International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

EFFECT OF BRACING AND UNBRACING IN STEEL STUCTURES BY USING ETABS

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Abstract - *The strengthening and stiffening of the system are most common dynamic performance improvement methods used for buildings to resist lateral forces. Bracing system is one of the effective structural system which plays a vital role in the structural behavior during earthquake.*

In the present study, modeling of the steel frame is done under the analysis mentioned above using E-TABS software is and the results so obtained for different bracing systems(X-bracing, Diagonal bracing) are compared. Conclusions are drawn based on the tables and graphs obtained. It's found out that steel frame with X-bracing is most suitable configuration as it shows Maximum stiffness and lower drift in compare to frame with diagonal or V-bracing.

Key Words: **Bracing System, displacement, drifts, shear force, Bending moments, E TABS 2015. etc.**

1. INTRODUCTION

In the beginning, people needed shelter to protect themselves from sun, rain and wind. They used to construct single dwelling houses with one or two storey's using mud blocks, timbers, stones etc... Gradually, the desire for better shelter increased which lead to the new invention and development in the field of civil engineering and nowadays cutting edge trend is towards more tall and slender buildings. In this way, the impacts of lateral loads on tall buildings are gaining importance consequentiality and every structural engineer is challenged with the quandaries of providing satisfactory strength and stability. Thus it is important to give satisfactory solidness and soundness in the structure with a specific end goal to discover imperviousness to horizontal loads instigated by the wind or seismic powers in tall structures. One simple solution is adopting steel braces in the RC frames. The blend of reinforced concrete frame with steel bracing enhances the behavior and performance of the structure and results in improvement of stiffness and strength of the structure.

The outline of tall structures includes a theoretical plan, surmised investigation, preparatory outline and streamlining, to securely convey gravity and horizontal burdens. The plan criteria are quality, serviceability, strength and human solace. Quakes have turned into a regular occasion everywhere throughout the world. It is exceptionally hard to anticipate the force, area, and time of event of tremor. Structures sufficiently intended for normal burdens like dead, live, wind and so on may not essentially protected against quake stacking. It is neither down to earth nor monetarily reasonable to configuration structures to stay inside flexible farthest point amid quake.

The outline approach embraced in the Indian Code IS 1893(Part I): 2002 'Criteria for Earthquake Resistant Design of Structures' to guarantee that structures have no less than a base quality to withstand minor seismic tremor happening much of the time, without harm oppose direct quakes without noteworthy auxiliary harm however, some non-basic harm may happen and points that structures withstand significant seismic tremor without fall. Structures need appropriate tremor safe elements to securely oppose vast parallel strengths that are forced on them amid incessant quakes. Common structures for houses are generally worked to securely convey their own particular weights.

1.1 Bracing Systems

Bracing is an effective and economical method of resisting horizontal forces in a framed structure. Braced frame systems are utilized both in RC as well as in steel buildings. Normally, the structure comprises of column and beams whose basic purpose is to transfer gravity load. When bracings are fixed to it, the total set of members forms a vertical cantilever truss like structure to resist the horizontal forces.

Bracing members are utilized in the building as a horizontal load resisting system to improve the stiffness of the frame for seismic forces. Braces can be connected with fixed-ended or pin ended connection. In the case of pin ended connection, it will be subjected to axial forces and it normally fails under compressive load by global buckling. Once the buckling occurs, its strength gets reduced in the succeeding cycles. But there will not be many changes in maximum tensile strength in subsequent cycles. The main advantage of using braces is that they dissipate the energy without damaging the building and also it can be replaced without any difficulty when it gets damaged.

1.2 TYPES OF BRACING

● **Horizontal bracing:** Bracing in every floor level gives a load path to transfer the horizontal forces to the planes of vertical bracing. The floor systems that are provided may themselves act as braces to provide resistance.

● **Vertical bracing:** Bracing in vertical planes (between lines of the column) provides load paths for transferring horizontal forces to ground level and provide a stiff resistance against overall sway.

This thesis work mainly deals with vertical bracing systems and therefore emphasis is given more to the vertical bracing system.

2. LITERATURE REVIEWS

Karthick S (2016) [1]: Explains the analysis of RC building for seismic analysis using different type of structural systems. Shear walls and bracing systems are the most appropriate structural forms in the recent decades. A shear wall is a wall that is designed to resist shear i.e. the lateral force that causes bulk damage to the structures during earthquakes. Bracing is also a highly efficient and economical method of resisting horizontal forces in a frame structures.

P. V. Srivardhan et al (2016) [2]: A typical 20 and 30 storeyed buildings are considered with four distinct plan shapes such as square, rectangle, plus and a T shape within an area of 40m x 40m having a span of 4m. Each building is analysed for Wind and Earthquake loads using the load combinations provided in IS code book. Three bracing types, a concrete shear wall system, steel X-bracing system and a combination of both shear wall and X-bracing for lower and upper half of the structure are used A deflection for rectangular building is lesser than square building along shorter base dimension and is higher along longer base side .

Raghavendra et al (2016) [3]: The present study made an attempt to understand the effect of earthquake on building frames resting on sloping ground with shear walls and bracings under severe zone. The computation models of ordinary moment resisting frame was developed in SAP2000 as 3D space frame to carry the seismic analysis as per IS 1893 Part (I) -2002. This study may help to understand the effect of buildings on sloping ground under seismic forces to suggest the efficient lateral force resisting configuration based on parametric study.

2.1 METHODOLOGY

In the present study, G+10 storey buildings are analyzed with and without braces. The plan consists of 5 bays of 5m center to center each in both X & Y directions and height of each storey being 3m. The plan of the building remains same for all the floors. The study is carried out for different types of bracing systems with different configurations using Response Spectrum method of analysis in ETABS 2015.

Different types of models considered for analysis

1. Building without bracings
2. Building with X-Bracing
3. Building with V-Bracing
4. Building with Inverted V-Bracing
5. Building with Diagonal Bracing
6. Building with K-Bracing

Table -1: Description of the model

Plan dimension	25m x 25m
No of grids	5 along both X & Y direction
Width of each bay	5.0 m
Height of each storey	3.0 m
Material Properties	Concrete ● Columns: M-30 ● Beams: M-25 ● Slabs: M-25 Steel ● Main bars: Fe-500 ● Confinement bars: Fe-415
Section Properties	Column section ● 0.50m x 0.50m Beam section ● 0.23m x 0.550m Slab thickness ● 150 mm Braces section (I section) ● ISMB 600
Loads	● Live load: 3kN/m2 ● Floor finishes: 1.5kN/m2

Table -2: Load combinations

Load Combination	Dead Load	Live Load	Earthquake Load
TDL + TLL	1.5	1.5	-
TDL + WL	1.5 or 0.9*	-	1.5
TDL + TLL + WL	1.2	1.2	1.2
TDL + EQ	1.5 or 0.9*	-	1.5
TDL + TLL + EQ	1.2	1.2	1.2

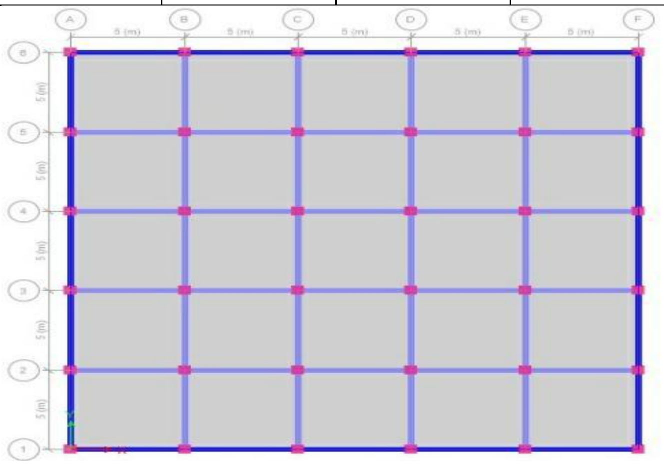

Fig. 1: Plan of the building.

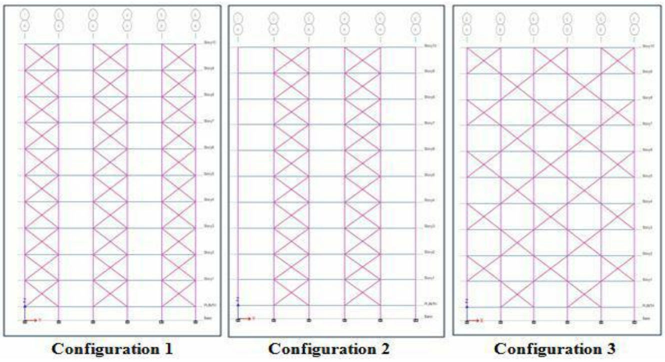

Fig. 2: G+10 RC framed building with X-bracings for different configurations.

RESULTS AND DISCUSSION

The displacement of the structure is reduced after application of braces compared to the bare frame. The maximum reduction in storey displacement is observed in X-braced frame i.e. 85.40% for Configuration 3 and minimum reduction is for K-braces i.e. 47.28 for Configuration 2.

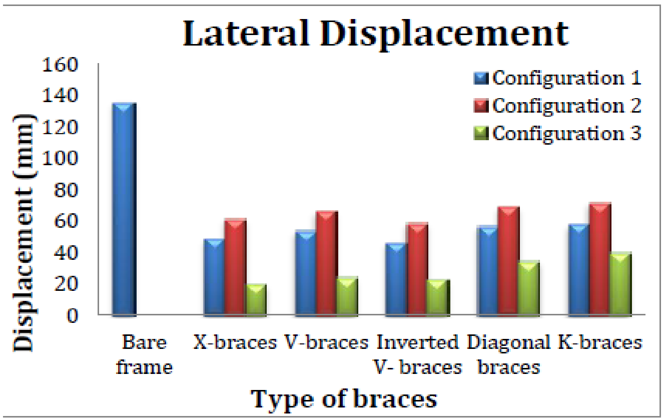

Fig. 3: Lateral displacements (mm) for G+10 storey building.

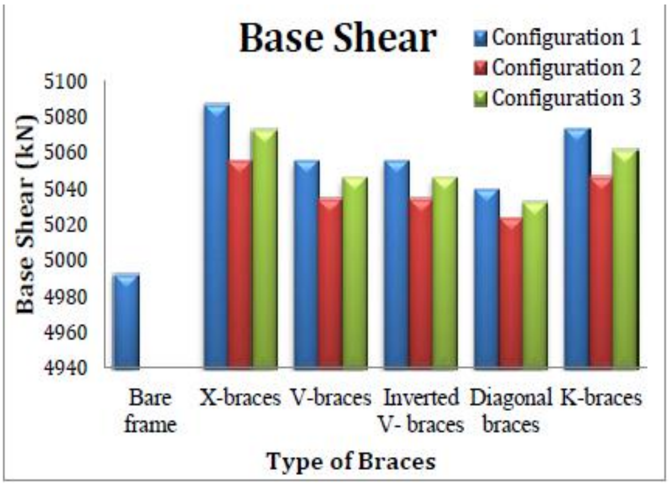

Fig. 4: Base shear (kN) of bracing system for different Configurations.

The Base shear for the bare frame is 4992.441kN in X and Y-direction respectively. It is found that base shear increases after application of bracings. The increase in base shear is more for X-braces compared to other bracing systems, as base shear mainly depends on the weight of the structure.

The time period for a bare frame is 1.745sec. The maximum reduction is 60.92% in X braces for configuration 3. After incorporation of braces, there is a reduction of the time period of the structure. This reduction is due to the fact that there is an increase in stiffness of the structure after application of braces. Therefore, braces influence the overall performance the structure.

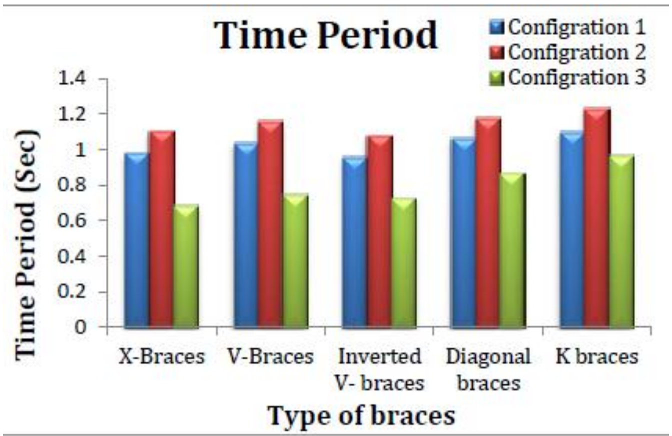

Fig. 5: Time Period (Sec) values for different bracing system

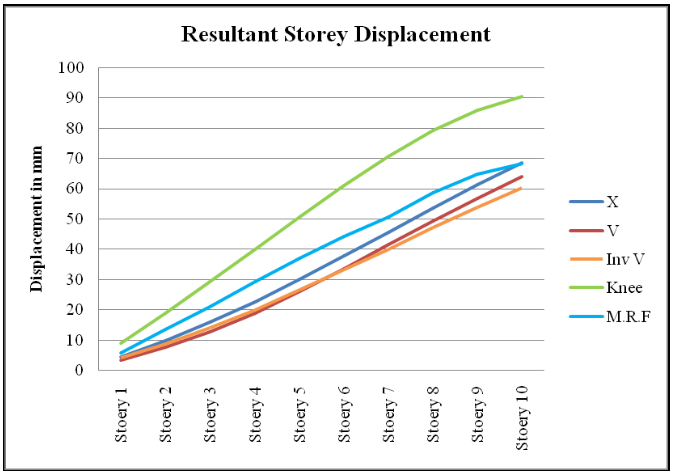

Figure 6 : Comparison of storey drift in different heights.

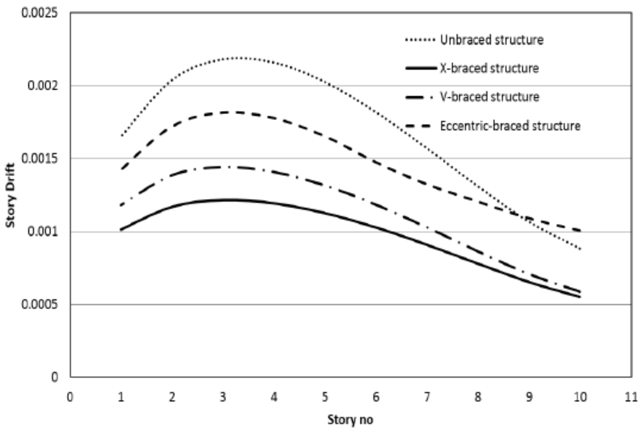

Figure 7: Story Drift of unbraced, X braced, V braced and eccentric braced structures.

3. CONCLUSIONS

● After introducing bracing to bare frame lateral displacement is found to reduce.

● Maximum reduction in lateral displacement is observed in inverted V braced frame and X braced frames.

● Inverted V-braces and X-braces shows better resistance to storey displacement. Hence, it can be recommended.

● Increase in base shear is observed after application of bracing. The minimum increase in the base shear is observed in the frame with X-bracing for all the configurations.

● The time period of the structure decreases with incorporation of braces as the stiffness of the building will be increased.

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