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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+40 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:

**Rishi Mishra et al. (2014)** did a study on analysis of RC building frames for seismic forces using different types of bracing systems and concluded that all the types of bracing systems control the lateral displacement of frame very effectively, inverted V-bracing was found to be most economical, bracing system reduces the lateral displacement upto 80% as compared to bare frame, bracing resist the seismic forces and also reduces the forces in the members and bracing provides effective control over storey drift upto 56% as compared to bare frame.

**S.P. Patil et al (2016)** did a study on comparison of shear wall and bracing in RCC frame structures and concluded that when shear wall is provided, displacement and storey drift reduces and storey shear and base shear increases, as size of shear wall increases the displacement and storey drift reduces and storey shear and base shear increases, the lateral

displacement of the building reduces by the use of X-type bracing system and steel bracing reduces flexure and shear demand on beams and columns and transfer the lateral loads through axial load mechanism.

**Fasil Mohi ud din (2017)** did a study on effectiveness of bracing in high rise structure under response spectrum analysis for comparing convention steel structure with X and Z bracing system and concluded that the percentage reduction in time period of the braced frame to that of unbraced frame was 36.43%, increase in frequency of the braced frame to unbraced frame was 36.37%, reduction in lateral displacement was 20.81% and increase in peak storey in both X and Z direction is given by 32.5% and 41.73%.

**Arathi Thamarakshan and Arunima S. (2017)** did a study on analytical study of knee braced frame with different bracing configuration like cross knee bracing, diagonal knee bracing and chevron knee bracing by pushover analysis and time history analysis and they concluded that cross braced configuration system are more effective under seismic loading as compared to diagonal and chevron braced configuration system, they reduce the drift of steel building also increases the stiffness at the same time and diagonal bracing system has least resistance to seismic forces.

### III. METHODOLOGY

The following steps are undertaken within the present study are as follows: 1. In present research 13 different models of G+40 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+40, 4. Height of building. = 123m, 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.

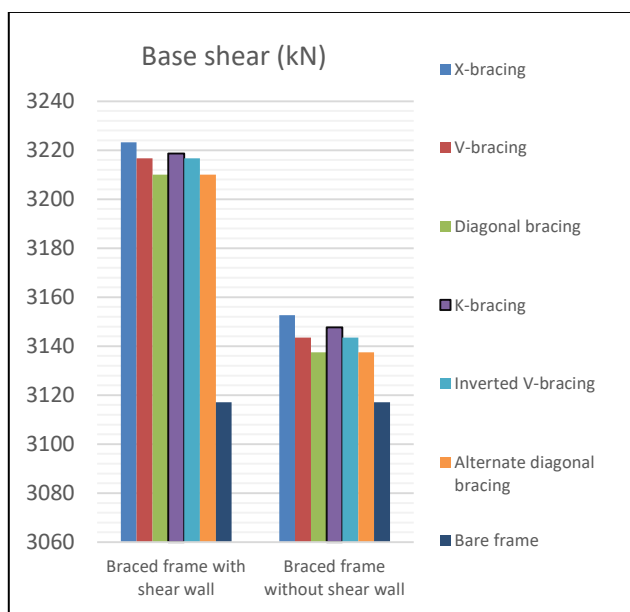
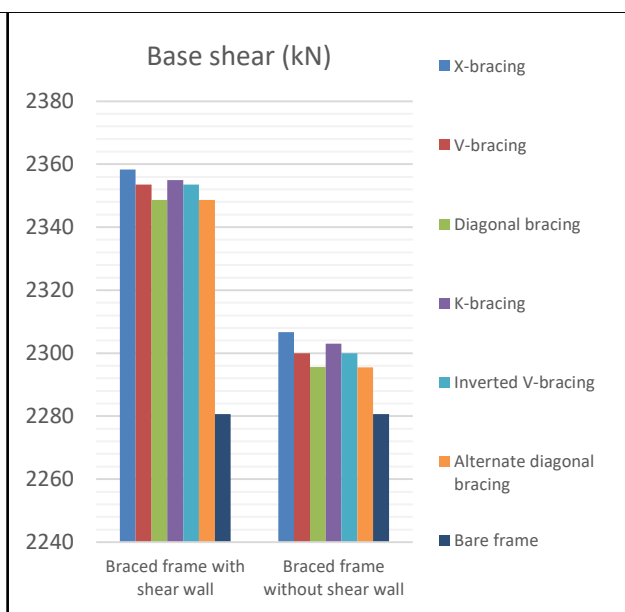
## VI. RESULTS AND DISCUSSIONS

**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	3223.18	3.29	3152.70	1.12	3117.11
V-bracing	3216.65	3.09	3143.47	0.84	
Diagonal bracing	3210.03	2.89	3137.46	0.65	
K-bracing	3218.64	3.15	3147.71	0.97	
Inverted V-bracing	3216.64	3.09	3143.47	0.84	
Alternate diagonal bracing	3210.03	2.89	3137.46	0.65	

**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	2358.26	3.29	2306.70	1.13	2280.63
V-bracing	2353.48	3.10	2299.95	0.84	
Diagonal bracing	2348.64	2.90	2295.54	0.65	
K-bracing	2354.94	3.16	2303.06	0.97	
Inverted V-bracing	2353.48	3.10	2299.94	0.84	
Alternate diagonal bracing	2348.64	2.90	2295.54	0.65	

**Fig. 2** Base shear in X-direction**Fig. 3** Base shear in Y-direction

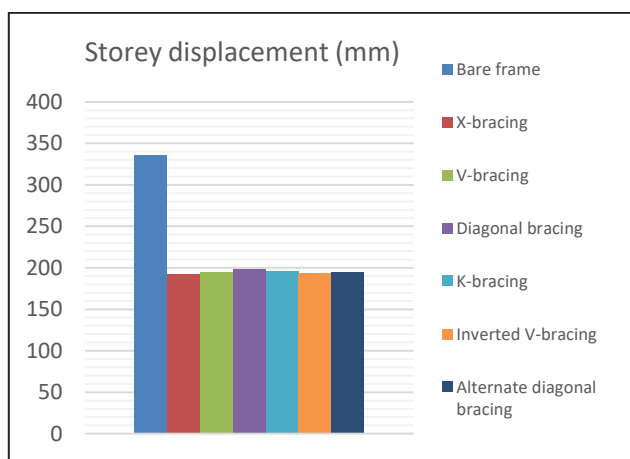
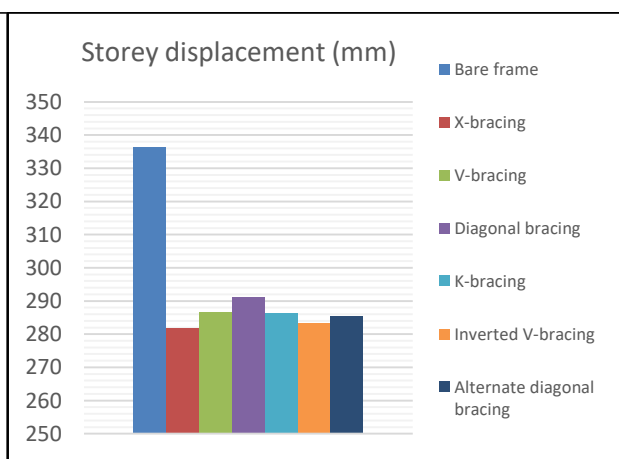


**Table 3** Storey displacement for braced frame with shear wall in X-direction

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	336.37	192.02	195.51	198.88	195.87	193.84	194.62
% Reduction		42.91	41.88	40.87	41.77	42.37	42.14

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

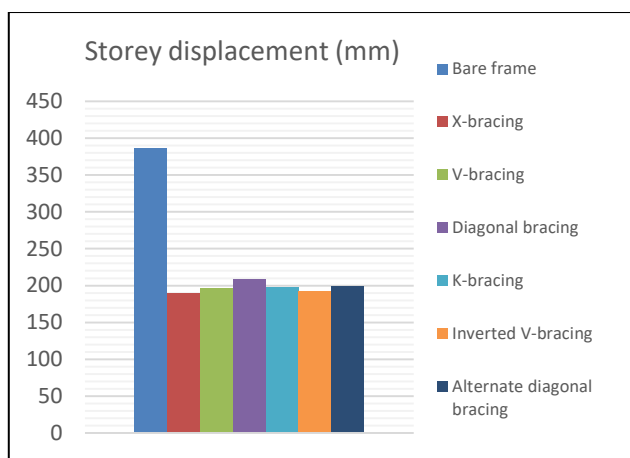
Storey displacement (mm)							
Storey Level	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
Top	336.37	281.66	286.47	291.09	286.41	283.25	285.40
% Reduction		16.26	14.83	13.46	14.85	15.79	15.15

**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

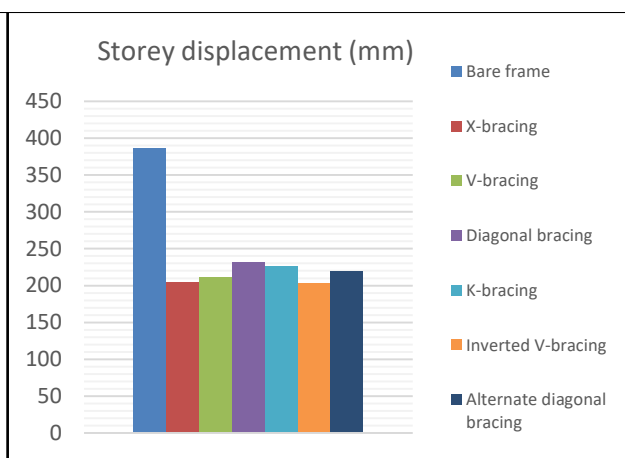
Storey displacement (mm)							
Storey Level	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
Top	386.40	188.76	195.99	208.20	198.24	192.53	198.62
% Reduction		51.15	49.28	46.12	48.70	50.17	48.60

**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	386.40	203.81	210.72	231.55	226.48	203.02	219.30
% Reduction		47.26	45.47	40.08	41.39	47.46	43.24



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



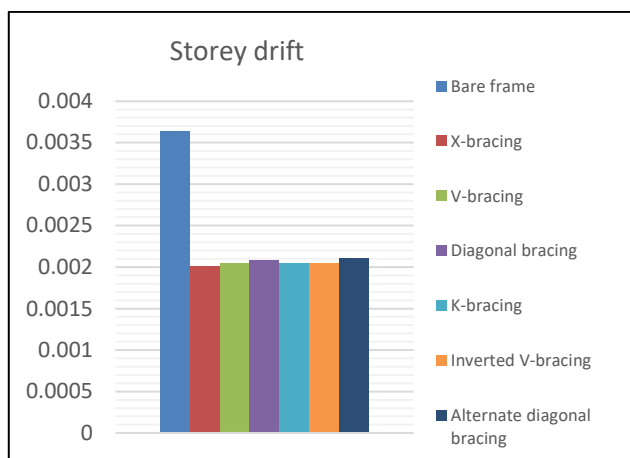
**Fig. 7** Storey displacement for braced frame without shear wall in Y-direction

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

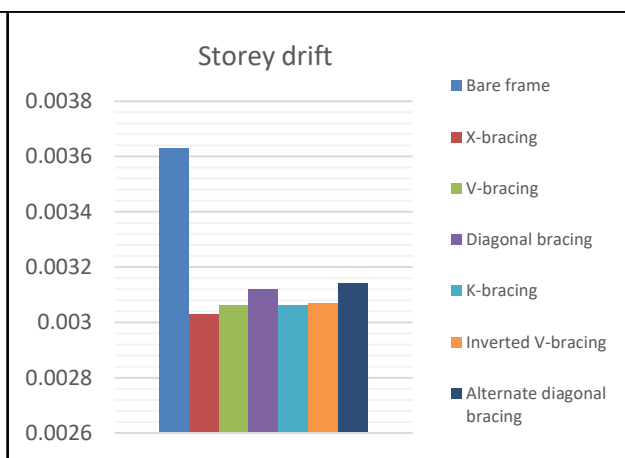
Storey drift							
Max storey drift	Bare frame	Types of bracing					
		X-bracing	V-bracing	Diagonal bracing	K-bracing	Inverted V-bracing	Alternate diagonal bracing
	0.00363	0.00201	0.00204	0.00208	0.00204	0.00205	0.00210
% Reduction		44.62	43.95	42.66	43.82	43.51	42.30

**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
	0.00363	0.00303	0.00306	0.00312	0.00306	0.00307	0.00314
% Reduction		16.47	15.70	14.07	15.64	15.59	13.61



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



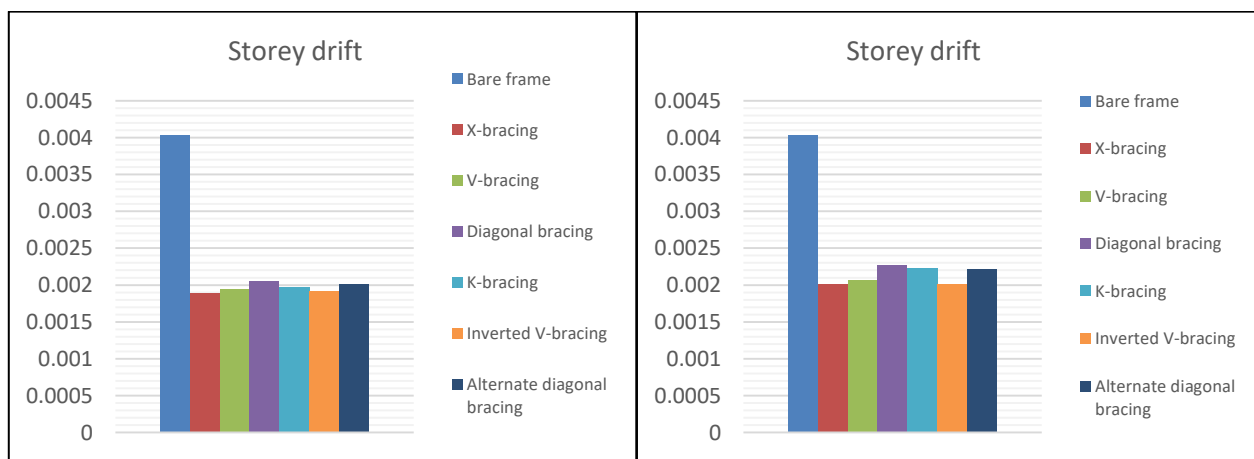
**Fig. 9** Storey drift for braced frame without shear wall in X-direction

**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
	0.00404	0.00189	0.00195	0.00205	0.00197	0.00192	0.00202
% Reduction		53.22	51.81	49.28	51.16	52.35	50.05

**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
	0.00404	0.00202	0.00207	0.00227	0.00223	0.00202	0.00221
% Reduction		49.95	48.64	43.78	44.80	49.93	45.25

**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 3.29 % for braced buildings with shear wall and it is increased by 1.12% braced buildings without shear wall and in Y-direction is increased by 3.29 % for braced buildings with shear wall and it is increased by 1.13% braced buildings without shear wall as compared to conventional building.
- Storey displacement in X-direction is reduced by 42.91 % for braced buildings with shear wall and it is reduced by 16.26 % braced buildings without shear wall and in Y-direction is reduced by 51.15 % for braced buildings with shear wall and it is reduced by 47.26 % braced buildings without shear wall as compared to conventional building.
- Storey drift in X-direction is reduced by 44.62 % for braced buildings with shear wall and it is reduced by 16.47 % braced buildings without shear wall and in Y-direction is reduced by 53.22 % for braced buildings with shear wall and it is reduced by 49.95 % 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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