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Literature Review on Study of High-Rise Structures by using Time History Analysis

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ABSTRACT: This paper aims to describe the study of time history analysis using ETABS. An earthquake occurs due to the rapid release of strain energy stored in the Earth's crust, generating seismic waves. Structures are susceptible to damage from earthquake ground motion. To mitigate structural damage from ground motion, understanding the characteristics of ground motion is essential. The key dynamic characteristics of an earthquake include peak ground acceleration, frequency content, and duration. These characteristics are crucial for studying the behavior of structures under earthquake ground motion. The earthquake analysis of multistory structures can be performed using linear and nonlinear methods. The response spectrum method is a linear dynamic analysis technique, while the time history method is used for nonlinear dynamic analysis. In this paper, the response spectrum method is employed for linear analysis.

KEYWORDS: Time History Method, Response Spectrum Method, Time Period.

I. INTRODUCTION

There is a significant global demand for the construction of high-rise buildings due to the growing population. Designing earthquake-resistant engineering structures is a crucial method to prevent damage from future earthquakes. This design is based on the ground motion specifications of past earthquakes. Therefore, it is essential to design important structures to withstand seismic frequencies to minimize damage. Since earthquake forces are unpredictable and vary, software tools are necessary to analyze structures under any seismic conditions.

Earthquakes produce varying intensities at different locations, causing different levels of damage to buildings depending on their type. Consequently, studying the seismic behavior of reinforced concrete (RC) framed buildings under different seismic intensities is essential. Seismic intensities are measured in terms of responses such as base shear and lateral displacement. Various types of analyses are used to identify a building's seismic resistance and behavior under applied seismic frequencies.

These analyses can be based on externally applied loads, structural materials, and the type of structure. They are classified into four types:

- Linear Static Analysis
- Nonlinear Static Analysis
- Linear Dynamic Analysis
- Nonlinear Dynamic Analysis

Time history analysis considers the response of the structure, including inertial effects, and is more advanced than response spectrum analysis. It provides information on base acceleration, displacement, and duration, making it particularly useful for understanding the behavior of very high-rise structures during seismic events. This analysis relies on historical earthquake data and involves a step-by-step examination of the structure's response to loads that may vary over time..

II. RELATED WORK

- S. Patil and P. D. Kumbhar, [1], The study finds that, for both models taken into consideration, time histories, and varied intensities (V to X), there are consistent patterns in the seismic responses (base shear, storey

displacements, and storey drifts). The reactions' values rise from V to X as the earthquake intensities rise. With reference to intensities VI to X, in comparison to intensity V, the base shear, storey displacements, and storey drifts are notably larger (1.85, 3.56, 7.86, 15.1, and 17.15 times) for both X and Y directions, regardless of the presence of a soft story in the models. Crucially, since the realistic time history method accurately calculates seismic hazard and captures true dynamic behaviour, it is a more efficient way to assess the safety of structures built in compliance with the IS code.

- Mr. Gururaj B. Katti and Dr. Basavraj S. Balapgol, [2], The research implies that time history analysis is essential for capturing the non-linear behaviour of irregular structures. Comparatively speaking, equivalent static analysis overestimates displacements, but dynamic studies such as response spectrum and time history analysis accurately reflect movements. Because of the non-linear distribution of forces, irregular buildings need to be studied dynamically. The differences in base shear values amongst the various techniques underline the shortcomings of comparable static analysis and the benefits of time history analysis in terms of capturing non-linear effects and changing mass. Comparing comparable static analysis and reaction spectrum methodologies to time history analysis yields a more accurate and trustworthy assessment of structural safety overall.
- Bahadur Begheri [3], A building's highest displacements rise from the first to the last floor, with the exception of the sixteenth floor, exhibiting inconsistent patterns of displacement. Plan property differences result in smaller centre of mass displacements at the 16th floor compared to the 15th floor. During earthquakes, reaction spectrum assessments record the highest structural response.
- Mayuri D. Bhagwat, Dr. P.S. Patil, [4], A review of the research results makes a number of noteworthy points. First off, compared to the Koyna earthquake, the base shear values for the Bhuj earthquake are 49.11% higher. In addition, results from the response spectrum method are 50% higher than those from time history analysis. It is also observed that the response spectrum analysis yields greater results for base shear and top story displacement when comparing time history analysis with response spectrum analysis. In particular, the reaction spectrum analysis results show that the base shear and top-story displacement for the Koyna earthquake are 39.70% and 31.18% higher, respectively, compared to the Bhuj earthquake's 40.53% and 31.99% higher values. The analysis also demonstrates that all stories' floor drifts stay within allowable bounds. Because time history analysis predicts the structural response analysis more accurately than response spectrum, it is strongly advised to use it in light of this conclusion.
- Arvindreddy, R.J. Fernandes, [5], The results of the investigation suggest that non-conservative behaviour is displayed by structures with irregular rigidity. The static study results indicate a likely influence of nonlinear force distribution, as they reveal lower storey displacement values when compared to response spectrum analysis. When comparing diaphragm irregularity to regular constructions, both static and reaction spectrum approaches see decreased storey displacement and storey drift. The pushover curve also shows that stiffness irregularity exhibits nonlinear behaviour earlier than in other structures, which makes it more vulnerable to amplified seismic effects. Furthermore, a 15-story structure's stiffness inconsistencies show the lowest base force when compared to other structures, according to time-history research. The behaviour of diaphragm irregularity and stiffness irregularity generally reverses with the number of stories.
- Sayed Mahmoud, Magdy Genidy, and Hesham Tahaon, [6], The study concentrated on reinforced concrete-framed buildings with fully and partially infilled walls that were subjected to seismic loads. The data demonstrated that brick infill walls had a considerable impact on overall building performance, influencing structural reactions such as displacements, moments, and shear forces. The use of masonry infill walls decreases storey displacements while increasing storey moments and shear stresses. These walls greatly improve the seismic performance of the structure by limiting displacements, minimising storey drifts, and boosting lateral stiffness. The level of a soft storey is important in induced storey shear pressures, particularly at lower storeys, and its effect on storey displacements and moments is more obvious in near-fault motion. Regardless of loading direction or earthquake records, infill frame models with soft storeys exhibit abrupt increases in responses at defined levels. The addition of a soft storey increases storey drift at that level, outperforming bare frame scenarios. The study advises that magnification factors for storey response and displacement reduction factors be included in building rules, taking into account the effects of masonry infill measures.
- Mohaiminul Haque, Sourav Ray, and Amit Chakraborty [7], The analysis of variously shaped multi-story buildings reveals that all structures satisfy the displacement criteria for equivalent static analysis, with the exception of Model-1, which exceeds the permitted limit. Model-1, on the other hand, demonstrates deflection greater than 80%, but the storey drift indices in Model-4 show an initial increase with storey height,

culminating at the third storey, followed by a reduction. Displacements from time history analysis surpass limits, although maximum displacements from response spectrum analysis are smaller but still excessive. Displacement differences between shapes are minor in lower levels but rise in higher stories, with irregular structures (Models 1 and 2) displacing more than regular structures (Models 3 and 4). Overall, the study shows that irregular-shaped buildings are more sensitive to earthquake loads than regular-shaped buildings.

- Atul N. Kolekar and Y.P. Pawar [8], Comparing the Bhuj and Koyna earthquakes, seismic response analysis reveals higher base shear values in Bhuj (45.44% difference) using time history analysis, while both earthquakes show higher base shear values (Koyna: 37.01%, Bhuj: 41.30%) in the response spectrum method. Top story displacements are likewise higher in the response spectrum method. Despite changes, story drifts stay below acceptable limits, demonstrating the building's seismic safety. Time history analysis is advised for predicting structural responses accurately.
- Sampath Nagod, Prof. A.J. Zede, [9], The study discovered that base isolation in buildings reduces base shear by approximately 40% when compared to fixed-base buildings. When compared to regular buildings, mass irregular structures have a 30% increase in base shear. Regular structures with base isolators have the lowest base shear. Base isolation extends the life of the building by 27% and lowers base displacements. Time history analysis using seismic records and taking mass abnormalities into account is advised for reliable assessment and design of multi-story buildings for earthquakes.
- Pruthviraj N. Juni, S.C. Gupta, and Dr. Vinubhai R. Patel, [10], The analysis demonstrates that seismic reactions, such as base shear, storey displacements, and storey drifts, follow a similar pattern of increasing with intensities (V to X) for both models investigated. Maximum values for intensities VI-X are much greater than those for intensity V (2.50-17.35 times). Time history analysis is critical for realistic seismic analysis and safety assessments of structures developed in accordance with the IS code.
- Gaurav Kapgate, Prof. D. L. Budhlani, [11], The seismic performance of special moment resistant (SMRF) structures is evaluated using nonlinear time history analysis utilising ETAB 2016 software. When compared to a bare frame, shear walls increase base shear, while the inner shear wall efficiently minimises displacements and mitigates peak spectral acceleration better than the outer shear wall. Inner shear walls improve the seismic performance of SMRF structures.
- Tanveer M1, C. S. Vijaya Kumar, and Dr. M. N. Shivakumar, [12], The study reveals that the base isolation system results in greater displacements in both the X and Y axes when compared to a fixed base. Furthermore, the isolated base has increased drift in both directions. This is due to the separated building's reduced rigidity, which provides flexibility and reduces the influence of seismic loads on the structure. Furthermore, the isolated basis has lower story acceleration up to the sixth level, whereas the fixed base has higher acceleration from the seventh to the thirteenth story. Finally, the study finds that a structure with an isolated basis is more resistant to seismic loading than one with a fixed base.
- Kalpak A. Zagade, Aniket Patil, and Abhijeet Galatage, [13], he research aims to improve the base isolation mechanism in order to reduce storey drift, base forces, and moments under high excitations. Mechanical qualities should be adjusted using semi-active control. Buildings with isolated bases have lower shear force, bending moment, acceleration, and base shear, but higher lateral displacement. The model outperformed fixed-base structures in terms of structural element damage reduction and storey drift with increasing height. The research focuses on improving building base isolation systems so that they can withstand intense shaking without being damaged.hey recommend utilising a technique known as semi-active control, which is similar to altering the building's characteristics. They discovered some amazing outcomes when they attempted this on structures with a specific base that can move during an earthquake. These structures were subjected to reduced pushing and pulling forces, bending, and shaking. Although they slid more sideways at the bottom, they were really safer because their parts were less damaged. When it came to preventing damage, the structures with this particular base outperformed the ones that were fixed in place, especially as the buildings went taller. So, the study says that improving this base isolation method and using the adjusting technique could really help buildings stay safer and suffer less harm during strong earthquakes
- Prajapati Ramdev, Prashant R. Barbude, and Dr. A.P. Patil, [14], In the study, a G+12-story reinforced concrete building was studied using three earthquake analysis methods: one that simulates the strongest earthquake, one that examines the building's response to different shaking levels, and one that considers how the building moves over time during an actual earthquake. The final method, called time history analysis, provided the most precise representation of the building's movement and stress. This implies it's quite good at forecasting what will happen to the building during an earthquake. The study emphasised the significance of

this strategy in obtaining accurate information on how buildings react to earthquakes. As a result, the study recommends employing time-history analysis when constructing buildings to withstand earthquakes.

- Selwyn Babu, J. Rex, V. Priya Reddy, and M.S. Britto Jeyakumar, [15], The research findings show that as the number of floors in a building increases, so do displacements, drifts, overturning moments, and base shears. Surprisingly, when low-rise base (LRB) isolation technologies are combined, displacements and drifts increase, contributing to improved structural adaptability during seismic events. Notably, the use of LRB systems significantly reduces overturning moments as well as storey and base shears, resulting in increased structural stability and cost-effective design options. Despite the initial rise in displacements and drifts associated with its implementation, this highlights the benefit of LRB base isolation in producing more durable and cost-effective structures

III. OBJECTIVE

- To perform seismic analysis of G+9 building model using Etabs software.
- To Find Maximum Value of Global Response.
- To Find Maximum Value of Local Response.
- To check response of model for earthquake ground acceleration.

IV. CONCLUSION

- Irregular buildings have irregular displacement patterns, with maximum displacements often increasing from the first to the last floor. However, several deviations are noted due to variances in plan features.
- Time history analysis is critical for capturing irregular structures' nonlinear behaviour. Equivalent static analysis overestimates displacements, whereas dynamic analysis produces more accurate conclusions.
- Seismic responses such as base shear, storey displacements, and storey drifts increase with increasing seismic intensity. Time history analysis is advised for a realistic assessment of structural safety.
- Base shear values vary between earthquakes (for example, Koyna and Bhuj). In comparison to time history analysis, response spectrum analysis produces greater values.
- The use of masonry infill walls in RCC buildings has a major impact on structural responses, reducing storey displacements while raising storey moments and shear forces. Soft storeys enhance storey drifts and create larger shear stresses at lower levels.
- Base isolation techniques reduce base shear and improve building seismic performance, whereas mass irregularities increase base shear.
- Nonlinear dynamic time history analysis gives a realistic assessment of the seismic performance of multi-storey buildings, capturing the effects of various earthquakes and structural imperfections.
- Overall, these studies emphasise the significance of using dynamic analysis methodologies like as time history analysis to effectively forecast structure reaction under seismic pressures. Inclusion of elements such as shear walls and base isolation systems can significantly improve the seismic performance of multi-storey RCC buildings.

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