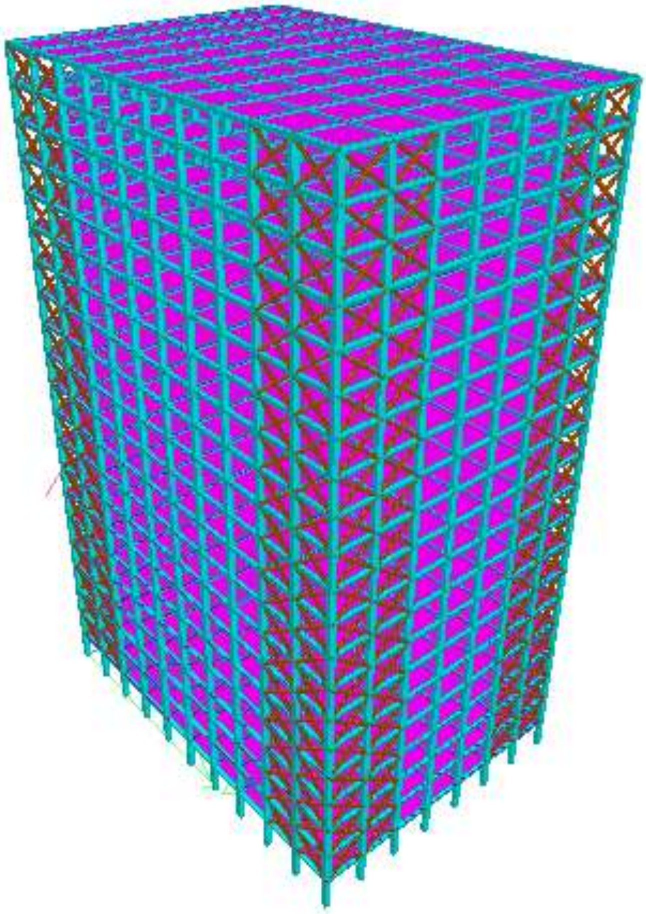

Fig 2 Typical Structure with bracing system

Table 1: material property

S.NO	Material property	Values
a)	Grade of concrete	M-25
b)	Young's modulus of concrete, E_c	$2.17x10^4$ N/mm^2
c)	Poisson ratio,	0.17
d)	Tensile Strength, Ultimate steel	505 MPa
e)	Tensile Strength, Yield steel	215 MPa
f)	Elongation at Break steel	70 %

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g)	Modulus of Elasticity steel	193 - 200 GPa

4. Loads considered in study:

a) Dead Load

Table 2 : dead load as per 875 part-1

Brick masonry wall load					Remark
For floor height 3.5 m	=	0.18 m x (3.5 - 0.45) m x 18 kN/m^3	10.300	kN/m	U.D.L.
Parapet wall	=	0.18 m x (1.2) m x 18 kN/m^3	4.6.00	kN/m	U.D.L.
Floor Load					
Slab Load	=	0.125 m x 25kN/m^3	3.125	kN/m^2	slab thick. 125 mm adopted
Floor Finish	=		.96	kN/m^2	Flooring
Total Load	=		4.025	kN/m^2	

b) Live Loads: as per IS: 875 (part-2) 1987.

Live Load on typical floors = 3.00kN/m^2

Live Load for seismic calculation as per I.S. code 1893-part1 = 0.75 kN/m^2

c) Earth Quake Loads: All frames are analyzed for (IV) earthquake zone.

The seismic load calculation are as per IS: 1893 (part-1)-2002.

Soil-Structure Interaction is a trying multidisciplinary subject which covers a couple of regions of Civil Designing. In every practical sense every advancement is connected with the ground and the cooperation between the old irregularity and the foundation medium might impact essentially both the superstructure and the foundation soil.

Here we are considering medium type of soil.

Table 3: lateral load details

S. No.	Parameter	Value
1	Zone (V)	0.1 & 0.24
2	Damping ratio	0.05
3	Importance factor	1
4	Response Reduction Factor	5
5	Soil site factor	Soft & Hard

d) Load combinations considered as per 875-partV

5. RESULTS AND DISCUSSION

I. Maximum bending moment:

As results showing fig. 3 below bending moment is decreasing in all the cases of bracing system in all the respective zones which shows that there will be reduction in reinforcement requirement in bracing case as compared to bare frame.

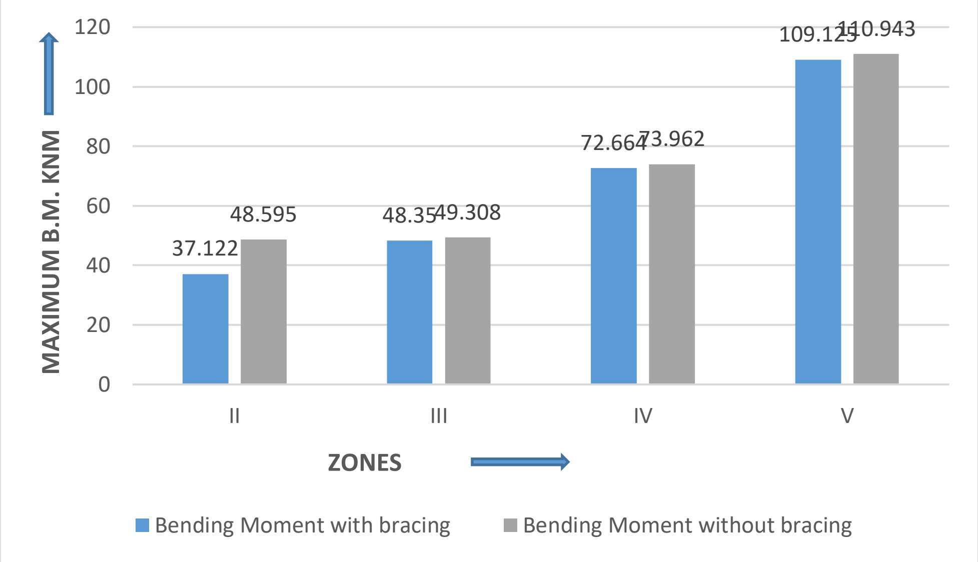

Fig: 3 Maximum Bending Moment

II. Maximum Axial force:

As comparative results are shown in below figure 4. It is clearly visible that in case of bracing system axial forces decreasing. Axial force is the compression or tension force of the member, they are the internal forces of a structure therefore in bracing system forces are reducing.

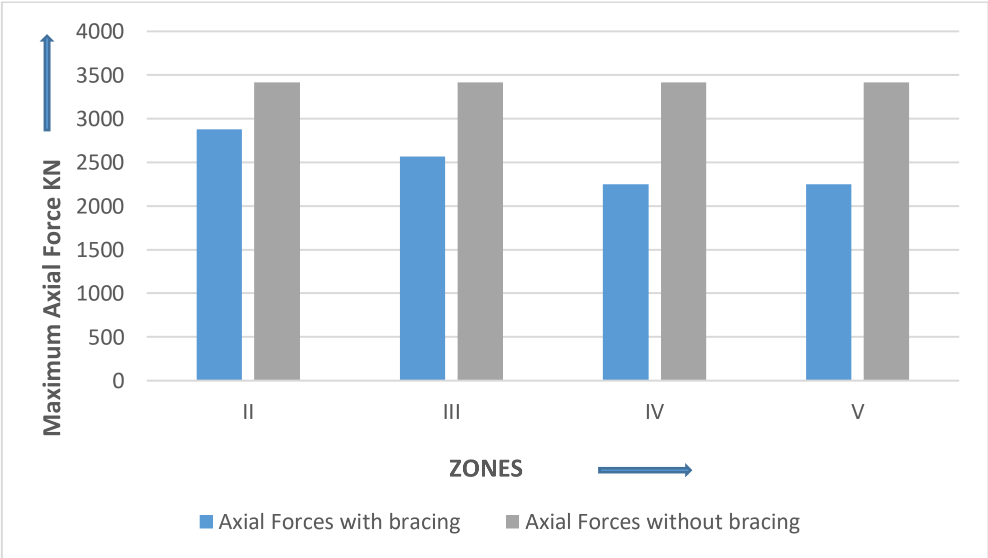

Fig: 4 Maximum Axial Force

III. Maximum shear force:

Magnitude of maximum stress for various forms of truss has been plotted in figure number 5 Shear force are the unbalance forces which are reducing in bracing system which shows that bracing system is reducing unbalanced forces. results shows that bracing system will increase its stability

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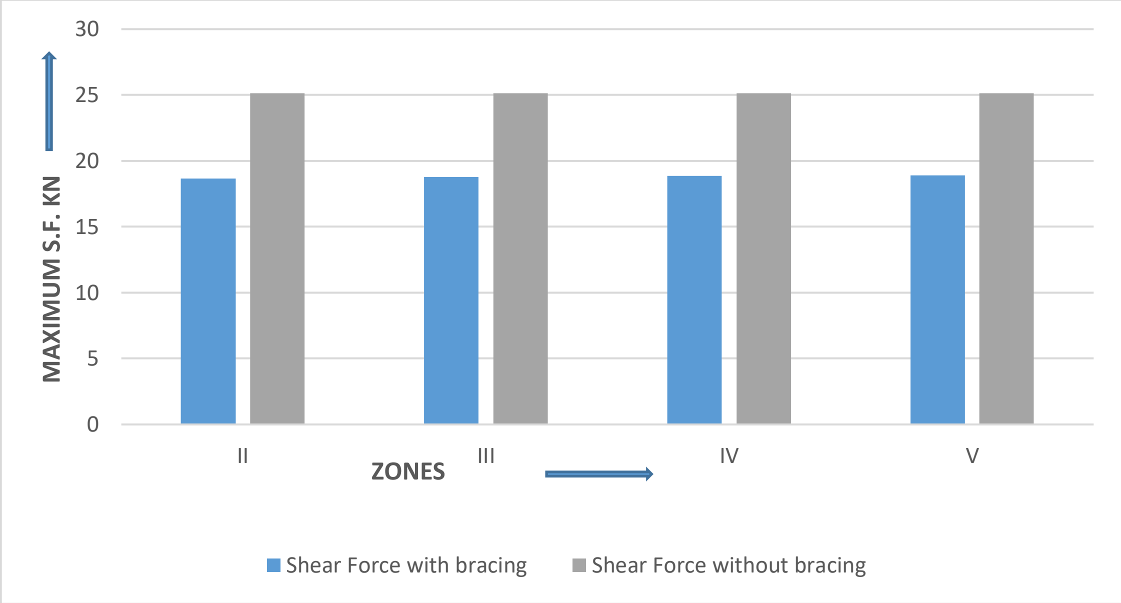

Fig: 5 Maximum Shear Force

.Maximum storey displacement

Below figure 6 shows maximum storey displacement in in the case of bare on last floor due to laterally deficient structure.

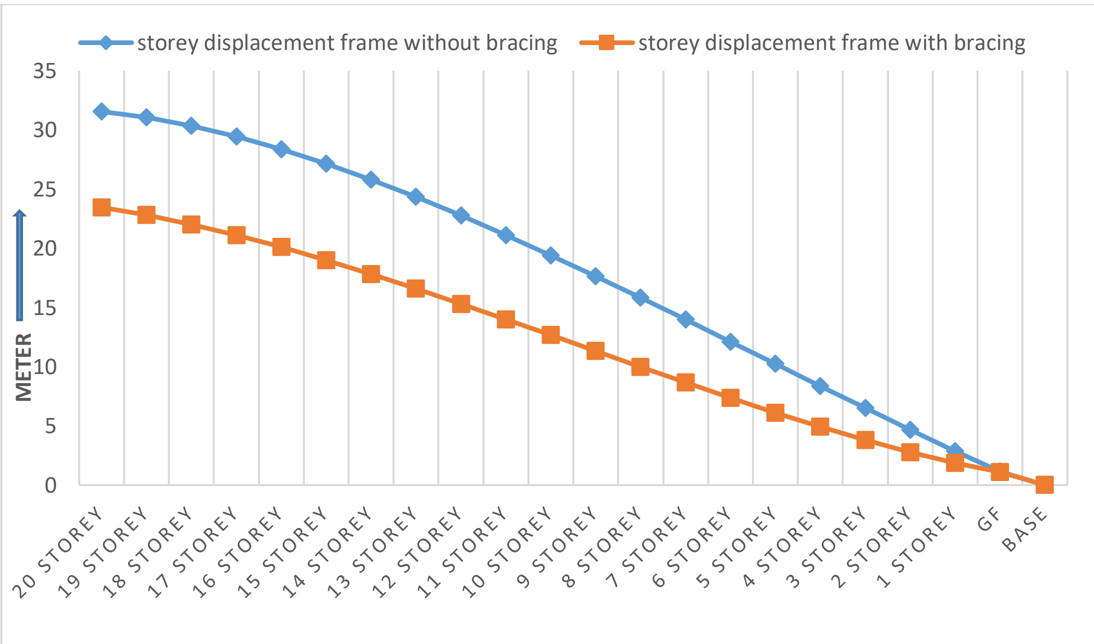

Fig 6 storey displacement

IV. Storey Drift:

In this figure7 shows bare frame structure value of drift is more as compared to other structure.therefore structure will show more relative unbalancing displacement. Value of drift in each case is showing maximum at the centre of the structure in elevation

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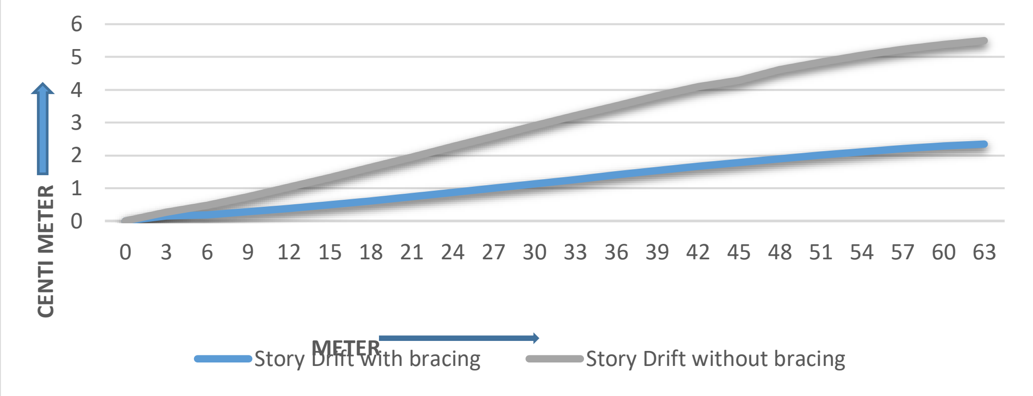

FIG 7 storey drift

6. CONCLUSION

Conclusion

1) The steel bracing system has not only improved displacement capacity of reinforced concrete structures, but also the lateral stiffness and strength capacity of the structures by increasing its shear capacity.
2) X-bracing of steel bracing types has found in the most efficient in terms of story displacement and story drift reduction when bracing is provided on two parallel sides of the building.
3) Story drift should be limited because deflection must be limited during the earth quake to protect the damage of structural elements, especially nonstructural elements, and hence the provisions of steel bracing for the RC structure give adequate stiffness for the structure and among the used bracing X-bracing types have been given better result in reduction of story drift.
4) The base shear capacity of steel braced frame is increased as compared to bare frame (without bracing) building which indicates that the stiffness of building has increased.
5) X-bracing type is found most efficient in increasing the shear capacity of RC frame building which indicates X-brace type of steel bracing significantly contributes to the structural stiffness.
6) The base overturning moment of RC frame has increased after the application of all bracing systems.

Finally we can conclude that both X-bracing system may be used to new design or retrofit for damage level earthquake, however, X-bracing system is more suitable to use The corner bracing configuration is better lateral displacement reduction arrangement from the other bay wise arrangement of steel braced reinforced concrete structures

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