International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 05 | Aug-2015 www.irjet.net p-ISSN: 2395-0072

SEISMIC BEHAVIOR OF RC BUILDING FRAME WITH STEEL BRACING SYSTEM USING VARIOUS ARRANGEMENTS

Shachindra Kumar Chadhar[1], Dr. Abhay Sharma[2]

[1] *M.Tech. Student, Department of Civil Engineering, MANIT, Bhopal (M.P.), India*
[2] *Associate Professor, Department of Civil Engineering, MANIT, Bhopal (M.P.), India*

Abstract - ***Steel bracing system is one of the effective measures for resisting the horizontal forces like seismic and wind forces in reinforced concrete multistory buildings. Bracing member's are subjected to tension and compression; subsequently they are provided to take these forces. Steel bracing framework expands the stiffness and strength of the RC multistory building and reduces their deformation. Present study is based on seismic analysis of RC building frames with V type bracing and inverted V type bracing. Seismic coefficient method (linear static analysis) has been conducted to evaluate the effect of different arrangements of bracing members in the building frame and influence of the different steel cross-section. For this study, a fifteen story building assumed to be situated at seismic zone IV as per the seismic zone map of India. Three steel profiles ISA, ISMC and ISMB were utilized as bracing members by considering same cross-sectional area. For modeling and analysis work computer software StaadproV8i was used. Result of this study revealed that inverted V bracing reduces the bending moment, shear force, storey drift and node displacement significantly. It was also found that the various arrangements of bracing systems has great influence on seismic performance of the building frame and double angle section give better result as compared to ISMB and ISMC section.***

Key Words: *Steel bracing system, V type bracing, inverted V type bracing, node displacement, storey drift , bending moment and shear force etc.*

1. INTRODUCTION

India at present is fast developing country which requires demands in increase of infrastructure facilities along with the growth of population. Due to increased population, the demand of land for housing is increasing day by day. To fulfill the need of the land for housing and other commercial offices, vertical development that is multistory buildings are the only option. This type of development requires safety because these multistory buildings are highly susceptible to additional lateral loads due to earthquake and wind. In broad, as the elevation of building increases, its reaction to lateral loads increases. Multistory reinforced concrete buildings are vulnerable to excessive deformation, which necessitate the introduction of special measures to decrease this deformation. Steel braced frame is one of the lateral load opposing frameworks in multistory structures. Steel bracing system enhances the resistance of the structure against horizontal forces by expanding its stiffness and stability. Bracings hold the structure stable by exchanging the horizontal loads, for example, quake or wind burdens down to the ground and oppose sidelong loads, in that way keep the influence of the structure. Steel bracing members in RC multistory building is conservative, simple to set up, involve less space and give obliged quality and inflexibility. There are various types of bracing systems like X bracing, V bracing, inverted V bracing, K bracing, diagonal bracing and so on.

1.1 Description of the Building

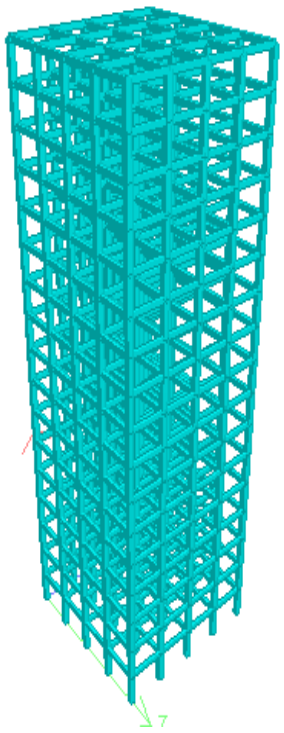
In this study, A G+15 storey reinforced concrete building of 4 bays have been considered for investigating the effect of V type and inverted V type bracings and there arrangements in various positions in the building.
Following two types of structural configuration is studied.
1. Reinforced concrete multistory building without bracing system
2. Reinforced concrete multistory building with V type and inverted V type bracing systems

Other building details are given below:
All RC Column sizes = 500mm x 500mm
All RC Beam sizes = 500mm x 300mm
Slab thickness = 150mm
Brick Wall thickness = 200mm
Bracing details 1= Double ISA 150x150x10
Bracing details 2 = ISMC 350
Bracing details 3= ISMB 300
Grade of concrete = M-25
Grade of steel = Fe-415

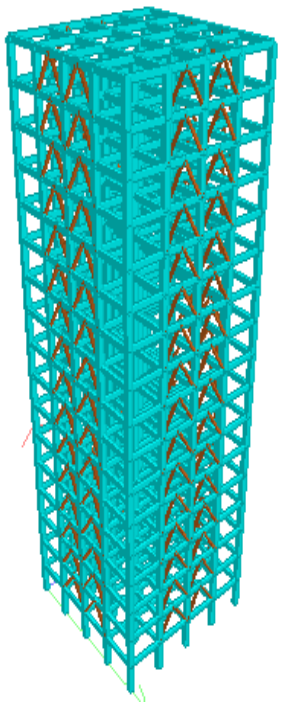
2. STRUCTURAL MODELLING & ANALYSIS

A G+15 storey reinforced concrete building with V type and inverted V type bracing provided on various positions in the building are analyzed for earthquake loading. The method of seismic analysis used in this present study is seismic coefficient method which is a linear static approach. Building is designed according to IS: 456-2008 and earthquake loading is applied as per the recommendation of IS: 1893-2002. Building is assumed to be located in seismic zone IV of India and rest on medium soil condition. Following seismic parameters considered for the present study.
Zone factor for seismic zone IV = 0.24
Soil site factor for medium soil condition = 2
For important building Importance factor = 1.5
Response reduction factor = 3
Damping ratio = 0.05
The structures are demonstrated by utilizing computer programming StaadProV8i. The floor load is taken as 4.75kN/m2 including floor finishing load as 1 kN/m2. The live load is taken as 3kN/m2 . Load combinations are applied as per the recommendation of Indian standard codes.

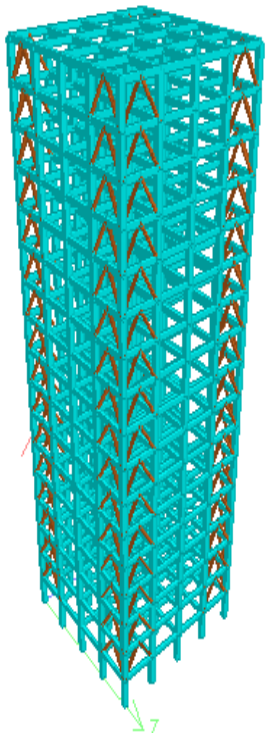
Total 11 models are analyzed in this study.
One bare frame model.
Five models of V bracing
Five models of inverted V bracing
ISA, ISMC and ISMB steel sections of same cross-sectional area are used for bracing members.
Figures given below shows the various arrangements of V type and inverted V type bracing in the building frame.



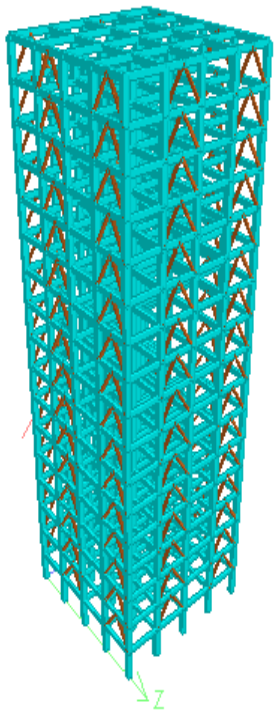
Bare Frame



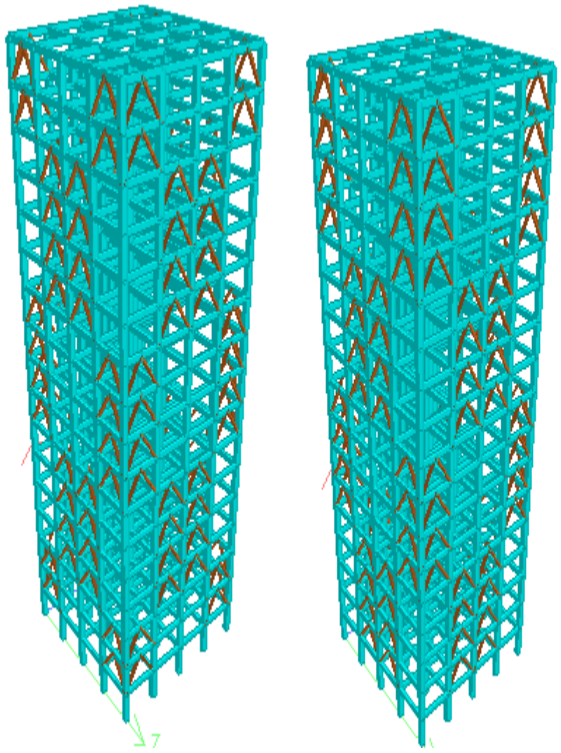
Arrangement1



Arrangement2



Arrangement3



Arrangement4 Arrangement5

Figure 1: RC building frames with inverted V bracing

Similarly V bracing system is provided using same arrangements. For these bracing members, three steel sections ISA, ISMC and ISMB are used.

2. RESULTS

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

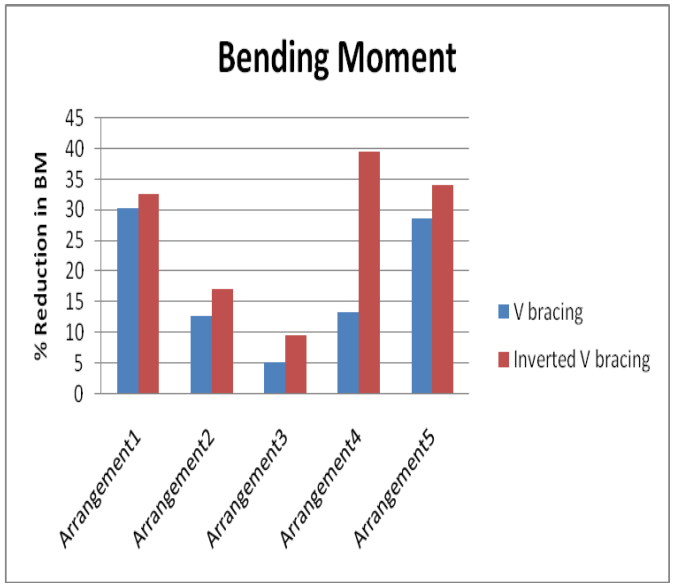


Figure 2: % Reduction in Bending Moment

Above diagram demonstrates the % reduction in bending moment for V type and inverted V type bracing system when compared with bare frame model. This graph shows that, inverted V type bracing systems have maximum reduction in bending moment (about 40%) as compared to V type bracing system. This means that inverted V type bracing minimize the bending moment effectively in the structure than V type bracing. Also the arrangement 4 of inverted V type bracing shows better result than other arrangements. For V type bracing arrangement 1 give better result than other arrangements. Arrangement 3 has minimum reduction in bending moment.

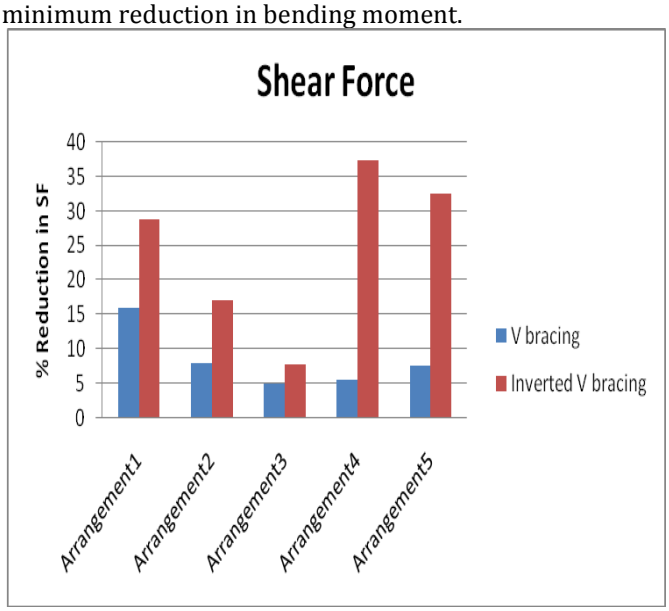


Figure 3: % Reduction in Shear Force

Above diagram shows % reduction in shear force for V type and inverted V type bracing system when compared with bare frame model. This graph demonstrates that inverted V type bracing have maximum reduction in shear

force (about 35%) than V type bracing. This means that inverted V bracing system significantly reduces the shear force in the structure as compared to V bracing system. Arrangement 4 of inverted V type bracing has maximum reduction in shear force than other arrangements. For V bracing system arrangement 1 shows better result. Arrangement 3 has minimum reduction in shear force.

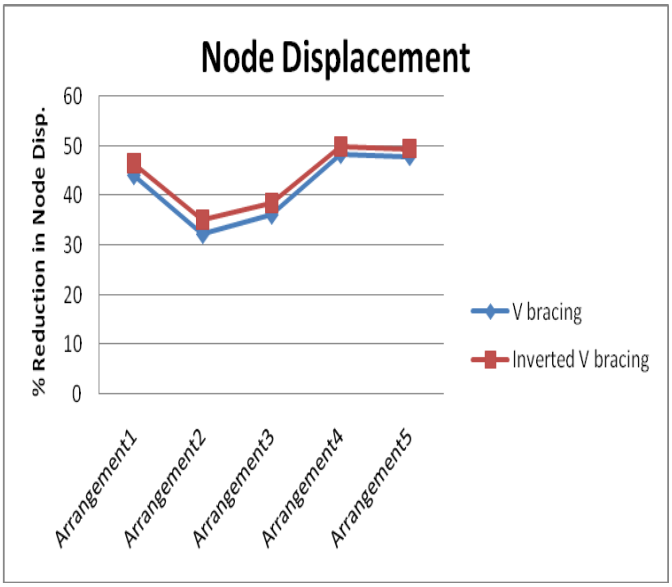


Figure 4: % Reduction in Node Displacement

Above chart demonstrates the % lessening in node displacement for V type and inverted V type bracing. Inverted V bracing system reduces the node displacement (about 50 %) significantly than V bracing system which means that lateral displacement is minimum for inverted V bracing. Arrangement 4 and 5 give better performance in minimizing the node displacement than other arrangements. Arrangement 2 shows minimum reduction in node displacement.

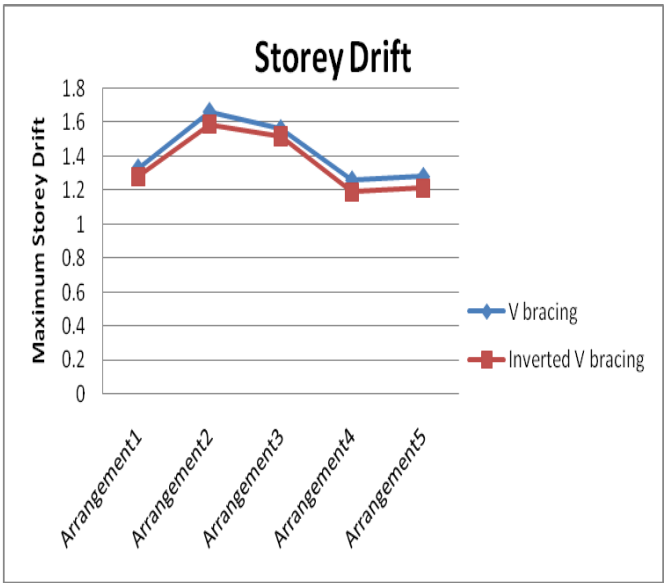


Figure 5: Storey Drift for V bracing & inverted V bracing

Above graph shows the maximum storey drift for V bracing and inverted V bracing. Inverted V bracing system has minimum values of storey drift as compared to V type bracing system. Arrangement 4 and 5 shows better results while arrangement 2 give maximum values of storey drift in the structure.

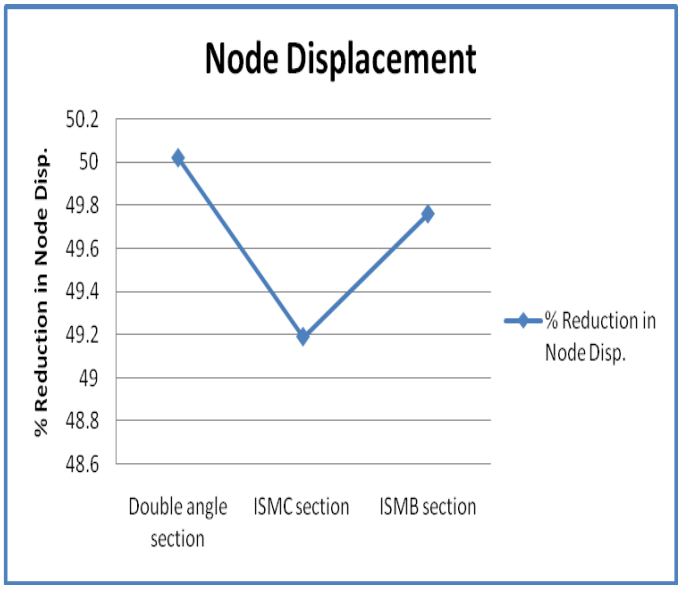


Figure 6: Node Displacement for inverted V bracing with different cross-section

Figure 6 shows the % reduction in node displacement for inverted V bracing. Double angle section, ISMC section and ISMB section are used for bracing members. From graph, it

is clear that double angle section has maximum reduction in node displacement, this means that double angle section reduces the lateral displacement significantly as compared to ISMC and ISMB sections.

3. CONCLUSIONS

Following are the conclusions of the study –

- Steel bracing system shows the efficient and economical measures for RC multistory buildings located in high seismic regions.
- Inverted V bracing system significantly reduces the bending moment and shear force than V type bracing system.
- Node displacements and storey drifts are minimum for inverted V braced frame as compared to V braced frame.
- It is concluded that arrangements of bracing systems has considerable effect on seismic performance of the building. From all five arrangements of bracing system, arrangement 4 gives better performance.
- From the result it is found that double angle section gives better results than ISMB and ISMC section.

REFERENCES

1. Desai J. P., Jain A. K. and Arya A. S., "Seismic response of R. C. braced frames", Computers and Structures Volume 29 No.4, pp 557568, 1988.

2. Marc Badoux and James O. Jirsa, "Steel bracing of RC frames for seismic retrofitting", Journal of Structural Engineering, Vol. 116, No. 1, January, 1990.

3. Maheri M.R. and Sahebi A., "Use of steel bracings in reinforced concrete frames", Engineering Structures, Vol. 19, No.12, 1997.

4. A.R. Khaloo and M. Mahdi Moseni "Nonlinear Seismic Behavior of RC Frames With RC Braced", Asian Journal of Civil Engineering (Building & Housing) Vol. 9 , No. 6, 2008.

5. Viswanath K.G., Prakash K.B. and Anant Desai, "Seismic analysis of steel braced RC frame" International Journal of Civil and Structural Engineering Volume 1, No 1, and 2010.

6. Pankaj Agarwal, Manish Shrikhande, "Earthquake Resistant Design of Structures" PHI Learning Private Limited, 2011.

7. .D. Kevadkar, P.B. Kodag, "Lateral Load analysis of RCC buildings" International Journal of Modern Engineering Research (IJMER) Vol.3, Issue.3, May-June. 2013.

8. Patil S.S., Aland S.S., Kore P.N. "Seismic Response of Concentrically Braced Reinforced Concrete Frames", International Journal of Scientific and Engineering Research, Volume 4, Issue7, July 2013.

9. Rishi Mishra, Dr. Abhay Sharma, Dr. Vivek Garg, "Analysis of RC Building Frames for Seismic Forces Using Different Types of Bracing Systems" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 3 Issue7, July-2014.

10. Z.A. Siddiqi, Rashid Hameed, Usman Akmal, "Comparison of Different Bracing Systems for Tall Buildings" Int. Jr. Engg. & Appl. Sci. Vol. 14, Jan., 2014

11. IS 456: 2000. "Indian Standard Code of Practice for plain and reinforced Concrete", Bureau of Indian Standards, New Delhi, 2000.

12. IS 1893(Part-I): 2002 "Criteria for Earthquake Resistant Design of Structures" Part-I General Provision and Buildings (Fifth Revision). Bureau of Indian Standards, New Delhi, 2002.