Comparative Study of Seismic behaviour in irregular Building with Ordinary and Eccentric Bracing System of Tall Steel Structure

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Abstract : Steel bracing systems are most widely used in medium to high rise buildings to provide stiffness, strength and energy dissipation required to resist lateral load imposed by earthquakes and wind. Steel bracing have been proved as most feasible solution for seismic Performance or strengthening of buildings. Now a days there are different type of bracing system used like eccentric and ordinary bracing. The eccentric braced are relatively new lateral force resisting system developed to resist seismic loads in a proper manner. This study represents the result of investigation on the seismic analysis of eccentric bracing with compared to ordinary type of bracing with different configuration of bracing with varying geometric irregularities like horizontal and vertical irregularities under different story height. In this study, we will analyze top story drift, story shear, and roof displacement. For this we will use ETABS software.

***Keywords* – BRB, wind analysis, steel structure, ETABS**

I. *INTRODUCTION*

In seismically active zones, structures are subjected to lateral earthquake forces in addition to bearing the primary gravity load. The performance of a structure during an earthquake depends on the intensity of the earthquake and the properties of the structure.

In case of high rise buildings, stiffness is more important than strength. Moment resisting frames and braced frames have been commonly used as lateral load resisting structural elements in steel buildings. Moment resisting frames provide ductility through yielding, but due to their flexibility, they do not satisfy stiffness criteria.

The primary purpose of all kinds of structural systems used in the building type of structures is to transfer gravity loads effectively. The most common loads resulting from the effect of gravity are dead load, live load and snow load.Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces.

1.1. Regular and Irregular configurations

Buildings with simple regular geometry and uniformly distribution mass and stiffness in Plan and elevation, suffer much less damage, than building with irregular configurations. All efforts shall be made to eliminate irregularities by modifying architectural planning and structure configuration. A building shall be considered to be irregular for the purpose of 1893:2016 standard, even if any one of the purposes of Is code 1893:2016.

Type of Irregularity:

Type of plan Irregularity:

1. Torsional irregularity
2. Horizontal geometric irregularity
3. Floor slabs having excessive cuts-outs or opening
4. Out of plan offsets in vertical elements
5. Non-parallel lateral forces system

Type of Vertical Irregularity:

1. Stiffness irregularity
2. Mass irregularity
3. Vertical geometric irregularity
4. In-plan discontinuity in vertical elements resisting lateral force
5. Strength irregularity
6. Floating or stub columns
7. Irregular modes of oscillation in two principal plan direction

1.2. Steel Bracing

The use steel bracing is also an effective solution for retrofitting and strengthening of seismically inadequate reinforced concrete frame structure. It is highly efficient and economical method to increase the lateral resistant capacity of the building by increasing its lateral stiffness.

Steel bracing is highly efficient and economic method to increase the resistance of existing structure against later forces.
Bracing improves the performance of frame structure by increasing its lateral stiffness, ductility and capacity. Through braces load can be transferred out of frame to braces by passing the weak columns while increasing strength.

Poor confinement of columns, week column beam joint, and inappropriate detailing of steel reinforcements are major factors for non-ductile behaviour of frame structure. In the presence of these deficiencies, addition of steel bracing has been proved a viable and economic solution to enhance the seismic performance of the system. Moreover, this technique of strengthening accommodates more openings and offer minimal self-weight to the structure.

A bracing system is a structural system which is designed primarily to resist wind and seismic forces. Braced frames are designed to work in tension and compression similar to a truss. Braced-frames virtually eliminate the columns and girder bending factors and thus improve the efficiency of the pure rigid frame actions. By the addition of truss members such as diagonals (between the floor systems) this can be achieved effectively. These diagonals carry the lateral loads and transfers the axial loads to the columns, which is an effective structural system.

There are mainly two types of bracing systems.

1. Concentric bracing system.
2. Eccentric bracing system.

Ordinary Concentric Bracing System

These are the type of bracings whose centroidal axis coincides with each other. They mainly increase the lateral stiffness of the frame which in turn increases the natural frequency and also decreases the lateral story drift. Further, the bracing increases the axial compression in the columns to which they are connected by decreasing the bending moments and shear forces in the column.

The steel braces are usually placed in vertically aligned spans. This system allows to obtaining a great increase of stiffness with a minimal added weight. Ordinary Concentric bracings increase the lateral stiffness of the frame thus increases the natural frequency and also usually decreases the lateral story drift. However, increase in the stiffness may attract a larger inertia force due to earthquake. Further, while the bracings decrease the bending moments and shear forces in columns and they increase the axial compression in the columns to which they are connected. Today most frames are designed and constructed as concentrically braced frames. In this system the centerline of the braces intersects the centerline intersection of the beams and columns.

The lateral load resisting behaviour of this system is highly dependent upon the behaviour of the brace, but it is also influenced by the axial and bending resistance of the frame. The bulk of the stiffness of a braced frame is provided by the brace. Therefore, the brace carries the major portion of the lateral loads until it buckles. After buckling, the brace loses strength.

Fig:1 Ordinary Bracing Frame

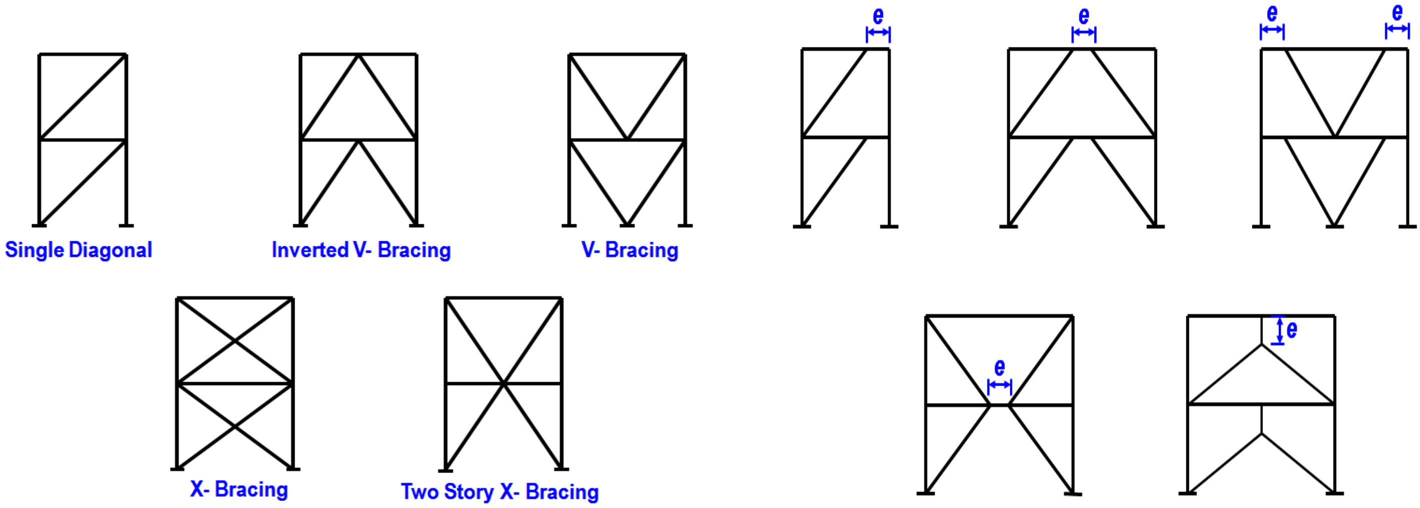

Fig:2 OCB & EB With Different Configuration

Eccentric Bracing System

These are the type of bracing whose center line braces are offset from the intersection of the center line of columns and beams.It mainly improves the energy dissipation capacity and reduces the lateral stiffness of the system.At the point of connection of eccentric bracings on the beams, the vertical component of the bracing force due to earthquake causes concentrated load.

Reduce the lateral stiffness of the system and improve the energy dissipation capacity. The lateral stiffness of the system depends upon the flexural stiffness property of the beams and columns, thus reducing the lateral stiffness of the frame.

The vertical component of the bracing forces due to earthquake causes lateral concentrated load on the beams at the point of connection of the eccentric bracings. In Eccentric braced frame, braces are eccentrically connected so that the central segment of the beam yields in shear and bending before the bracing elements could buckle.

This appears to be good design since the energy dissipation characteristics of steel beams in moment resisting frames, which are well understood, are known to be excellent. In this way they can develop full (unpinched) hysteretic loops without any reduction in ultimate strength.

This full hysteresis loops should permit the structure to dissipate a large amount of energy as large cyclic deflections can take place without failure or deterioration in the hysteretic behavior. This is because yielding occurs over a large segment of the beam web and is followed by the formation of a cyclic diagonal tension field. The web buckles after the yielding in shear but the tension field forms to prevent any deterioration or pinching due to buckling.

It is essential to have a pair of stiffeners at the brace-beam connection and to have beam flange restrain at the beam-column joint to develop the required trussing action of the beam web.It is noted that large deflections occurs in the beams and, hence, considerable damage to the floor slabs must be expected. For tall buildings the exterior braced frames are designed to carry the major portion of the lateral load. Thus the bracing is arranged in a way to reduce the high tensile loads that may develop in the lower columns.

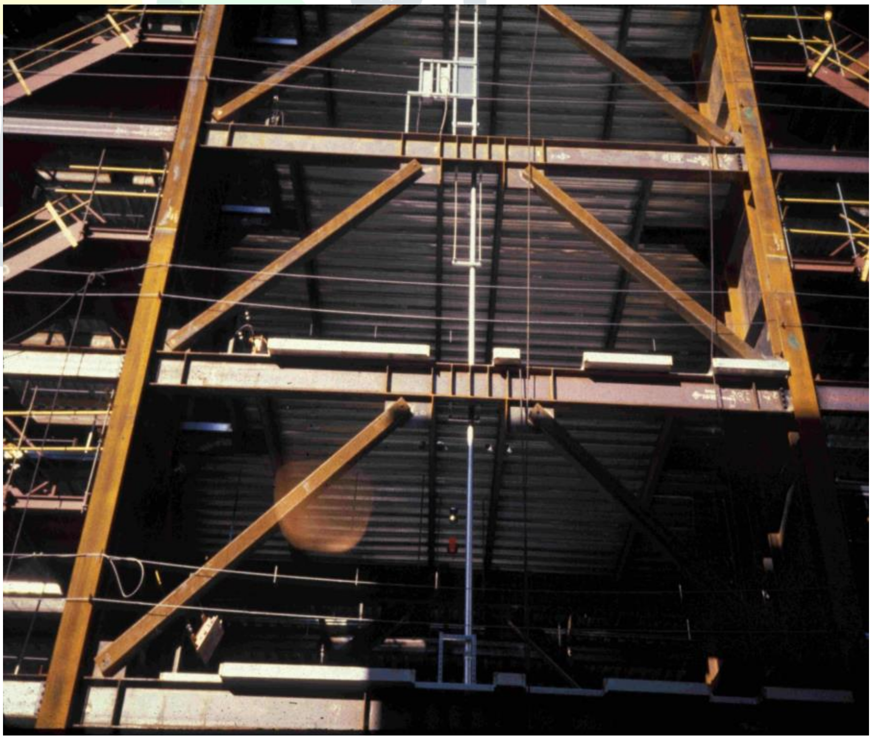

Fig:3 Eccentric Bracing Frame

1.3. Objectives :

- The main aim of this study is to various effects on performance of Tall steel structure having horizontal and vertical irregularities under different story height using ordinary and eccentric steel bracing using different bracing configuration system.
- To compare the analysis of story drift, story shear, roof displacement and time period.
- Proposing the various configurations which have better performance.

Conclusion :

- The use of BRBs in two and four bay in each of the perimeter frames of the RC building results in a significant improvement.
- The storey displacement were decreased by 45% for providing BRB in two bays and decreased by 57% for providing BRB in four bays,
- The storey drift were decreased by 33% for providing BRB in two bays and decreased by 63% for providing BRB in four bays.
- In BRBFs, braces acts more effective in inverted V geometry than in any other form in steel structure.

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