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Seismic Analysis of a G+20 High-Rise Building (Live Structure) Using ETABS Software: A Comparative Study between Zone 4 & Zone 5

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ABSTRACT: The multi-story buildings are constructed to accommodate numerous residents in confined spaces due to the growing population and lack of available land. Because of the expanding population and scarcity of land, the multi-story structures are designed to house many people in cramped quarters. Multi-story buildings are made to fit a lot of people into a compact space because of the limited land and growing population. The industrial revolution and population growth caused people to migrate from rural to urban areas, which made the construction of multi-story structures for both residential and commercial use necessary. Tall constructions collapse entirely because they are not constructed to handle lateral loads. 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, Comparative Study

I. INTRODUCTION

Earthquakes occur due to the abrupt movement of one of the planet's several strata, which releases 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 and the lack of available land. 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].

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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 Modelling 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.

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.

The 21st century is known to be the age of digital world. There has been the adoption of computers to a great extent. Today without computers and Internet one cannot survive as we are dependent on these machines for almost all our work. Taking into consideration starting from home to education till banking and even corporate functioning everything has now been automated to computers. Computers contain all our important data in the digital format. With this the need to store the digital data has increased and virtual environment has replaced the physical storage for storing all our credentials as shown in Fig. 1. The most devastating challenge of cloud is to prevent the unauthorized deletion of the stored data on cloud because one can easily delete the stuff without any proper authorization. The data deletion is totally dependent on deletion of nodes that are pointing to some information in Virtual Machine.

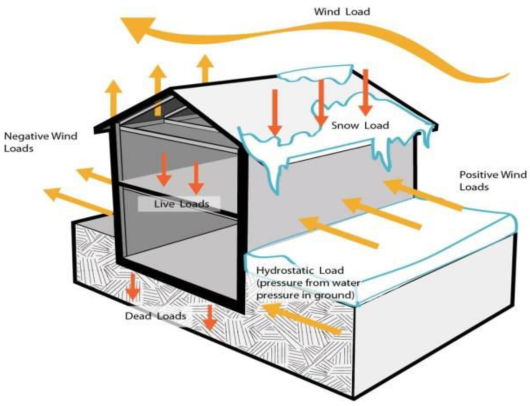

Figure 1: Different types of loading in building Structure

Extra Load Factors for Structural Design
For building structures subjected to dynamic loading conditions:

- It is essential to consider additional factors beyond standard live load factors (which are typically around 1.5 or 1.7).
- The American Association of State Highway and Transportation Officials (AASHTO) provides guidelines that suggest using an impact factor alongside live load factors when designing bridges or similar structures.
- These sources provide comprehensive standards and guidelines regarding structural design principles related to various types of loading conditions including dead, live, impact, and environmental loads which are critical for ensuring safety in engineering practices.

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II. PROBLEM STATEMENT

The analysis of a multi-story building using ETABS (Extended Three-Dimensional Analysis of Building Systems) involves several critical steps to ensure that the structure can withstand various loads and forces while maintaining safety and functionality.

1) The building model in the study has G+20 storeys with constant storey height of 3m. two models are used to analyze with constant bay lengths and the number of Bays and the bay width along two horizontal directions are kept constant in each model for convenience.
2) Different values of zone factor are taken and their corresponding effects are interpreted in the results.
3) Design Basis Report G+20 Multi- storey Building
4) Building Location - Pune
5) Functional Requirements - Residential Building
6) No of Basement levels - 1
7) Other floor levels - B+3P+14 storey (Incl. future expansion)
8) Vertical Future expansion - Nil
9) Horizontal future expansion - Nil
10) Height of structure from basement. - 56.398m
11) Height of structure above plinth - 56.398 - 3.3 = 53.1 m (For seismic purpose)
12) Plan dimension of building - 33.35m X 10.45m

III. OBJECTIVES OF STUDY

The present work aims at the study of following objectives How the seismic evaluation of a building should be carried out.

1. 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.
2. To study the behavior of a building under the action of seismic loads.
3. To compare various analysis results of building under zone IV and zone V using ETABS Software.
4. To know the displacement, storey drift and storey shear of the structure.

IV. METHODOLOGY & DESIGN

ETABS software

ETABS is a sophisticated engineering software product developed for the analysis and design of multi-story buildings. For structures with grid-like geometry, it incorporates a variety of Modelling tools, analysis techniques, and design capabilities. In the field of civil engineering, the program is well known for its capacity to manage both simple and intricate structural systems.

Structural Elements Design

Incorporate structural components:

- Draw columns at appropriate locations according to load distribution.
- Design beams connecting columns based on structural analysis results from ETABS.
- Ensure that all elements are aligned correctly using AutoCAD’s alignment tools.

Elevation Views Creation

- Generate elevation views from the floor plans:
- Use the “Section” command to create vertical slices through the building.
- Draw exterior finishes, window placements, and roof details in elevation views.

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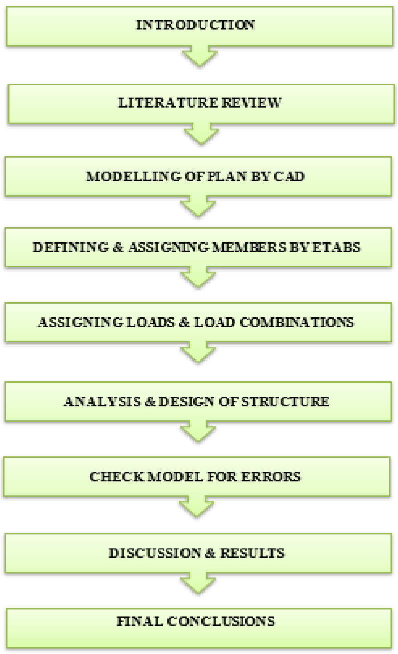

Methodology

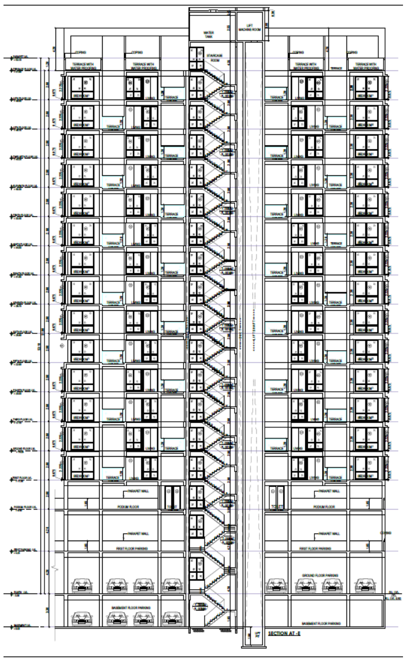

Figure 2; Plan of G+20 Multi-Storey Building with Basement , 3 podium Floor and 14 storey (Including future expansion).

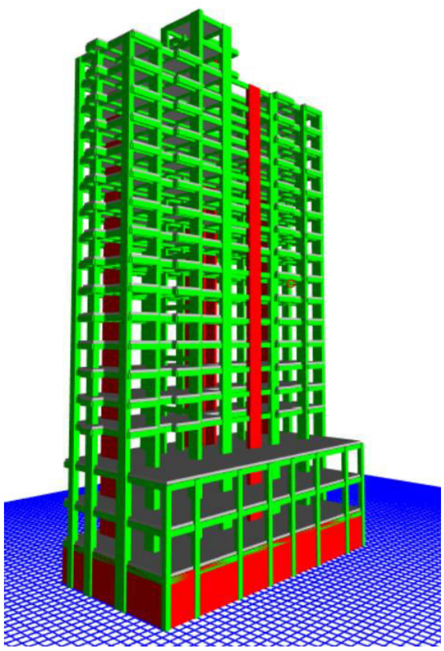

Figure 3 ;Elevation Views Creation of G+20 Multi-Storey Building with Basement , 3 podium Floor and 14 storey (Including future expansion).

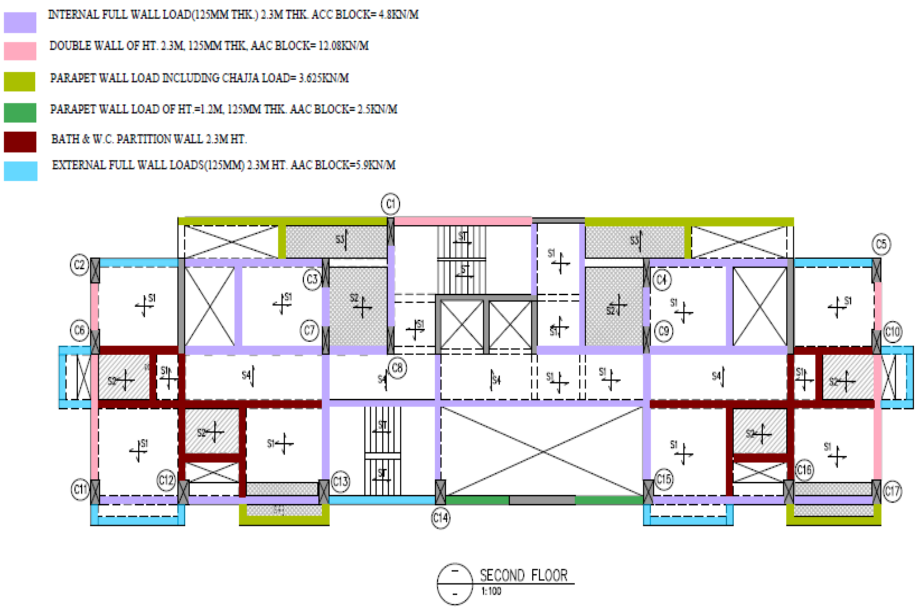

Figure 4; Wall Second Floor of G +20 multi-story buildings

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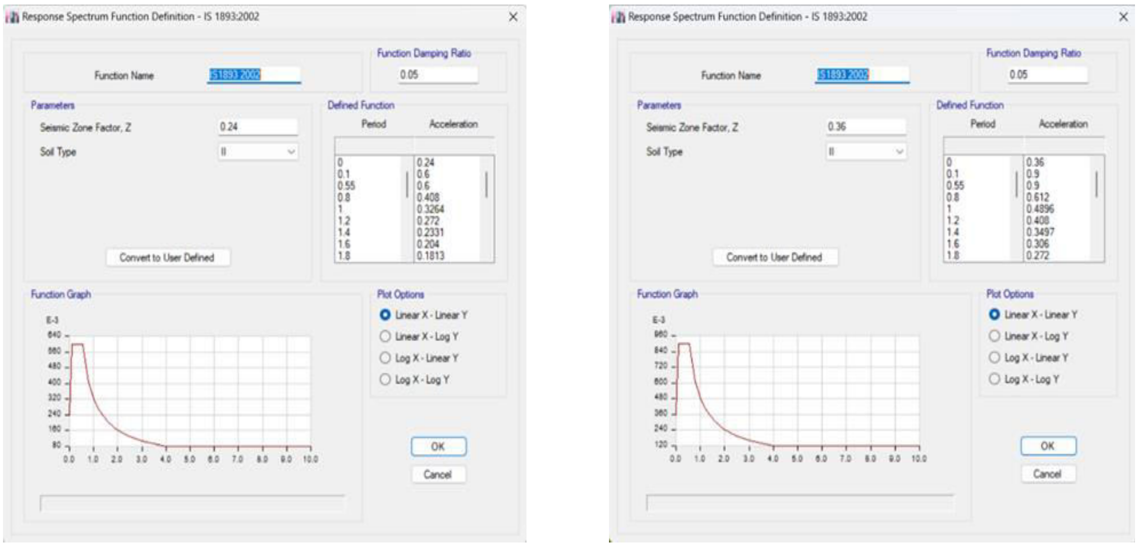
V. RESULT ANALYSIS & DISCUSSION

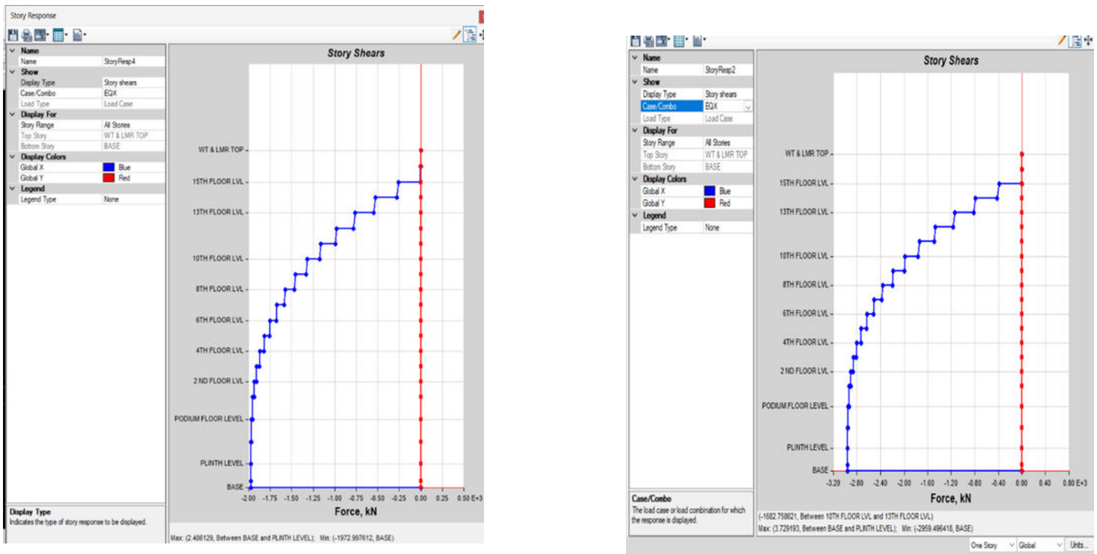
Comparative Seismic Analysis Zone IV & Zone V by Response Spectrum Function Using ETABS Software
Response Spectrum Function For Zone IV & Zone V



(a). Response spectrum function For Zone IV **(b)**. Response spectrum function For Zone V

Figure 5; Response Spectrum Function For Zone IV & Zone V

Story shear distribution for in For Zone IV & Zone V in X Directions



(a)Story shear distribution for in X direction (IVth zone) **(b)Story shear distribution for in X direction (Vth zone)**

Figure 6; Story shear distribution for in X direction (IVth zone & Vth zone)

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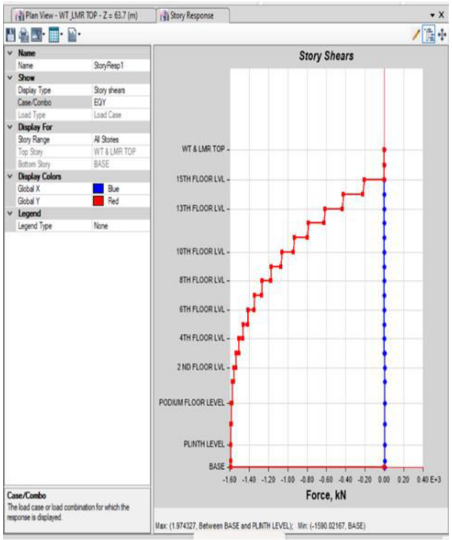
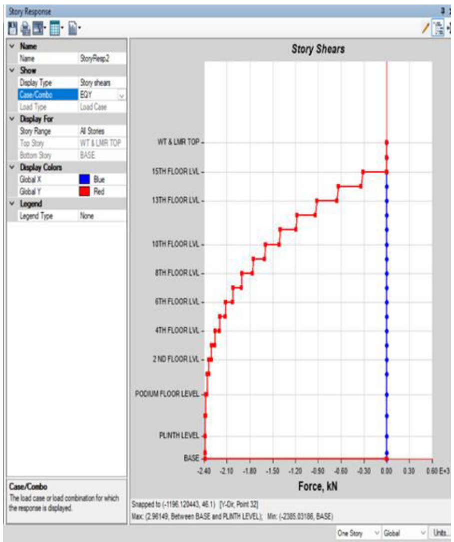


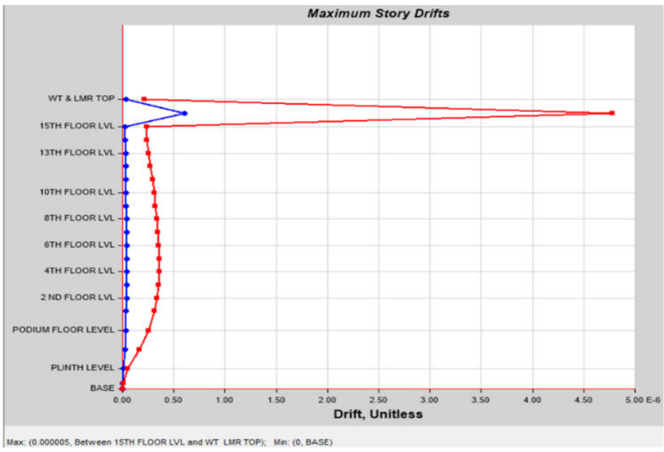
(a)Story shear distribution for in Y direction (IVth zone)



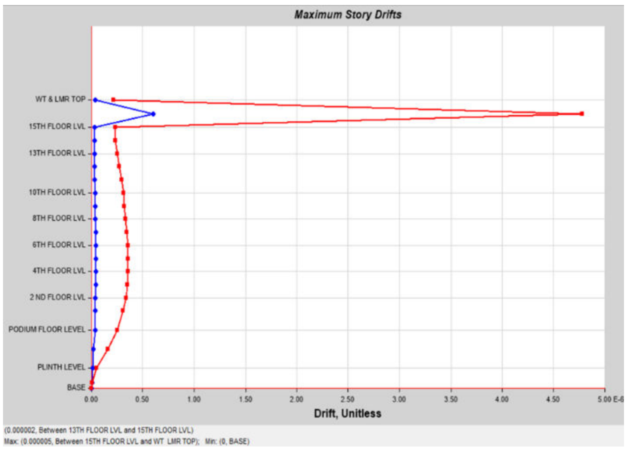
(b)Story shear distribution for in Y direction (Vth zone)

Figure 7; Story shear distribution for in Y direction (IVth zone & Vth zone)

Story drift for in For Zone IV & Zone V



Story drift for in For Zone IV



Story drift for in For Zone V

Figure 8 Story drift for in For Zone IV & Zone V

VI. CONCLUSIONS

The following conclusions are made from the present study

1. The base shear of structure increases as we go to higher seismic zones. For a similar building the base shear value of ZONE IV is -1972.9976 KN and ZONE V is -2959.4901 KN at X directions. This means base shear increases by more than 150% if seismic ZONE changes from IV to V.
2. The base shear of structure increases as we go to higher seismic zones. For a similar building the base shear value of ZONE IV is -1590.0217 KN and ZONE V is -2385.02 KN at Y directions. This means base shear increases by

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more than 150% if seismic ZONE changes from IV to V.

3. The displacement of building models increases with the increasing of seismic Zones. The displacement is very high at roof and very low at the base.
4. The storey drift is mainly occurred at the middle of the building structure. From table 5.4 to 5.6 and fig 5.4 to 5.6, it is concluded that the storey drift increases with the increasing of seismic zone factor.
5. The maximum storey drift at X direction is available at ZONE V for the max. Load combo at 6th floor. The story drift for ZONE IV is 0.000642 and story drift for ZONE V is 0.000963 at 6th floor. This means the storey drift is increases by more than 150% when compare to ZONE IV to ZONE V.
6. The maximum storey drift at Y direction is available at ZONE V for the max. Load combo at 6th floor. The story drift for ZONE IV is 0.000904 and story drift for ZONE V is 0.001315 at 6th floor. This means the storey drift is increases by more than 145% when compare to ZONE IV to ZONE V.

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