iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** X **Month of publication:** October 2025

DOI: https://doi.org/10.22214/ijraset.2025.74693

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue X Oct 2025- Available at www.ijraset.com

A Comparative Study on Seismic Analysis of Regular, Plan and Vertical Irregular G+12 RC Structure

Murulinaik G R[1], Chetan Gonni S[2].
[1]*Student, M Tech. in Structural Engineering, Department of Civil Engineering, Bapuji Institute of Engineering and Technology, Davanagere-577004, Karnataka*
[2] *Assistant Professor, Department of Civil Engineering, Bapuji Institute of Engineering and Technology, Davanagere-577004, Karnataka*

Abstract: Due to urbanization and less availability of construction land, the engineers are planning for multi-storied construction. In this study, a multi-storied (G+12) RC building is considered for earthquake analysis by using previous earthquake data i.e., the analytical method used for this work is response spectrum analysis. When the multistorey building constructions comes into the practice there are various possibility of failure of the structures, either it might be due to gravity loading or might be due to lateral pressures i.e., Earthquake or wind loads. If the structures are not analysed and designed for the above-mentioned loading conditions as per the IS codal specifications, a severe damage might be observed. So, in this study, the analysis is performed for gravity loadings and by using the previous earthquake analytical data, "Response Spectrum Analysis" method is used for the earthquake analysis. There is various finite element approach software are available in the market, for this study ETABS (version 21) is used for analysing the structure. In this study totally 5 models are used they are plan regular, regular and vertical irregular building are considered and the results for all of these are discussed in the coming chapters.

Keywords: Comparative Study on Regular building, Irregular building, Vertical irregular building, Seismic Zone, Response spectrum method.

I. INTRODUCTION

This study examines the impact of structural irregularities on the seismic performance of multi-story buildings. Irregular configurations whether in plan or elevation are frequently linked to structural failures during earthquakes due to stress concentrations and disrupted force flow. Misalignments between canters of mass and rigidity often cause torsional effects, increasing vulnerability. As architectural design decisions largely dictate structural layout, they play a critical role in seismic resilience and cost-effectiveness. Despite widespread use of irregular structures in urban environments for functional and aesthetic reasons, these irregularities especially in stiffness, mass distribution, and vertical geometry must be carefully evaluated. Among them, stiffness irregularity exerts the most significant influence on a building's dynamic response. Furthermore, the study underscores that analysing irregularities in isolation can yield misleading results, given that most buildings exhibit multiple forms. In regions where retrofitting existing structures is more urgent than new construction, risk-based strategies and seismic upgrades like the use of shear walls are essential. Shear walls enhance both strength and stiffness, reducing lateral displacement and improving overall performance under seismic loads. This research aims to support informed design of asymmetrical and irregular buildings without compromising structural integrity.

II. METHODOLOGY

The methodology adopted to achieve the above said objectives are as follows: To develop a suitable Analysis of Response Spectrum method for analysing story shear, storey drift, and story displacement in structures, a thorough assessment of the body of literature was carried out, in addition to pertinent regulations from the Indian Standard Codes. For our study we considered 12 stories tall building, with 5 bays and plan dimensions of (25 x 30) meters. The height of each floor is 3.1 meters and base 3 meter. A total of 40.2 meters is the elevation of the building from the first to the twelfth floor and base. The columns are 600 mm by 900 mm in size, the beams are 300 mm by 450 mm, and the slab thickness is 150 mm.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue X Oct 2025- Available at www.ijraset.com

Seismic loads are applied to the structure models in both X and Y directions, based on ground motions from earthquakes. In the present study, a 12-storey RC framed building is analysed using the response spectrum method. The parameters evaluated include base shear, storey shear, 13 storey displacement, and storey drift for plan-regular, plan-irregular, and vertically irregular buildings. For modelling purposes, the following considerations are adopted. the following considerations are made which are tabulated below:

Table 3.1: Basic Parameters for the development of the structural models

Sl. No	Parameter	Value
1.	Type of Structure	Commercial
2.	No. of Stories	12
3.	Total Height of Building	40.2 m
4.	Storey Height	3.1m
5.	Base height	3m
6.	Plan Size	25 m x 30m
7.	Column Size	600 mm x 900mm
8.	Beam Size	300 mm x 450 mm
9.	Grade of Concrete	M30
10.	Steel Grade	Fe550
11.	Slab Thickness	150 mm
12.	Bays Width in X-Direction	5 m
13.	Bays Width in Y-Direction	6m
14.	Concrete Density	25 kN/cum
15.	Brick Density	20 kN/cum
16.	Earthquake Load	As per IS 1893-2016
17.	Moment Resisting Frame	SMRF
18.	Types of Soil	II
19.	Zone Factor	0.16
20.	Importance Factor	1.2
21.	Response Reduction Factor	5
22.	Earth quick zone	3

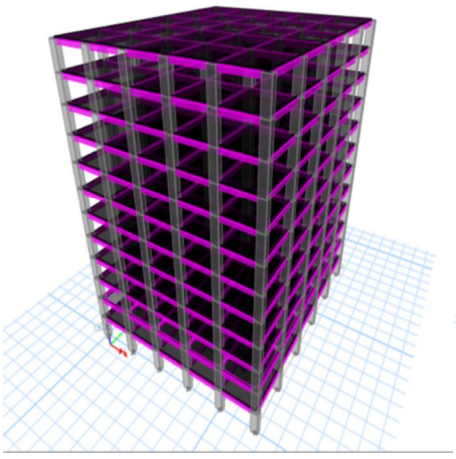


Fig a: Column 3D View of Regular Model

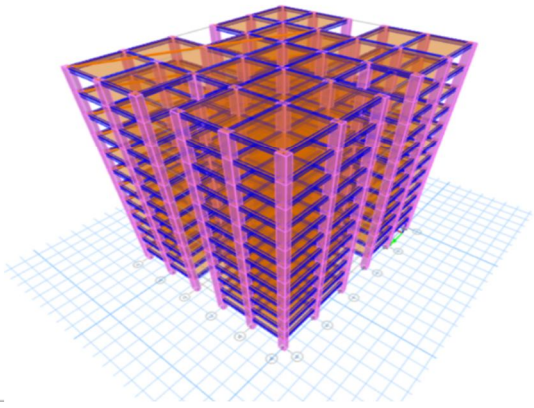


Fig b: Column 3D View of Irregular Model

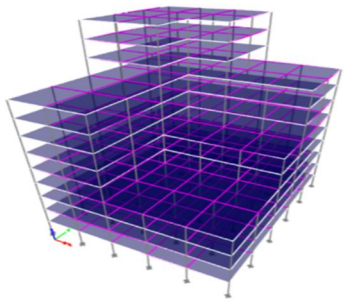


Fig c: Column 3D View of L-Shape (Vertical irregular) Model

III. RESULTS AND DISCUSSIONS

The response spectrum analysis is performed on all the model's comparative study on earthquake data used in response spectrum method analysis are as mentioned in clause 4.2. The behaviour of models is studied by extracting the results from the analysis in the form of Storey Drift, Storey Shear and Storey Displacement. The results are plotted in a graphical form as shown in following figure below.

1) Storey Drift: The comparison of regular, irregular and vertical irregular model of story drift in X-direction

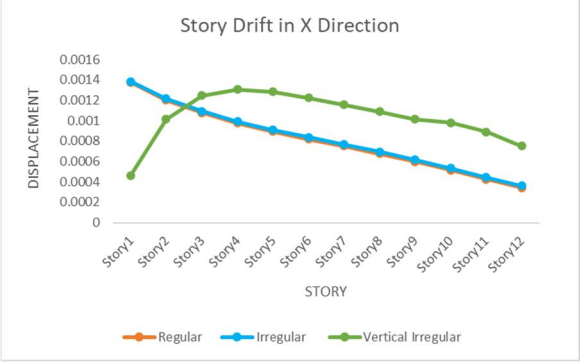
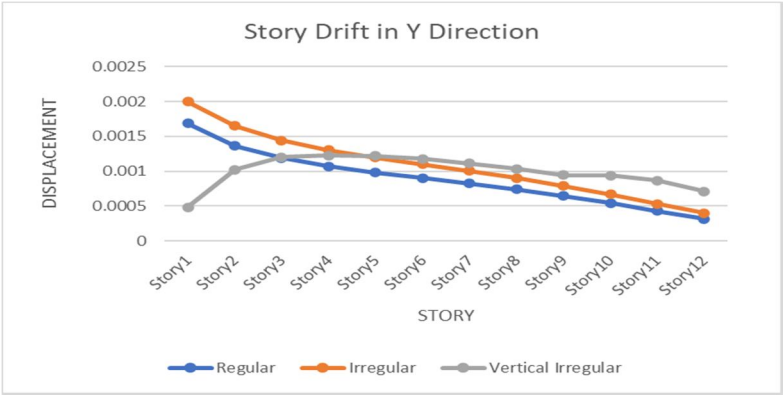


Fig 4.10: Storey Drift of structures in X direction

"From the graph, it is noticed that for a 12-storey structure with specific material and section properties, the maximum storey drift of the earthquake data in the X-direction is maximum for the irregular shape structure, around at the storey when it is compared with regular shape and irregular shape

2) Storey Drift: The comparative of regular, irregular and vertical irregular model of story drift in Y- direction



"From the graph, it is observed that for a 12-storey structure with specific material and section properties, the maximum storey drift of the earthquake data in the Y- direction is maximum for the irregular -shape structure around maximum at the storey when it compared with Regular shape, irregular shape.

3) Storey Shear: The comparative of regular, irregular and vertical irregular model of story shear in X-direction

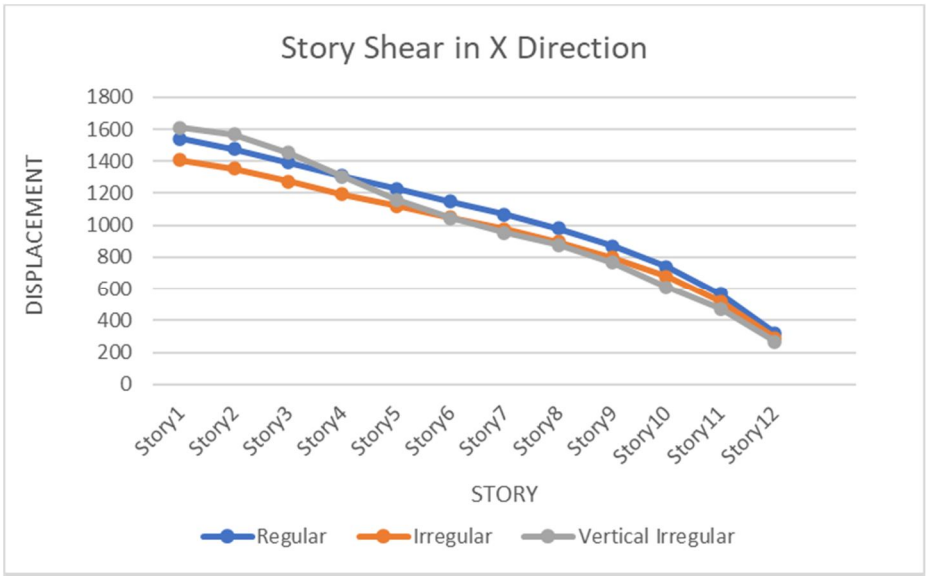


Fig 4.12: Storey Shear of structures in X direction

From the graph, it is observed that for a 12-storey structure with specific material and section properties, the maximum storey shear of the earthquake data in the X- direction for a regular shaped building, when compared with irregular shaped building, it is decreased to about 8.52%, whereas it got increased to about 4.3%.

4) Storey Shear: The comparative of regular, irregular and vertical irregular model of story shear in Y-direction

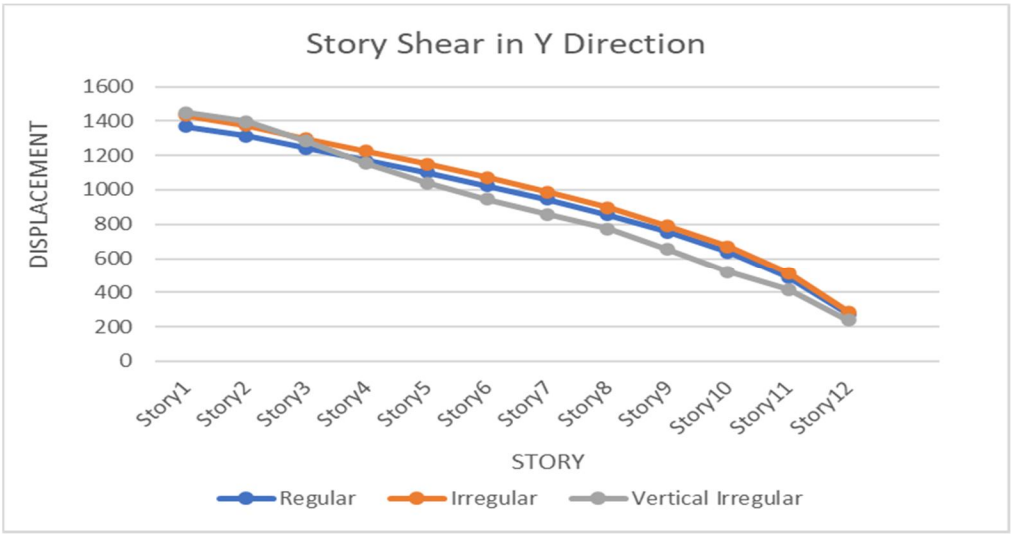


Fig 4.13: Storey Shear of structures in Y direction

"From the graph, it is observed that for a 12-storey structure with specific material and section properties, the maximum storey shear of the earthquake data in the Y-direction is a regular shaped building, when compared with irregular shaped building, it is increased to about 4.63%, whereas it got increased to about 5.81%.

5) *Storey Displacement:* The comparative of regular, irregular and vertical irregular model of story displacement in X-direction

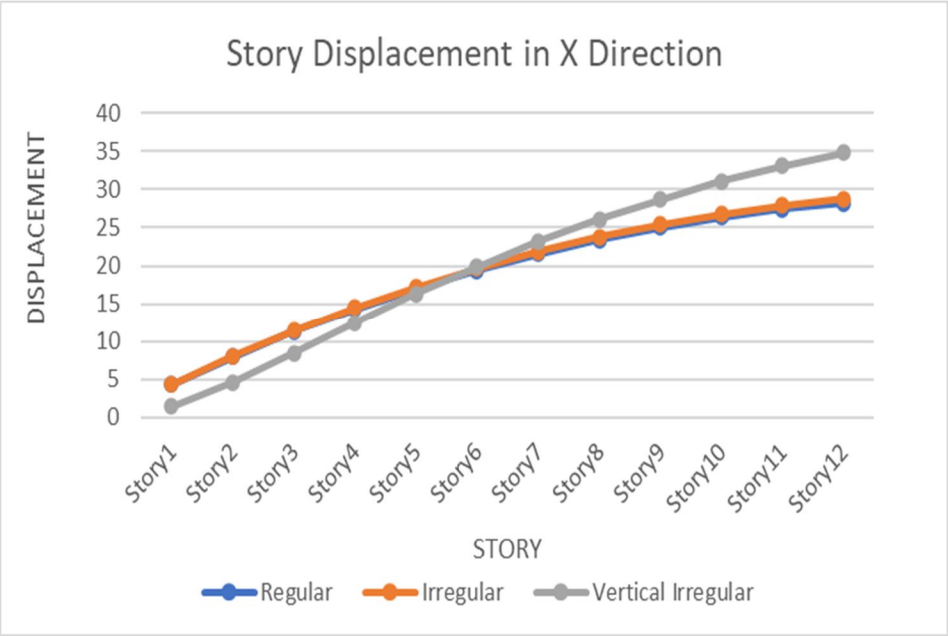


Fig 4.14: Storey Displacement of structures in X direction

"From the graph, it is observed that for a 12-storey structure with specific material and section properties, the maximum story displacement of the earthquake data in the X-direction is a regular shaped building, when compared with irregular shaped building, it is increased to about 1.76%, whereas it got increased to about 23.42 %

6) *Storey Displacement:* The comparative of regular, irregular and vertical irregular model of story displacement in Y-direction

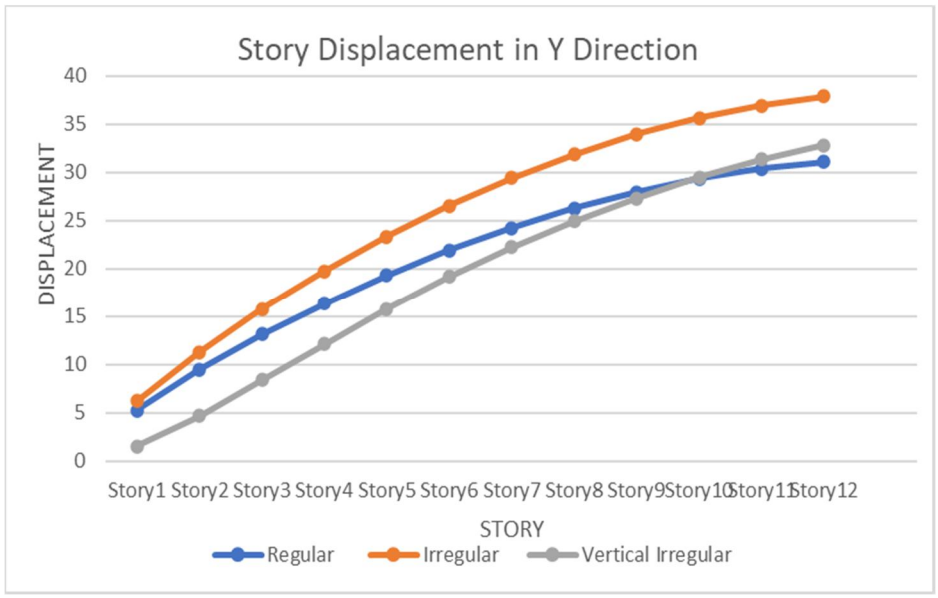


Fig 4.15: Storey Displacement of structures in Y direction

From the graph, it is observed that for a 12-storey structure with specific material and section properties, the largest storey displacement of the earthquake data in the Y-direction is a regular shaped building, when compared with irregulated building, it is increased to about 22.02%, whereas it got increased to about 5.62%.

IV. CONCLUSION

The comparative analysis for plan regular, plan irregular and vertical irregular structures are made by channelized graphs and tabular columns and the discussion w.r.t results are discussed in the chapter 4 and the conclusions for those results and discussions are derived here:

1) Analysis of RSA method using ETABS has provided a comprehensive understanding of the building's response to particularly during seismic events.

2) As per the analytical results, the comparison between plan regular, plan irregular and vertical irregular buildings, the results of plan irregular showed 22.02% displacement w.r.t Y-direction is higher than plan regular building and w.r.t vertical irregular building, it showed 5.62%. Hence it can conclude that keeping the requirement of the architectural considerations, can be suggested to consider vertical irregular structure.

3) As per the analytical results, the comparison between plan regular, plan irregular and vertical irregular buildings, the results of plan irregular showed 1.76% displacement w.r.t X-direction is higher than plan regular building and w.r.t vertical irregular building, it showed 23.42%. Hence it can be concluded that is keeping the requirement of the architectural considerations, this can be suggested to consider vertical irregular structure.

4) As per the analytical results, the comparison between plan regular, plan irregular and vertical irregular buildings, the results of plan irregular showed 8.52% shear w.r.t X-direction is lesser than plan regular building and w.r.t vertical irregular building, it showed higher 4.3%. Hence it can be concluded that keeping the requirement of the architectural considerations, it can be suggested to consider vertical irregular structure.

5) As per the analytical results, the comparison between plan regular, plan irregular and vertical irregular buildings, the results of plan irregular showed 5.81% shear w.r.t Y-direction is higher than plan regular building and w.r.t vertical irregular building, it showed higher 4.63%. Hence it can be concluded that keeping the requirement of the architectural considerations, it can be suggested to consider irregular structure.

6) As per the analytical results, the comparison between plan regular, plan irregular and vertical irregular buildings, the results of plan irregular showed drift w.r.t X-direction is higher than plan regular building and w.r.t vertical irregular building, it showed lesser. Hence it can be concluded that keeping the requirement of the architectural considerations, it can be suggested to consider irregular structure.

7) As per the analytical results, the comparison between plan regular, plan irregular and vertical irregular buildings, the results of plan irregular showed drift w.r.t Y-direction is higher than plan regular building and w.r.t vertical irregular building, it showed lesser. Hence it can be concluded that keeping the requirement of the architectural considerations, can be suggested to consider irregular structure.

All the models were analysed in ETABS using the response spectrum method. In comparison with plan regular, plan irregular, and vertical irregular buildings, the plan regular building showed better performance than the other two types. However, considering architectural requirements, the plan irregular building proved to be safer with respect to storey shear, storey drift, and storey displacement. Therefore, it can be concluded that, taking into account economy, structural safety, stability, and overall requirements, the plan irregular building can be suggested as the final choice.

REFERENCES

[1] Al-Sabaeei, Mohammed Sadeq, K. R. Dabhekar, and I. Khedikar. "State of art on seismic comparison of different types (V, diagonal and X) of bracings on different shapes of buildings (L, H, Tand rectangular) with response spectrum method." Materials Today: Proceedings (2023). Vol. 04, issue 0.5, pp 1061

[2] Arvindreddy, R. J., and M. Fernandes. "Seismic analysis of RC regular and irregular frame structures." Int. Res. J. Eng. Techno 2 (2015): 44-47. Vol. 8, issue 9, pp.3423-3426

[3] Chaudhary, Krishna Prasad, and Ankit Mahajan. "RSA of irregular shaped high-rise buildings under combined effect of plan and vertical irregularity using csi ETABS." IOP Conference Series: Earth and Environmental Science. Vol. 889. No. 1. IOP Publishing, 2021.

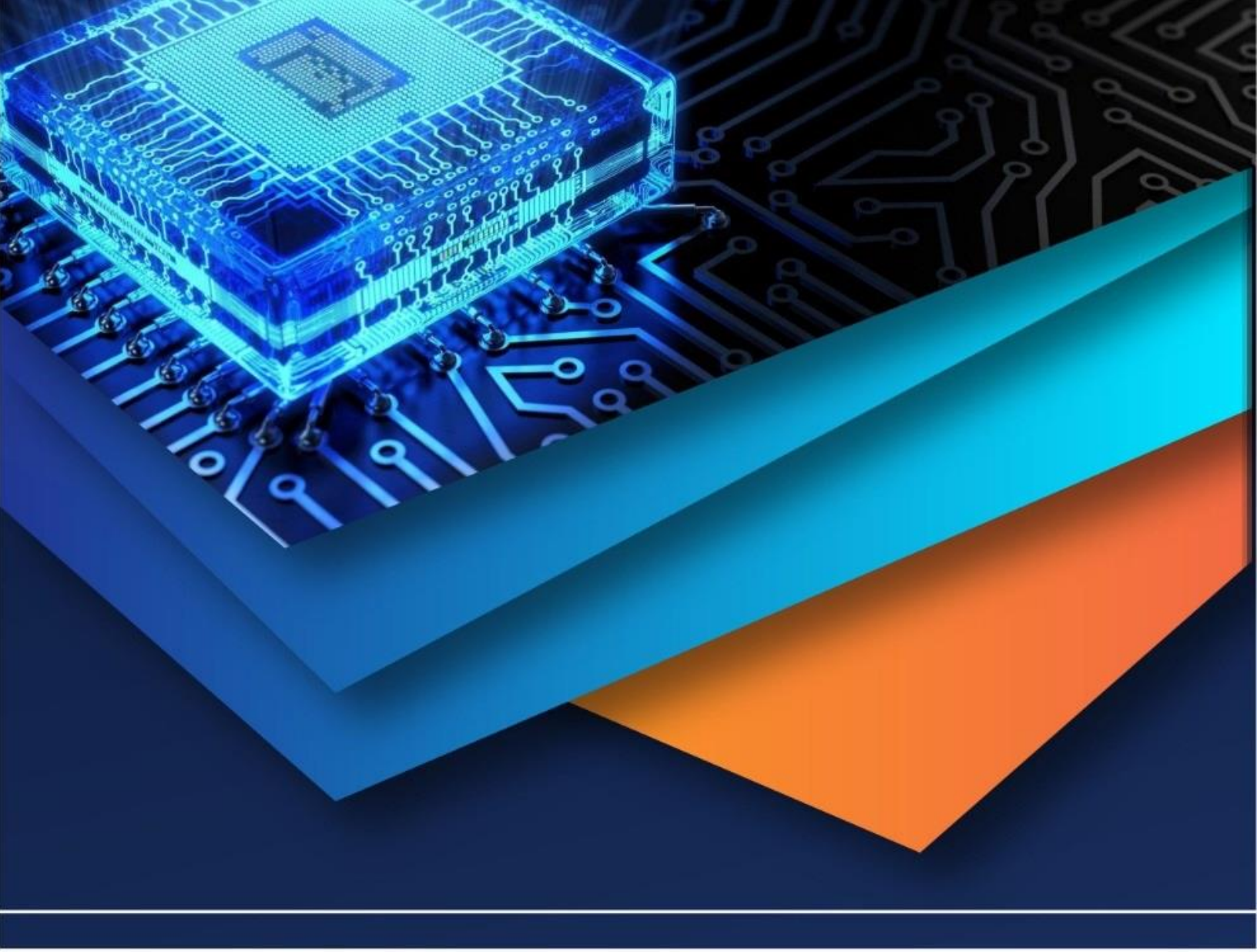
[4] Divya, Rachakonda, and K. Murali. "Comparative analysis of behaviour of horizontal and vertical irregular buildings with and without using shear walls by ETABS software." Materials Today: Proceedings 52 (2022): Vol. 8, issue 9, pp.471-476

[5] Haque, Mohaiminul, et al. "Seismic performance analysis of RCC multi-storied buildings with plan irregularity." American Journal of Civil Engineering 4.3 (2016): Vol. 03, No.02, pp.68-73.

[6] Krishnan, R., and V. L. Sivakumar. "A comparative study of geometry and locations of shear walls on regular and irregular RC structures by using response spectrum analysis." Indian J Sci Techno 16.30 (2023): Vol. 8, issue 9, pp. 2358-2364.

[7] Mukundan, Hema, and S. Manivel. "Effect of vertical stiffness irregularity on multi-storey shear wall-framed structures using RSA. " International Journal of Innovative Research in Science, Engineering and Technology 4.3 (2015): 1186-1198.

[8] Prathap, G. Vamshi, and D. Radha. "Comparative Analysis of Behaviour of Horizontal and Vertical Irregular Buildings with and Without Using Shear Walls by ETABS Software." Journal of Engineering Sciences (2023). Vol.02, issue 03, pp.91-96
[9] Shelke, Ravindra N., and U. S. Ansari. "Seismic analysis of vertically irregular RC building frames." International Journal of Civil Engineering and Technology 8.1 (2017): 155-169.
[10] Sowmya, G. S., and Vinod Kundaragi. "Comparison Of Conventional and Flat Slabs Using RSA Method for Symmetric and Asymmetric Commercial Building Using E Tabs." (2020).
[11] IS 456 (2000), "Plain and Reinforced Concrete-Code of Practice", Bureau of Indian Standards, New Delhi, India.
[12] IS 875-Part 1 (1987), "Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures. Part 1 Dead Loads Unit Weights of Building Materials and Stored Materials", IS, New Delhi, India.
[13] IS 875-Part 2 (1987), "Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures. Part 2 Imposed Loads", IS, New Delhi, India.
[14] IS 1893-Part 1 (2016), "Criteria for Earthquake Resistant Design of Structures. Part 1-General Provisions and Buildings", IS, New Delhi, India.
[15] Textbook; Earthquake Resistant Design of Structures by Pankaj Agarwal and Manish Shrikhande.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY