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A Study between Zone 4 and Zone 5 of G+20 High-Rise Building Using ETABS Software: A Review

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***Abstract*: These People moved from rural to urban areas as a result of the industrial revolution and population increase, necessitating the development of multi-story buildings for both residential and commercial purposes. Because tall structures are not built to withstand lateral loads sufficiently, the structure collapses completely. Construction of earthquake-resistant buildings takes into account a number of factors, including the building's intrinsic frequency, damping factor, kind of base, significance, and ductility. In order to design earthquake-resistant structures, it is crucial to comprehend seismic analysis and provide safety against the seismic pressures of multi-story buildings. The objectives of the present work are to study the behavior of a multi storied RC building in live structure located in Pune (India) in plan subjected to earth quake load by adopting Response spectrum analysis. In the context of your thesis, this refers to analyzing and comparing the building's response under different seismic zones (Zone 4 vs. Zone 5) to assess how the level of seismicity affects the structural behavior. The present study is limited to reinforced concrete (RC) multi-storey commercial building with two different zones IV & V. The analysis is Carried out with the help of FEM software's ETABS. G+20 Multi-Storey Building with Basement, 3 podium Floor and 14 storey (Including future expansion). High-rise buildings have unique structural challenges due to their height, especially under seismic loading. Different values of Seismic Zone Factor are taken and their corresponding effects are interpreted in the results.**

***Keywords*: Multistorey building, ETAB, Response spectrum analysis, Base shear, Seismic zone, Reinforcement steel.**

1. Introduction

This an enormous amount of energy. An earthquake strikes swiftly, violently, and abruptly without warning. It might damage badly built or designed buildings, endangering or possibly killing the occupants. Large chunks of new concrete or steel deck are joined to the concrete element utilizing a hydraulic compressive connection, enabling the two components to work together as a cohesive block. This construction technique is known as a "metal assembly procedure" [1].

Low-rise buildings make up the majority of the structures utilized in Indian construction. For these constructions, steel and concrete members are typically used because of their ease of construction and achieved economies. However, many cities now have to develop more structures vertically due to the alarming rate of population growth. As a result, many medium- to high-rise buildings are constructed nowadays in order to meet the goals [2].

For these high-rise buildings, it has been shown that using composite elements rather than reinforced concrete beams is more effective and economical. To evaluate the structural response to fast, nondeterministic, transient dynamic events, a response spectrum analysis is performed. Two instances of these events are earthquakes and shocks/impacts. A time-dependent analysis is difficult to do since the load's exact temporal history is unknown. Since the event is too brief to be classified as an ergodic ("stationary") process, a random response technique is thus inappropriate. The response spectrum technique is based on a special type of mode superposition [3].

Multi-story building analysis and design are done with ETABS. This type of structure has a grid-like geometry, which is taken into consideration using modeling tools and templates, code-based load prescriptions, analytical methods, and solution approaches.

Systems that are basic or complicated can be analyzed using ETABS in both static and dynamic environments. For a more in-depth assessment of seismic performance, modal and direct-integration time-history analysis can be combined with P-Delta and large displacement effects.

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Fig. 1. Earthquakes in Kashmir & Bhuj (Gujarat) India

2. Literature Review

Kiran Devi et al. (2023), "A Comparative Study on Seismic Analysis of Multistorey Buildings in Different Seismic Zones" The multi-story buildings are constructed to accommodate numerous residents in confined spaces due to the growing population and lack of available land. The population growth and industrial revolution caused a migration of people from rural to urban areas resulting in the need for the construction of multi-story buildings for both residential and commercial uses. The tall buildings, which are not adequately constructed to resist lateral stresses, result in the total collapse of the structure. Buildings that can withstand earthquake forces are created by considering different criteria such as the building's inherent frequency, damping factor, kind of base, significance of the building and ductility of the structure. Because they have better moment distribution properties, structures designed for ductility need to be designed for lower lateral loads. To ensure safety against the seismic stresses of multi-story buildings, it is essential to understand seismic analysis in order to develop earthquake-resistant structures. Both a regular moment-resisting frame and a special moment-resisting frame were taken into account for the seismic study. In the present study, a G+8 storey reinforced concrete (RC) structure in three different seismic zones was compared in terms of percentage longitudinal steel, reinforcement details, and design base shear. The structure was examined for seismic zones III, IV, and V in accordance with the guidelines of IS 1893 (Part 1): 2016. Results showed that base shear increased with the change in the seismic zone from III to V.

Harsha Sri et al. (April 2023), "Dynamic Analysis of G+5 Residential Building in Zone-IV Using ETABS "Dynamic analysis of a G+5 residential building in Zone-4 using ETABS would typically include a summary of the study's purpose, methodology, and findings. The purpose of the study is to evaluate the building's seismic response and ensure its structural stability under the effect of earthquake loads. The methodology involves creating a three-dimensional (3D) model of the building in ETABS software and analyzing it using dynamic analysis methods such as response spectrum analysis and time history analysis. The findings of the study will provide an understanding of the building's behavior under different earthquake scenarios, including peak ground acceleration, spectral acceleration, and time history response. The study aims to propose recommendations for improving the building's seismic performance and enhancing its overall structural stability. The results of the study showed that the G+5 residential building performed satisfactorily under the design earthquake forces specified by the building code. The analysis revealed that the maximum displacement, acceleration, and base shear were well within the acceptable limits. The building's lateral stiffness was found to be adequate to resist the design lateral loads. Overall, the study demonstrated that ETABS software is an effective tool for analyzing the seismic performance of buildings in high seismic zones. The results of this study can be useful for engineers and designers in designing and evaluating the seismic performance of similar buildings in seismic zone-4.

Savan Kumar (August 2022), Analysis Of G+20 RC Building in Different Zones Using ETABS". The response of a building to an earthquake is vibration. The two horizontal & vertical directions may be used to decompose an earthquake's power (z). The structure shakes and vibrates in all 3 axis as a result of this motion, with the horizontal being the major direction of shaking. Into study of structural concrete, particularly multi-storeyed structures, it is critical to take into account the impacts on lateral stresses caused by wind and earthquakes. The primary goal of earthquake resistance analysis is to ensure that structures can withstand even small quakes without suffering damage. It is likely that the lateral force is reallocated to another system when the original one fails or yields, in order to avoid further failure. With the use of Response spectrum analysis, we're trying to learn more about behavior of a multi-story R.C. structure with an irregular layout. Reinforced concrete (RC) multi-story commercial structure with zones II, III, IV, and V is the focus of this research. ETabs from FEM program is used to carry out analysis. There are twenty storeys in building model in the study, each having a height of 3 meters. For ease of comparison, the amount of bays & width of every bay in 2 horizontal directions are maintained constant throughout all 4 models. It is possible to take a range of possibilities of SEISMIC ZONE FACTOR and see how they affect the results.

3. Objectives of the Present Work

- The objectives of the present work are to study the behavior of a multi storied RC building in Before live structure located in Pune (India) in plan subjected to earth quake load by adopting Response spectrum analysis.
- In the context of your thesis, this refers to analyzing and comparing the building's response under different seismic zones (Zone 4 vs. Zone 5) to assess how the level of seismicity affects the structural behavior.
- The present study is limited to reinforced concrete (RC) multi-storey commercial building with two different zones IV & V.
- The analysis is Carried out with the help of FEM software's ETABS. G+20 Multi-Storey Building with Basement, 3 podium Floor and 14 storey (Including future expansion).
- High-rise buildings have unique structural challenges due to their height, especially under seismic loading.
- Different values of Seismic Zone Factor are taken and their corresponding effects are interpreted in the results.

4. Proposed Methodology

A. *Response Spectrum Analysis:* A method used to estimate the maximum response (e.g., displacement, velocity, acceleration) of a structure during an earthquake. It is based on the building's natural frequencies and the seismic input at these frequencies.

B. *Seismic Zones:* Areas classified based on the seismicity of the region. In your case, Zone 4 and Zone 5 represent areas with different levels of earthquake risk, with Zone 5 being the most severe.

C. *ETABS (Extended Three-dimensional Analysis of Building Systems):* A software tool used for structural analysis and design, particularly for high-rise buildings. It allows engineers to model, analyze, and design structures under various loading conditions, including seismic forces.

D. *G+20 High-Rise Building:* Refers to a building with a ground floor plus 20 additional stories. High-rise buildings have unique structural challenges due to their height, especially under seismic loading.

E. *Seismic Load:* The forces exerted on a structure due to an earthquake. These loads are essential in designing structures to ensure they can withstand seismic events without catastrophic failure.

F. *Natural Frequencies:* The frequencies at which a structure naturally tends to vibrate. In seismic analysis, understanding these frequencies is crucial for predicting how the building will respond to an earthquake.

G. *Comparative Study:* In the context of your thesis, this refers to analyzing and comparing the building's response under different seismic zones (Zone 4 vs. Zone 5) to assess how the level of seismicity affects the structural behavior.

H. *Structural Behavior:* Refers to how the building reacts to different loads, particularly seismic loads, including aspects like displacement, shear forces, and bending moments.

I. *Seismic Performance:* The ability of a building to withstand and perform adequately during an earthquake. This involves ensuring that the structure remains stable and minimizes damage during seismic events.

Table 1
Design basis report

S.No.	Project Description	Details
1	Building Location	Pune
2	Residential Building	-
3	No of Basement levels	1
4	Other floor levels (Incl. future expansion)	B+3P+14 storey
5	Height of structure from basement.	56.398m
6	Height of structure above plinth (For seismic purpose)	56.398 - 3.3 = 53.1 m
7	Plan dimension of building	33.35m X 10.45m

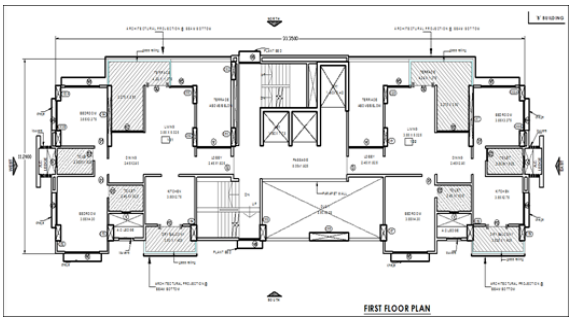

Fig. 2. CAD Drafting of high-rise building


Fig. 3. Front elevation of multistorey by CAD

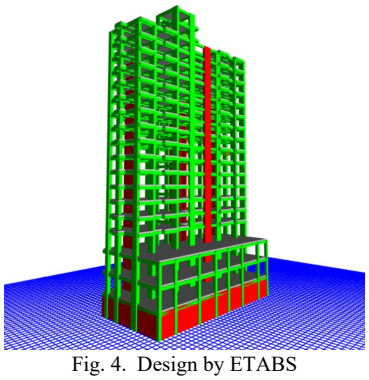
Fig. 4. Design by ETABS

Construction Type:

The basic material chosen for the structural elements in the building is reinforced concrete. The building is proposed to be designed as reinforced concrete. All partition walls (non-structural) are of AAC blocks of 125 mm thk. & Reinforcement used is TMT 500. Grade of Concrete used is M20 and Reinforcement used is TMT 500.

Design Philosophy:

The limit state approach as per IS456:2000 and ductile detailing as per IS13920:1993 is adopted in the design and detailing of the structural members. All water retaining structures shall be designed as un-cracked sections using IS3370:1965 part I & II and IS3370:1967 part III & IV code.

Structural System:

Foundations: As per geotechnical report available (refer Annexure-A), foundation recommendations are to be taken as follows.

1. Borehole no – BH-0001
2. Soil type –silty sand and gravel
3. The founding is considered at a depth 4.5m below from Ground level.
4. The safe bearing capacity of the strata is 35T/m^2
5. No water table below ground.
6. SPT test N value - 25
7. Angle of internal friction ϕ-27 and cohesion value - 0.02 kg/cm^2

Superstructure:

- RC slab and beam system is adopted for the structure. The lateral load resisting system will consist of a combination of shear wall and moment resisting frames.

Standards:

- The analysis and design shall be carried out in accordance with the codes of practice of Bureau of Indian Standards and sound engineering practice.

5. Conclusion

1. In Dynamic Analysis values of Storey Drifts are less than Static Analysis.
2. Storey displacement increases gradually along the height of the building with highest displacement on the top of the building in both X and Y directions.
3. Bending moments in beams are less in Dynamic Analysis than Static Analysis.
4. All the critical parameters like story drift, story displacement, bending moment in beams and axial load on columns shows significant low values in Dynamic Seismic Analysis as compared to Static Seismic Analysis.
5. The precise estimation of seismic forces and structural response in dynamic analysis is accounted for reduction in all critical parameters. so, it is highly recommended to use dynamic analysis in high-rise buildings.
6. This work focuses on linear static and linear dynamic analysis and can be improved by performing non-linear static push over analysis and non-linear dynamic time history analysis.

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