© April 2025 | IJIRT | Volume 11 Issue 11 | ISSN: 2349-6002

A Review on Dynamic Analysis of High Rise Normal and Unsymmetrical Steel Building with Eccentric Bracing System

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***Abstract*—Eccentrically braced frames (EBFs) are commonly used in steel structures as lateral load-resisting systems. These systems are designed to undergo inelastic deformations during strong seismic events, allowing them to absorb and dissipate earthquake energy. Most seismic design codes account for this energy dissipation by introducing a strength reduction factor, which reduces the calculated earthquake loads to better reflect the actual behavior of structures under seismic forces. This reduction is achieved by dividing the base shear obtained from analysis by the strength reduction factor. The factor itself is influenced by three main components: ductility, over strength, and redundancy, which depend on both the structural system and the properties of the construction materials. In this study, a parametric analysis was conducted to determine the strength reduction factor values for eccentrically braced steel frames. Key parameters such as storey height, number of bays, length of the shear link, and location of the braced bay were varied across different 2D models. Both static analysis and response spectrum analysis were used to evaluate the strength reduction factor for each configuration. The results were then compared with values recommended in various design codes to assess the influence of the considered parameters on structural performance.**

***Index Terms*—Steel Building, Ductility, ETABS.**

I. INTRODUCTION

Eccentrically Braced Frames (EBFs) became the commonly acknowledged kind of seismic resistance system after substantial study in the 1970s, 1980s, and 1990s. Prior to this study, EBF was the widely regarded method of windbreak. EBF is a kind of brace frame in which one end of the weed is linked to a beam rather than a frame node, which is shown by a black circle in a concentrated braced frame (CBF). The arrangements of CBF and EBF members, as well as the distinctions between nodes, are shown in depicts an EBF in which each weed has a length equal to half the length of the link on the longitudinal axis at the midway of the beam. Illustrates a CBF in the Chevron design, where each weft's longitudinal axis intersects the beam's center.

Lateral loads have an effect on the structural integrity of buildings. As a result, lateral loading must be avoided by the use of lateral load resistance devices such as shear walls and bracing. The structural components that brace the structure are either isolated or clustered. If the above requirement is not met, bracing is referred to as concentration if it is attached to the column beam junction or directly to the column beam junction in the beam's center. The G + 21 multi-story steel building model with the same design is used for this purpose, but with different bracing methods. This project compares disconnected high-rise steel frame structures and exhibits novel bracing techniques, as well as each frame inside a single structure, such as transverse V and single diagonal bracing. The connection system performs effectively in terms of lateral displacement, base shear, and overall weight.

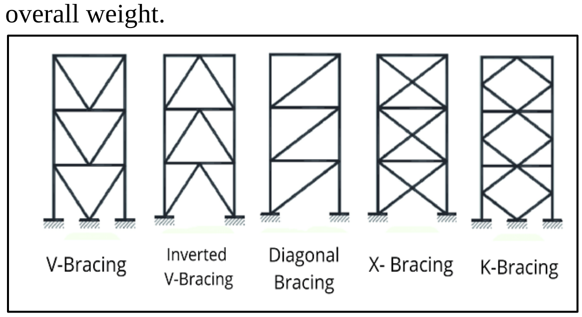


Fig 1 Bracing Details

A. V Bracing

The two diagonal members forming a V-shape extend downward from the first two corners of a horizontal member and meet at a focal point on the lower horizontal member (left hand diagram). Inverted V-bracing (right hand diagram, also known as chevron bracing) is a meeting of two members at a focal point on the upper horizontal member.

B. X bracing

Cross-bracing (or X-bracing) is when two diagonal members cross each other. They should only be resistant to stress, acting to prevent one weed side at a time depending on the loading direction. As a result, steel cables can also be used for cross-bracing.

C. Y bracing

The interconnect on each floor (in horizontal planes) provides a load path to transfer horizontal forces to the planes of the vertical interconnect. Horizontal bracing is required at each floor level; however, the floor system also provides adequate resistance. The roofs need to be connected to each other.

D. Diagonals Bracing

Trussing, or triangle, is made by inserting diagonal structural members into the rectangular areas of the structural frame, which helps to stabilize the frame. If a weed is used, it must be sufficiently resistant to tension and compression.

II. STATE OF DEVELOPMENT

1) M. Bosco et. al., (2009) Historically, analyses of the seismic behavior of overhanging frames constructed in accordance with capacity design principles have emphasized the critical relevance of the linkover strength factor. However, the link over strength factor could not account for a large number of seismic reactions since it was specified in terms of the structures' elastic nature. To get a better understanding of the seismic behavior of externally linked systems, this section defines a new metric called the Damage Distribution Capacity Factor. The suggested parameter is determined using unstable structural behavior and is meant to quantify the effect of link premature yields on a structure's potential to generate substantial inefficient behavior across all links prior to link failure. The article analyzes the influence of this parameter on the distribution of the damage distribution capacity factor and the seismic response of structures developed using capacity design concepts in severe weed constructions. Finally, an analytical connection was created between the link's high strength factor, the damage distribution capacity factor, and the link's plastic rotation in order to produce a quantitative assessment of the structural damage to unusually hanging structures upon the link's initial failure.

2) Samuel Dalton Hague, et. al. (2013) Brassed frame is a widely utilized technique for seismic lateral strength resistance in steel construction. Eccentrically Braided Frame (EBF) is a relatively recent lateral resistive structure that was created to reversibly avoid earthquakes. By cutting or simply relinquishing the link element, properly designed and detailed EBFs behave elastically. Brace extravagance along center lines or beam midpoints forms the link column. Tensile yield results in broad, balanced hysteresis traps, indicating superior energy dissipation, which is necessary for large seismic occurrences. This article details the research that went into developing EBF's behavior and the seismic specification that was employed in its design. The EBF design methodology is detailed, along with design estimates for two- and five-story buildings. The design approach is based on the minimum design load for ASCE 4-10 buildings and other structures subject to gravity and lateral loads specified in AISC 371-10 seismic norms for structural steel buildings. The equivalent lateral force procedure is used to determine the earthquake load. The final members of the two-story EBF were compared to the findings of an Eric Grusenmeyer research (2012). The parametric study's findings are reviewed in depth.

3) R. Snehaneela, et. al. (2015) Outrigger brass buildings feature an efficient structural design with a central core connected to the outside column by horizontal cantilever "outrigger" trusses or girders. When the structure is loaded horizontally, tension in the windward column and compression in the lever column cause the rig trigger to halt the core's vertical plane rotation. The effective structural depth of the structure is raised significantly, resulting in enhanced lateral visibility and a reduction in lateral deflection and main components. Indeed, the form intersects with the column's core, causing it to behave somewhat like a mixed cantilever. By resizing and evaluating the link's size, we may create a unified system in the rig trigger frame. Push-over analysis is carried out by altering the link size with the use of a computer software, SAP 2007, in order to determine their seismic performance. Elastic behavior of substantially suspended frames is critical for constructions susceptible to significant ground motion. The massively suspended structure provides maximum stiffness, strength, flexibility, and power dissipation capacity. Outrigger frames have been studied for use in high-rise steel structures that are vulnerable to seismic stress. The braces are intended to be unbound regardless of the magnitude of the lateral stress on the frame. As a result, the exquisitely woven frame provides fall protection.

4) M. Alirezaei, et. al. (2015) Two one-story, single-span concrete frames were spaced apart. The height ratios (B = H1 and B = H> 1) are used to determine the seismic resistance of concrete buildings equipped with metal yielding elements (YE). The type of the structural damage is dependent on the pace of energy absorption. Thus, study into the behavior of structures based on the notion of energy may be regarded a critical approach in the development of seismically resistant structures. It is required to concentrate perceived energy on particular yielding components in order to lower the concentration of critical components and/or to avoid harm. The use of metal yielding dumpers is a very effective technique for retracting old buildings and generating seismically new concrete structures. Metal dampers distort during an earthquake and operate similarly to fuses, which may then be replaced. This research employs a parametric approach based on static analysis to ascertain the optimal placement and angle of these pieces inside the frame. Furthermore, the reactions of these frames to three earthquakes are presented and compared. It was discovered that the yielding element in a solid reinforced structure emits up to 60% of seismic energy.

5) Swapnil N. Dhande, et. al. (2015) The structural structure of the structure must withstand lateral stresses caused by gravity, as well as earthquakes and wind. The lateral load generates significant tension, which results in vibration and flow. If a structure is not constructed to sustain lateral loads, it may collapse, resulting in the death of occupants or damage to the structure's contents. Therefore, it is critical that the structure be not only strong enough to sustain the gravitational load, but also stiff enough to endure lateral forces. According to the assessment of the literature, LLRSS (Lateral Load Resistant Structural System) is used as a base isolation device and dampers to regulate seismic vibration and lateral flow. However, these gadgets are prohibitively costly and are only effective on towering structures. As a result, it is necessary to research LLRSS or other technology that is suited for the precise height of the structure. The goal of this study is to present a simple but effective LLRSS or seismic control technology and approach that can be applied in both new and existing structures. Since the 1994 Northern Earthquake, it has been shown that concentrated hanging steel frames, also known as LRSS, have been popular in seismic zones. Despite its increasing popularity, analytical research on brass frame building in India is limited, as is the ubiquitous requirement to manage seismic reaction. Due to the great size of the members of RC structures, they have a high dead load, which may result in interior damage during earthquakes. Thus, it is recommended to investigate the response of steel buildings/frames equipped with various kinds of steel bracing configurations in the form of LLRSS with the purpose of reducing vibration and story drift. The duration, natural frequency frequency, and roof displacement were chosen as the structural response characteristics for the investigation. The purpose of this research is to conduct a parametric analysis of the non-linear time history analysis (NLTHA) response of three-dimensional industrial steel structures with varying bracing configurations using SAP-2000 software during the Bhuj earthquake. Bracing configurations utilized in SDB, CDB, VVB, and INVB concentration bracing to highlight the compatibility of certain bracing designs with the structural integrity of the building under seismic stress.

6) Muhammed Tahir Khalee, et. al. (2016) Lateral stability is critical for steel constructions that are located in seismic zones. A bracing system is an excellent approach to improve lateral strength. Additionally, attempts have been made to assess the impact of seismic stress on regular and irregular steel-framed tall structures using a variety of bracing techniques in order to determine the optimal bracing method. Buildings are modeled and evaluated by ETABS, and sections are chosen for their ability to regulate the greatest lateral floor movement. According to IS 1893-2002, Zone V was chosen for the investigation. The equivalent static technique and the response spectrum approach are used to do the analysis. Numerous characteristics were investigated,

including displacement and base shear. The research finds that cross bracing is the optimal bracing strategy for reducing floor movement in simple and irregular structures. Additionally, because to the higher viscosity, the cross-bracing system exhibits a significant base cut.

7) B.M. Broderick, et. al. (2012) The method investigates the seismic response of uniaxial multi-story steel brass framed buildings by using a variety of transient dynamic testing techniques in conjunction with numerical modeling. Dynamic testing entails substructured hybrid tests in which the first level of a complicated brass frame in an irregular structure is physically examined as the remainder of the structure's reaction is developed concurrently. The seismic response of unplanned multi-story brass frame buildings is investigated parametrically using linear time history seismic analysis, comparing the confirmed open-source model to the findings of this experimental hybrid test. This approach is used in parametric studies to identify critical parameters affecting the seismic response of irregularly woven structures, such as static extremes and lateral torsional frequency ratios. The seismic response parameter is the displacement ductility demand for the flooring, which is inversely proportional to the critical response volume of the weed member deformation ductility demand.

8) ThasneemYaseen, et. al. (2016) Brass frames are the most often used kind of structure because they are cost effective to build and simple to evaluate. Bracing is a cost-effective method of improving the global stiffness and strength of steel frames. The current research analyzes a typical ten-story steel frame with X bracing for various IS steel sections with varying depths. The structure is in Seismic Zone III. Response spectrum analysis is used to assess the seismic performance of a multi-story steel frame structure and to determine the component that is most successful in preventing lateral loads. ETABS was utilized to conduct this investigation. Maximum floor drift, maximum floor displacement, response spectrum, and floor drift floor cut are all terms used to describe the maximum floor drift.

9) Gayatri Thakre, et. al. (2016) A structure that is capable of withstanding a wide variety of loads. The structure must be solid and robust to withstand lateral loads. Due to the structure's height limitation, the cross-sectional area of the bottom component rises in order to ensure stiffness and avoid lateral loads. Otherwise, the floor portion below will be big, making maintenance difficult and installation impossible in the case of steel structures. There are several ways for preventing lateral forces; however, cutting walls and bracing are the most well-known. The wind impact as a side load on different co-centered bracing systems is discussed in this article. Diagonal, V-bracing, and transverse V bracing are all examples of comparison bracing systems. STAAD Pro V8i SS6 is a software analysis tool that compares a variety of factors.

10) Yatendra Singh, et. al. (2016) The reaction of brass steel frames has been widely researched in a variety of structural engineering fields. Numerous academics have spent years examining these structures in detail, primarily for their capacity to support an external load. Because frames that resist each specific moment are subjected to significant lateral stress, they are prone to lateral displacement. As a consequence, engineers have resorted to brass steel frames as a cost-effective method of absorbing seismic stress. According to IS 400-2007, the present research used a Steel Moment Resistance Frame (SMRF) with a centralized connection. Comparative studies are conducted on K bracing, transverse V bracing, X bracing, and unbranded steel frames. Each kind of steel frame has proportions equivalent to G + 9 floors, with a maximum height of 30 meters. Each level is three meters high and is labeled with four digits. Bay with a length of 12 meters and a width of 12 meters (12 m). The analysis is carried out with the help of the industry-standard program STADD Pro. By including various methods of bracing, it is possible to compare these models for various parameters such as shear force, bending moment, displacement, narrative drift, and lateral pressures. Equivalent static analysis is used to determine the performance of each frame.

11) Sina Kazemzadeh Azad, et. al. (2017) This article summarizes studies on Steel Accelerated Braided Frames (EBF). The reactions of such hanging frames at the component and system levels are addressed and analyzed. A detailed assessment of the inquiry into the key causes of energy dissipation in the EBF is offered for a component level response. The authors present the findings of experimental and numerical investigations on force, rotational capacity, and connection overload. Additionally, investigations on the impact of axial force, the presence of visible slabs,

loading history, compactness, link details, and lateral bracing on link behavior are summarized. The existing research on link-to-column linkages is analyzed. Additionally, several techniques to numerical modeling of linkages are discussed. The features of EBF systems are explored at the system level in light of the capacity design method. The findings of statistical analyses of the seismic performance of EBFs are addressed in order to shed light on the response parameters that should be employed in their design. Additionally, specific sections on replaceable connections and upcoming uses of the EBF are included. The study findings are used to highlight the influence of the study findings on the design of EBF systems that comply with AISC seismic requirements for structural steel structures. Finally, future research requirements for improving EBF design and implementation will be outlined and shown.

12) Chaitanya CVK, et. al. (2017) The purpose of this research is to investigate the influence of various factor ratios on the estimated response reduction factor value for various braced and unbraced steel frame types. The aspect ratio is the ratio of the building frame's total height to its base width, when the total height of the building frame fluctuates but the base width remains constant. As a result, all structural models are assessed using three bay frames, and two-dimensional steel frame models are examined without bracing, with middle bay bracing, and with one to five various aspect ratios. External bay bracing of different brace designs is included in the latter. ETAB software is employed in this analytical work, and static nonlinear push-over analysis is utilized to estimate the response reduction factor (R) values by calculating the components of the R-factor, which include the over-strength factor and the ductility reduction factor. Finally, R values from the static push over curve are presented for several structural models with varying aspect ratios.

13) Man Mohan Singh, et. al. (2017) The most often employed technology for resisting seismic stresses in a framed construction is a concentric hanging, unusually hanging, and moment-resistant frame. This research exhibits the behavior of these frames and also shows why they were designed with seismic requirements in mind. Three three-story, six-story, and nine-story frames are being examined for investigation. Comparative studies in diverse sectors are undertaken in accordance with the Indian Code of Practice IS 800: 2007 and IS 1893 (Part-1): 2002, with STAD Pro V8I software utilized for loading conditions and frame analysis. Proceeds

14) Amol Patil, et. al. (2018) The goal of this study was to investigate effective bracing methods for G + 20 buildings using STAAD.pro v8i. The goal of this study is to use staad.pro v8i to assess and design numerous factors in high-strength steel construction. To do this, the G + 20 structure is employed in conjunction with novel bracing methods to withstand a variety of lateral loads. Staad.pro design and analysis findings for efficient bracing systems

15) Jorge Ruiz-García, et. al. (2018) The purpose of this work is to evaluate the seismic response of extreme braced frames (EBFs) to simulated narrow-band mainhoshock-aftershock sequences using a precise analytical design typical of Mexico City Code-compliant structures. These mathematical models explain for the link's linear behavior, as well as the failure criteria. According to engineering experience, powerful aftershocks after link failure considerably increase interstory drift requirements, although surrounding components (adjacent beams, columns) behave normally, contrary to design philosophy. Additionally, a nununiform distribution of hysterical energy with link height is seen, which does not completely use the shear link's energy dissipation ability.

16) Pei Chi, et. al. (2019) Self-centering bracing systems are regarded to be excellent methods for achieving seismic ductility because they may lessen the residual deformation of structures after an earthquake. The seismic response of intermediate and high-rise steel-framed structures equipped with innovative self-centered pressure-only bracing (SC-TOB) is statistically studied in this article. (The visibility attenuation factor, activation pressure, and initial axial visibility of SC-TOB are explored in order to establish the optimal design position for the SC-TOB frame (SC-TOBF) in relation to their unique stability. Bracing systems that are conventional. Steel frames resembling BRBs) were also developed and tested for comparative reasons (E findings indicate that raising the viscosity attenuation factor improves the SC-second TOBF's appearance and effectively boosts the interstory. While excessive activation of TOBFs may cause distortion, it has a little impact on interstory drift; it can, however, improve early axial vision. Fewer narratives. Comparable to the BRB

frame in terms of behavior. Additionally, a high By selecting a high visibility attenuation factor and a low starting axial visibility, the seismic action on the SC-TOBF may be effectively mitigated, resulting in a rather uniform distribution across the building's height. (E SC-TOBF is regarded a sort of performance-tunable structure, and tuning is accomplished by adjusting the frame's adjustable characteristics.

17) Arshia Keivan, et. al. (2019) The purpose of this article is to conduct a statistical analysis of steel self-penetrating actuated brass frame (SCEBF) structures that have been subjected to seismic excitation. The goal of this work is to analyze the nonlinear seismic system behavior of two different kinds of SCEBF systems - K-type and D-type SCEBF seismic (DBE) level systems, depending on their design. The SCEBF system has been shown to be capable of replacing typical steel EBFs via the use of two prototype framed buildings, a three-story D-type and a four-story K-type SCEBF building intended for Los Angeles, California. In contrast, may be intended to offer strength and stamina. When maintaining plumbing systems that have been subjected to seismic ground motion excitation at a DBE level. The non-linear time history analysis reveals that the residual drift of SCEBF is quite minimal and that structural damage is mostly limited to fusing devices below the DBE. Additionally, parametric research was conducted using three different amounts of post-tensioning (PT) cables for K- and D-type SCEBFs to highlight the method by which self-centered EBFs tune their seismic behavior to starting pressures. Complete. The findings of the parametric simulations indicate that by carefully adjusting the length and beginning stress level of the PT cable, critical structural characteristics such as equivalent yield strength and SCEBF's post-gap opening visibility may be modified

III. LOW-RISE BUILDING IN ETABS (IS 1893:2016)

A. Normal Building

- Steel Frame Model

Size: (L*B*H) = (0.3*0.15*1.21) m
Each bay has length = 0.3 m
Material: Steel
Section size: 12.5 MM (0.5 inch) Box section
E = 197.30 KN\mm^2
Poisson's ratio = 0.3
Density = 7833.41 Kg/m^3

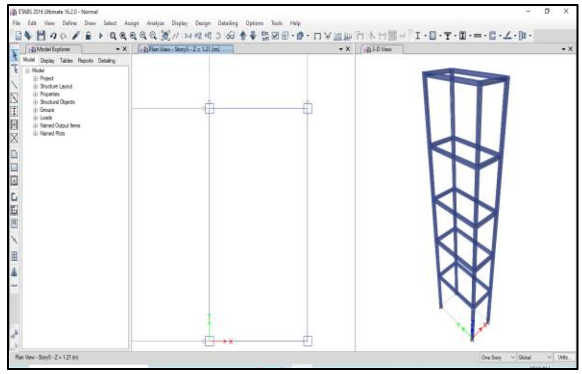


Fig 1 Normal Building

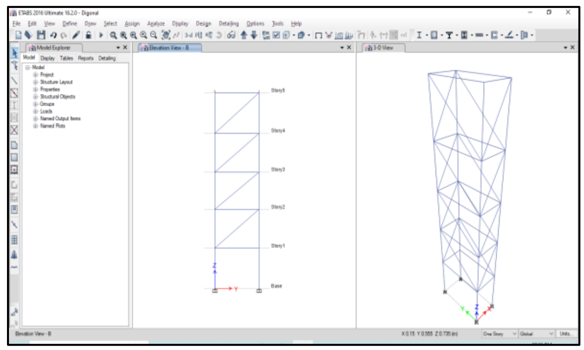
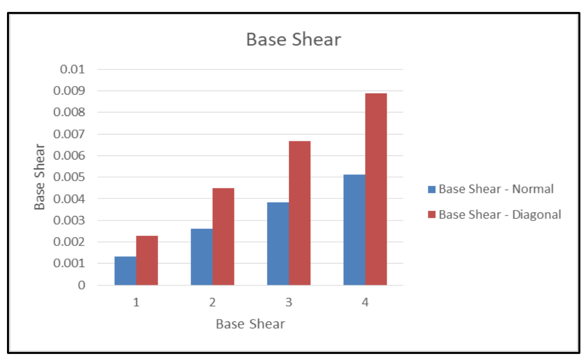


Fig 2 Diagonal Building Model

Table 1 Comparative Analysis Results for Base Shear

Base Shear - Normal	Base Shear - Diagonal
0.00132	0.00228
0.0026	0.0045
0.00384	0.00668
0.00512	0.0089
0.00644	0.01022



Graph 1 Comparative Analysis Results for Base Shear

Base shear is dependent on the input earthquake history, and a building's design base shear is low if it's not expected to experience high dynamic forces.

IV. CONCLUSION

Modern steel buildings are increasingly required to withstand complex loads, including seismic, wind, and live loads. Bracing systems are crucial for improving the lateral stiffness, stability, and strength of steel structures. However, selecting the appropriate type of bracing system is challenging due to varying structural demands, economic considerations, and safety requirements. The need for comparative analysis of different bracing systems arises to determine their influence on the building's performance under various loading conditions. This analysis will help in optimizing designs for better structural efficiency, cost-effectiveness, and safety compliance.

Need To Conduct a Study of Efficient Eccentric Bracing Systems in Tall Steel Buildings. Need To conduct an analysis and design of many parameters in a high-rise steel building utilizing staad.pro v8i to accomplish this, a G+20 structure with eccentric bracing will be employed under various forms of lateral strain.

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