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# A STUDY ON THE EFFECT OF STEEL BRACED FRAMES ON THE SEISMIC BEHAVIOUR OF A MULTI-STOREY BUILDING

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***Abstract - In multistory building there a lot of parameters of concern which need to be considered for the effect of earthquake and wind load. There are many ways by which the performance of a building during the seismic activity can be improved. Bracing is one of the best method for lateral load resisting system as it is economical and easy to apply. This paper compares the response of building with different types of bracing systems such as X, V, inverted V , Knee bracing and single diagonal bracing. It also compares the seismic behavior of structure under the concentrically and eccentrically braced frames using ETABs and different methods of analysis like Response spectrum, pushover and Time History analysis.***

***Keywords- Bracing, Storey displacement, storey drift, base shear, response spectrum, pushover and time history methods, analysis using ETABs.***

## 1. INTRODUCTION

At present India is developing at a very fast rate which requires increased demand of infrastructure facilities with the growth in population. Due to increase in population the demand of housing is also increasing, so to full fill the need for construction of housing and commercial buildings the use multi-storey building is highly in demand now days. These types of development require safety both for life and property because multi storey buildings are highly susceptible to additional lateral load due to earthquake and wind. Earthquakes are the most life damaging and destructive phenomenon; these are generated due to sudden release of energy in the earth crust that creates the seismic waves which appears at different instances with different intensity level. When earthquake occurs, the building collapse and damage due to earthquake. Ground motion which is radiated in all direction from epicenter. Due to the effect of earthquake, the building encounters supreme level of displacements, the inertial force which is caused due to tendency of a building to remain at rest. All though, the lateral instability is the major issue while designing a multistory building and seismic zones are also considered while designing a multi-storey building.

*SEISMIC ZONE*:- The earthquake zoning map of India divides India into 4 seismic zones (Zone 2, 3, 4 and 5). According to the present zoning map, zone 5 expects the highest level of seismicity whereas zone 2 is associated with the lowest level of seismicity.

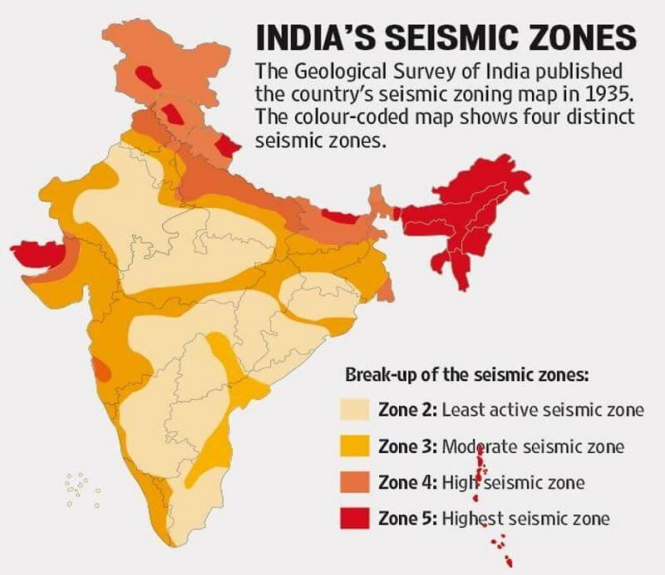


*Figure showing the seismic zones in India*

Structures which are subjected to a lateral load must have adequate stiffness and strength which helps in controlling the deflection and also prevents any damage which may occur. Steel framed construction is a new concept in which lateral loads are better resisted by bracings. Steel braced frame models are effective means to transverse lateral forces caused by earthquake and wind forces in multi-story buildings. Bracings hold the structure stable by distributing the loads. Braced frames are less in weight than shear wall so it attracts less seismic forces. There are various types of Braced Frames such as concentrically braced frames and eccentrically braced frames. These Bracings are arranged in different configuration like X Bracing, V bracing, Inverted V bracing, Single diagonal Bracing.

- ***Concentrically Braced Frames (CBFs)*:-** CBFs increases the lateral stiffness of the frame and usually decrease the lateral drift.

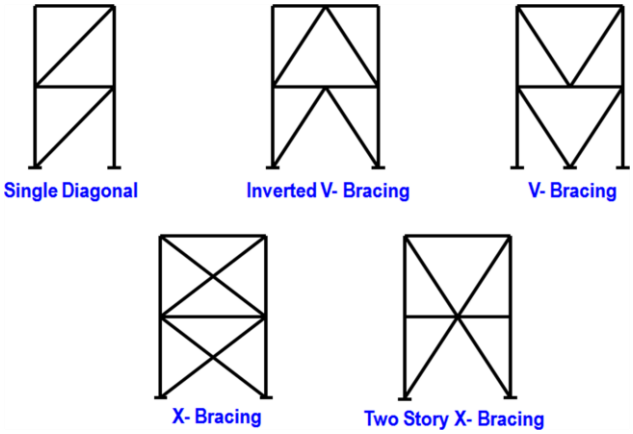


*Figure showing concentric Bracings*

- ***Eccentrically Braced Frames (EBFs):-*** Eccentrically bracing reduces the Lateral stiffness of the system and improve the Energy Dissipation capacity.
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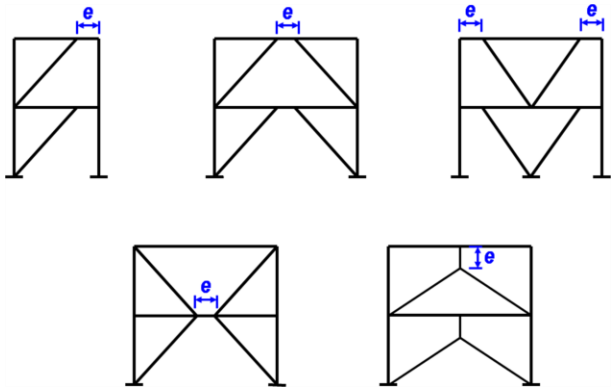


*Figure showing eccentric bracing*

## 2. LITERATURE REVIEW

**Dawn LEHMAN[1] (2004)** Proposed an innovative design methods based on balancing the control yield mechanism, secondary yield mechanism and critical failure mode to improve seismic performance of gusset plate connection used in concentrically braced frame system. Recommendation are examine for modeling the inelastic and post buckling behaviour of the brace for pushover and dynamic time history performance.

**A.H. Salmanpour[2] (2008)** Study shows that the buckling Restrained braced frames (BRBFs) can more readily satisfy the collapse prevention criteria than the special concentrically braced frames (SCBFs) because the collapse prevention probability of BRBF model is less than 2% and the immediate occupancy probability of BRBF model is 66% where as the collapse prevention probability is about 43%, a value much higher than 2%.

**N.Ozhendekci[3] (2008)** studied nine eccentrically braced steel frames with various geometries with static pushover analysis. The rotation of load pattern and maximum link rotations pattern are similar and not similar respectively in pushover and inelastic dynamic analysis for EBFs with shear link.

**S. Sabouri-Ghomi[4] (2008)** an introduction and application of easy going steel (EGS) theory for improvement of behavior of X bracing system is discussed. The lateral stiffness ductility and energy absorption capacity of the system increase and lateral drift decreases with EGS. Stability of the system increases**.**

**E.M. Hines [5] (2010)** Understood the need for further analysis determine the capacity design load on EBF column. A strong view should be given to design links as weak as possible. It discussed that longer, weaker links at the Top of the building experience problem due to higher mode effect. This paper advises to study the relationship bi/w EBF system ductility and column over strength demand with maximum link rotation capacity.

**Sanda KoboevicI[6] (2012)** This paper studied the global seismic response of 3- and 8- story eccentrically braced frames EBFs using non linear time history analysis. it was found that modeling has limited impact on force response but large influence on deformation response. Peak interstory drift and plastic link rotation have a strong correlation.

**P.SAIRAJ[7] (2014)** This paper is represent an economic aspects of G+4 multi-storey building design by using braced frame composite construction. For the ductile performance over all displacement and inter story drift can be effectively controlled by adopting braced frame model. This concept is very use full for retrofitting of and seismic up gradation of existing multi-storied building.

**R. Snehaneela[8] (2015**) Outrigger braced structures are studied using pushover analysis. 0.8m link is not sufficient but 1.5m link proved to be sufficient for 15 storey outrigger frame structure**.**

**Shachindra Kumar chadhar[9] (2015)**
The analysis is done on G+15 story building using seismic coefficient method. Inverted v bracing reduces the bending moment and shear force compared to V type bracing. Story drift and node displacement are minimum for inverted V braced frame. There is a considerable effect of arrangement of bracing on seismic performance of building.

**Sreeshma.K.K[10] (2016)** Using pushover analysis it was determine that MRF have lowest lateral strength and lateral stiffness and high deformation capacity.EBF came in b/w CBF and MRF in performance.

**Pooja.B.Suryawanshi[11] (2016)** This paper is based on analysis of Nonlinear and static pushover for the G+5 storey steel building with braced and un braced system. Braced system results enhanced level of performance not only in terms of displacement of roof but also sustaining capacity base shear.

**Muhammed Tahir khaleel[12] (2016)**
Analysis of G+9 story building with different bracing both regular and irregular building using response spectrum method. In both Regular and irregular building cross bracing gives less displacement and more base shear. Knee bracing gives least amount of base shear.

**Sara Raphael[13] (2016)** In this paper pushover analysis is used and comparative study of knee bracing is presented. Double knee bracing showed very good behavior during seismic activity with pushover analysis. The degree of inclination with $35^0$ of the knee member shows maximum stiffness.

**Mrutyunjay.S.Hasarani[14] (2016)** A 15 storey building is analyzed for eccentric K and V Bracing under response spectrum and Time history analysis. maximum storey drift is reduced in K2, K15 and V2,V15models .Base shear is increased in K2, K25, V2 V25 and V35 models.

**S.Khusru[15] (2017**) Include analysis of 10 story building using Time history analysis and shows that un braced structures gives higher displacement than the braced structures. On considering the product of unit weight and displacement, X braced system is more economical and safer than eccentric braced system.

**Swetha sunil[16] (2017)** It focuses on seismic study of reinforced concrete building with different bracing system by changing the height of the system using response spectrum analysis .X bracing is more effective than other bracing, base shear increases but drift has no effect with increase in aspect ratio.

**Safvana P[17] (2018)** Analysis of +6 G+12,G+18 storey building with various types of steel bracing mainly X braced Zipper braced and SBS is provided in each storey. Zipper bracing contributes to the reduction displacement and SBS contribute to the reduction of storey drift as compared to X bracings.

## 3. CONCLUSION

This study came to a conclusion that bracing is the most economical, safe and easy method for providing lateral stiffness to the structure. Concentrically and eccentrically braced frame are analyzed both have their own advantages since EBFs provide more space than CBFs so it is more use for further study. The X and inverted V bracing are found to be most effective under seismic loading. A new concept of providing bracing system was introduced which is knee bracing also be used as a seismic retrofitting method. Mostly response spectrum and Time history analysis methods are used for analysis in ETABS.

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***BIOGRAPHY***

Mr. Mohd Atif khan was born in 1996 in Bareilly city. He received his Bachelor of Technology degree in civil engineering from Babu Banarasi Das University, Lucknow in 2017. Now He is pursuing his Master of Technology in Structural Engineering from Babu Banarasi Das University, Lucknow.