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A REVIEW ON COMPARATIVE STUDY OF MULTI-STOREY RCC BUILDING BASED ON (NON-LINEAR) TIME HISTORY ANALYSIS AND PUSHOVER ANALYSIS

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Abstract—
Reinforced Concrete (RCC) buildings utilizing both Non-linear Time History Analysis (NTHA) and Pushover Analysis (PA) methodologies. The primary objective is to evaluate and contrast the structural behavior, performance, and seismic response of these buildings under varying loading conditions. The abstract begins by highlighting the significance of seismic evaluation for multi-story RCC buildings, considering their susceptibility to seismic forces. It emphasizes the necessity for accurate assessment techniques to ensure structural integrity and safety. The research methodology involves the application of both NTHA and PA techniques to analyze the structural response of multi-story RCC buildings subjected to seismic loads. NTHA, recognized for its precision in capturing dynamic characteristics, simulates ground motion effects by considering the non-linear behavior of the structure and soil-structure interaction. On the other hand, PA, known for its simplicity and efficiency, evaluates the building's seismic performance based on a simplified pushover curve derived from static pushover analysis.
A Review on Comparative study of Multi-storey RCC Building based on (Non-linear) Time History Analysis and Pushover Analysis
The abstract proceeds to outline the key parameters investigated in both analyses, including displacement profiles, inter-story drifts, distribution of forces, and deformation patterns. Comparative insights into the strengths and limitations of each method in predicting the structural behavior of multi-story RCC buildings under seismic loads are presented. Furthermore, the abstract highlights critical findings and discrepancies between the outcomes obtained from NTHA and PA, shedding light on their effectiveness in representing the actual structural response. These findings contribute to enhancing the understanding of the behavior of multi-story RCC buildings under seismic conditions, thereby aiding in the refinement of design and assessment practices. In conclusion, the abstract underscores the importance of employing complementary analysis techniques such as NTHA and PA in seismic evaluation, emphasizing the need to interpret their results holistically for a more comprehensive understanding of the structural response. The comparative review serves as a valuable reference for structural engineers, researchers, and stakeholders involved in seismic design and evaluation of multi-story RCC buildings.

Index Terms— Non-linear Time History Analysis, Pushover Analysis, Structural Performance, Seismic Evaluation, Dynamic Response

I. INTRODUCTION

The world has seen several devastating earthquakes throughout history, which have led to a high number of fatalities and significant property loss. The Bhuj earthquake in India caused extensive damage and even the collapse of several structures, both engineered and non-built. Due to the migration of people from rural to urban regions for economic reasons, the population of an urban area has grown rapidly during the last several decades in that country. The majority of structures that are in use today, all around the world, are not built to endure severe ground tremors. However, the lack of data necessary for evaluating each building's seismic susceptibility leads to increased damage and

fatalities. Earthquakes of different magnitudes are often observed across the Indian subcontinent. Low to moderate earthquakes happen infrequently, usually every two to three years. According to the Indian zoning map, Nagpur is located in Zone II, which is regarded as the safest zone due to its minimal seismicity. Despite this, no earthquake of a magnitude of 4 on the Ritcher scale has occurred in the town since 1938. The Indian Geological Survey has identified prominent neo-tectonic activity characteristics in the 200+ km radius surrounding Nagpur, which have the potential to cause mild to major earthquakes. According to GSI, the Narmada and Gwaligarh faults are both 200 km from the city, and their impact cannot be disregarded.

1.2 Seismic Vulnerability

Any structure's susceptibility to damage during intense ground shaking is referred to as its seismic vulnerability. In cities with large densities of inhabitants and infrastructure, it is necessary. Building vulnerability may be evaluated using a variety of techniques both before and after an earthquake. An engineer must be able to quickly evaluate existing buildings' seismic response while working with a large portfolio of buildings in order to potentially remodel the less well-maintained structures. For accuracy in the evaluation that is often employed, three-level assessment techniques are typically utilized. These are as follows:
a) Quick visual screening b) Initial evaluation c) Comprehensive analysis

1.3 Time History Analysis

Throughout the whole ground motion period, the time history approach computes all possible forces and, consequently, structure displacement at equal intervals, usually o.o5 to o.1 second.

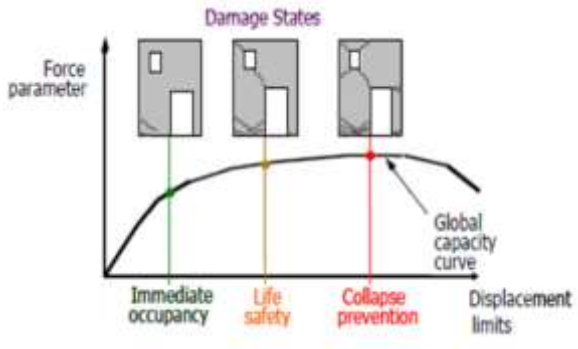
Time-history analysis is used to examine how a structure behaves when exposed to past earthquake or wind acceleration data. It is not necessary for the structure to be an SDoF system.

In time history studies, the structural response is calculated at several successive time instants. Stated differently, this leads to the acquisition of temporal histories of the structural response to a specific input. reaction spectrum analysis is not capable of estimating the temporal development of a reaction.

1.4 Pushover Analysis (POA)

The method of determining a building's capacity is called pushover analysis (POA). A structure is given incremental lateral loads and gravity loadings until a monitored or target point is achieved in the Pushover, a nonlinear static analysis. A specific pattern of lateral force propels the structure, and a building's roof node is tracked until it reaches its destination. At each stage of the migration climb, vertical stiffness, or base shear, is measured during this process. The pushover/capacity curve, which represents the connection between shear base and roof displacement, is the result of this work. Certain information, such as material properties and plastic hinged properties, are required while performing the POA. The nonlinear material property determines a frame member's strength and deformation relationship. A performance stage establishes a limit on damage that can be considered reasonable for a specific structure with a specific amount of ground motion. According to FEMA 356-2000 and ATC-40, the following are the performance stages:

- Immediate occupancy (IO): minimal to nonexistent damage; the building maintains its initial rigidity.
- Life safety (LS): The structure has sustained significant damage and may have lost a significant amount of its rigidity. Before complete breakdown, a sizable margin for further lateral distortion is left.
- Collapse prevention (CP): If deformation persists before this time, the structure may be shifted toward collapse since it has sustained significant damage.



II. LITERATURE REVIEW

1. Mouzzoun et. al., tried to use pushover analysis to assess the seismic susceptibility of a six-story residential structure in seismic zone III that was constructed in accordance with the Moroccan seismic code RPS2000. The analysis was performed using SAP2000. The building is first given a gravity push that includes seismic stresses as well. Laterally, the second and third pushes are made in the X-X and Y-Y directions, respectively. The demand and capacity curves were found to meet at the IO (Immediate Occupancy) level during a mild earthquake and at the LS (Life Safety) level during a major earthquake. While significant damage to some structural components is possible, there are no significant risks of falling debris.

2. Prathibha and Prasad, carried out the pushover study on an RC MRF building that was thought to be in India's zone V. The capacity spectrum was created using the ATC-40 rules and the SAP2000 application for modeling. Three pushes—push X, push Y, and gravity—were used, in that order. The region's demand and capacity spectra have been overlapped after the capacity curve was transformed into a capacity spectrum. The structure was unable to guarantee life safety in the event of a maximum credible earthquake.

3. Lakshmanan, a typical two-story structure and conducted a pushover study to determine the performance characteristics relevant to the Indian environment. For various percentages of damping, a capacity spectrum was displayed versus demand spectra. Additionally, utilizing the hinge count at the conclusion of the pushover study, vulnerability indices for the beam and column were computed. Retrofitting and testing beams and beam-column joints revealed that, according to the study, repair is not appropriate in these situations. Appropriate performance parameters should also be developed.

4. Hakim et. al., conducted pushover analyses on four RC structures to see how well each one the Saudi Building Code intended to function. ATC-40, FEMA-356, and FEMA-440 are the three analytical standards that were used to compute and compare the target displacement. Plotting capacity and demand spectra led to the conclusion that ATC-40 provisions would result in a smaller target displacement.

5. Dya and Oretaa, We a pushover analysis in SAP2000, taking into account ATC-40 principles, on a four-story, three-bay, soft-story building following an initial vulnerability assessment. After calculating the soft storey ratio and estimating the local seismic vulnerability index for various floors, it was determined that the localization of earthquake forces was the reason for the soft storey's poor performance.

6. Kassem et. al., suggested a simple method for calculating the seismic risk index using nonlinear analysis, and three vulnerability classes were covered. Pushover analysis and nonlinear time history analysis have also been carried out for Malaysia in order to ascertain the weighted inclusion of components. and a suggested mean damage grade that the seismic vulnerability index can be used to compute.

7. Chaudhury and Singh, suggested a design process with friction and metallic dampers for a performance-based frame building that aimed to accomplish hinge rotation and inter-story drift. Additionally, the whole design process has been addressed, and the technique has been confirmed.

8. Analyzing ANSYS time history analysis data based on input type System for International Nuclear Information (INIS) Park, Keun Bae; Kim, In Yong; Kim, Tae Wan; Nam, Kung. Depending on the kind of input time history, this study evaluates and explains the analytical reliability of dynamic analysis using the commercial FEM analysis code ANSYS. Using ANSYS with displacement time history and GT/STRUDL with displacement time history, two different dynamic analyses were performed and compared for the same model. The displacement time history ANSYS results were more conservative than the acceleration time history results depending on which way the input was directed. the analysis's findings with an acceleration time history using ANSYS. CEDM seismic analysis using ANSYS was performed to examine the impact on the analysis for the NSSS structures. The cases in the input time history are BLPB, OBE, and SSE. The acceleration floor response spectra of each example, which are acquired after post-processing the analysis findings, are used to make comparisons. Compared to seismic analyses using acceleration time histories, those with displacement time histories showed more conservative conclusions. In conclusion, conclusions from a displacement time history time history time history study utilizing ANSYS may be too cautious. It is thus advised to employ the acceleration time history option in ANSYS whenever feasible and to carefully examine the displacement time history option in ANSYS. 22 figures, 7 references, 6 tabs (Author)

9. Time history nonlinear seismic response analysis taking geometrical nonlinearity and materials into account The INIS, or International Nuclear Information System Yamashita, K.; Takaoka, E.; Nakazawa, M.; Shikama, Y.; Kobayashi, T. 2002-01-01 A time history nonlinear earthquake response analysis approach was created and utilized to forecast the earthquake reaction for a Large size Seismic Test (LSST) Program in Hualien, Taiwan, where a 1/4 size model of a nuclear reactor containment structure was erected on a layer of sandy gravel. Both strain-dependent material nonlinearity and geometrical nonlinearity resulting from base mat elevation were considered in the study. The use of 'Lattice simulate' was utilized to model the interplay between soil and structure. Based on an earthquake record obtained on the soil surface of the location, the analytical model's input motion was deconvoluted to GL-52 m with 300 Gal of maximum acceleration. A pair of analyses were considered: Along with (A) similar linear and (B) nonlinear time histories, the benefits of the time history nonlinear seismic response analysis technique are described.

10. Time-history analysis-based seismic performance evaluation of the dam's susceptibility Swedish Open Access Journal Directory Oumnia Elmrabet January 1, 2018 The current seismic assessment strategy can be computationally demanding due to its performance-based methodology and multiple time history analyses (THA) that need time-consuming post-processing of the results. Time history analysis, which computes a structure's response to an earthquake, is a subset of structural analysis. It is one of the primary structural design procedures in areas with a high seismic activity. This study aims to assess the embankment dam's seismic performance using the THA technique, situated on the Oued RHISS in the Province of AL HOCEIMA. When assessing a structure's seismic susceptibility under real earthquake data, the interplay of soil, structure, and fluid is taken into account to monitor structural behavior. In this study, dynamic numerical simulations are conducted to investigate and ascertain the overall response of the soil-structure system. Ground acceleration time history data are utilized for seismic analysis, and a basic assistant program is created to implement earthquake analyses of structures using ANSYS.

11. A comparison between measurement and time-history elastic plastic piping analysis The INIS, or International Nuclear Information System Sansalone, K.H. & Scavuzzo, R.J. 1992-01-01 At each pipe foundation, hydraulic sleds applied strong seismic inputs to the GE/ETEC Green piping system. The bending stresses were pushed into the plastic regime by these high enough inputs. The pipe reaction was measured by strain gauges at several points in the system. The dynamic input and the pipe system were modeled using the ABAQUS finite element code. Issues related to the dynamic input are spoken about. Several types of finite elements were evaluated for accuracy. An elastic and an elastic-plastic time-history analysis were performed on the system. The results of these analyses are compared with the experiment's findings. These comparisons demonstrated the good agreement between the

experimental data and the nonlinear elastic-plastic analysis, as well as the conservative nature of elastic assessments of dynamic stresses across all comparison locations.
12. Simplified non-linear time-history analysis using the DEFF Research Database (Denmark) for Theory of Plasticity Joao Domingues Costa January 1, 2005 This work aims to contribute to the task of building simpler non-linear time-history (NLTH) analysis of structures whose dynamical response is predominantly determined by plastic deformations, so as to provide designers with findings that are sufficiently exact. The technique that will be discussed is based on the Theory of Plasticity. Initially, the time-history analysis formulation and computational procedure for a rigid-plastic single degree of freedom (SDOF) system are explained. Both strength decrease and pinching are necessary for the method.
13. Comparing a pipe system's non-linear time history analysis with its modal spectral analysis The INIS, or International Nuclear Information System Aelbrecht, D.; Lafaille, J.P.; Gerard, R. 1987-01-01 A standard piping system of the chemical and volumetric control system's discharge line outside the containment, between the penetration and the heat exchanger in a running power plant, was analyzed using four different techniques: modal spectral analysis with 2% constant damping, modal spectral analysis using ASME Code Case N411 (PVRC damping), and non-linear time history analysis. This study presents an assessment of the conservatism of linear methodologies compared to non-linear analysis.
14. Requirements for producing spectra with constant time histories The INIS, or International Nuclear Information System C.-W. Lin 1977-01-01 There are several methods for doing seismic analysis on the systems and parts of nuclear power plants. The most popular methodology among them for linear modal analysis is the response spectrum approach. For designs that require the response to be calculated as a function of time and contain structural or material nonlinearities, such as frequency-dependent soil properties, gaps, single tie rods, and friction between supports, the time history approach is the only practical method of analysis. Two examples of time history analysis are as follows: 12) A coupled reactor coolant system and building analysis to compute the nonlinear system time history response or generate the floor response particular; 3) An investigation of the connection between soil and structure. The development of a suitable time history input for the study has been covered in the literature. Some general criteria are provided to guarantee that the time history imput is as conservative as the design response spectrum. There hasn't been much discussion of how the dynamic features of the time history input affect the system response. Actually, the existing discussion in this area is limited to the statistical independence of the time history components. This study presents numerical results for situations that make use of the time history approach. Furthermore, criteria that may be helpfully implemented to attain realistic and, more importantly, conservative spectra consistent temporal histories are outlined.

CONCLUSION

Poor quality should be taken into account when building structures with different levels in order to prevent significant damage; lines with independent foundations are more durable than lines with displacement. Small earthquakes don't cause buildings to collapse; instead, they keep their flexibility.
• Research was done to determine how the building's height affects the vertical position of the transfer plate within the structure. Below are some of the study's conclusions.
• The shear force increases from floor to floor in proportion to the building's total height since the transition level is situated at the lowest point of the structure.
• Storytelling Because of the size difference, the shear force on the transfer plate will always decrease.
• In both the X and Y directions, the variance will decrease as the conversion plate reaches its lowest point and increase as it reaches its highest point. and then suddenly lets go of more.
• As the transformation plate's position varies, the maximum base shear force value drops; on the other hand, the maximum base shear force value increases as the plate's position changes.

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