Comparative Study on Seismic Analysis of Symmetric And Asymmetric RC Building With Concentric And Eccentric Bracing

Jay A. Parmar[1], Megha Thomas[2]
[2] Associate Professor
[1, 2] Parul Institute of Engineering & Technology, Limda- 391760, Gujrat, India

Abstract- *In this study, seismic analysis of high rise symmetric and asymmetric RC building frames have been carried out considering concentric X braced, concentric inverted V braced, eccentric X braced and eccentric inverted V braced systems. Bracing systems is resisting lateral load in RC building. Bracing is a structural element that provides resistance or stiffness to the building against lateral forces i.e., Earthquake and wind. In proposed problem G+15 story symmetric and asymmetric RC building frame is analyzed for concentric X bracing system, concentric inverted V bracing system, eccentric X bracing system and eccentric inverted V bracing system under lateral loading i.e. earthquake and wind. ETABs software is used for analysis. The results for symmetric and asymmetric RC building with concentric X bracing system, concentric inverted V bracing system, eccentric X bracing system and eccentric Inverted V bracing system compared with bare frame model of symmetric and asymmetric RC building, then analysis to evaluate the effectiveness of a particular type of bracing system in order to reduces the lateral displacement and story drift in the frame. It is found that all the bracing systems reduces the lateral displacement and story drift of frame very effectively. In this study eccentric X braced system performed better than other braced system and bare frame system.*

Keywords- ETABS, displacement, story drift, X type bracing, inverted V type bracing.

I. INTRODUCTION

Generally the purpose of high rise buildings is to transfer the primary gravity load safely. The common gravity loads are dead load, live load. Also the structure should withstand the lateral loads caused by earthquake and wind depending on terrain category. The lateral loads reduce stability of structure by producing sway moment and induce high stresses. So in such cases stiffness is more important than strength to resist lateral loads. Steel braced frame is one of the lateral load opposing frameworks in multistory structures. Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure. Bracing has been used to stabilize laterally the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracingis efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear. A bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity. Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength. Steel braced frames are efficient structural systems for buildings subjected to seismic or wind lateral loadings. There are various types of bracing systems like X bracing, V bracing, inverted V bracing, K bracing, diagonal bracing and so on. There are two types of steel braced frames, (a) Eccentric braced frames and (b) Concentric braced frames depending upon their geometric characteristics.

II. MODELLING AND ANALYSIS

In this study, A G+15 story symmetric RC building of 3 bays in both the direction, the size of a bay in X direction is 5m and Y direction is 4m have been considered for investigating the effect of concentric X bracing system, concentric inverted V bracing system, eccentric X bracing system and eccentric inverted V bracing system.

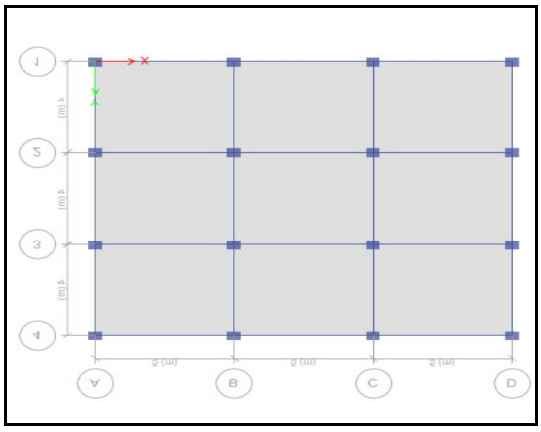

Figure 1. Plan of symmetric RC building

A G+15 story asymmetric RC building of 5 bays in both the direction, the size of a bay in X direction is 5m and Y direction is 4m have been considered for investigating the effect of concentric X bracing system, concentric inverted V bracing system, eccentric X bracing system and eccentric inverted V bracing system.

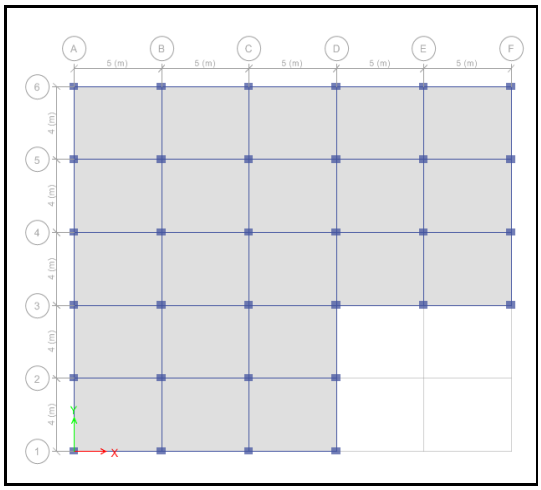

Figure 2. Plan of asymmetric RC building

Following three types of structural configuration is studied in symmetric and asymmetric RC building. (a) Reinforced concrete multi-story building without bracing system (b) Reinforced concrete multistory building with concentric X bracing system and concentric inverted V bracing systems (c) Reinforced concrete multistory building with eccentric X bracing system and eccentric inverted V bracing system.

Total 10 models are analyzed in this study are given below:
In symmetric building total 5 models are analyzed.

1. Moment resisting frame.
2. Concentric X braced frame.
3. Concentric inverted V braced frame.
4. Eccentric X braced frame.
5. Eccentric inverted V braced frame.

In asymmetric building total 5 models are analyzed.

6. Moment resisting frame.
7. Concentric X braced frame.
8. Concentric inverted V braced frame.
9. Eccentric X braced frame.
10. Eccentric inverted V braced frame.

Properties of all materials for symmetric and asymmetric RC building are same. Building details are given below table:

Table 1. General data of G+15 story RC building

Sr. No.	Content	Detail
1	Numbers of story	G+15
2	Story height	3.0 Meters
3	Type of soil	Medium soil
4	Seismic Zone of a building	4
5	Importance factor	1
6	Grade of concrete	M 30
7	Grade of steel	Fe 415
8	Size of a beam	300*450mm
9	Size of column	400*500mm
10	Thickness of slab	150 mm
11	Size of bracing	ISMB 200
12	Live load	2.5 KN/m^2
13	Floor finish	1 KN/m^2

2.1 Models for Symmetric RC building

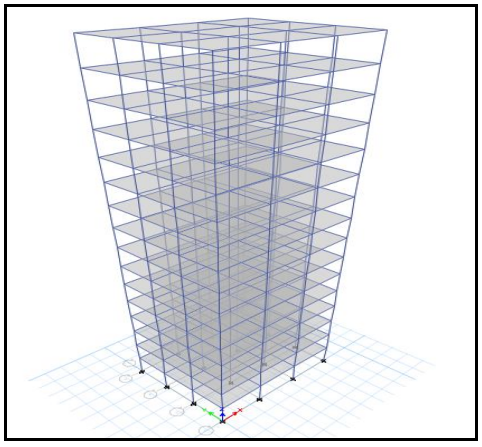

Figure 3. Moment resisting frame

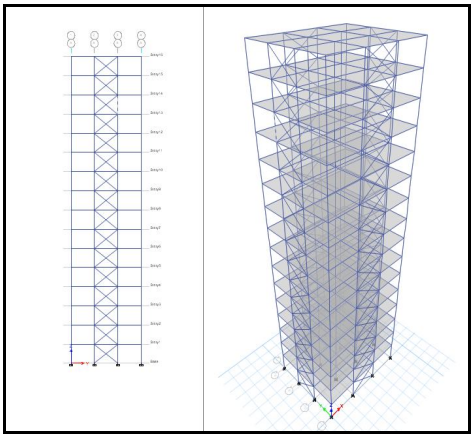

Figure 4. Concentric X braced frame

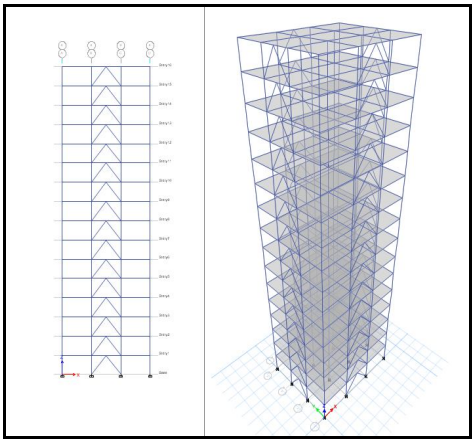

Figure 5. Concentric inverted V braced frame

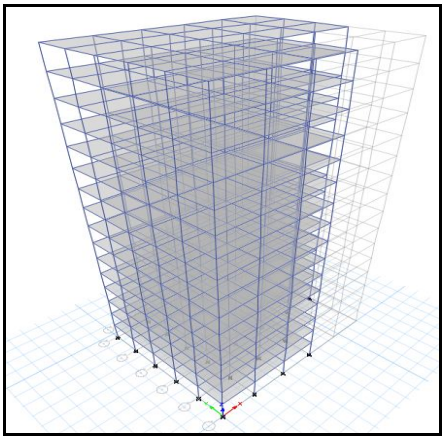

Figure 8. Moment resisting frame

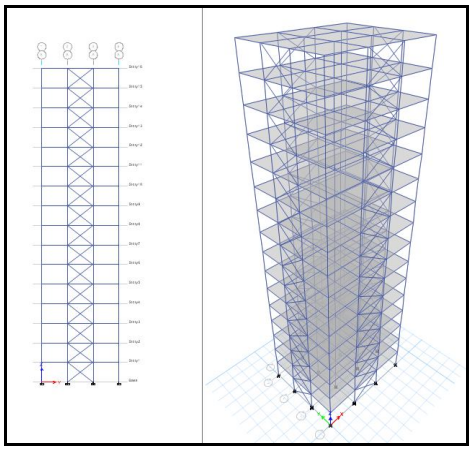

Figure 6: Eccentric X braced frame

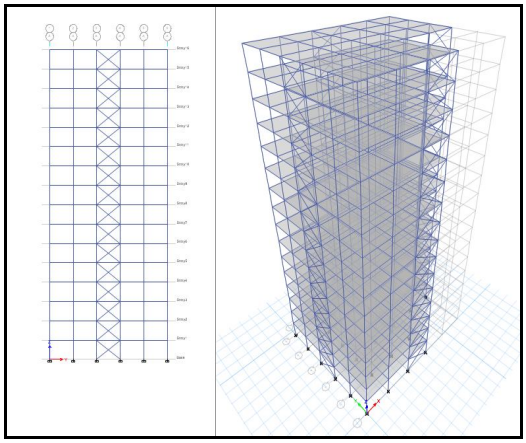

Figure 9. Concentric X braced frame

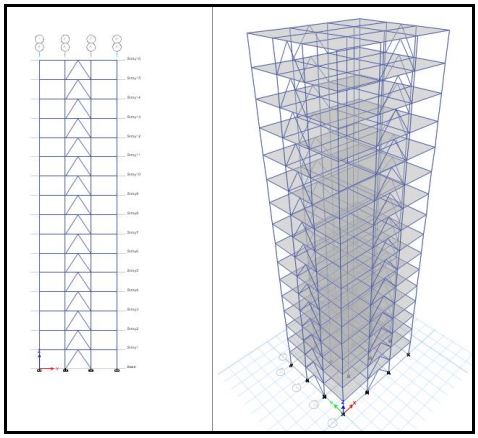

Figure 7. Eccentric inverted V braced frame

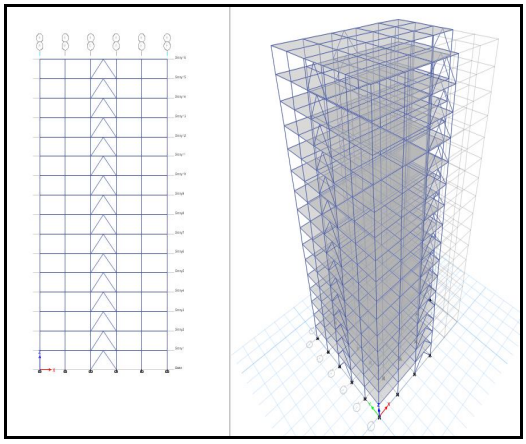

Figure 10. Concentric inverted V braced frame

2.2 Models for Asymmetric RC building

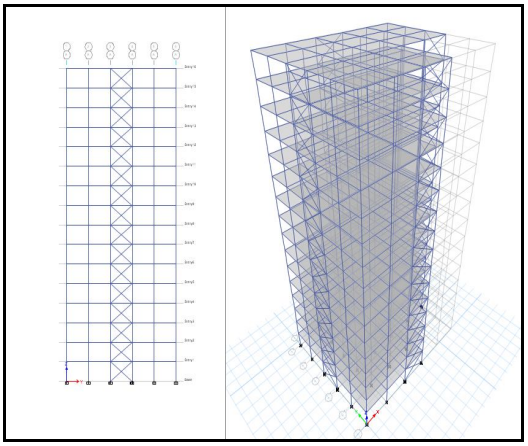

Figure 11. Eccentric X braced frame

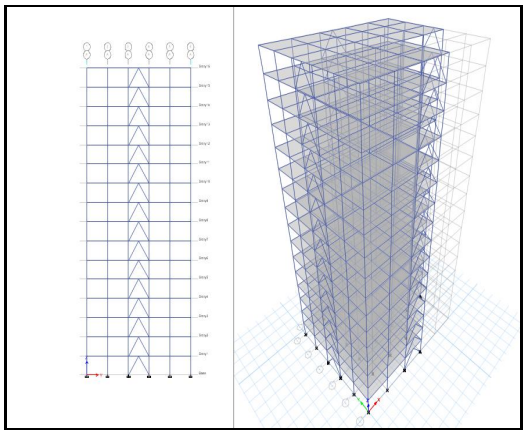

Figure 12. Eccentric inverted V braced frame

III. RESULTS AND DISCUSSIONS

Results of analysis are given below in the form of various graphs and their discussion.

3.1 Results for Symmetric building –

Table 2. Result of displacement for symmetric building

Sr. no.	Model	Displacement (mm)	% of reduction in disp.
1	MRF	121.51	-
2	CONC X	81.07	33.30
3	CONC INV V	83.14	31.58
4	ECC X	80.96	33.37
5	ECC INV V	83.27	31.47

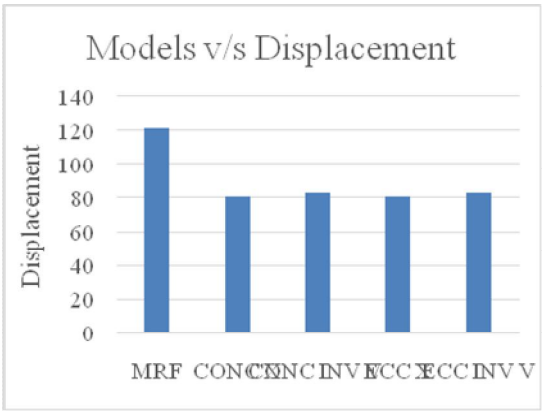

Figure 13. Displacement for symmetric building

On comparing displacement for Symmetric RC building having 15 story, it was observed that there is reduction of displacement in RC buildings braced with concentric X braced system is 33.30, eccentric X braced system is 33.37%, concentric inverted V braced system is 31.58% and eccentric inverted V braced system is 31.47% in comparison to bare frame system. In this study eccentric X braced system performed better than other braced system and bare frame system.

Table 3. Result of drift for symmetric building

Sr. no.	Model	Drift (max)	% of reduction in drift
1	MRF	0.003781	-
2	CONC X	0.002094	44.62
3	CONC INV V	0.002189	42.10
4	ECC X	0.002090	44.72
5	ECC INV V	0.002192	42.02

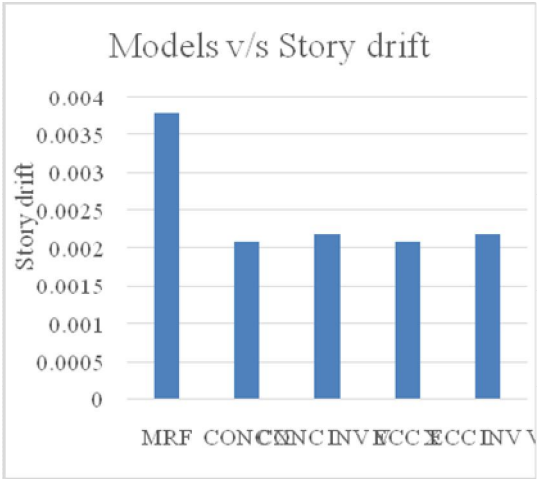

Figure 14. Drift for symmetric building

On comparing drift for Symmetric RC building having 15 story, it was observed that there is reduction of drift in RC

buildings braced with concentric X braced system is 44.62%, eccentric X braced system is 44.72%, concentric inverted V braced system is 42.10% and eccentric inverted V braced system is 42.02% in comparison to bare frame system. In this study eccentric X braced system performed better than other braced system and bare frame system.

3.2 Results for Asymmetric building –

Table 4. Result of displacement for asymmetric building

Sr. no.	Model	Displacement (mm)	% of reduction in disp.
1	MRF	124.24	-
2	CONC X	98.36	20.83
3	CONC INV V	98.98	20.33
4	ECC X	98.21	20.95
5	ECC INV V	99.05	20.27

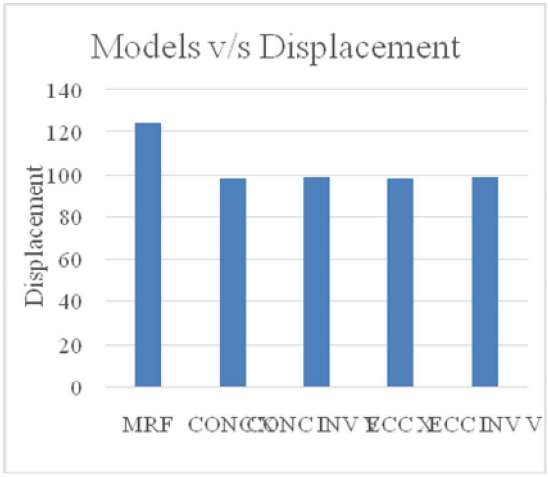

Figure 15. Displacement for asymmetric building

On comparing displacement for Asymmetric RC building having 15 story, it was observed that there is reduction of displacement in RC buildings braced with concentric X braced system is 20.83%, eccentric X braced system is 20.95%, concentric inverted V braced system is 20.33% and eccentric inverted V braced system is 20.27% in comparison to bare frame system. In this study eccentric X braced system performed better than other braced system and bare frame system.

Table 5. Result of drift for asymmetric building

Sr. no.	Model	Drift (max)	% of reduction in drift
1	MRF	0.003914	-
2	CONC X	0.002623	32.98
3	CONC INV V	0.002682	31.47
4	ECC X	0.002684	31.42
5	ECC INV V	0.002819	27.97

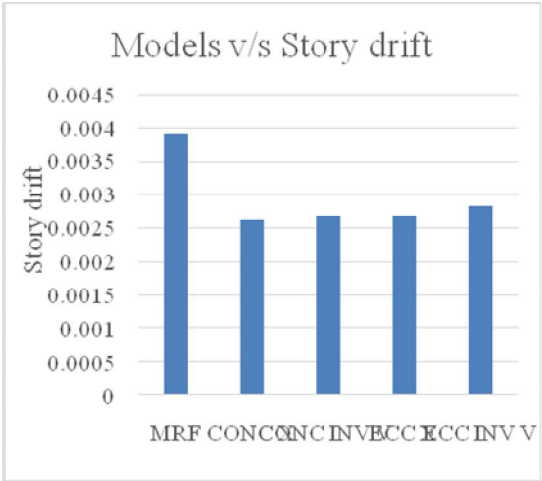

Figure 16. Drift for asymmetric building

On comparing drift for Asymmetric RC building having 15 story, it was observed that there is reduction of drift in RC buildings braced with concentric X braced system is 32.98%, eccentric X braced system is 31.42%, concentric inverted V braced system is 31.47% and eccentric inverted V braced system is 27.97% in comparison to bare frame system. In this study concentric X braced system performed better than other braced system and bare frame system.

IV. CONCLUSIONS

Following are the conclusions of the study –

1) Bracing provides better strength and stiffness to the RC building.
2) Eccentric X bracing is performed better than concentric X bracing, concentric inverted V bracing and eccentric inverted V bracing in reducing the displacement of the symmetric and asymmetric RC building.
3) Eccentric X bracing is performed better than concentric X bracing, concentric inverted V bracing and eccentric inverted V bracing in reducing the drift of the symmetric RC building.

4) Concentric X bracing is performed better than concentric inverted V bracing, eccentric X bracing and eccentric inverted V bracing in reducing the drift of theasymmetric RC building.

REFERENCES

[1] H. Moghaddam, I. Hajirasouliha "An investigation on the accuracy of pushover analysis for estimating the seismic deformation of braced steel frames" *Journal of Constructional Steel Research, Science Direct,* 2006, 343–351.

[2] M. R. Maheri, R. Kousari, M. Razazan "Pushover tests on steel X-braced and knee-braced RC frames" *Engineering Structures, Science Direct*, 2003, 1697–1705.

[3] Ghobarah, H. AbouElfath "Rehabilitation of a reinforced concrete frame using eccentric steel bracing" *Engineering Structures, Science Direct,* 2001, 745–755.

[4] Kadid, D.Yahiaoui "Seismic Assessment of Braced RC Frames" *Procedia Engineering, Science Direct,* 2011, 2899–2905.

[5] M. A. Youssef, H. Ghaffarzadeh, M. Nehdia "Seismic performance of RC frames with concentric internal steel bracing" *Engineering Structures,Science Direct*, 2007,1561–1568.

[6] Hendramawat A Safarizki, S.A. Kristiawan, A. Basuki "Evaluation of the Use of Steel Bracing to Improve Seismic Performance of Reinforced Concrete Building" *Procedia Engineering, Science Direct,* 2013,447 – 456.

[7] Hassan A. Moghaddam, Homayoon E. Estekanchi "Seismic behavior of off Centre bracing systems" *Journal of Constructional Steel Research, Science Direct* 1999, 177–196.

[8] Jung-Han Yoo, Charles W. Roeder, Dawn E. Lehman "Simulated behavior of multi-story X-braced frames" *Engineering Structures, Science Direct,* 2009, 182-197.

[9] TemelTurker, AlemdarBayraktar "Finite element model calibration of steel frame buildings with and with-out brace" *Journal of Constructional Steel Research, Science Direct*, 2013, 164–173.

[10] Mahmoud R. Maheri, R. Akbari, "Seismic behavior factor, R, for steel X-braced and knee-braced RC building" *Engineering Structure, Science Direct,* 2003, 1505–1513.

[11] Jay A. Parmar, Megha Thomas "Analysis of bracing in symmetric and asymmetric RC building" *International Journal of Research*, 2018, Volume 05, 2039-2045