© November 2025| IJIRT | Volume 12 Issue 6 | ISSN: 2349-6002

Seismic Response Analysis of Multi-Storey Asymmetric Buildings for Various Type of Bracing Using Etabs

Hrishikesh [1], K. V. Mahesh Chandra[2], Puneeth M S[3]
[1]Student, Department of Civil Engineering, Bangalore Institute of Technology, Bangalore, Karnataka, India
[2]Assistant professor, Department of Civil Engineering, Bangalore Institute of Technology, Bangalore, Karnataka, India
[3]Assistant professor, Department of Civil Engineering, Bangalore Institute of Technology, Bangalore, Karnataka, India

Abstract- The evolution of multi-storey building structural systems based on new structural concepts with newly adopted high strength materials and construction methods have been towards "stiffness" and "lightness". Recently braced structural system is adopted in buildings due to its structural efficiency and flexibility.

To enhance the seismic performance of tall buildings, various bracing systems are employed. Braces are structural elements designed to provide additional lateral support, improving the building's ability to withstand seismic forces. The angle and configuration of these braces can significantly impact the building's response to earthquakes.

Earthquake is the natural calamity known to mankind from many years, from the antiquated time researchers looked into numerous approaches to secure the structures. There was a need to control the damage caused by earthquake to the existing buildings. Many strengthened solid structures need retrofit to overcome inadequacies to oppose seismic loads. Bracing was the best technique which can be used to existing reinforced concrete buildings. Steel bracing is economical, simple to erect, involves less space and has adaptability to plan for meeting the required strength and stiffness. The present work deals with study of effect of steel bracings on RC framed structures.

For present study, 12 Storey Multi storey Asymmetric building having Regular Square shape with different Bracings and without Bracing structure is considered and is modeled using ETABS software for dead, live and earthquake. It is assumed that the structure lies in a zone 5 of medium soil. Linear static and Dynamic analysis is carried out and scale factor considered as per IS code in both X and Y directions. Comparison between the structures with varying Bracings and without Bracings is to be done and to compute the results. It is expected that for the Multi-storey Asymmetric system can be used for the better performance of lateral load and gravity load resistance.

I. INRODUCTION

Multi-storey buildings started being built tall in the late 1800s because of the need for places to work and live. Nowadays, it's really important to understand how tall buildings have changed over time because our cities are growing really fast, and there's not much space left on the ground. So, we have to build upwards to accommodate more people and make the best use of the limited space available.

The advancement of high-strength concrete, superior materials, innovative construction techniques, and sophisticated engineering methodologies has ushered in a new era of flexible, low-damping, slender, and lightweight tall structures. The resurgence of high-rise construction is now indispensable for urban expansion, driven by the need to accommodate a growing population and the escalating demand for residential spaces.

Multi-storey buildings, commonly known as high-rise or mid-rise structures, are integral to urban architecture, designed to accommodate several floors above ground for various uses, including residential, commercial, and mixed-use purposes. These buildings maximize land efficiency in densely populated areas, offering innovative designs and advanced structural systems that ensure stability and safety. Key features include vertical transportation systems like elevators and stairwells, as well as integrated utilities for plumbing and HVAC. Modern multi-storey buildings increasingly prioritize sustainability, incorporating energy-efficient systems and green spaces. While they provide numerous benefits, such as enhanced community living and economic viability, they also present challenges like regulatory compliance, higher construction costs, and ongoing maintenance needs. As urbanization continues to rise, multi-storey buildings will play a crucial role in shaping sustainable and vibrant cities.

1.1 EFFECTS OF SEISMIC LOADS ON HIGH RISE BUILDINGS:

Seismic loads, generated by the forceful tremors of earthquakes, exert profound and potentially devastating effects on Multi-storey buildings. The unique characteristics of these towering structures, such as their height and structural complexity, render them particularly vulnerable to the seismic forces unleashed during an earthquake. These effects include structural damage, lateral sway, base shear forces, and resonance phenomena, all of which can compromise the integrity of the building. To counter these challenges, engineers employ innovative design techniques, like controlled lateral movement and dampening systems, to mitigate structural damage and ensure occupant safety Multi-storey buildings must also contend with non-structural damage, vertical accelerations, and the critical importance of adhering to building codes and regulations tailored to seismic-prone regions. Retrofitting existing structures and conducting rigorous seismic hazard assessments are essential steps in bolstering the earthquake resilience of these iconic edifices. In sum, the intersection of seismic loads and high-rise buildings demands meticulous engineering, comprehensive planning, and unwavering commitment to safeguarding both occupants and the structural soundness of these towering urban landmarks

1.2 INTRODUCTION TO BRACED SYSTEM:

Bracing is a critical structural element used in engineering and architecture to enhance the stability and rigidity of buildings, especially in multi-storey constructions. By employing diagonal members or braces, this technique helps resist lateral forces caused by wind, earthquakes, or other dynamic loads, thereby preventing structural failure or deformation. Bracing systems can be categorized into various types, including cross-bracing, K-bracing, and shear walls, each offering unique advantages depending on the design requirements and environmental conditions. Effective bracing not only ensures safety and structural integrity but also allows for more open floor plans by reducing the need for extensive interior columns. As urban environments become increasingly complex, the role of bracing in providing robust, resilient structures is more important than ever.

II. LITERATURE REVIEW

2.1 LITERATURE SUMMARY

A literature review helps us to get the current state of a topic and to understand the current demand. It's a short way to represent past published work based on study, rather than reporting new facts or analyzes. It is termed as survey articles or, in news release, overview articles. For the current project the review of article is based on the Diagrid system structures.

Iftekhar, C. S. R., Kabir, E., & Farnaz, T: The percentage reduction in maximum storey displacement is found out. It is find out that the type of concrete bracing significantly contributes to the structural stiffness and reduces the maximum storey drift of the frames. Bracing reduces maximum deflection from 1.1215 inch (no bracing) to 0.12936 inch (full bracing) Bending moments from 717.091 Kip-in (no bracing) to 202.757 Kip-in (partial bracing).

Goudar, S. S., & Talasadar, R. G. (2017).: This study evaluates the buckling behavior of reinforced concrete buildings with various bracing types, bare frames, P-Delta effects, slenderness ratios. Using ETABS and ANSYS for single and three-storey buildings, the analysis shows that bracing systems enhance both structural stiffness and buckling resistance. Among various bracing types, Inverted V bracing yields the highest buckling factor improvement, with increases of up to 89% compared to no bracing. Simulations from ETABS and ANSYS show variations of up to 25%, but overall, adding bracings increases the structural strength and stiffness.

Akshay Trivedi , Dr. Gunjan Shrivastava , Kishor Patil: From the study a comparative statement has been made for the use of bracing at different locations of tube in tube building. Comparative analysis will ease the designer to select the proper bracing type and location for high-rise tube in tube buildings. From the two-location decided for bracing i.e., centre and corner for the study, it has been found that centre bracing system with angle section performs well as compare to other bracing system and location

Prof. Bhosle Ashwini Tanaji: The percentage reduction in storey displacement is found out. It is found that the which type of concrete bracing significantly contributes to the structural stiffness and reduces the maximum storey drift of the frames. Concrete bracing has shown the result in base shear in X bracing system and the Steel bracing has shown the best result for base shear in V bracing system.

Md. Ahasan – ul – Haque, Md. Atik Masum, Md. Muhtadi Ratul, Zasiah Tafheem: The structural performance of the steel building has been investigated using different types of bracing system such as crossed bracing, and eccentric bracing. From the study, it has been found that in case of crossed braced structure lateral displacement is reduced by 41% which is the largest one and thus significantly contributes to greater structural stiffness.

Harshitha M K, Vasudev M V: To compare the lateral displacement of the structure with different type of bracing system. 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.

2.2 GAP ANALYSIS:

- Based on the literature review, After the study of the above research paper and their analysis of using different type of bracing system (Inverted V, K and X) for the lateral support of the building or steel structure and were compared to the behavior of non – braced system to the same structure. And the result was compared accordingly.
- Form the research papers studied, analyses were not done using mega bracing or x-bracing, this is the GAP identified and the objective were framed accordingly

2.3 OBJECTIVES:

1. To develop the detailed modal of Multi-storey Asymmetric buildings with Mega bracing, X-bracing
2. To perform modal analysis, response spectrum analysis.
3. To compare the results from the above type of bracings given

III. METHODOLOGY

Determining the behavior of RCC structure by providing different Braced buildings analysis using ETABS software. A typical R.C design of 12 Storey is considered for the analysis having six bays in X direction with equivalent spacing of 5 m and six bays in Y direction with equivalent spacing of 5 m. The plan size is 30m x 30m. The floor to floor height is 3 m and the total height of the building is 36 m.

Plan dimension	30 x 30 m
Structure	OMRF
No. of storey	G+12
Floor to floor height	3.00 m
Type of building	Commercial
Foundation type	Isolated footing
Soil strata	Medium

Thickness of slab	150 mm
Floor beam	300 x 450 mm
Plinth beam	300 x 300 mm
Column	380 x 600 mm
Steel bracings	ISMB300

3.1IRREGULARITY OF BUILDING :

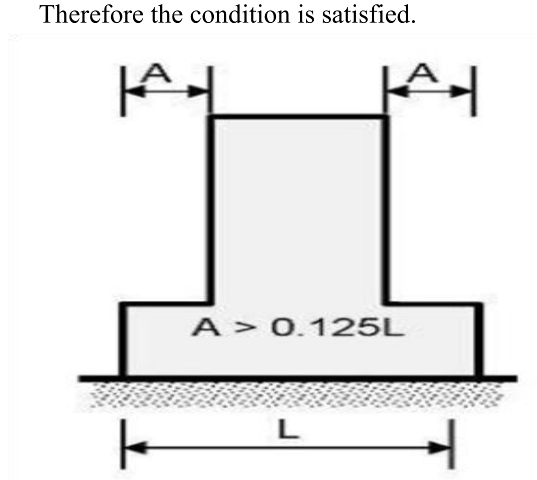
- The model of the mutlti-storey building is VERTICAL GEOMERTIC IRREGULARITY which is considered with the reference of IS 1893:2016 Page no.:18
- According to IS 1893:2016 : A>0.125L

  L=30m

  A=5m

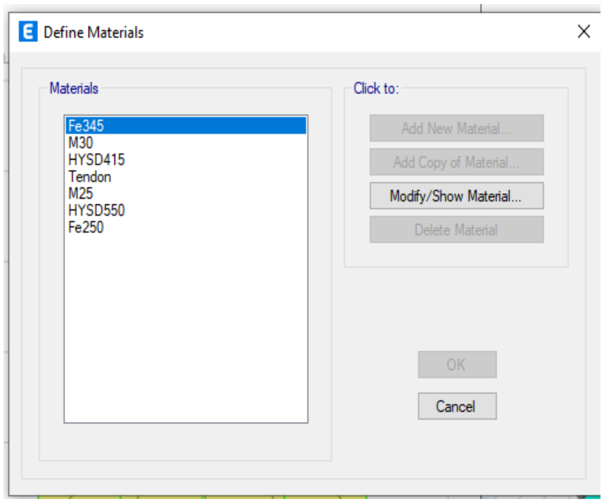
  5m>0.125(30m)

  5m>3.75m
- Therefore the condition is satisfied.

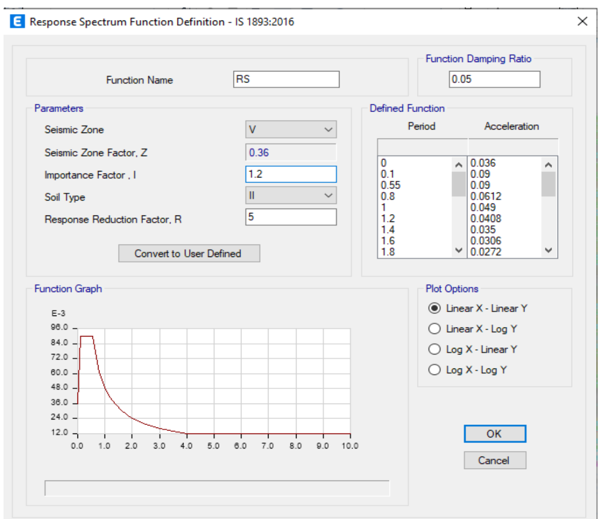


3.2 DEFINING OF MATERIAL AND LOAD PROPERTIES IN ETABS:

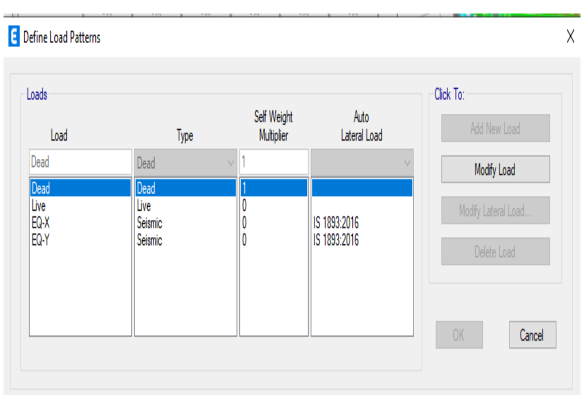
- MATERIAL PROPERTIES :



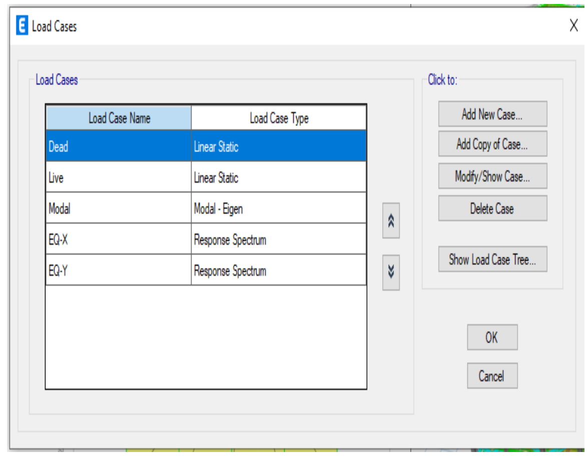
- RESPONSE SPECTRUM FUNCTION:



- LOAD PATTERNS:

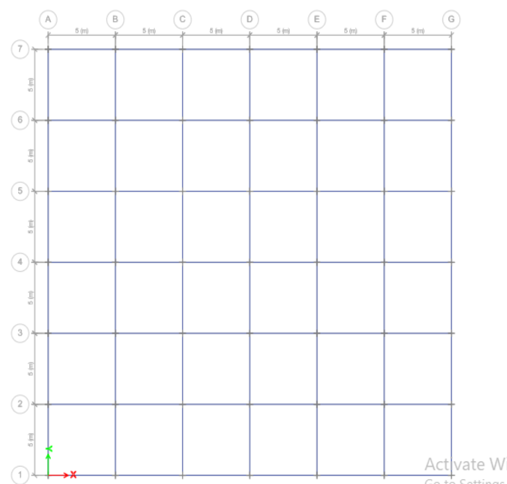


- LOAD CASES:

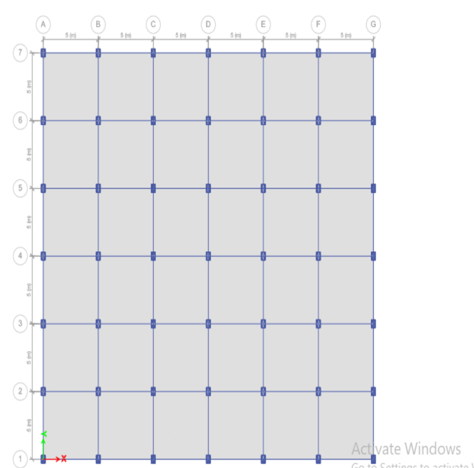


3.3 MODELLING IN ETABS:

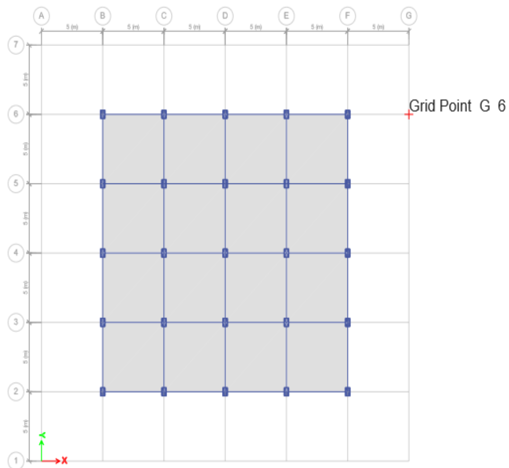
- BASE PLAN VIEW



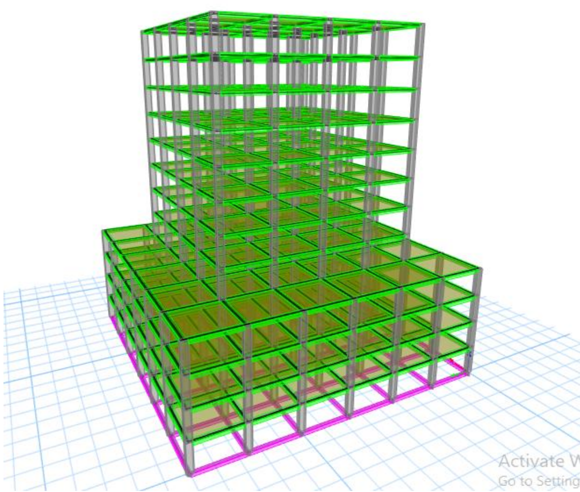
- PLAN VIEW FROM STOREY 1-4:



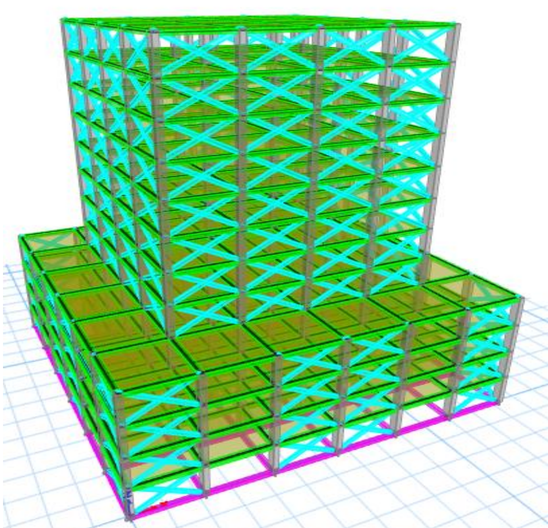
- PLAN VIEW FROM STOREY 5-12



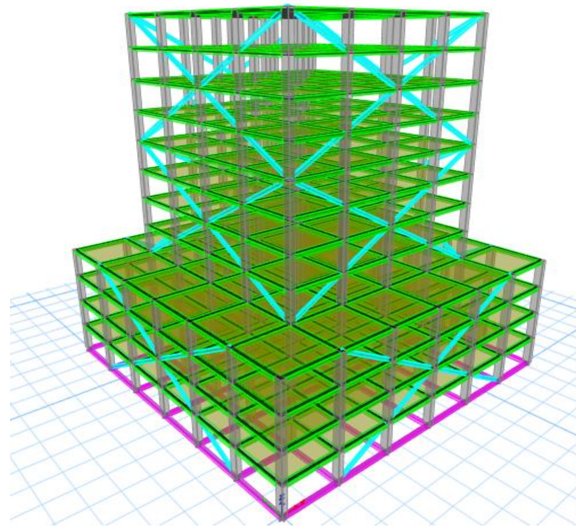
- 3D MODEL WITHOUT BRACINGS:



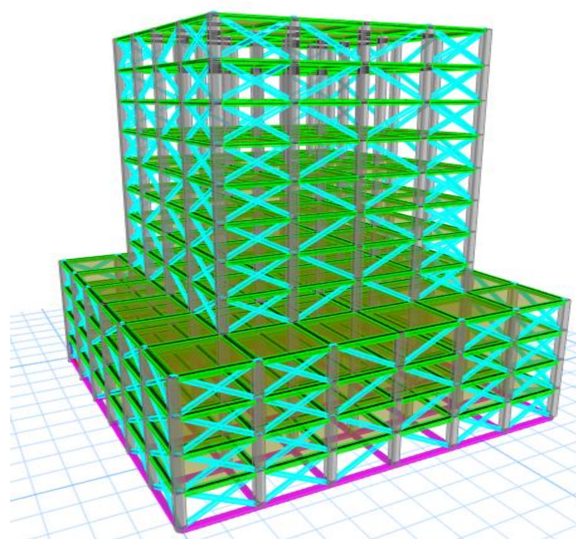
- 3D MODEL WITH-X BRACINGS:



- 3D MODEL WITH MEGA BRACINGS



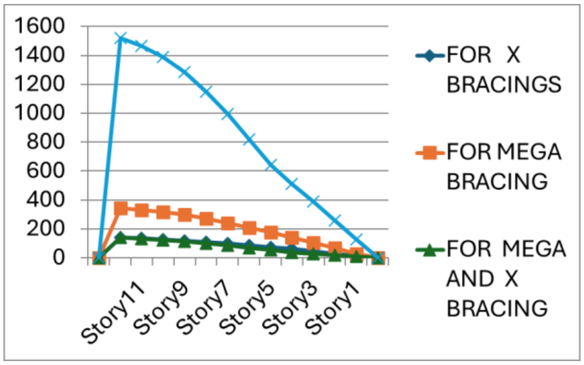
- 3D MODEL WITH MEGA AND X BRACINGS:



IV. RESULTS

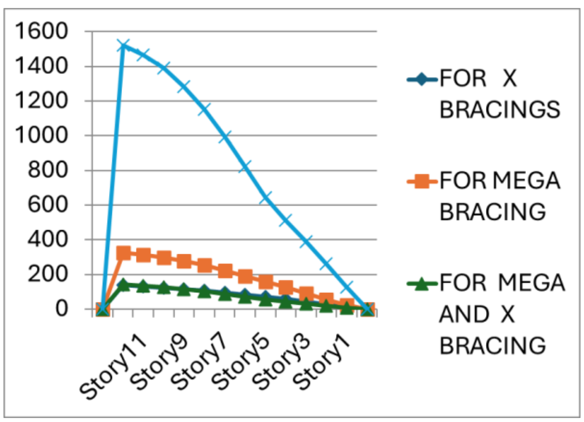
MAXIMUM STOREY DISPLACEMENT IN X DIRECTION

STOREY	ELEVATION (m)	FOR X BRACINGS (mm)	FOR MEGA BRACING (mm)	FOR MEGA AND X BRACING (mm)	FOR NO BRACINGS (mm)
Story12	36	141.239	344.514	**139.99**	1520.538
Story11	33	135.768	332.927	**132.979**	1467.599
Story10	30	128.723	319.037	**123.856**	1389.873
Story9	27	120.196	300.165	**112.652**	1283.852
Story8	24	110.355	273.016	**99.777**	1150.615
Story7	21	99.397	241.466	**85.405**	993.927
Story6	18	87.55	210.085	**70.079**	820.458
Story5	15	75.076	176.017	**54.018**	642.289
Story4	12	63.166	141.371	**39.12**	513.016
Story3	9	46.817	106.326	**29.675**	387.963
Story2	6	29.621	68.342	**19.634**	259.792
Story1	3	12.845	28.511	**9.106**	128.389
Base	0	0	0	**0**	0



MAXIMUM STOREY DISPLACEMENT IN Y DIRECTION

STOREY	ELEVATION (m)	FOR X BRACINGS (mm)	FOR MEGA BRACING (mm)	FOR MEGA AND X BRACING (mm)	FOR NO BRACINGS (mm)
Story12	36	136.974	323.483	**131.166**	1520.538
Story11	33	131.46	312.146	**130.163**	1467.599
Story10	30	128.439	298.001	**125.177**	1389.873
Story9	27	116.943	278.968	**114.161**	1283.852
Story8	24	106.147	253.036	**101.467**	1150.615
Story7	21	95.25	222.92	**87.296**	993.927
Story6	18	83.483	191.886	**72.122**	820.458
Story5	15	71.119	158.516	**56.564**	642.289
Story4	12	59.272	125.755	**43.023**	513.016
Story3	9	43.554	92.017	**31.668**	387.963
Story2	6	26.974	56.399	**20**	259.792
Story1	3	10.896	21.288	**8.274**	128.389
Base	0	0	0	**0**	0



COMPARISSION OF THE RESULT :

MODEL:	MAX. DISPLACMENT OF TOP STOREY IN X DIRECTION:(mm)	MAX. DISPLACMENT OF TOP STOREY IN Y DIRECTION:(mm)
Without bracing	1520.538	1519.334
With X-bracing	141.239	136.974
With mega bracing	344.514	323.483
With combination of mega and X bracing	**139.99**	**131.166**

- From all the braced system the combination of mega and x braced system performed well.

CONCLUSION

1. Buildings with bracing system perform more efficiently than building without bracing system
2. When the types of bracings are compared to unbraced structure, the combination of X braced and Mega braced showed a reduction of max. story displacement is by 108.6%.
3. When the types of bracings are compared to unbraced structure, the X braced showed a reduction of max. story displacement is by 107.4%
4. When the types of bracings are compared to unbraced structure, the Mega braced showed a reduction of max. story displacement is by 44.35%.
5. When compared to various bracing system it can be concluded that the combination of Mega and X braced system is most suitable for 12 storey building.

REFERENCE

[1] Iftekhar, C. S. R., Kabir, E., & Farnaz, T.(2007) *Analysis of a 7-storied RC Building with Different Patterns of Cross Bracing System*.

[2] Goudar, S. S., & Talasadar, R. G. (2017). Buckling Analysis of RC Framed Structures with and Without Bracings. *International Research Journal of Engineering and Technology*, *4*(10).

[3] Akshay Trivedi1, Dr. Gunjan Shrivastava2, Kishor Patil3 (July 2023) "*Seismic Analysis of High-Rise Tube in Tube Structures with Different Bracing Conditions*" Civil Engineering Department, Sushila Devi Bansal College of Engineering.

[4] Tanaji, B. A., & Shaikh, A. N. (2016). Analysis of reinforced concrete building with different arrangement of concrete and steel bracing system. *INTERNATIONAL JOURNAL*, *2*(4).

[5] Ahasan–ul–Haque, M., Masum, M. A., Ratul, M. M., & Tafheem, Z. (2018, February). Effect of different bracing systems on the structural performance of steel building. In *Proceedings od the 4th International Conference on Civil Engineering for Sustainable Development (ICCESD 2018)* (pp. 9-11).

[6] Harshitha, M. K., & Vasudev, M. V. (2018). "Analysis Of RC Framed Structure With

Structural Steel Braced Using Etabs ". *International Research Journal of Engineering and Technology*, *5*(1).

[7] Kulkarni, J. G., Kore, P. N., & Tanawade, S. B. (2013). Seismic response of reinforced concrete braced frames. *International Journal of Engineering Research and Applications (IJERA)*, *3*(4), 1047-1053.

[8] Azar, B. B., & Karimi, M. R. B. (2012). Study the Effect of using Different Kind of Bracing System in Tall Steel Structure. *American journal of scientific research, ISSN*, 24-34.