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Seismic Analysis of Multi-Storey Irregular RCC Buildings with Bracing System: A Review

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Abstract – In this review paper we study some research papers which are relevant to my topic. Steel bracing system is one of the most suitable methods for improvement of reinforced concrete structures against lateral loading. Bracing systems is very efficient in reducing lateral displacements by increasing stiffness and strength. We reviewed studies on reinforced cement concrete structures, or frames, that included various bracing systems in this review paper. Once these studies are finished, we shall write some conclusions. The RC structure is fastened to the X, V, K, etc. steel bracing system in the earlier study project. The primary goal of the steel bracing system is to lessen the impact of wind and seismic activity on the structure, preserving the building's safety. Wind and seismic analysis are used to analyse this construction.

Indexed Terms- RC Structure, Steel bracing, seismic analysis, Wind analysis, ETABS, SAP2000.

I. INTRODUCTION

The transfer of gravitational loads is the main purpose of structural systems design in buildings. Other than these, in addition to vertical stresses, buildings can experience lateral loads from blasts, wind, earthquakes, and other events. Because of this, the main consideration in the design of multi-story structures is to ensure that the structure has adequate lateral stability to withstand lateral stresses and manage lateral drift. To improve the lateral resistance of tall structures, a variety of structural methods are currently available, including outrigger systems, frame-tube, braced-tube, bundled-tube, rigid frame, braced frame, and shear walled frame.
Laterally braced systems often reduce the amount of relative lateral movement and, as a result, damage by stiffening a building against horizontal stresses. It is evident that lateral displacements are the main cause of both structural and non-structural damages that are exhibited during earthquake ground motions. Therefore, shear walls or steel bracing are frequently utilized to strengthen the seismic strength of framed structures. Steel bracing, however, seems to be a superior option given its ease of fabrication and affordable price. Steel bracings can be placed in the following configurations: diagonal, cross, X, V, inverted V, or chevron. This study examines the use of cross bracing, one of the most successful bracing systems, in irregular reinforced concrete buildings.

1.1 Type of the Irregularities
A. Plan Irregularities
B. Vertical Irregularities

1.2 Type of the bracing system
There following are types of the bracing system provided in the structure:
A. X bracing system
B. K bracing System
C. V bracing system
D. Diagonal Bracing system
E. Eccentrically Bracing System
F. Inverted V Bracing system

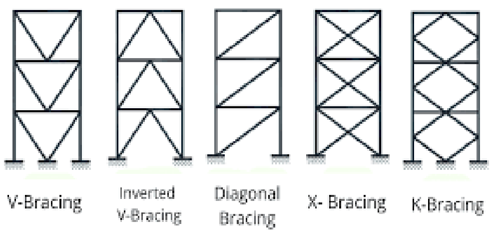

Figure 1. Types of Bracing System.

II. LITERATURE REVIEW

The summary of the research paper is given below:

2.1 Anjaly Anilkumar, Ann Mary Jose (2023) [(1)]

The purpose of this project is to use ETABS and sophisticated software to study how normal and vertical irregular dwellings behave under lateral and static loads. It focuses on how the geometry of the structure affects its ability to withstand lateral forces. Three distinct configurations are examined in the study: the L-form, I-form, and rectangular form. Structures with asymmetrical floor patterns are more vulnerable to torsional forces. Steel bracing constructions' great strength, stiffness, and financial advantages can boost their resilience to earthquakes. This study can be applied to the analysis and design of new and existing irregular building systems. According to the study, regular structures in zone V soft soil experience less force and better protection during earthquakes. It highlights how crucial it is to distribute loads evenly and steer clear of anomalies. Bracings can lessen movement.

2.2 Rahul Kumar Meena, G P Awadhiya, Abhishek Prakash Paswan and Harshit Kumar Jayant (2020) [(2)]

Concentrically braced frames have replaced moment-resistant ones in steel construction in seismically vulnerable places. This study examines seven models and examines the effects of seismic and wind pressures on a 20-story steel frame building. The Backward bracing pattern is the most preferred bracing design because it minimizes horizontal displacement in a backward braced frame construction by about 50%. This article focuses on bracings for horizontal deflection resistance and earthquake-prone zones, presenting a pattern-based classification for structural structures of tall buildings. The study comes to the conclusion that forward bracing yields the maximum bending moment and inverted backward bracing yields the maximum shear force. About 50% less horizontal movement occurs when using backward bracing. Future studies ought to concentrate on braces with significant shear forces and bending moments in particular applications.

2.3 Ayaanle Ali, Erdal Coskun, (2020) [(3)]

This study focuses on retrofitting existing reinforced concrete buildings using steel bracing systems as an active part of the lateral load resisting system. The main objective is to check the performance of the concentric bracing system using static nonlinear pushover analysis and static linear system (equivalent method). The study compares different types of CSB systems to find the most effective during earthquakes. The tested types include x-bracing, diagonal bracing, inverted bracing, and zipper bracing. The study uses various RC structures, including three-story, five-story, nine-story, and twelve-story buildings.

The pushover method is applied to all models, and the results show that the X bracing system is the most irresistible compared to other types. X-bracing systems increase the structure's strength and participate in energy dissipation. The sequence of hinge formation in braced frames is first in the brace member, followed by the column and beam. If joint stiffness and column stiffness increase, it reduces axial deformation of structural elements. This research highlights the importance of considering earthquake loads when designing moment resistance frames for reinforced concrete buildings.

2.4 Shivani B. Dasare, Prof. Mrs. Kariappa M.S. (2022) [(4)]

The need for housing is increasing because to India's expanding population, which makes the building of multistory buildings vertically necessary. While structures made of reinforced concrete are essential for withstanding gravity loads, lateral loads from winds and earthquakes can cause greater harm. Measures for earthquake-resistant structure design must be implemented in order to lower this risk. The purpose of this study is to use the X and V bracing systems—which are thought to be the most effective during earthquakes—to examine seismic and wind stresses. An alternate approach that decreases lateral movement and increases stiffness is the use of steel bracings, as demonstrated by the examination of G+8 and G+6 reinforced concrete buildings. X bracing is a dependable and practical retrofitting technique for multistory buildings in seismically active areas because it is more successful at reducing lateral displacement and story drift.

2.5 MOHD HUZAIFA YAMAN, SHABANA, (2022) [(5)]

The study investigates the dynamic behaviour of multi-storied buildings in seismic zones with different bracings. The research was conducted on three different stories in Zone V, using X, K, V, O, and X-O, V-O, K-O bracings. Non-Linear Time history analysis through FEM using SAP 2000 was used to determine parameters such as story displacement and story drift. The results showed that the combination of K-O bracing resulted in 12% less story displacement and 11% less story drift compared to other bracing combination. The study concluded that K brace (65.8 mm) was less effective than X (58.5 mm) and V (58.13mm) braces, as the displacement due to K brace is 1.2 times greater than that of V brace. The K-O brace combination was found to be effective due to its less displacement. The study also found that concentrically braced frames had high ductility performance, which can be easily retrofitted with framed structures and effectively control building responses like story drift and displacement. Story displacement was reduced significantly, with X bracing and V bracing being more effective. The study proposed a new type of bracing system, the O-Grid bracing system, which is ductile and rigid, allowing it to be used in any portion of the structure without sacrificing architectural space or firm.

2.6 Snehal Mevada, Darshana Bhatt Aryan Kalthiya, Neel Parmar, Vishal Baraiya Dhruvit Bhanderi, Tisha Patel (2022) [6]

The suggested project uses STADD PRO and dynamic analysis to examine multi-story (G+4) RCC buildings with four irregularities while taking seismic zone IV and medium soil into consideration. The impact of various irregularities on storey displacement, storey drift, and storey shear are the main topics of the study. The findings indicate that stiffness uneven structures with soft storeys at bottom level have the lowest storey shear, while regular structures have larger storey shear. At soft storey levels, storey drift values are higher, which raises the possibility of structural failure. Because they have larger columns along one side, torsional irregular structures have higher storey shear values; however, storey drift and displacement are less along torsional irregularity. Compared to regular structures, plan irregular structures exhibit reduced shear values, drift, and displacement.

III. GAP ANALYSIS

These gaps or areas of concern are crucial for improving the structural performance and safety of such buildings:

- The examination of multi-story reinforced concrete buildings equipped with cross bracing systems and various design differences.
- The seismic zone of the seismic analysis will be changed for the purpose of conducting another investigation.
  Zone of Seismic Activity V.
- Comparative analysis using various building shapes, such as L & T & Plus & C & H.
- Different software can be used to conduct the same study.
- If the kind of bracing (such as cross or zigzag bracing) or the position of bracing are altered, further research must be done.
- Comparative research using base isolation and bracings.
- Using various seismic zones, as well as various earthquake data and the impact of bracing systems on torsion in structures that have irregular mass, stiffness, and combined plan shapes.
- To contrast the outcomes of linear dynamic and static analysis. OR combining non-linear dynamic and static analysis.

CONCLUSION

This study uses dynamic seismic analysis and Staad-Pro software to investigate irregular structures in 12-story buildings. When massive masses are shifted, the results demonstrate that columns wobble minimally from side to side, but L-shaped structures are not as resilient to lateral forces. Innovative design and construction techniques require a thorough understanding of irregular structures. In seismically risky areas, moment-resistant steel frames have been substituted with concentric braced ones. The study's main objective is to retrofit steel bracing systems as an active component of the lateral load-resisting system into already-existing reinforced concrete buildings. All models use the pushover approach, and the X bracing system is the most enticing when compared to other kinds. The study looks into how multi-story structures behave dynamically in seismic zones when they have various bracings.

Using a variety of bracings, the study investigates the dynamic behaviour of multi-story buildings in seismic zones. It was discovered that the K-O bracing combination decreased drift and story displacement by 11% and 12%, respectively. Less displacement meant that the K-O bracing combination proved to be more effective. Additionally, the study discovered that concentrically braced frames perform well in terms of ductility, which facilitates retrofitting. A rigid and ductile alternative called the O-Grid bracing system was suggested. Additionally, the study looked at four abnormalities in multi-story buildings: storey displacement, drift, and shear.

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