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A Review Paper on Linear and Nonlinear Analysis of G+15 Story Building with and without Shear Wall by using Time History Analysis Method

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Abstract: An earthquake is the result of the rapid release of deformation energy stored in the earth's crust, which generates seismic waves. The structures are sensitive to earthquakes and structural damage. In order to take preventive measures against damage to structures due to ground motion, it is important to know the characteristics of ground motion. The most important dynamic characteristics of an earthquake are peak ground acceleration, frequency content, and duration. These characteristics play the main rule in the study of the behavior of structures during earthquake ground motion. Earthquake analysis of a multi-story structure is performed using linear and non-linear methods. The response spectrum analysis method is linear dynamic analysis. The time history method is used for nonlinear dynamic analysis. In this paper, the response spectrum method is used for linear analysis. The time history method is used for nonlinear analysis. For the time history method Both analyzes are performed using ETABs software.

Linear Time History analysis of RCC building considering 4 different time histories is carried out. The time history data of Bhuj earthquake, Chamba earthquake, Chamoli earthquake and NE (Myanmar) earthquake has been considered. Here, a building has been modelled using Etabs software for seismic analysis and time history analysis. This paper highlights the effects of different time histories of different region on the same structure. The effects under considerations are story shear, building deflection and story drift.

Keywords: Earthquake, Ground motion, Time history analysis, Shear wall, Seismic waves, Ground motion, Response spectrum analysis, Time history analysis.

I. INTRODUCTION

Worldwide, there is a huge demand for the construction of high-rise buildings due to the increasing population Earthquake-resistant design of engineering structures is one of the most important ways of future earthquake damage. Earthquake design of the structure is based on ground motion specification from previous earthquake results. Therefore, it is very important to be able to overcome the damage of any important earthquake-resistant structure according to the seismic frequency. However, earthquake forces are varied and unpredictable, so software tools must be used to analyze structures under any seismic forces. Earthquakes develop different intensities in different places, and the damage induced in buildings in these places also varies according to the type of structure. Therefore, it is necessary to study the seismic behavior of RC prefabricated buildings for different seismic intensities. Seismic intensities in terms of various responses such as base shear, lateral displacement. Different types of analysis are used to identify the seismic resistance and behavior of a building at applied seismic frequencies.

The calculation can be done based on external applied loads, structural materials used and type of structure, the analyzes are classified as

1) Linear static analysis
2) Non-linear static analysis
3) Linear dynamic analysis
4) Non-linear dynamic analysis.

Time history analysis is the response of the structure including inertial effects, this is advanced to spectrum response analysis and provides basic acceleration, displacement and duration. This is useful for very tall structures to know how the structure behaves under any seismic attacks.

This analysis requires previous earthquake data to perform the analysis. It is a step-by-step analysis of the structure's response to a specified load that may change over time.

A. Theme of Investigation

The non-linear El-centro time history analysis is carried out for special moment resisting frame under earthquake loading using computer software E-TAB 2016. Seismic analysis of RC frame with bare and different position of shear wall in frame is carried out using Non-linear dynamic analysis method as per IS 1893 (Part I): 20016 by using E-TAB 2016 For this analysis different types of models will discussed in chapter are considered and comparison is carried out.

B. Seismic Method Of Analysis

To determine the seismic responses, it is necessary to perform a seismic analysis of the structure. The analysis can be performed on the basis of the external action, the behavior of the structure or structural materials and the type of structural model chosen.
Based on the type of external action and behavior of the structure, the analysis can be further divided into:

1) linear static analysis
2) nonlinear static analysis
3) linear dynamic analysis
4) Nonlinear dynamic analysis

For a regular structure with limited height, linear static analysis or an equivalent static method can be used. Linear dynamic analysis can be performed using the response spectrum method. A significant difference between linear static and linear dynamic analysis is the level of forces and their distribution along the height of the structure. Nonlinear static analysis is an improvement over linear static or dynamic analysis in that it allows for inelastic behavior of the structure. Nonlinear dynamic analysis is the only method to describe the actual behavior of a structure during an earthquake. The method is based on the direct numerical integration of the differential equations of motion by considering the elastoplastic deformation of the structural element.

a) Equivalent Static Analysis

This procedure does not require a dynamic analysis, but takes into account the dynamics of the building in an approximate way. The static method is the simplest – it requires less computational effort and is based on the formulation given in the code of good practice. The design base shear for the entire building is first calculated and then distributed over the height of the building. The lateral forces obtained in this way at the individual floor levels are divided into individual elements that resist the lateral load.

b) Linear Dynamic Analysis

Linear dynamic analysis can be done in two ways, either mode superposition method or response spectrum method and elastic time history method. This analysis will produce the effect of higher modes of vibration and the actual distribution of forces in the elastic region in a better way. They represent an improvement over linear static analysis. A significant difference between linear static and linear dynamic analysis is the level of forces and their distribution along the height of the structure.

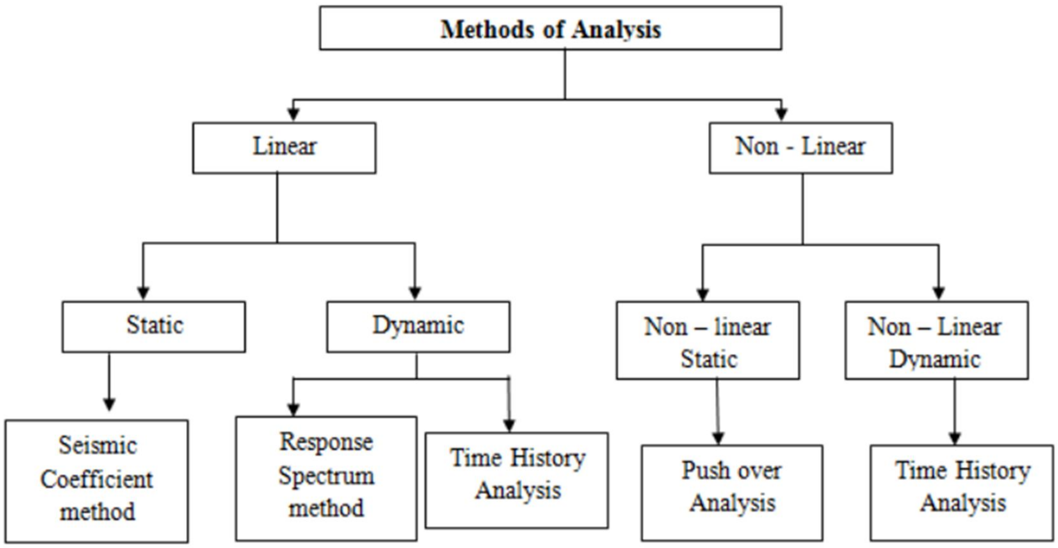
c) Nonlinear Static Analysis

Nonlinear static analysis is an improvement over linear static or dynamic analysis because it allows for inelastic behaviour of the structure. The method still assumes a set of static incremental lateral loads over the height of the structure. The method is relatively simple to implement and provides information on the strength, deformation and ductility of the structure and the distribution of demands. This allows identifying critical elements likely to reach limit states during an earthquake that should be addressed during the design and detailing process. However, this method contains many limiting assumptions that neglect the behavior of load patterns, the effect of higher modes and the effect of resonance. Push over analysis has gained great popularity nowadays, despite these shortcomings, this method provides a reasonable estimate of the global deformation capacity, especially for structures that primarily respond according to the first mode.

d) Nonlinear Dynamic Analysis

Nonlinear dynamic analysis of inelastic time analysis is the only method to describe the actual behavior of a structure during an earthquake. Time history analysis is a step-by-step analysis of the dynamic response of a structure to a specified load that may vary over time. Time history analysis is used to determine the seismic response of a structure under dynamic loading from a representative earthquake. This method is based on the direct numerical integration of the differential equations of motion by considering the elastoplastic deformation of the structural element.

This method captures the gain effect due to resonance, the change of displacements at different levels of the frame, the increase in the duration of the movement and the tendency to regularize the movements as the level increases from bottom to top.



II. TIME HISTORY ANALYSIS

In order to investigate the exact nonlinear behavior of structures, a nonlinear time history analysis must be performed. In this method, the structure is subjected to real ground motion records. This makes this method of analysis quite different from all other methods of approximate analysis because the inertial forces are directly determined from these ground motions and the building responses in either deformations or forces are calculated as a function of time with respect to the dynamic properties. structures.

In Etabs, non-linear time analysis can be performed as follows: 1. Building models are created and vertical loads (dead and service loads), member properties and non-linear member behavior are defined and assigned to the model.

The ground motion record is defined as a function of acceleration versus time. Next, the analysis and time history parameters are defined in order to perform a nonlinear time history analysis. The total analysis time is the number of output time steps multiplied by the output time step size. To fit the time history of the target response spectrum, there are two options in ETABS.

III. RESPONSE SPECTRUM METHOD

Reaction spectrum analysis (RSA) is a method extensively used for the design of buildings. Conceptually the method is a Simplific ation of modal analysis, i.e. response history (or time history) analysis the usage of modal decomposition, that advantages from the homes of the reaction spectrum idea. The purpose of the method is to provide short estimates of the height re sponse witho ut the need to carry out reaction records evaluation. that is very important due to the fact response spectrum analysis (RSA) is primarily based on a chain of quick and easy calculations, while time history evaluation requires the solution of the differential equation of movement over the years. no matter its approximate nature, the approach is very useful because it permits using reaction spectrum, a totally convenient manner to describe seismic risk.

IV. TIME FUNCTION

Time-history analysis provides for linear or nonlinear evaluation of dynamic structural response under loading which may vary according to the specified time function.

Dynamic equilibrium equations, given by K u(t) + C d /dt u(t) + M d 2 /dt u(t) = r(t), are solved using either modal or directintegration methods. CSI Software handles the initial conditions of a time function differently for linear and nonlinear time-history load cases. Linear cases always start from zero, therefore the corresponding time function must also start from zero. Nonlinear cases may either start from zero or may continue from a previous case. When starting from zero, the time function is simply defined to start with a zero value. When analysis continues from a previous case, it is assumed that the time function also continues relative to its starting value. A long record may be broken into multiple sequential analyses which use a single function with arrival times. This prevents the need to create multiple modified functions.

Time History Analysis In order to examine the exact nonlinear behavior of structures, nonlinear time history analysis has to be carried out. In this method, the structure is subjected to real ground motion records. This makes this analysis method quite different from all of the other approximate analysis methods as the inertial forces are directly determined from these ground motions and the responses of the building either in deformations or in forces are calculated as a function of time, considering the dynamic properties of the structure.

In Etabs 2016, the nonlinear time-history analysis can be carried out as follows:

1) The models representing the buildings are created and vertical loads (dead load and live load), member properties and member nonlinear behaviors are defined and assigned to the model.
2) The ground motion record is defined as a function of acceleration versus time. Here after, the analysis and the time history parameters are defined in order to perform a nonlinear time history analysis. The total time of the analysis is the number of output time steps multiplied by the output time-step size. To match time history to target response spectra, there are two options in ETABS 2016. These are spectral matching by time domain and spectral matching by frequency domain options. In spectral matching by time domain option, the damping values with the first and second periods are assigned. Using these values, the program calculates the mass proportional and stiffness proportional coefficients. Spectral matching by frequency domain has the same interface but this time frequency values instead of periods are assigned. In the analysis of the analytical models spectral matching by time domain" option is used. The user graphic face of Etabs 2016 while defining the output steps and time step size for nonlinear time history analysis.

V. CONCLUSION

1) Based on Literature review concerning time history analysis and response spectrum analysis. In time history analysis uses the time history of input force or acceleration directly which is then united to get the response. In response spectrum analysis the time evolution of response cannot be computed. Only the maximum response is estimated. No information is available also about the time when the maximum response occurs.
2) The study is based on linear and nonlinear analysis of multistorey structure for finding base shear, storey displacement and time period.
3) It is recommended that time history analysis should be performed as it predicts the structural response more accurately than the response spectrum analysis.
4) This study shows that the time history analysis procedure leads to good estimates of the trends of building response. Equivalent static method and response spectrum analysis are not sufficient for structures in higher seismically active regions (i.e., for zone V).
5) Time history analysis represents a seismic design method which avoids the approximations of other linear seismic analysis methods, which leads to conservative results and can be applied to any structure.
6) A high-rise building of 15 floors subjected to seismic, wind and live loads were analysed using ETABS 2016 software.
7) Better accuracy of the analysis can be obtained by using this software.
8) By addition of shear wall base shear is increased than in bare frame.
9) Inner shear wall reduced large displacement in both directions than outer shear wall.
10) Also inner shear wall reduced peak spectral acceleration drastically than outer shear wall.
11) Provision of shear wall results in a huge decrease in base shear and roof displacement both symmetrical building and un-symmetrical building.
12) The performance based seismic design obtained by above procedure satisfies the acceptance criteria for immediate occupancy and life safety limit states for various intensities of earthquakes.

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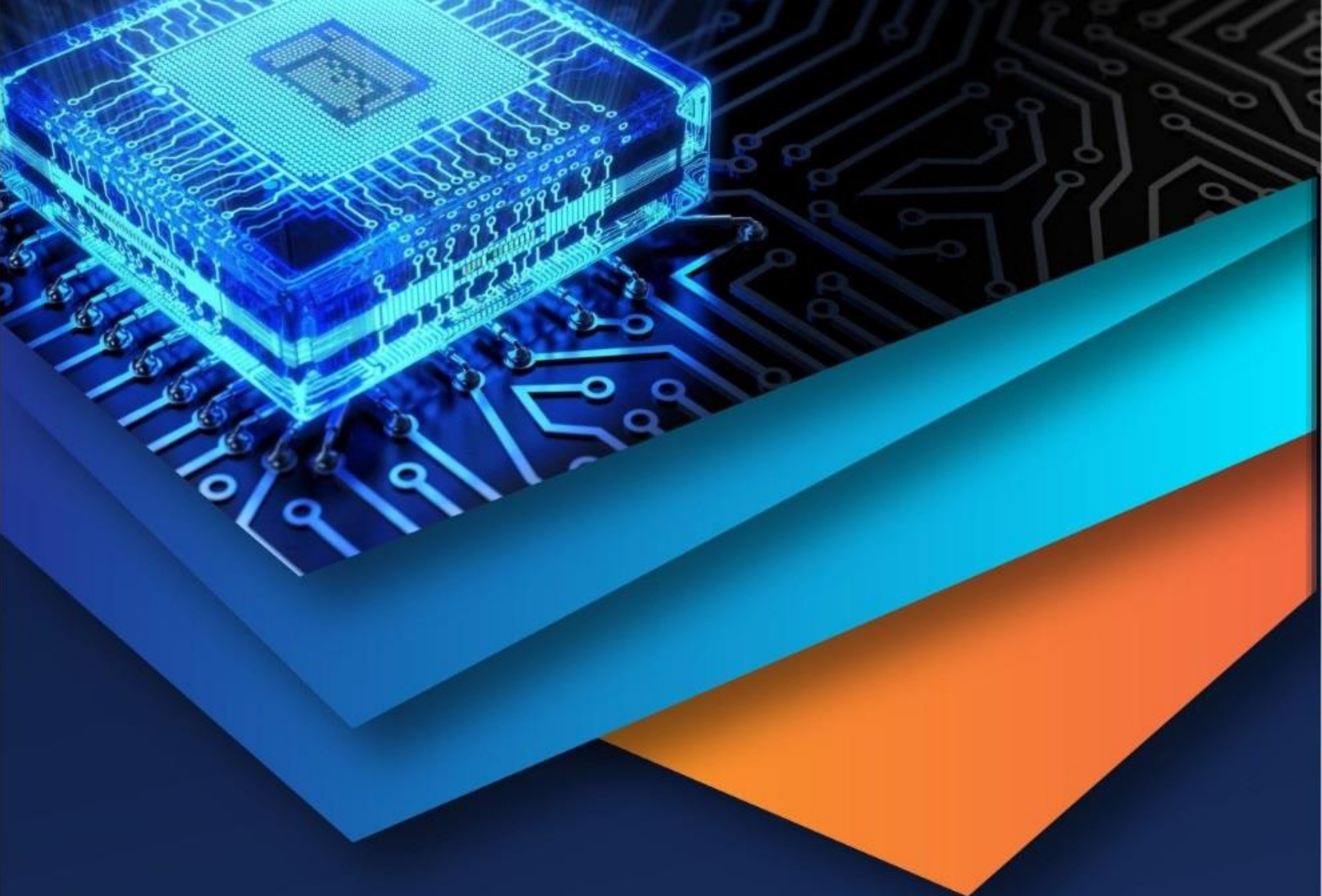

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