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# A Review of Seismic Analysis of High Rise Building Using Etabs Software

*Kanchan Wakalwar*[1] *and Dr. Rajeev Chandak*[1]

[1]Department of Civil Engineering, Jabalpur Engineering College, Jabalpur (M.P.)

**ABSTRACT**

Testing and performing seismic building analysis is important because earthquakes have caused a lot of damage and structural damage in the past. It is imperative to analyze the response of the building structure to possible damages. Seismic response to real-time history is essential for the performance of a building designed under seismic consideration. The research involved the analysis of four different building models that are vertically irregular. The chosen method is vertical random problem analysis with respect to time history analysis. Four building models are considered along with time history reference data to work out and conduct the research. The software used to perform the analysis is ETABS. All analyzes are compared for results such as deflection, base response and stress. The data collection is organized in tabular format mainly for deflection, base shear and stress. This software is mainly used for structures like high rise structure, concrete and steel structures. The aim of the paper is to investigate a high rise building of (G+10) storeys considering seismic, dead and live loads. The appearance criteria for skyscrapers are strength, serviceability and stability.

**KEY WORD-** Multistory Buildings, Vertical Irregularity, Seismic Analysis, Time History Analysis, Displacement

## 1. INTRODUCTION

Researchers have studied earthquakes for a long time and still those earthquakes are unpredictable. It is impossible to predict the time and location of an earthquake. The design and construction of structures that can withstand earthquakes has been a topic of research for many years, with researchers needing to measure earthquake frequency and intensity for future structural design. Safety, strength and performance are parameters that are considered while designing a structure, especially in seismic zones. However codes and guidelines are prepared by engineering societies in the world which can be used to design buildings. The factors responsible for the failure of the structure under seismic are:

(i) Wrong and weak infrastructure configuration and irregularities at the planning stage.

(ii) Less strength and ductility consideration at the design stage.

(iii) Unplanned and unscientific construction activities and sequences. increase in population leading to land shortage.

This type of skyscraper structure is affected by natural phenomena. As such earthquakes are most dangerous because of the damage and impact they cause to structural components, and they cannot be controlled. These natural disasters damage structures and disrupt normal life cycle development. Since this is a global concern, most of the analysis should be explored and results should be provided to prepare the structure for achieving the time period. With technological progress, man tried to deal with these natural phenomena in various ways such as developing early warning systems for disasters, adopting new preventive measures, adopting proper relief and rescue measures.

## 2. LETERATURE REVIEW

**Gaurav B N et al (2021),** they studied the effects of soil type I for different seismic zones for a high rise building of (G+29) storeys using ETAB software and response spectrum analysis. The response spectrum is used to compare the behavior of the models in four seismic zones (zones II, III, IV, and V), using base response, storey drift, time duration, and storey stiffness as criteria. Used to be.

**Yashshree Unclekhop et al. (2021),** they studied the analysis and design of a building using rectangular and circular column, they determine the parameters of all floors of a building, shear force, base reaction, floor stiffness, storey Shear, overturning moment, storey displacement, storey drift and so on. Their study shows that both analysis and design were compared by software and manual calculations as per IS 456-2000.

**Nitin R. Mulay et al. (2020),** their study shows that a multiple hazard-based method for assessing the damage risk of high-rise buildings, when a multi-storey RC building is subjected to wind and earthquake hazards, each Floor displacement varies from floor to floor. , i.e. the storey displacement does not increase with the height of the building as compared to the regular earthquake excitation. With wind and seismic excitation the storey drift value increases with the height of the building but decreases drastically at 14 storeys.

**W Bourouia et al (2019),** their study suggests that the research aims to simulate the interaction between a concrete wall and the earth under seismic loads. Their study goal is to investigate the effects of soil characteristics and soil-structure interactions on the seismic response of structures. The findings suggest that soil condition has a significant effect on the seismic behavior of structures.

**Shubham Borkar et al. (2019),** they studied the analysis and design of (G+6) storey building in different seismic zones and soil types. Their study shows that because soil-I is a hard soil, base reactions are less because the soil is harder and stronger than soil-II and soil-III. The storey drift value increases as the seismic field factor increases.

**Mindala Rohini et al. (2019),** they carried out seismic response of (G+15) storey residential building in Zone III and V using response spectrum and time history methods in ETAB. The results show that the value of storey displacement is higher in zone V than that of zone III. The storey shear is greatest on the ground in both the response spectrum method and the time history method. Zone V values are higher than Zone III.

**Umamaheswara Rao Tallapalem et al. (2019),** their study suggests that when an earthquake hits a multi-storey building in a populated area, it will cause massive damage. In this work, the (G+7) structure was modeled in Staad Pro and earthquake analysis of the structure was carried out in different seismic zones (II, II, IV and V) of India. The results show that base shear, displacement, support reactions and steel content are zone factor dependent, so these values are higher in zone V.

**Jayaprakash et al. (2019),** they studied the response spectrum method of analysis of a (G+30) storey reinforced concrete high-rise building under wind and seismic loads. The results show that the floor displacement is maximum at the top floor and it is also observed that as the height of the building increases, the lateral stiffness decreases, the floor drift is maximum at the middle height of the building and decreases to the level of the ceiling.

**Nilesh F Uke et al. (2019),** their study shows that (G+11) observation of the effects of seismic and wind loads on the building. It was concluded that the seismic and wind stress on multi-storey buildings increases with increasing height of the building. It found that seismic forces are less effective than wind forces for tall buildings because tall buildings are more flexible, but seismic forces are more effective for short buildings. The storey displacement is considerable at the upper levels during seismic events, but negligible at the top storey with wind forces.

**P Rajeshwari et al. (2019),** their study suggests that earthquake resistant construction by enterprise seismic investigation of the structure using static equivalent technique of study. For this purpose a (G+10) storey residential building plan is being proposed. The displacement of the building increases with increasing seismic fields and wind pressure. Most of the storey drift occurred in the central part of the building structure and it increases with the increase in seismic zone.

**Amir Hasan et al (2018),** they studied the effect of soil condition under isolated foundation of (G+12) storey building using ETAB software. The seismic performance of multi-storey buildings is compared and investigated using a systematic approach. The result shows that the value of base shear is proportional to the ductility of the soil and the stiffness of the superstructure.

**Gaurav Sachdeva et al. (2017),** they studied the effect of different soil and seismic zones on different height of frame structure. There are three varieties of soil: soft, medium and hard with heights of 15 m, 18 m, 21 m and 24 m respectively, rated for maximum bending moment in hard soil strata as compared to soft soil strata in the seismic zone and is studied. II, III and V, and the lowest for the same.

**Mohd Mahmood Azad et al (2015),** their study shows that, effect of building size on wind and earthquake response. In the present study, three different building forms were studied, and a comparison of different building forms against the effect of lateral loads due to wind and earthquake was presented. The investigation took into account the Bangladesh National Building Code (BNBC) of 2006. The results suggest that the design of the structure has a substantial effect on reducing building drift.

## 3. SCOPE OF THE STUDY

With ever increasing population in future as well as limited space, horizontal expansion is not a viable solution especially in metropolitan cities. Today there is enough technology to construct super-tall buildings, but in India we are yet to catch up to the technology that is already established in other parts of the world.

Recently there has been a significant increase in the number of high-rise buildings, both residential and commercial, and the modern trend is towards tall structures. Thus the effects of lateral loads such as wind loads, earthquake loads are gaining increasing importance and almost every designer is faced with the problem of providing sufficient strength and stability against lateral loads. For this reason earthquake loads can be predicted on the design of skyscrapers.

## 4. METHODS OF ANALYSIS OF STRUCTURE

In this study, the lateral design forces for the building model considered for the study are determined by the response spectrum method, as per the provisions of IS 1893 (Part-1):2016. Buildings are analyzed by building results for different zones for different load combinations to arrive at a conclusion about the importance of conducting seismic analysis. The present work is extended to study these effects on our building model by performing lateral load analysis.

## 5. METHODOLOGY

Building response is planned to be tested with ETABS software defining all dimensional parameters and material properties. The history of different periods has to be analyzed for vertical irregularities. In short description:

1. The model is modeled with different types of vertical irregularities.
2. Time history analysis is performed on the models in ETABS.
3. The results are tabulated and then compared with time history and vertical irregularities.

Collapse of a structure can be minimized if the latter points are considered. Most building structures include structural elements such as beams, columns, braces, shear walls and floor slabs. Floor slabs in multi-storey buildings, which normally transmit gravity loads to the structural system, are required to transfer lateral inertia forces to the structural system.

Failure patterns can be made ductile rather than brittle. If tensile strength is assured, the dissipation of energy produced will show less degradation.

1. Shear should not fail before bending.
2. Column failure occurs after beam failure.
3. Joints should be stiffer than the members
4. Dynamic analysis of structure using response spectrum method

## 6. SEISMIC ANALYSIS

It is necessary to conduct seismic analysis of the structure for the determination of seismic responses. The analysis can be done depending on the external action, structure or behavior of the structural material and the type of structural model selected. Based on the type of external action and the behavior of the structure, analysis can be further classified into:

(1) Linear Static Analysis,

(2) Nonlinear Static Analysis,

(3) linear dynamic analysis; And

(4) non-linear

### *6.1 Dynamic Analysis*

For regular structure with limited height linear static analysis or equivalent static method can be used. Linear dynamic analysis can be done by the response spectrum method. The key difference between linear static and linear dynamic analysis is the level of forces and their distribution along the height of the structure. Non-linear static analysis is an improvement over linear static or dynamic analysis, in the sense that it allows for nonlinear behavior of the structure. A non-linear dynamic analysis is the only way to describe the actual behavior of a structure during an earthquake. The method is based on direct numerical integration of the differential equations of motion by considering the elasto-plastic deformation of the structural element.

### *6.2 Equivalent Static Analysis*

This process does not require dynamic analysis, however, as it accounts for the dynamics of the building approximatively. The static method is the simplest - it requires less computational effort and is based on the formulation given in the code of exercises. First, the design base shear is calculated for the entire building, and then it is distributed along the height of the building. At each floor level thus obtained the lateral forces are distributed to the individuals in the lateral load resisting elements.

### *6.3 Nonlinear Static Analysis*

It is a practical method in which to estimate the deformation and damage pattern of a structure under permanent vertical load and gradually increasing lateral load.

### *6.4 Linear Dynamic Analysis*

The response spectrum method is a linear dynamic analysis method. In that method the peak response of the structure during an earthquake is derived directly from the earthquake response, but it is accurate enough for structural design applications.

### *6.5 Nonlinear Dynamic Analysis*

This is known as time history analysis. It is an important technique for structural seismic analysis, especially when the structural response evaluated is nonlinear.

### *6.6 Time history analysis*

Time history analysis is the step-by-step analysis of the dynamic response of a structure to a specified loading that may vary with time. Time history analysis is used to determine the seismic response of a structure.

## 7. CONCLUSIONS

It is concluded that in ETABS four models are considered and modeled and two time histories are considered to analyze the model. It is recommended that ETABS may be successfully considered and employed to analyze such cases and buildings considering different time histories. It is found that for all values of displacement, base reaction and stress the results obtained from Yermo time history are higher than Hollist time history. Further it can be concluded that ETABS is providing correct. In conclusion it is recommended that irregular buildings are safer than regular buildings under seismic conditions and should be preferred over regular buildings. The column size is made lighter with the height of the building so it is concluded that designing a lighter column saves the building cost and helps in achieving optimized design of the building.

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