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# Comparative Study of R.C. Braced Frame with and without Shear Wall

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**ABSTRACT:** The application of the bracing system and shear wall system in buildings has become wider, which is generally used to minimize seismic effects. Both of the systems have significance effect on the structural performance. Although both systems are used for same the reasons, their effect shows unequal variations and behaviour against seismic load. This is the reason that the values of response factors are miscellaneous for varying structural systems. Hence to reduce the seismic forces, bracing system and shear wall system can be used. In this study, G+30 storey building is analysed by using Response Spectrum method for seismic zone III using different types of Bracing (X bracing, V bracing, Diagonal bracing, K bracing, Inverted V bracing, and alternate Diagonal bracing) with and without Shear wall. ETABS software is used for analysis The results are compared with bare frame model analysis to evaluate the effectiveness of a particular type of bracing system in order to control the lateral displacement due to seismic forces. It is found that all the bracing systems control the lateral displacement of frame very effectively. However X bracing is found to be most effective. The results are shown using parameters like Base shear, Storey displacement, Storey drift.

**KEYWORDS:** Shear wall, Bracing, Response Spectrum Method, Base shear, Storey displacement, Storey drift.

## I. INTRODUCTION

Today's tall buildings are becoming more and more slender, leading to the possibility of more sway in comparison with earlier high-rise buildings. This has brought more challenges for the engineers to satisfy both gravities load as well as lateral loads, earlier buildings were designed for the gravity loads but now because of tall height and seismic zone the engineers have taken care of lateral loads due to earthquake force. So, to cater all the lateral forces, we have to design the structure very uniquely so that the structure can withstand the lateral load comfortably, so that there is no harm to the society. For this reason use of bracing system and shear wall have become more common and effective. A bracing system is a structural system commonly used in structures subject to lateral loads such as wind and seismic pressure. The members in a brace system are generally made of structural steel, which can work effectively both in tension and compression. Shear wall system is a lateral load resisting system, mostly used in high rise buildings. Shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal loads and support gravity loads, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents.

## II. LITERATURE REVIEW

The present work is aimed at comparative study of RC braced frame with and without shear wall. Various studies related to the study has been carried out till date which is as follows:

**K.M. Bajoria et al. (2012)** did a study on seismic analysis of high rise steel frame with and without bracing by time history analysis with different bracing such as diagonal bracing-A, diagonal bracing-B, X-bracing, K-bracing and knee bracing configuration and concluded that the base shear increases by 38%, the roof level displacement reduced by 17%, the modal time period decreased by 65% and the diagonal bracing-B system showed highly effective design of bracing system.

**Ashik S. Parasiya and Parein Nimodiya (2013)** did study on comparison of brace frame RC structure with conventional lateral load resisting frame and they concluded that bracing system provides better result, when structure is subjected to dynamic loads, bracing system also increased the stiffness and ductility of the structure when the

structure is subjected to seismic force and bracing system is better for high rise RCC structure for reducing the damage in RCC structure during dynamic loads by increasing its resisting capacity.

**Kulkarni J.G. et al. (2013)** did a study on seismic response of reinforced concrete braced frames and concluded that optimally braced frames are stiff, strong and economical structural system and at the same time induces least forces in the structure and produces maximum displacement, fully braced frame are very conservative when lateral drift is concerned but uneconomical and braced frames are very efficient and effective system for resisting lateral forces.

**Pravin S. Kamble et al. (2016)** did a study on lateral load analysis of building with and without knee bracing for G + 4 steel structure on SAP2000 by pushover analysis with different bracing systems such as diagonal, X, K, V, inverted V and knee bracing system and concluded that storey drift ratio of bare frame is very close to permissible value in X-direction, but exceeding in Y-direction, hence the bracing system has significant effect in reducing the lateral displacement, V-bracing system is more effective than other bracing system as it increases the base shear more than other bracing system and X-bracing system also increases the base shear and reduces the time period as compared to other bracing system.

### III. METHODOLOGY

The following steps are undertaken within the present study are as follows: 1. In present research 13 different models of G+30 storey building using braced frame with and without shear wall is done 2. Model the structure in ETABS 3. Seismic analysis is applied as per IS1893-2016. 4. Running the model in E-TABS. 5. Obtaining seismic parameters like base shear, storey displacement, storey drift. 5. Observation and comparison of result. 6. Conclusion.

### IV. PRELIMINARY DATA

Following are the data assumed for carrying out this study, 1.Type of building. = Residential building, 2. Typical storey height = 3m, 3.No. of storey = G+30, 4.Height of building. = 93m, 4.Steel section (bracing) = ISWB500, 5.Grade of concrete = M60, 6.Grade of reinforcement = Fe500, 7.Seismic zone = III.

### V. STRUCTURAL MODELLING

In this study, structure is modelled for the following cases: 1. Conventional building, 2. Braced frame with X-bracing without shear wall, 3. Braced frame with V-bracing without shear wall, 4. Braced frame with diagonal bracing without shear wall, 5. Braced frame with K-bracing without shear wall, 6. Braced frame with inverted V-bracing without shear wall, 7. Braced frame with alternate diagonal bracing without shear wall, 8. Braced frame with X-bracing and with shear wall, 9. Braced frame with V-bracing and with shear wall, 10. Braced frame with diagonal bracing and with shear wall, 11. Braced frame with K-bracing with shear wall, 12. Braced frame with inverted V-bracing with shear wall, 13. Braced frame with alternate diagonal bracing with shear wall.



Fig. 1 shows plan and 3D of the braced building with shear wall.



VI. RESULTS AND DISCUSSIONS

Table 1 Base shear in X-direction

Type of bracing	Base shear (kN)				
	Braced frame with shear wall	% increase	Braced frame without shear wall	% increase	Bare frame
X-bracing	3063.88	1.59	3053.03	1.24	3015.05
V-bracing	3057.40	1.38	3043.87	0.95	
Diagonal bracing	3050.83	1.17	3037.90	0.75	
K-bracing	3059.38	1.45	3048.23	1.09	
Inverted V-bracing	3057.40	1.38	3043.87	0.95	
Alternate diagonal bracing	3050.83	1.17	3037.90	0.75	

Table 2 Base shear in Y-direction

Type of bracing	Base shear (kN)				
	Braced frame with shear wall	% increase	Braced frame without shear wall	% increase	Bare frame
X-bracing	2241.76	1.60	2233.82	1.25	2205.97
V-bracing	2237.01	1.39	2227.12	0.95	
Diagonal bracing	2232.21	1.18	2222.75	0.76	
K-bracing	2238.46	1.45	2230.31	1.09	
Inverted V-bracing	2237.01	1.39	2227.11	0.95	
Alternate diagonal bracing	2232.21	1.18	2222.75	0.76	

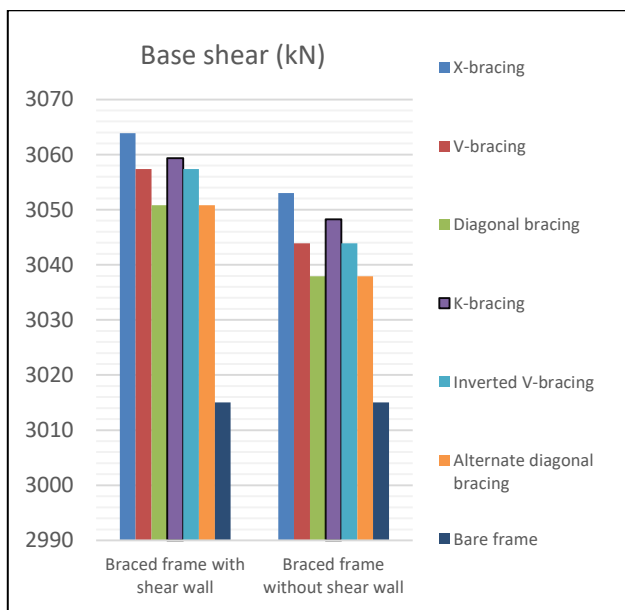


Fig. 2 Base shear in X-direction

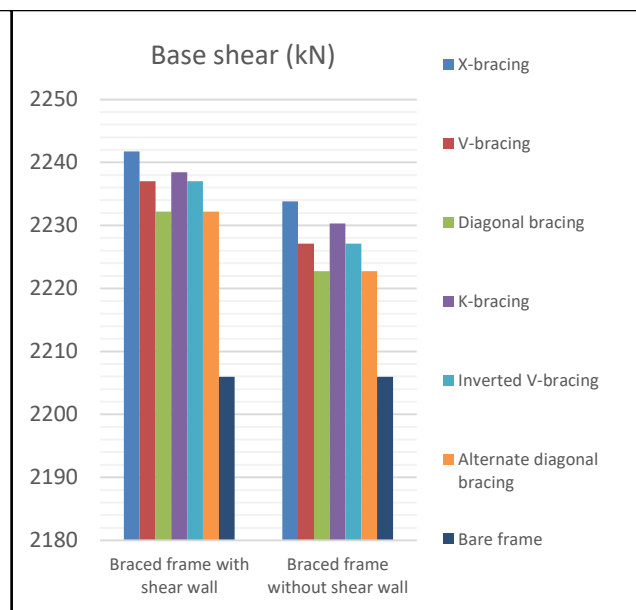


Fig. 3 Base shear in Y-direction

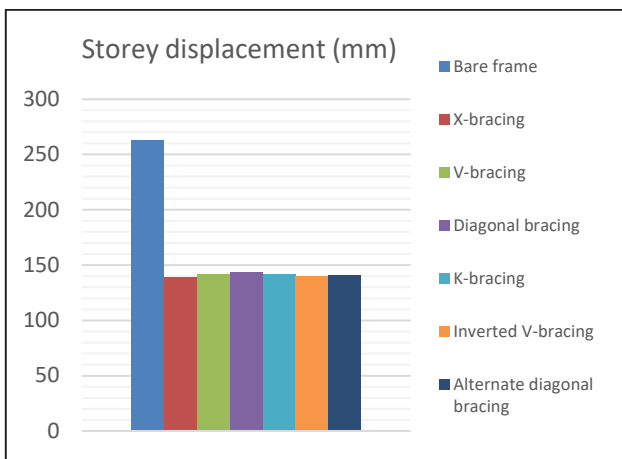


**Table 3** Storey displacement for braced frame with shear wall in X-direction

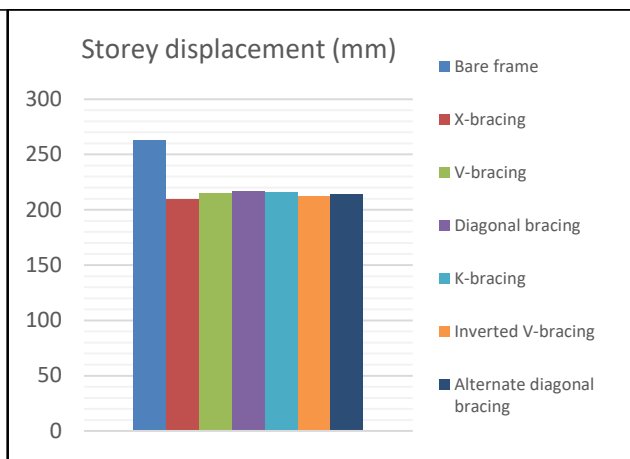
Storey displacement (mm)							
Storey Level	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
Top	262.58	138.62	141.20	143.14	141.41	139.63	140.90
% Reduction		47.21	46.23	45.49	46.15	46.82	46.34

**Table 4** Storey displacement for braced frame without shear wall in X-direction

Storey displacement (mm)							
Storey Level	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
Top	262.58	209.69	214.66	216.92	215.71	212.13	214.12
% Reduction		20.14	18.25	17.39	17.85	19.21	18.46



**Fig. 4** Storey displacement for braced frame with shear wall in X-direction



**Fig. 5** Storey displacement for braced frame without shear wall in X-direction

**Table 5** Storey displacement for braced frame with shear wall in Y-direction

Storey displacement (mm)							
Storey Level	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
Top	277.01	112.24	113.27	126.05	115.62	110.53	118.33
% Reduction		59.48	59.11	54.50	58.26	60.10	57.28

**Table 6** Storey displacement for braced frame without shear wall in Y-direction

Storey displacement (mm)							
Storey Level	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
Top	277.01	130.26	135.23	152.86	148.70	130.04	143.49
% Reduction		52.98	51.18	44.82	46.32	53.05	48.20

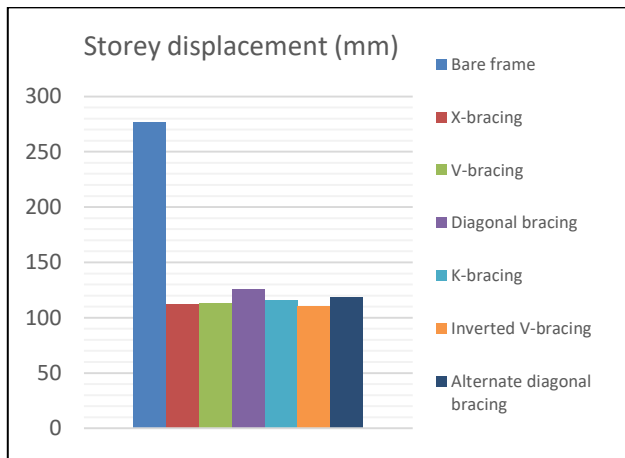


Fig. 6 Storey displacement for braced frame with shear wall in Y-direction

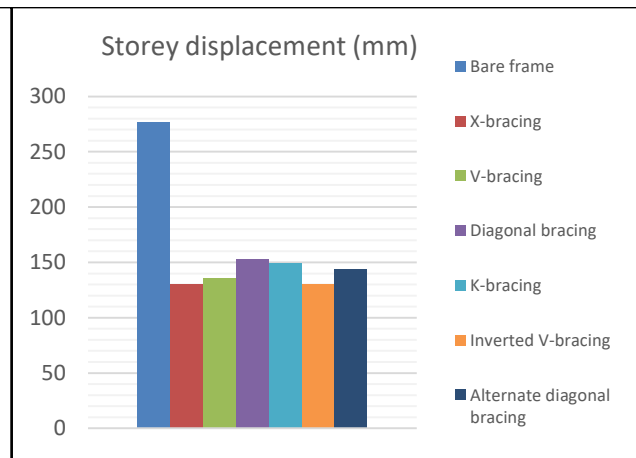


Fig. 7 Storey displacement for braced frame without shear wall in Y-direction

Table 7 Storey drift for braced frame with shear wall in X-direction

Storey drift							
Max storey drift	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
		0.00382	0.00195	0.00198	0.00201	0.00198	0.00197
% Reduction		49.01	48.35	47.33	48.22	48.59	47.25

Table 8 Storey drift for braced frame without shear wall in X-direction

Storey drift							
Max storey drift	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
		0.00382	0.00296	0.00301	0.00305	0.00302	0.00300
% Reduction		22.54	21.31	20.16	20.95	21.68	19.82

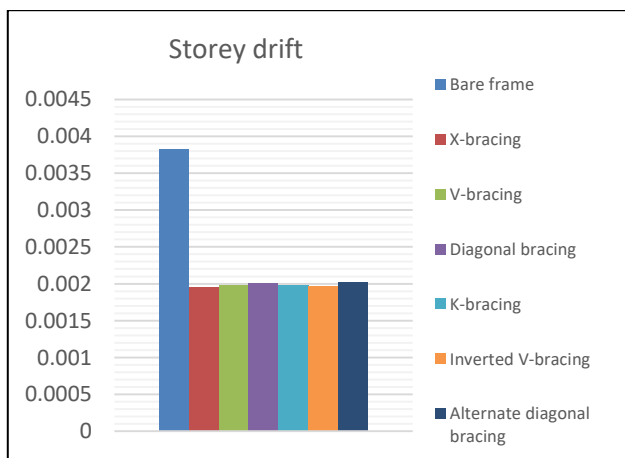


Fig. 8 Storey drift for braced frame with shear wall in X-direction

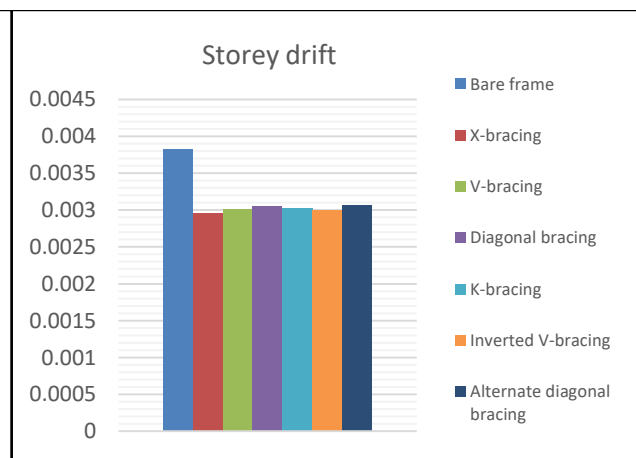


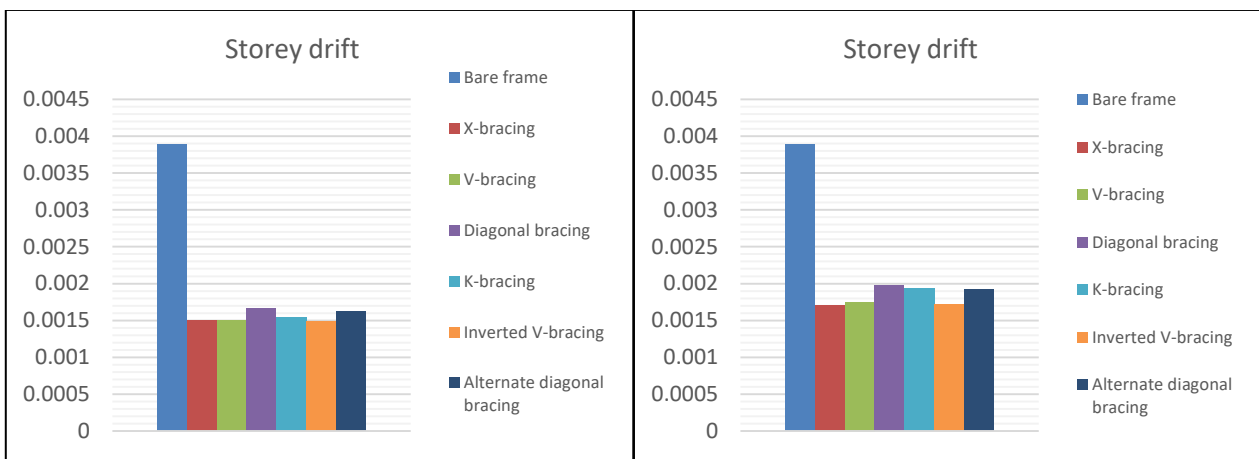
Fig. 9 Storey drift for braced frame without shear wall in X-direction

**Table 9** Storey drift for braced frame with shear wall in Y-direction

Storey drift							
Max storey drift	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
	0.00389	0.00150	0.00150	0.00166	0.00154	0.00148	0.00162
% Reduction		61.36	61.31	57.27	60.39	61.83	58.38

**Table 10** Storey drift for braced frame without shear wall in Y-direction

Storey drift							
Max storey drift	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
	0.00389	0.00170	0.00175	0.00197	0.00193	0.00171	0.00192
% Reduction		56.27	55.01	49.27	50.45	56.04	50.63



**Fig. 10** Storey drift for braced frame with shear wall in Y-direction

**Fig. 11** Storey drift for braced frame without shear wall in Y-direction

VII. CONCLUSION

- Use of lateral load resisting systems like Shear wall and Bracing system increases stiffness and is more effective as compared to conventional building.
- Base shear in X-direction is increased by 1.59% for braced buildings with shear wall and it is increased by 1.24% braced buildings without shear wall and in Y-direction is increased by 1.60% for braced buildings with shear wall and it is increased by 1.25% braced buildings without shear wall as compared to conventional building.
- Storey displacement in X-direction is reduced by 47.21% for braced buildings with shear wall and it is reduced by 20.14% braced buildings without shear wall and in Y-direction is reduced by 59.48% for braced buildings with shear wall and it is reduced by 52.98% braced buildings without shear wall as compared to conventional building.
- Storey drift in X-direction is reduced by 49.01% for braced buildings with shear wall and it is reduced by 22.54% braced buildings without shear wall and in Y-direction is reduced by 61.36% for braced buildings with shear wall and it is reduced by 56.27% braced buildings without shear wall as compared to conventional building.
- While observing the comparison between the types of bracing configurations, it is obtained that X-bracing is most effective type of bracing.

- While observing the comparison between braced frame with and without shear wall, it is obtained that braced frame with shear wall is more suitable, as it reduces the storey displacement and storey drift more effectively.

#### VIII. FUTURE SCOPE

Various studies can be carried for design of this lateral load resisting shear wall.

- The study can be carried out for different zones.
- The study can be carried by increasing height of building as well as for different zones.
- Introduction of other lateral load resisting system like belt truss and outrigger system can be done and their results can be compared.
- The study can be carried for horizontally as well as vertically irregular building.
- Opening in shear wall can be used and research can be carried by studying their effects.
- Other different types of bracings can be used like zipper bracing, etc.
- The study can be carried out using analysis methods like P-delta, Pushover, Time history and their results also can be compared.

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