SEISMIC RESPONSE OF STEEL STRUCTURE WITH CONCENTRIC BRACING SYSTEM

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Abstract—In General, the structure in high seismic areas may be susceptible to the severe damage. Along with gravity load structure has to withstand the lateral load which can develop high stresses. Now a day, shear wall in R.C. structure and steel bracings in steel structure are most popular system to resist lateral load due to earthquake, wind, blast etc. The bracing is one of the best lateral load resisting systems and it will be the viable solution for enhancing earthquake resistance. A Bracing is a system that is provided to minimize the lateral deflection of structure. The members of a braced frame are subjected to tension and compression, so that they are provided to take these forces similar to a truss. Braced frames are always designed of steel members. Use of the braced frames has become very popular in high rise structure and also in seismic design of them. So there is a need of precise and exact modeling and analysis using software ETABS to interpret relation between brace frame and without brace frame aspects. The present study assesses the seismic response of steel structure with concentric bracing system. Two structural configurations were utilized; vertical irregular model (VIRM), vertical irregular model with concentric bracing (VIRM_CB). A 15 storey steel moment resisting frame was analyzed for all zones of soil type-II (medium). The analyses were carried out to assess the structural performance under earthquake ground motions. These models are compared in different aspects such as storey drift, storey displacement and base shear.

Index Terms— base shear ,concentric brace,storey drift, storey displacement.

I. INTRODUCTION

Generally framed structures are used up to height of 60 to 80m. Tubular structures will be used 100 to 200m structures. Diagonal braced structures are used in tall buildings to enhance the seismic performance. In the past, steel bracing has been used in the majority of the world's tallest structures including the 1250 foot high Empire State Building. A braced frame consists of a non-rigid frame with the addition diagonal members to carry shear. The system is very efficient because the diagonal members carry the shear stress axially like a truss which serves to keep member sizes small. In effect, a braced frame behaves as a vertical truss cantilevered out of the ground. The columns behave as chords and the diagonals and girders act as the web. Diagonal bracing has the disadvantage of cutting across open spans between columns and must therefore be used in locations where the architecture will not be disrupted. In buildings of low to moderate height this is usually not a problem as the magnitude of horizontal shear is not significant and therefore the size and number of diagonal braces will not be substantial. In taller buildings, the engineer must communicate with the architect early on in the design process to determine the best placement of diagonal bracing so as to maximize the potential lateral resistance of the bracing while minimizing the disruption to the architecture of the building. Because of the potential disruption caused by diagonal bracing, it is usually placed in locations such as around elevator shafts, stairwells or service corridors where its presence will cause the least obstruction. Truss bracing may take many different shapes. The diagonals may be relatively short such as a story high brace or may span several stories. The most efficient bracing layouts are those that form a fully triangulated vertical truss. A distinct advantage of this type of layout is that girder moments and shears are independent of the lateral loading. Floor framing may then be designed for gravity loads only and be repetitious throughout the structure with the potential for significant cost savings in material and construction time.

Two general types of joints are commonly used in braced frames those are concentric and eccentric. Concentric connections are those in which diagonal members join with columns and beams at corner joints. Eccentric connections, which give the structure improved seismic performance, are made when diagonal members connect with columns and beams a short distance from corner joints. When subjected to typical lateral loads such as wind, an eccentrically braced frame will behave in an elastic manner similar to a concentrically braced frame. Under severe loading due to earthquakes however, the short girder span between the diagonal and the column will act as a fuse and will deform plastically. This deformation is designed to absorb and dissipate energy from the ground motion which reduces damage to the rest of the structure. Eccentric connections may also be used for non-seismic purposes. A diagonal connection a short distance from a column may be considered close enough to act concentrically, however the connection itself is greatly simplified over a true concentric connection which speeds construction time and reduces cost.

Fig: 1. Concentrically x-bracing

II. METHODOLOGY

The methodology includes:

- Firstly a detailed introduction regarding the steel building frames, its structural and constructional aspects, its effects on the analysis, method of analysis and seismic behavior are collected along with organization of the report.
- A detailed literature survey is carried out on analysis of moment resisting steel frames.
- The design of 3D steel frame using IS 456-2000 considering dead load, live load and earthquake load.

The modal analysis of 3D steel frames is carried out to get the response of steel structure. The steel frame models are of five bay with fifteen storey for with and without bracing system

III. MODELING

ETABS is a full-featured program that can be used for the simplest problems or the most complex projects. This topic briefly describes the newer features in the program and directs you to manuals and technical support to help you get started using this version of the program.

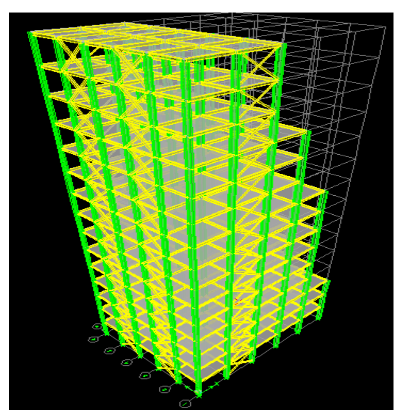


Fig: 2. Analytical Model

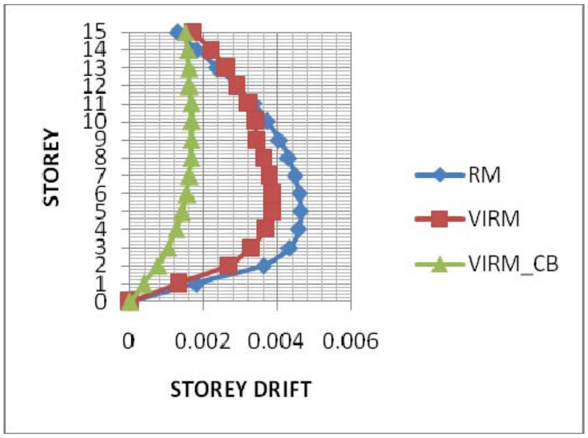
Table 1 DESCRIPTION OF STRUCTURE

No. of Floors	15
Shape Of Building, Plan, Elevation whether Symmetric in Elevation	Non symmetrical building
Maximum plan dimension in either direction in mt.	B=22.5m & L=17.5m
Ratio of plan dimension	Ratio=L/B=2.10
Typical Floor to floor height in mt. Maximum floor to floor height in entire height of building in mt.	3.5 m 3.5 m
Aspect ratio (Height of building till Terrace/ Minimum Dimension of Building)	Aspect Ratio =H/B=52.5m/22.5m=2.33
Type of floor slab	Beam slab
Average thickness of floor slab in mm.	150mm
Whether column are RCC, Composite or In structural steel	Structural steel
Whether the Geometry of Building is Symmetric/ Non symmetrical	Non symmetrical
Use of floor at different levels (Residential /Commercial / industrial)	Commercial

IV. RESULTS AND DISCUSSIONS

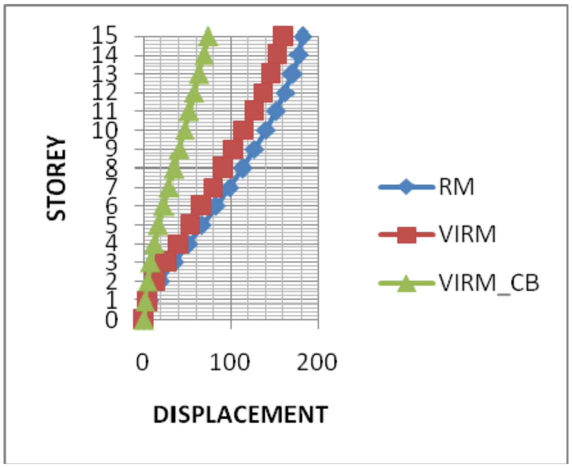
Storey drift:

For comparison of Storey drift of vertical irregular frame, the storey v/s storey drifts of various models without & with bracing system frame are shown in fig below. It is observed that storey drift is more in without brace frame as compared to concentric brace frame. It shows that 10.82% of storey drift for concentric brace frame decreased compare to without brace frame.



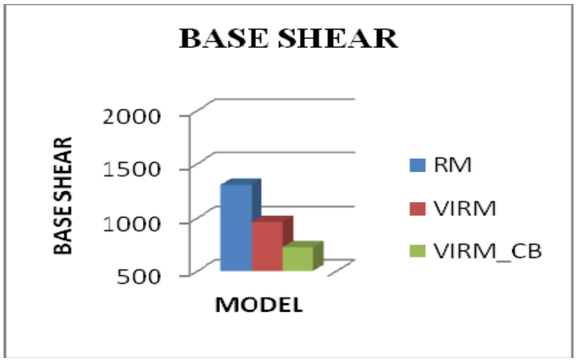
Storey displacement:

The values obtained for displacement from analysis, storey v/s storey displacement graph as been ploted. It clear that the percentage decrease compare to without bracing system, displacement for concentric brace it is decreased upto 54%.



Base shear:

The maximum base shear for concentric brace frames as shown in fig below. From this result observed that maximum base shear for concentric (VIRM_CB) bracing frame decreased by 24.58% in compared without brace frame.



V. CONCLUSIONS

The following conclusions have been drawn based on the results obtained from present study:

1) The results of the performed inelastic analyses demonstrate that concentric bracing frames are most effective to resist earthquake.
2) It concludes that the reduction of storey drifts in concentric braced frame occurs with respect to the without braced frame.
3) The storey displacement of the vertical irregular structure is reduced 54% by the use of concentric bracing system in comparison to without bracing system. As a result, it can be said that bracing system has more influence on the restriction to relative floor to floor displacement.
4) The maximum base shear for concentric (VIRM_CB) bracing frame are decreased by 24.58% as compared to VIRM without bracing frame.

REFERENCES

1. Ashik S. Parasiya1 Paresh Nimodiya2 (Dec.2013), A Review On Comparative Analysis Of Brace Frame With Conventional Lateral Load Resisting Frame In RC Structure Using Software.
2. Cheol-Ho Lee* and Seon-Woong Kim (2007), Elastic Seismic Design of Steel High-rise Buildings in Regions of Strong Wind and Moderate Seismicity, Department of Architecture, Seoul National University.
3. Christian Sandelin&EvgenijBudajev (December 2013),the Stabilization of High-rise Buildings. An Evaluation of the Tubed Mega Frame Concept, Department of Engineering Science, Applied Mechanics, Civil Engineering, Uppsala University.
4. DhavalP.AdvaniDr. R.K. Gajjar (May 2011), Investigation of Efficient Bracing System As Per IS 800:2007, National Conference on Recent Trends in Engineering &Technology, B.V.M. Engineering College, V.V Nagar, Gujarat, India.
5. Huy Van Pham (August 2013), Performance-based assessments of buckling-restrained braced steel frames retrofitted by self-centering shape memory alloy braces, Georgia Institute of Technology.
6. Lekhraj Pandit1, R. R. Shinde2 (Volume 5, Issue 3, March 2015), Survey Paper on Structural Behavior of Steel Building with Concentric and Eccentric Bracings Using Different Sections at Different Location.
7. Luigi DI SARNO and Amr S. ELNASHAI (September 2006),Bracing systems for seismic retrofitting of steel frames, First European Conference on Earthquake Engineering and Seismology, Geneva, Switzerland.
8. Mohsen Gerami, YahyaSharbati and Abbas Sivandi-Pour (2013),Nonlinear seismic vulnerability evaluation of irregular steel buildings with cumulative damage indices, International Journal of Advanced Structural Engineering.
9. Mohamed Omar (2014), Seismic Response of Braced Steel Frames with Shape Memory Alloy and Mega Bracing Systems, International Journal of Civil, Architectural Science and Engineering.
10. Nathan Canney (2008),Performance of concentrically braced frames under cyclic loading, Seattle University, University of Washington.
11. Nitin Bhojkar1, Mahesh Bagade2 (Vol. 2 Issue 3, March 2015), Seismic Evaluation of High-rise Structure by Using Steel Bracing System.
12. Xinzheng Lua1, Xiao Lua, Hong Guanb,Wankai Zhangaand Lieping Yea, Earthquake-Induced Collapse Simulation of a Super-Tall Mega-Braced Frame-Core Tube Building, Department of Civil Engineering, Tsinghua University, Beijing 100084, China.
13. ZasiahTafheem, ShovonaKhusru (2013),Structural behaviour of steel building with concentric and eccentric bracing: A comparative study, International Journal of Civil and Structural Engineering.