iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** V **Month of publication:** May 2025

DOI: https://doi.org/10.22214/ijraset.2025.70020

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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 V May 2025- Available at www.ijraset.com

Review Paper on Comparative Study and Analysis of Vertical Mass Irregularities of RCC Building with Zone 3 and Zone 5

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Abstract: ***The rapid pace of urbanization has led to the widespread construction of RCC building in seismically active zones. Many of these structures, however, where designed according to outdated codes that did not fully account for increased population density are the potential for strong earthquakes. The vulnerability of these building is often linked to mass irregularities, which disrupt the uniform distribution of weight across floor, resulting in poor structural performance during seismic events. This paper focus on studying the impact of mass equality at different floor level and different seismic zones in RCC building. Through seismic analysis using methods like the equivalent and response spectrum approach in Etabs, the paper highlights how mass distribution variations influence the structural response, offering insights into safer and more resilient design strategies.***

Keywords: RCC building, Seismic Analysis, Vertical Mass Irregularity, Equivalent Static Method and Response Spectrum Analysis.

I. INTRODUCTION

When building is constructed with sudden variation in mass between floors known as irregularities their ability to resist earthquake forces is significantly affected. Mass irregularity, in particular is a common issue in multistory structures and can lead to several structural damage during seismic event.

India's seismic zone map has been updated and making it essential for new and existing structures to meet modern earthquake resistant design standards. For building located in earthquake prone regions, ensuring they can handle seismic forces is a critical part of the design process.

This paper focus on studying how mass irregularity at different floor level and different seismic zones influence the seismic performance of G+9 RCC building. Through a comparative analysis involving parameters like base shear, story displacement, and story drift under different seismic conditions, the study aims to highlight the importance of ductility and proper mass distribution for enhancing structure residence.

KINDS OF IRREGULARITIES

Plan Irregularities (Horizontal Irregularities)

These occur when the layout of the building is not uniform in shape, causing uneven force distribution.

- Torsional Irregularity.
- Re-entrant Corner Irregularity.
- Diaphragm Discontinuity.
- Out-of-Plane Offset.
- Non-Parallel Lateral Force Systems.

Vertical Irregularities

These occur when there are inconsistencies in strength, stiffness, or mass along the height of the structure.

- Stiffness Irregularity (Soft Storey).
- Weak Storey Irregularity.
- Vertical Geometric Irregularity.
- In-Plane Discontinuity in Vertical Elements.

Mass Irregularity: When a building has a sudden increase in mass at a particular level—exceeding 150%–200% of the adjacent floors—it results in mass irregularity, making the structure more vulnerable to seismic forces.

II. METHODOLOGY

The available research reports are categorized in various parts: -
A Comparative Study on the Application of Response Spectrum Analysis (RSA) and Time History (TH) Analysis for Buildings.
A Comparative Analysis of Response Spectrum (RSA) and Time History (TH) Methods Applied to Building Structures.
Exploring the Factors Driving the Need for Research on Vertical Mass Irregularity in RCC Buildings.

III. LITERATURE REVIEW

B Swapnil & Basavalingapp (2015) - They had carried out research on comparative analysis of the combined RC-masonry's seismic behaviour. In their study, irregularity is examined between G+9 multi-storey R.C.C. and Composite buildings and taken into account as mass. Using SAP 2000 software, equivalent static and response spectrum methods are employed to analyse the building in accordance with IS 1893 (Part 1):2002. According to the study, composite structures with uneven mass will perform better than R.C.C. structures.

N.Anvesh , Dr. Shaik Yajdani, K. Pavan kumar (2015) - In this paper analysis for G+10 Reinforced cement concrete building having mass irregularity in 3rd and 6th floors and building without mass irregularity are analysed in etabs. To analyze the building as per code IS 875 Part III criteria for wind loads. Base shear of irregular mass is greater than regular mass but displacement of irregular mass is slightly less than the regular mass.

Asha Vijayan & Aswathy Prakash (2016) - With the aid of the ETABS programme, they had used a time history analysis method to examine the multi-storey RCC building while taking into account mass irregularity at various floor levels. The first step is to simulate a typical G+11-storey building across the building. The model consists of a G+11-storey building with irregular mass distribution on the first, fifth, and tenth floors by altering the dead load on the structure. By using time history analysis, compare these three models. Compare the structure's natural frequency, base shear, and tale drift as well. Which led them to the conclusion that constructions with no mass anomalies are better able to withstand seismic loads. If there are any large imperfections, they should be concentrated on the bottom, top, or any core portions of construction components.

Mya Mya Aye & P.Narasimhara (2017) - In this study, twelve-storeyed vertical irregular RCC building is selected to analyze the behavior of the structural members due to change of mass and inter-storeyed height. This building is situated in seismic zone IV. It is composed of special moment-resisting frame system. The superstructure is designed with ETABS software. The structure is initially analyzed and designed with static analysis. It is found that the safety factor values are satisfied within allowable limits. And then, this structure is analyzed with dynamic (time history
y analysis) based on change of mass and inter-storeyed height. The results of column size in dynamic analysis are greater than that in static analysis.

Rashmi S. Patil (2017) - In this study, 3D Analytical model of G+15 storeyed buildings have been generated for vertical mass irregularity. Three models are generated with difference in vertical mass irregularity analysed by using analysis tool ‘ETABS. All the structures have been considered to be located in seismic region V. In this study when a mass irregular change location than base change and story displacement.

Dr Prashant Hiwase, Vipul V Taywade, Sharda P. Siddh (2021) - In this study 2 kinds of buildings of (G+15) were created one is regular structure and alternative one Mass irregular. A multistoried RC Building with help of Equivalent Static method in E-TABS Software For zone V. Regarding to Moments in irregular structure Gives Slightly higher than regular structure.

Md. Sabbir Hossain & S.K. Singh (2022) - In this study, two different irregulars Reinforced Cement Concrete (RCC) building plans of 25th storey buildings with the ground floor (G+25) and 9th storey buildings with the ground floor (G+9) were subjected to four different zones making a total of eight model structures to test their ability to withstand gravity and seismic loads. The design was response spectrum method (RSM) then subjected to an earthquake load in accordance with Indian Standard (IS) 1893.When building height increase than story displacement increases but story drift decrease.

Nilesh Kumar, Jay Parmar, Maitri Dalal, Abhishek Samal, Jenish Patel, Y. D. Patil (2022) - In present study G+14 story building with mass and vertical geometrical irregularity is analysed using static method and dynamic method in ETABS v 18.0.2 as per IS-1893-2016 (part 1). Analysis is performed for zone III. Equivalent and dynamic analysis linear time history method. ESA story drift is max of time history analysis.

Syed Aatif Hussain & Gajendra H. (2023) -In this study Nonlinear Time History Analysis of Mass and Geometric Regular and Irregular Multi Storey Moment Resisting RCC Frames. A G+10 stories building with mass and geometric irregularity has been modeled for seismic analysis. In this thesis design of structure for this building is carried out by using ETABS software. After being analyzed, structural response such as Storey displacement, Storey drift, and Base shear are compared.

IV. CONCLUSION

Many researchers have conducted analytical and comparative studies on the design of high-rise buildings.

Although modern codes may recommend strengthening buildings in response to zone upgrades and mass irregularity, it remains essential to verify the adequacy of the existing reinforcement.

Regular building exhibit better seismic performance, so for future seismic event and when building seismic zone change.

When seismic zone increase than results are more increase to lower seismic zone.

Dynamic analysis methods, such as Response Spectrum and Time History analysis, offer more precise results compared to static linear analysis (Equivalent Static Method), particularly for high-rise and irregularly shaped buildings.

Among these, Time History analysis is considered the most accurate, as it simulates the actual response of a structure to an earthquake over time. However, it is also more computationally demanding and less cost-effective than Response Spectrum analysis.

Response Spectrum analysis strikes a balance between accuracy and efficiency, making it a suitable and widely used method for low- to mid-rise buildings.

It is also commonly applied to assess the seismic behaviour of a building both before and after modifications or extensions.

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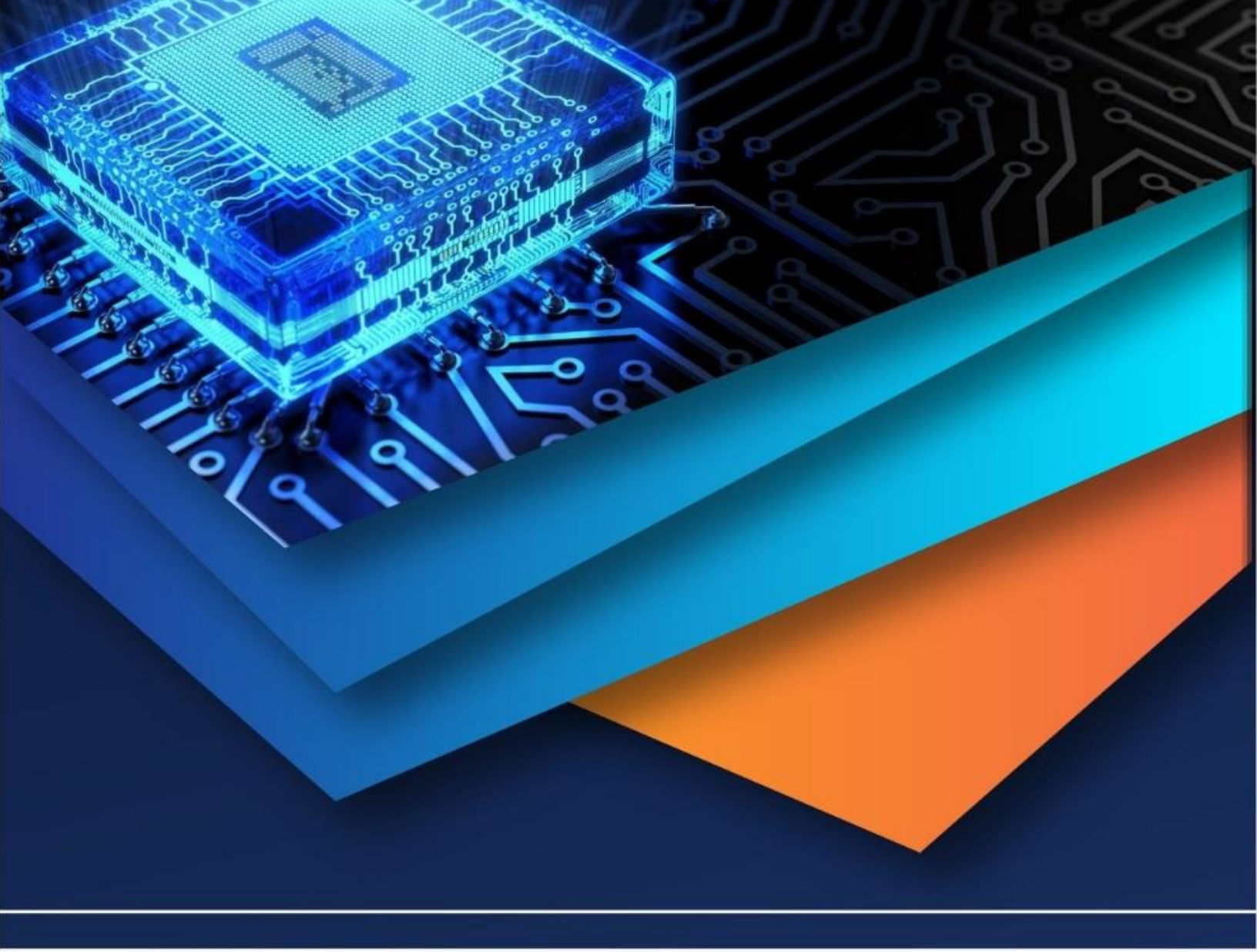

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