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Seismic Analysis and Design of G+10 RCC Buildings across Different Environment Zones Using ETABS

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***Abstract:** In India, reinforced concrete frame construction is the prevailing building practice. With the growing economy and urbanization, with the rising cost coupled with limited horizontal space and the demand for agricultural land, high-rise buildings are increasingly favored. These tall structures, must withstand both gravity and lateral forces. Given that many major Indian cities are located in high-risk seismic zones, hence strengthening buildings against lateral forces is essential. This study aims to compare seismic performance of G+10 storey structures in seismic Zones- II, III, IV and V and with soil types is conducted using ETABS. The structure with a uniform floor height, are analyzed for all relevant load combinations, including dead loads, live loads, masonry loads and seismic loads. All frames are designed under identical gravity loading. The structural design incorporates standard beam and column sections, and the foundation supports are modeled as fixed, adhering to ETABS specific condition and seismic calculation standards. This investigation for the seismic behavior of G+10 RCC building is examined using Response Spectrum Method of analysis using ETABS.*
***Keywords:** seismic zones, soils, high rise, response spectrum methods, storey drift, storey shear, ETABS*

I. INTRODUCTION

A. *Background*

Traditionally, India's building landscape has been dominated by low rise structures. However, increasing urban migration has led to significant population growth in major cities. Consequently, to accommodate this expanding population within limited land areas, there is a shift towards medium and high-rise buildings. Structural planning and design represent both an art and a science, aiming to create economical, elegant, serviceable and durable structures. This process demands not only creative and conceptual thinking but also a robust understanding of structural engineering principles, coupled with practical knowledge of relevant design codes, regulations and real-world experience. The design process begins with structural planning, focusing on fulfilling specific requirements, even when the may not fully grasp all implications. While the architects typically address, functional and aesthetics considerations, structural designers are responsible for adhering the safety, serviceability, durability and economic viability of the structure. ETABS, with its modern user interface, visualization tools, and sophisticated analysis and design engines, offers advanced finite element and dynamic analysis capabilities. It is the preferred software for designing various structures including low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges and piles, using materials like steel, concrete, timber, aluminum and cold-formed steel. ETAB's graphical user interface (GUI) facilitates model generation, which then analyzed by the ETABS engine. To ensure accurate analysis, structural engineer must define critical parameters such as structural loads, geometry, support conditions, and materials properties. The analysis results, including support reactions, stresses and displacements are subsequently compared against established failure criteria.

B. *Objectives of study*

The study aims to enhance knowledge and provide valuable insights for future implementation in reinforced concrete (RCC) building design. Specifically, the objectives are;

1) To conduct dynamic analysis of the building using Response Spectrum Method.
2) To analyse a G+10 storey building according to IS 456- (Plain and Reinforced Concrete-Code of Practice) using ETABS software.
3) To design a G+10 storey building in compliance with IS 1893 (Criteria for Earthquake Resistant Design of structures- Part 1), using ETABS software.

4) To compare the analysis results across various soils types and seismic zones.
To determine the displacement caused by earthquake and wind loading.

C. Scope of Study

In India, a limited number of buildings are designed with adequate structural engineering expertise. The accurate analysis and design of building structures are subjected to both static and dynamic loads are critical. Achieving acceptable precision in the analysis results is also a critical consideration. The study aims to model and analyse reinforced concrete frame structures of varying heights, considering various seismic zones and soil type. We will also discuss the various factors incorporated into the model analysis. The observations will be analysed to determine the variation in the seismic response of reinforced concrete designed structures.

D. Limitations of the Study

Reinforced concrete (RCC) column in multi-story buildings typically require larger cross section compared to steel columns due to the lower compressive strength of concrete.
The higher dead weight of RCC, can limit its suitability for high-rise buildings, as it results in increased loads on the foundation.

E. Expected Outcomes

This report presents an analysis of a G+10 storey reinforced concrete building using ETABS program, employing the Response Spectrum Method. This analysis is crucial for ensuring safe habitation, and building's ability to withstand lateral force. Structural engineers must design building with optimal, prioritizing both efficiency and economy. They should guarantee that the structure is serviceable, provides a healthy environmental for occupants and maintain a long design lifespan. This involves the best proprieties of construction materials, while meeting specific requirements, such as building type, load conditions, soil characteristics, construction timelines, flexibility and economics constraints.

II. LITERATURE REVIEW

Several investigators studied the influence of soil flexibility on buildings. They performed the studies by changing various parameters of soil and structure and found that due to soil flexibility the structural forces are altered. Some of noteworthy configuration of researchers in this field is discussed below.

M V Naresh et.al (2019) **[5]** analysed seismic moderate zone, the equivalent static force method to estimate the seismic force, subsequent vulnerability and behaviour of RC building under seismic load is inadequate. It has been demonstrated that numerous structures are completely or halfway harmed because of the quake. This reality was never disregarded while plan of multi-storey structures by the basic specialists, scientists to guarantee wellbeing against tremor powers while erection. In this paper seismic reaction of a private G+10 RC outline building is breaking down by the direct examination methodologies of Equivalent Static Lateral Force and Response Spectrum techniques utilizing ETABS Ultimate software according to the Seems to be 1893-2002-Part-1. These analyses are carried out by considering different seismic zones. A substitute response like lateral force, storey drift, displacements, base shear are plotted to think about the consequences of the static and dynamic investigation.

Arun Babu M, Ajisha R (2018) **[3]** studied foundation of a building is the substructure through which the loads of the whole structure are transmitted to the soil. There are various types of soil present in India. The types of soil play a major role while designing a structure. Here the analysis and design of building is done by varying the type of soil. The difference in analysis of structure is studied. After that the seismic analysis for various zones are carried out for the same soil conditions and also by changing the model of building, the same are done. And the difference is studied.

Dipak M. Kolekar and Mukund M. Pawar (2017) **[4]** analysed variation in base shear, storey shear and base moment for different seismic zones. They have studied in earthquake load is applied on G+3, G+5, G+7, G+9 storey buildings for two different plan areas and different seismic zones. The performance of building for base shear, store shear and base moment has been studied. This analysis is done by using STAAD-Pro v8i software and referring to the code IS 1893:2002(Part-I).

A. Pavan Kumar Reddy et.al (2017) **[1]** studied earthquake is a disaster causing occasion. Up to date days' constructions are fitting increasingly narrow and extra inclined to sway and consequently detrimental within the earthquake. After many functional reports it has proven that use of lateral load resisting methods in the constructing configuration has drastically increased the performance of the structure in earthquake by using ETABS. The work has been carried out for the distinctive instances utilizing shear wall and bracings for the exceptional heights, and maximum top regarded for the reward gain knowledge of is 93.5m. The modelling is completed to examine the outcome of special circumstances along with specific heights on seismic parameters like base shear, lateral displacements and lateral drifts. The gain knowledge of has been implemented for the Zone IV and Zone V in Soil Type II (medium soils) as targeted in IS 1893-2002.

Manish Kumar Gupta and Senthil Pandian M (2017) **[6]** studied the dynamic analysis, a plan of a multi-storey building is taken and it has been modelled with different structural elements for minimum storey displacement. The dynamic analysis of multi-storey buildings is done using ETABS 2015 by IS and SP codal provisions (ETABS User's Manual, 2015). The multi-storey building is R.C.C. structure with 3 basements + ground floor + 14 upper floors in zone IV with a maximum earth fill of 750 mm on the ground floor for landscape requirements. By comparing the results of dynamic analysis, the performance of the structural system can be evaluated.

Alhamd Farqaleet1 (2016) **[2]** studied nonlinear time history analysis is performed on a ten storey RCC building frame considering time history of EL Centro earthquake 1940 using SAP 2000. The main parameters of the seismic analysis of structures are load carrying capacity, ductility, stiffness, damping and mass. The various response parameters like base shear, storey drift, storey displacements etc. are calculated. The storey drift calculated is compared with the minimum requirement of storey drift as per IS 1893:2002.

Wensheng L U and Xilin LU (2000) **[7]** evaluated several scaled multi-tower high-rise building models on the shaking table. The assumption of rigid floor has obviously unsuitable for the analysis of multi tower buildings. A new analytic model considering the effect of flexible transfer floor is put forward. The theoretical dynamic behaviour is compared with the test results. The conjunction floors between towers at higher levels, and the stiffness of foundation contribution to structural dynamic behaviour is also discussed. Several suggestions and conceptual guidelines are concluded.

III.METHODOLOGY

A. Response Spectrum Method

This method is applicable for those structures where modes other than the fundamental one affect significantly the response of the structure. In this method the response of multi degree of freedom system is expressed as the superposition of modal response, each modal response being determined from the spectral analysis of single degree of freedom system, which is then combined to compare the total response. Modal analysis of the response history of structure to specified ground motion; however, the method is usually used in conjunction with a response spectrum.

B. Seismic Base Shear

According to IS 1893 (Part-I): 2002, Clause 7.5.3 the total design lateral force or design seismic base shear (VB) along any principal direction is determined by

$$V_b = A_h * W$$

Where,
Ah is the design horizontal acceleration spectrum
W is the seismic weight of building

C. Design Horizontal seismic coefficient

For the purpose of determining the design seismic forces, the country (India) is classified into four seismic zones (II, III, IV, and V). Previously, there were five zones, of which Zone I and II are merged into Zone II in fifth revision of code. According to IS 1893: 2002 (Part 1), Clause6.4.2 Design Horizontal Seismic Forces Coefficient Ah for a structure shall be determined by following expression.

$$A_{h} = (Z/2) * (I/R) * (Sa/2g)$$

Where,
Z = Zone factor seismic intensity.

The Seismic Zones (India)

India is categorized into four seismic zones. Zone II and Zone III encompass the majority of the country's land area. Eastern India experiences higher seismic intensity, placing it within Zone V. North-Eastern India falls under Zone IV. Statistically geographical data indicates that approximately 54 % of India's land is susceptible to earthquakes. Table 3.1 & Fig.3.1 shows various seismic zones of India and their respective approximate land area percentage.

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The Importance factor *(I)* is utilized to determine the design seismic force, which is dependent on the structures functional use. This factor accounts for the potential hazardous consequences of structural failure, the post- earthquake functional requirement, the historical value, and the economic significance of the building (as specified in IS 1893-2016 cause no.6.4.2/table6/pg.no.18).

The Response Reduction factor *(R) is* determined based on the anticipated seismic damage performance of the structure, which is characterized by either ductile or brittle deformations, as detailed in Table 3.1 (BIS 1893-2016 cl.no.6.4.2/Table7/pg.no.23). Sa/g = Average response acceleration coefficient (dimensionless value). The value of Sa/g is obtained from fig.3.2 from BIS: 1893 (Part 1): 2016

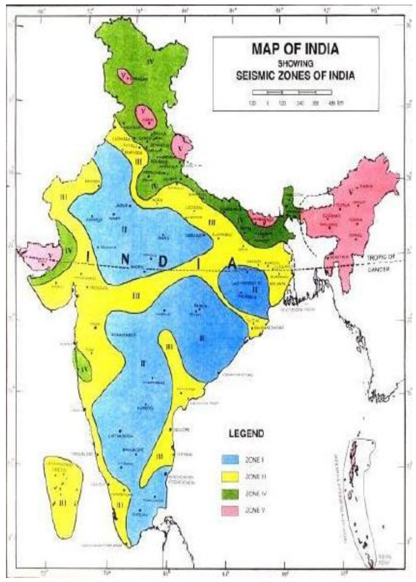

Fig 3.1 Indian seismic zone map as per BIS 189 (Part 1): 2016, Map from BIS 1893 (Part 1) 2016 source: researchgate.net

Seismic Intensity	Low	Moderate	Severe	Very Severe
Zone	II	III	IV	V
Z	0.1	0.16	0.24	0.36

Table 3.1 Indian Seismic Zoning

Sr. No.	Lateral Load Resisting System	R
1	Ordinary RC Moment Resisting Frame (OMRF)	3
2	Special RC Moment Resisting Frame (SMRF)	5
3	Ductile Shear Wall with SMRF	5

Table 3.2 Response Reduction Factor R for Building System.

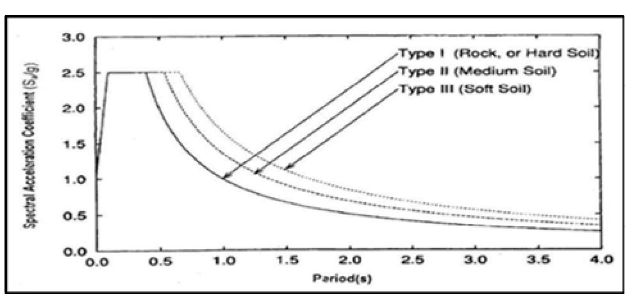

Fig.3.2 Response Spectra for Rock and Soil Sites for 5% damping

Damping

For rocky or hard soil sites:
1+15T (0.00 << 0.10s 2.5)
= {2.50(0.10s < < 0.40s)}
= {1.00 s / (0.400s<< 4.00s}

For medium soil sites:
1+15 (0.000 <, 0.10s)
= {2.50s (0.10 << 0.55s)}
0.36s / (0.55< < 4.00s)

For soft soil sites:
1+15(0.00<<0.10)
= {2.50(0.10 < < 0.67s)}
1.67 /(0.67< < 4.00s)

D. Fundamental Natural Period

The fundamental natural time period as mentioned in clause 7.6 IS 1893 (part 1): 2002 for moment resisting RC frame building without brick infill walls and moment resisting steel frame building without brick infill walls, respectively is given by

$Ta = 0.075h^{0.7}$

$Ta = 0.085h^{0.75}$

Where,

h = height of the building in 'm' excluding basement storey, if it is connected with the ground floor decks or fitted in between the building column.

If there is brick filling, then the fundamental natural period of vibration, may be taken as

$Ta = 0.09h/\sqrt{d}$

Where,

h = height of the building in m, as defined above, and

d = base dimension of the building at the plinth level, in meter, along the considered direction of the lateral force.

3.5 Seismic Weights

The total seismic weight of a building is calculated by summing the seismic weights of all the floors. The seismic weight of each floor comprises its full dead load plus a proposition of the imposed load, representing the portion likely present during an earthquake. This includes the weight of permanent and movable partitions, fixed equipment, and a portion of the live load. When determining the seismic weight of a floor, the weight of columns and walls within a storey should be evenly distributed between the floors above and below. Any weight supported between stories should be distributed to the adjacent floors in inverse proportion to its distance from the floors.

According to IS 1893(Part I):2002, the percentage of imposed load to be considered is specified in Table 8. for the purpose of calculating the design seismic forces of the structure, the imposed load on the roof is excluded.

Imposed uniformly distributed floor load (KN/m^2)	Percentage of Imposed load
Up to and including 3.0	25
Above 3.0	50

Table 3.3 For Percentage of imposed load to be considered

Buildings and their structural components must be designed and constructed to withstand the effects of design lateral force. This force is initially calculated for the entire building and subsequently distributed to each floor levels. The resulting overall design seismic force at each floor level is then allocated to individual lateral load-resisting elements, taking into account the floor diaphragm action.

According to IS1893-1:2002 Clause 7.7 the design base shear (VB) is distributed along the building's height using the following expression:

$$Qi = \frac{\sum w_h{}^{2} * V_b}{Wh^2} \quad \text{........... (3.17)}$$

Where,
Qi = design lateral force at i^{th} floor
Wi= seismic weight of i^{th} floor
hi= height of i^{th} floor measured from base, and
n = numbers of storey in the building is the number of the levels at which the masses are located.

Sr. No	Parameters	Values
1	Material Used	Concrete-M25
		Reinforcement Fe-500 and Fe-415Mpa
2	Plan Dimension	
3	Height of Each Story	3.0m
4	Height of Ground Story	1.2m
5	Density of Concrete	$25KN/M^3$
6	Poisson Ratio	0.2-Concrete And 0.15-Steel
7	Density of Masonry	$20KN/M^3$
9	Code of Practice Adopted	IS456:2000, IS1893:2002
10	Seismic Zone for IS1893:2002	II, III, IV and V
12	Importance Factor	1
13	Response Reduction Factor	5
14	Foundation Soil	Hard and Medium
15	Slab Thickness	150mm
16	Floor Finish	$1KN/M^2$
17	Live Load	$2KN/M^2$
18	Earthquake Load	As Per IS 1893 2016
19	Model to Be Design	G+10
20	Ductility Class	IS1893:2016 SMRF

Table 3.4: Detail Features of Buildings

E. Types of Loads

Unless otherwise specified, all loads listed, shall be considered in design for the Indian Code following load combinations shall be considered.

1) Load case

- DL: Dead load
- LL: Live load
- EQ: Earthquake load
- W: Wind Load

2) Load Combination

- 1.5DL+1.5LL
- 1.2DL+1.2LL + 1.2EX
- 1.2DL+1.2LL- 1.2EX
- 1.2DL+1.2LL+ 1.2EY
- 1.2DL+1.2LL - 1.2EY
- 1.2DL+1.2LL+1.2WLX

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- 1.2DL+1.2LL-1.2WLX
- 1.2DL+1.2LL+1.2WLY
- 1.2DL+1.2LL-1.2WLY
- (0.9DL±1.5EQ)

F. Parametric Investigation

This section represents a comprehensive parametric investigation focused on the design of high-rise structure in accordance with Indian Standards (IS). The study specifically examines reinforced concrete structures. All analyses of the aforementioned structures were conducted using the Equivalent Static Method, as prescribed by Indian Standards. Furthermore, a cost effectiveness assessment of the structures, limited to material considerations has been performed.

Modulus of elasticity E: 2 x 105 N/mm2

Live load on typical floor: 4.0 kN/m2

Live Load on Roof = 1.5 kN/m2

SIDL: 2.5 kN/m2 on floors and SIDL = 3.0 kN/m2 on roof (for Water Proofing)

Gravity Load	Value
Live load for typical floor	4.0 (kN/m^2)
Live load on Roof	1.5 kN/m^2
Superimposed dead load - Floors	2.5 kN/m^2
Superimposed dead load – Roof	3.0 kN/m^2

Table 3.5 Gravity loads which are assigned to the RC buildings

Table 3.2 shows the concrete and steel bar properties, which are used for modeling of the reinforced concrete buildings in Software.

Concrete Properties		Steel Bar Properties	
Unit weight (γcc)	25 (kN/m^3)	Unit weight (γss)	76.97 (kN/m^3)
Modulus of elasticity ($EEcc$)	25994.86 (MPa)	Modulus of elasticity ($EEss$)	2x10^5 (MPa)
Poisson ratio (νcc)	0.2	Poisson ratio (νss)	0.3
Thermal coefficient ($\alpha\alpha cc$)	5.5 x 10^{-6}	Thermal coefficient ($\alpha\alpha ss$)	1.170 x 10^{-6}
Shear modulus ($GGcc$)	9316.95 (MPa)	Shear modulus ($GGss$)	76923.08 (MPa)
Damping ratio (ςcc)	5 (%)	Yield strength ($FFyy$)	500 (MPa)
Compressive strength ($FFcc$)	25 (MPa)	Tensile strength ($FFuu$)	485 (MPa)

Table 3.6 Concrete and steel bar properties as per IS 456 - 2016

G. Building center Line Plan

Multi-storied, reinforced concrete, moment resisting space frame were analysed using professional software. A G+10 building frame model, featuring three bays both in horizontal and lateral direction was analysed using the Equivalent Static Method. The plan dimensions of the buildings are presented in the table below, while the plan view and elevations of the various frames are illustrated in the accompanying figures.

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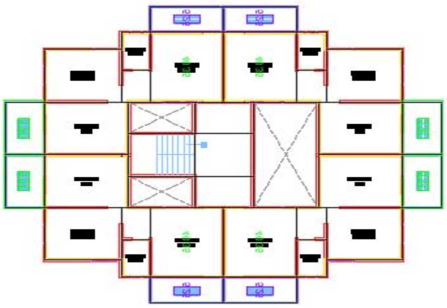
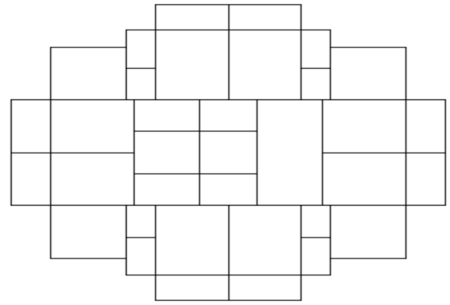
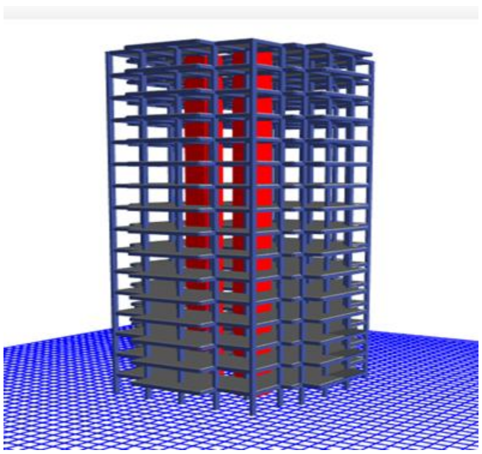
A. *Building plan for G+10 storey building*



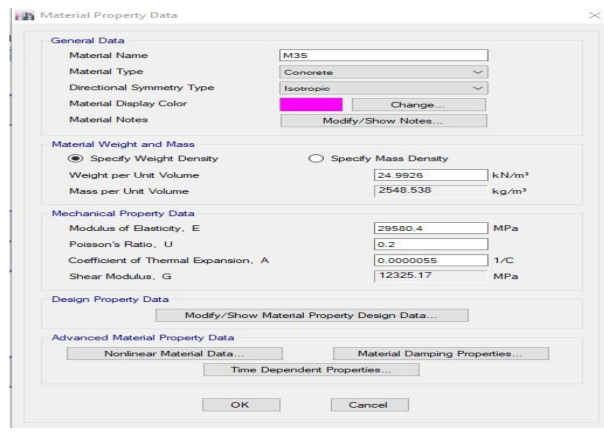
B. *Center line plan for G+10 storey building*



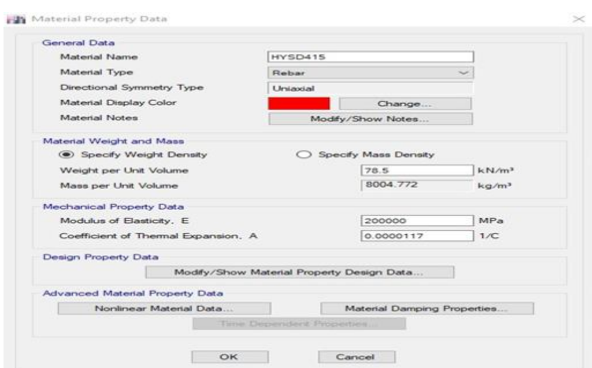
C. *3D rendering image for G+10 storey building*



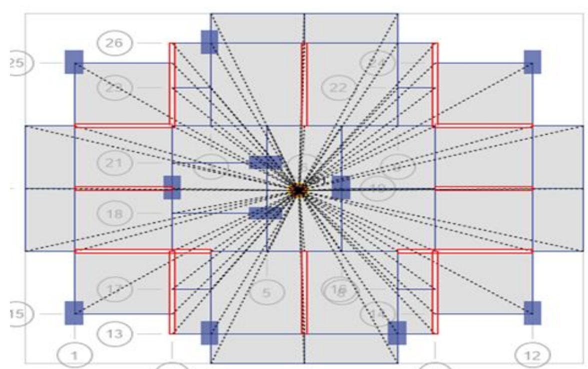
D. Grade of Concrete Define



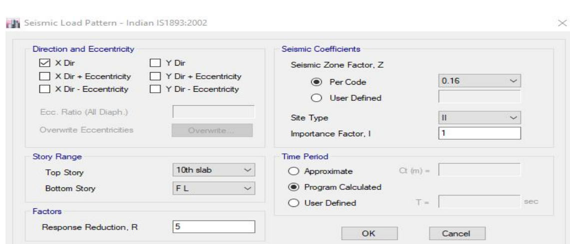
E. Grade of Steel Define



F. Diaphragms Define

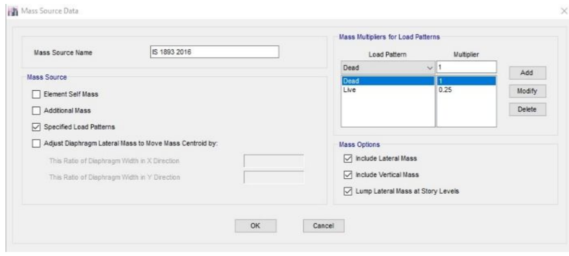


G. *Earthquake Load Define*



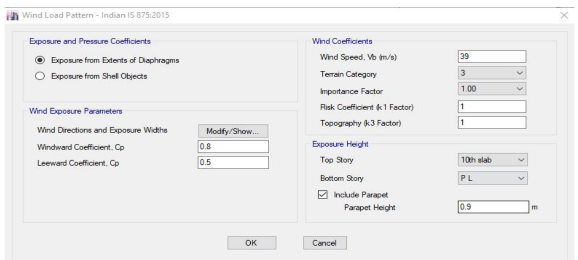
As building height increases, structures more susceptible to lateral loads, exhibiting greater flexibility and vulnerability. Consequently, lateral loads primary derived from seismic and wind forces must be considered in the structural analysis.

H. Mass Source Define



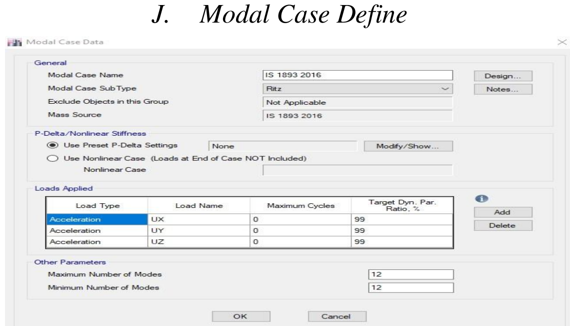
A Mass Source is a user-defined parameter. Typically, models utilize a single mass source applied to all load cases, which serves as default settings. However, additional mass source can be created to address specific scenarios. These included analysing the dynamic behaviour of structures supporting varying configurations of heavy equipment or explicitly accounting for the influence of different storey mass eccentricities on the mode shapes.

I. Wind Load Define



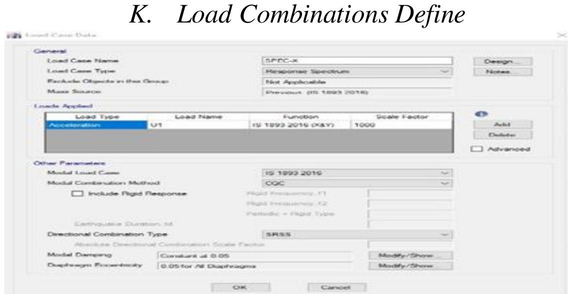
Wind is a mass of air, typically moving horizontal direction from high pressure to low pressure areas. Strong winds can cause significant damage due to the pressure they exert on a structures surface. This pressure is known as the wind load. The impact of wind varies based on structures size and shape. Accurate wind load calculations are essential for designing and constructing safer, more wind-resistant buildings and for properly placing objects like antennas on rooftop.

J. Modal Case Define



In ETABS 2020 and subsequent versions, mode shapes can be accessed through the following path; >Tables >Analysis > Results >Displacements >Diaphragm Center of Mass Displacements. Ensure that modal results have been generated and that load cases including modes are selected, as modal results are excluded by default.

K. Load Combinations Define



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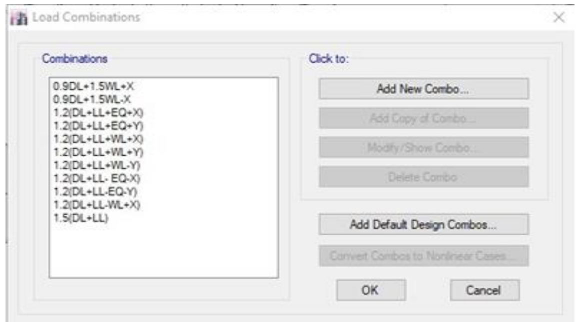
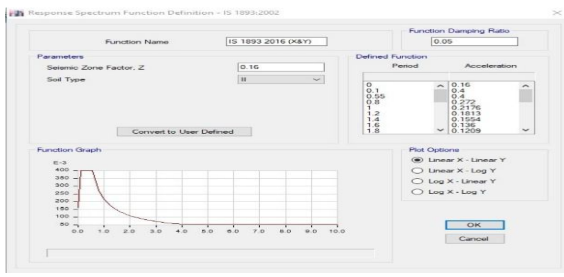
L. Response Spectrum Case Define



M. Response Spectrum Functions Define



A response spectrum is a graph that displays the peak response of a simple harmonic oscillator, subjected to a transient event, plotted against frequency or period. The spectrum is dependent on the oscillator's natural frequency and its damping characteristics.

IV. RESULTS AND DISCUSSIONS

A. Base Shear Results for G+10Story building

Base shear represents an estimate of the maximum anticipated lateral force that will act at the base of the structure due to seismic ground motion. Building codes typically mandate, the use of both equivalent static force procedure and a dynamic lateral force procedure during analysis. Consequently, the base shear obtained from the dynamic analysis is often scaled down to a specified percentage of the base shear calculated using the static force procedure.

TABLE: Auto Seismic - IS 1893:2002								
Load Pattern	Z	Soil Type	I	R	Period Used	Co eff Used	Weight Used	Base Shear
					sec		kN	kN
EQ+X	0.1	II	1.2	5	0.865	0.018871	41901.1052	790.7347
EQ-X	0.1	II	1.2	5	0.865	0.018871	41901.1052	790.7347
EQ+Y	0.1	II	1.2	5	0.721	0.022625	41901.1052	948.021
EQ-Y	0.1	II	1.2	5	0.721	0.022625	41901.1052	948.021

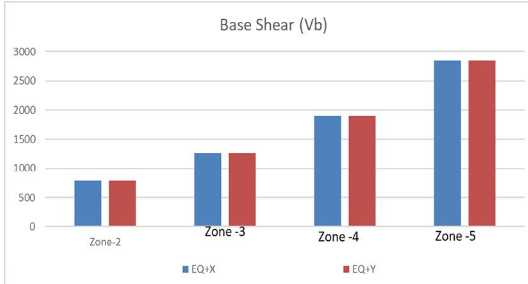
TABLE: Auto Seismic - IS 1893:2002								
Load Pattern	Z	Soil Type	I	R	Period Used	Co-eff Used	Weight Used	Base Shear
					sec		kN	kN
EQ+X	0.16	II	1.2	5	0.865	0.030194	41901.1052	1265.176
EQ-X	0.16	II	1.2	5	0.865	0.030194	41901.1052	1265.176
EQ+Y	0.16	II	1.2	5	0.721	0.0362	41901.1052	1516.834
EQ-Y	0.16	II	1.2	5	0.721	0.0362	41901.1052	1516.834

Table 4.1 Base Shear Results G+10 Storey Building in Earthquake Zone-2 Table 4.2 Base Shear Results G+10 Storey Building in Earthquake Zone-3

TABLE: Auto Seismic - IS 1893:2002								
Load Pattern	Z	Soil Type	I	R	Period Used	Co-eff Used	Weight Used	Base Shear
					sec		kN	kN
EQ+X	0.24	II	1.2	5	0.865	0.045291	41901.1052	1897.763
EQ-X	0.24	II	1.2	5	0.865	0.045291	41901.1052	1897.763
EQ+Y	0.24	II	1.2	5	0.721	0.0543	41901.1052	2275.251
EQ-Y	0.24	II	1.2	5	0.721	0.0543	41901.1052	2275.251

TABLE: Auto Seismic - IS 1893:2002								
Load Pattern	Z	Soil Type	I	R	Period Used	Co-eff Used	Weight Used	Base Shear
					sec		kN	kN
EQ+X	0.36	II	1.2	5	0.865	0.067937	41901.1052	2846.645
EQ-X	0.36	II	1.2	5	0.865	0.067937	41901.1052	2846.645
EQ+Y	0.36	II	1.2	5	0.721	0.081451	41901.1052	3412.876
EQ-Y	0.36	II	1.2	5	0.721	0.081451	41901.1052	3412.876

Table 4.3 Base Shear Results G+10 Storey Building in Earthquake Zone-4 Table 4.4 Base Shear Results G+10 Storey Building in Earthquake Zone-5



Graph 4.1 Base Shear Vs. Different Types of Zone

B. Earthquake Displacement Results for G+10 Storey building

According to IS 1893-2016 (Criteria for Earthquake Resisting Design of Structure) the allowable displacement limit under earthquake is H/250, where H represents the height of the building. If the calculated displacement remains within the limit, the structure is safe. However, if the displacement exceeds H/250, the structure is deemed unsafe in terms of displacement.

TABLE: Diaphragm Center of Mass Displacements						
Story	Load Case/Combo	UX	Point	X	Y	Z
		mm		m	m	m
Head Room	EQ+X	9.115	5	7.6136	12.0377	35
10thslab	EQ+X	8.387	8	10.2114	12.0133	32
9th slab	EQ+X	7.415	13	10.3105	12.0035	29
8th slab	EQ+X	6.426	15	10.3294	11.9942	26
7th slab	EQ+X	5.424	17	10.3294	11.9942	23
6th slab	EQ+X	4.423	20	10.2936	11.9645	20
5th slab	EQ+X	3.452	29	10.2591	11.9351	17
4th slab	EQ+X	2.533	31	10.2591	11.9351	14
3rd slab	EQ+X	1.697	33	10.2591	11.9351	11
2nd slab	EQ+X	0.981	39	10.2591	11.9351	8
1st slab	EQ+X	0.428	41	10.2591	11.9351	5

Table 4.5 Earthquake Displacement Results G+10 Storey Building in Building in
Earthquake Zone-2

TABLE: Diaphragm Center of Mass Displacements						
Story	Load Case/Combo	UX	Point	X	Y	Z
		mm		m	m	m
Head Room	EQ+X	14.584	5	7.6136	12.0377	35
10thslab	EQ+X	13.419	8	10.2114	12.0133	32
9th slab	EQ+X	11.864	13	10.3105	12.0035	29
8th slab	EQ+X	10.281	15	10.3294	11.9942	26
7th slab	EQ+X	8.678	17	10.3294	11.9942	23
6th slab	EQ+X	7.077	20	10.2936	11.9645	20
5th slab	EQ+X	5.524	29	10.2591	11.9351	17
4th slab	EQ+X	4.052	31	10.2591	11.9351	14
3rd slab	EQ+X	2.715	33	10.2591	11.9351	11
2nd slab	EQ+X	1.57	39	10.2591	11.9351	8
1st slab	EQ+X	0.685	41	10.2591	11.9351	5

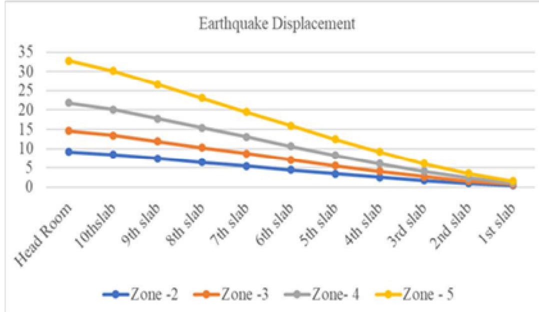
Table 4.6 Earthquake Displacement Results G+10 Storey
Earthquake Zone-3

TABLE: Diaphragm Center of Mass Displacements						
Storey	Load Case/Combo	UX	Point	X	Y	Z
		mm		m	m	m
Head Room	EQ+X	21.876	5	7.6136	12.0377	35
10thslab	EQ+X	20.129	8	10.2114	12.0133	32
9th slab	EQ+X	17.796	13	10.3105	12.0035	29
8th slab	EQ+X	15.421	15	10.3294	11.9942	26
7th slab	EQ+X	13.017	17	10.3294	11.9942	23
6th slab	EQ+X	10.616	20	10.2936	11.9645	20
5th slab	EQ+X	8.286	29	10.2591	11.9351	17
4th slab	EQ+X	6.078	31	10.2591	11.9351	14
3rd slab	EQ+X	4.072	33	10.2591	11.9351	11
2nd slab	EQ+X	2.355	39	10.2591	11.9351	8
1st slab	EQ+X	1.027	41	10.2591	11.9351	5

Table 4.7 Earthquake Displacement Results G+10 Storey Building in Building in
Earthquake Zone-4

TABLE: Diaphragm Center of Mass Displacements						
Storey	Load Case/Combo	UX	Point	X	Y	Z
		mm		m	m	m
Head Room	EQ+X	32.814	5	7.6136	12.0377	35
10thslab	EQ+X	30.194	8	10.2114	12.0133	32
9th slab	EQ+X	26.694	13	10.3105	12.0035	29
8th slab	EQ+X	23.132	15	10.3294	11.9942	26
7th slab	EQ+X	19.525	17	10.3294	11.9942	23
6th slab	EQ+X	15.924	20	10.2936	11.9645	20
5th slab	EQ+X	12.429	29	10.2591	11.9351	17
4th slab	EQ+X	9.117	31	10.2591	11.9351	14
3rd slab	EQ+X	6.108	33	10.2591	11.9351	11
2nd slab	EQ+X	3.533	39	10.2591	11.9351	8
1st slab	EQ+X	1.54	41	10.2591	11.9351	5

Table 4.8 Earthquake Displacement Results G+10 Storey
Earthquake Zone-5



Graph 4.2 Earthquake Displacement Vs. Different Types of Zone

C. Wind Displacement Results for G+10 Storey building

TABLE: Diaphragm Center of Mass Displacements

Storey	Load Case/Combo	UX	Point	X	Y	Z
		mm		m	m	m
Head Room	EQ+X	21.876	5	7.6136	12.0377	35
10thslab	EQ+X	20.129	8	10.2114	12.0133	32
9th slab	EQ+X	17.796	13	10.3105	12.0035	29
8th slab	EQ+X	15.421	15	10.3294	11.9942	26
7th slab	EQ+X	13.017	17	10.3294	11.9942	23
6th slab	EQ+X	10.616	20	10.2936	11.9645	20
5th slab	EQ+X	8.286	29	10.2591	11.9351	17
4th slab	EQ+X	6.078	31	10.2591	11.9351	14
3rd slab	EQ+X	4.072	33	10.2591	11.9351	11
2nd slab	EQ+X	2.355	39	10.2591	11.9351	8
1st slab	EQ+X	1.027	41	10.2591	11.9351	5

Table 4.9 Wind Displacement Results G+10 Storey Building in Earthquake Zone- 2

TABLE: Diaphragm Center of Mass Displacements

Storey	Load Case/Combo	UX	Point	X	Y	Z
		mm		m	m	m
Head Room	WL+X	5.287	5	7.6136	12.0377	35
10thslab	WL+X	4.813	8	10.2114	12.0133	32
9th slab	WL+X	4.277	13	10.3105	12.0035	29
8th slab	WL+X	3.732	15	10.3294	11.9942	26
7th slab	WL+X	3.179	17	10.3294	11.9942	23
6th slab	WL+X	2.621	20	10.2936	11.9645	20
5th slab	WL+X	2.073	29	10.2591	11.9351	17
4th slab	WL+X	1.544	31	10.2591	11.9351	14
3rd slab	WL+X	1.053	33	10.2591	11.9351	11
2nd slab	WL+X	0.621	39	10.2591	11.9351	8
1st slab	WL+X	0.278	41	10.2591	11.9351	5

Table 4.10 Wind Displacement Results G+10 Storey Building in Earthquake Zone- 3

TABLE: Diaphragm Center of Mass Displacements

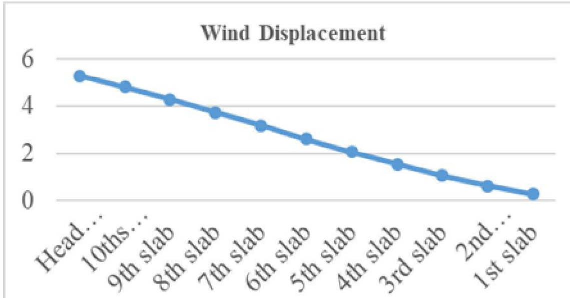
Storey	Load Case/Combo	UX	Point	X	Y	Z
		mm		m	m	m
Head Room	WL+X	5.287	5	7.6136	12.0377	35
10thslab	WL+X	4.813	8	10.2114	12.0133	32
9th slab	WL+X	4.277	13	10.3105	12.0035	29
8th slab	WL+X	3.732	15	10.3294	11.9942	26
7th slab	WL+X	3.179	17	10.3294	11.9942	23
6th slab	WL+X	2.621	20	10.2936	11.9645	20
5th slab	WL+X	2.073	29	10.2591	11.9351	17
4th slab	WL+X	1.544	31	10.2591	11.9351	14
3rd slab	WL+X	1.053	33	10.2591	11.9351	11
2nd slab	WL+X	0.621	39	10.2591	11.9351	8
1st slab	WL+X	0.278	41	10.2591	11.9351	5

Table 4.11 Wind Displacement Results G+10 Storey Building in Earthquake Storey Building in Earthquake
Zone-4

TABLE: Diaphragm Center of Mass Displacements

Storey	Load Case/Combo	UX	Point	X	Y	Z
		mm		m	m	m
Head Room	WL+X	5.287	5	7.6136	12.0377	35
10thslab	WL+X	4.813	8	10.2114	12.0133	32
9th slab	WL+X	4.277	13	10.3105	12.0035	29
8th slab	WL+X	3.732	15	10.3294	11.9942	26
7th slab	WL+X	3.179	17	10.3294	11.9942	23
6th slab	WL+X	2.621	20	10.2936	11.9645	20
5th slab	WL+X	2.073	29	10.2591	11.9351	17
4th slab	WL+X	1.544	31	10.2591	11.9351	14
3rd slab	WL+X	1.053	33	10.2591	11.9351	11
2nd slab	WL+X	0.621	39	10.2591	11.9351	8
1st slab	WL+X	0.278	41	10.2591	11.9351	5

Table 4.12 Wind Displacement Results G+10
Zone-5



Graph 4.3 Wind Displacement Vs. Different Types of Zone

D. Storey Drift Results for G+10 Storey building

Storey drift is defined as the difference in lateral displacements between one floor and the floor directly below it. According to IS 1893-2016, the storey drift in any storey, resulting from the minimum specified design lateral force with partial load factor 1.00, must not exceed 0.004 times the storey height. Given a storey height is 3.000 m in this case, the limited story drift is calculated as storey drift = 0.004 x 3000.

TABLE: Storey Drifts						
Storey	Load Case/Combo	Drift	Label	X	Y	Z
				m	m	m
Head Room	EQ+X	0.000248	50	9.1068	13.3127	35
10thslab	EQ+X	0.000344	100	5.7568	19.3377	32
9th slab	EQ+X	0.00035	100	5.7568	19.3377	29
8th slab	EQ+X	0.000353	100	5.7568	19.3377	26
7th slab	EQ+X	0.000351	100	5.7568	19.3377	23
6th slab	EQ+X	0.00034	100	5.7568	19.3377	20
5th slab	EQ+X	0.000322	100	5.7568	19.3377	17
4th slab	EQ+X	0.000291	100	5.7568	19.3377	14
3rd slab	EQ+X	0.000249	100	5.7568	19.3377	11
2nd slab	EQ+X	0.000192	100	5.7568	19.3377	8
1st slab	EQ+X	0.000121	93	2.2568	18.3377	5
P L	EQ+X	0.00005	18	2.2568	15.1877	2

Table 4.13 Storey drift Results G+10 Storey Building in Earthquake Zone-2

TABLE: Storey Drifts						
Storey	Load Case/Combo	Drift	Label	X	Y	Z
				m	m	m
Head Room	EQ+X	0.000396	50	9.1068	13.3127	35
10thslab	EQ+X	0.00055	100	5.7568	19.3377	32
9th slab	EQ+X	0.000559	100	5.7568	19.3377	29
8th slab	EQ+X	0.000565	100	5.7568	19.3377	26
7th slab	EQ+X	0.000562	100	5.7568	19.3377	23
6th slab	EQ+X	0.000544	100	5.7568	19.3377	20
5th slab	EQ+X	0.000515	100	5.7568	19.3377	17
4th slab	EQ+X	0.000466	100	5.7568	19.3377	14
3rd slab	EQ+X	0.000398	100	5.7568	19.3377	11
2nd slab	EQ+X	0.000307	100	5.7568	19.3377	8
1st slab	EQ+X	0.000193	93	2.2568	18.3377	5
P L	EQ+X	0.00008	18	2.2568	15.1877	2

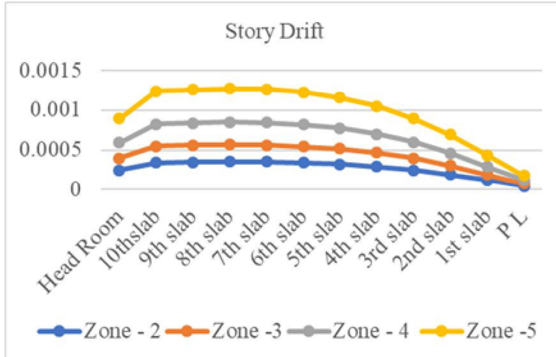
Table 4.14 Storey drift Results G+10 Storey Building in Earthquake Zone-3

TABLE: Storey Drifts						
Storey	Load Case/Combo	Drift	Label	X	Y	Z
				m	m	m
Head Room	EQ+X	0.000595	50	9.1068	13.3127	35
10thslab	EQ+X	0.000826	100	5.7568	19.3377	32
9th slab	EQ+X	0.000839	100	5.7568	19.3377	29
8th slab	EQ+X	0.000848	100	5.7568	19.3377	26
7th slab	EQ+X	0.000843	100	5.7568	19.3377	23
6th slab	EQ+X	0.000816	100	5.7568	19.3377	20
5th slab	EQ+X	0.000772	100	5.7568	19.3377	17
4th slab	EQ+X	0.000699	100	5.7568	19.3377	14
3rd slab	EQ+X	0.000597	100	5.7568	19.3377	11
2nd slab	EQ+X	0.00046	100	5.7568	19.3377	8
1st slab	EQ+X	0.000289	93	2.2568	18.3377	5
P L	EQ+X	0.000121	18	2.2568	15.1877	2

Table 4.15 Storey drift Results G+10 Storey Building in Earthquake Zone-4

TABLE: Storey Drifts						
Storey	Load Case/Combo	Drift	Label	X	Y	Z
				m	m	m
Head Room	EQ+X	0.000892	50	9.1068	13.3127	35
10thslab	EQ+X	0.001238	100	5.7568	19.3377	32
9th slab	EQ+X	0.001259	100	5.7568	19.3377	29
8th slab	EQ+X	0.001272	100	5.7568	19.3377	26
7th slab	EQ+X	0.001265	100	5.7568	19.3377	23
6th slab	EQ+X	0.001225	100	5.7568	19.3377	20
5th slab	EQ+X	0.001158	100	5.7568	19.3377	17
4th slab	EQ+X	0.001049	100	5.7568	19.3377	14
3rd slab	EQ+X	0.000895	100	5.7568	19.3377	11
2nd slab	EQ+X	0.00069	100	5.7568	19.3377	8
1st slab	EQ+X	0.000434	93	2.2568	18.3377	5
P L	EQ+X	0.000181	18	2.2568	15.1877	2

Table 4.16 Storey drift Results G+10 Storey Building in Earthquake Zone-5



Graph 4.4 Storey drift Vs. Different Types of Zone

V. CONCLUSION

This study conducted a comparative evaluation of tall structures built on medium soils, analyzing building with varying numbers stories under earthquake loads corresponding to Zone II, III, IV and V. Comparisons were made across several structural parameters including base shear, earthquake displacement, wind displacement and storey drift.

Based on the analysis results following conclusions are drawn:

1) The maximum base shear in the X-direction was observed in the G+10 storey building located in Zones V. Specially, the base shear in the G+10 storey building increased approximately 3.6 times in Zone V, 2.4 times in Zone IV, 1.6 times in Zone III as compared to building in Zone- II
2) The maximum earthquake displacement was also observed in G+10 storey building in Zone V. Similarly, the earthquake displacement in the G+10 Storey building increased approximately 3.6 times in Zone V, 2.4 times in Zone IV, 1.6 times in Zone III, compared to Zone- II. However, all buildings were found to be within safe limits for earthquake displacement.
3) For a basic wind speed of 39m/sec, the wind displacement was 5.23mm. All buildings were determined to be within safe displacement for wind loads.

The allowable storey drift, as per IS 1893-2016, is 0.004 times the storey height. With a storey height of 3 meters, this translates to a maximum allowable storey drift of 12mm (0.004x3000 =12mm). The analysis of the G+10 storey structure analysis in software yielded storey drift value of 0.00248, 0.00396, 0.000596 and 0.000892 for Earthquake Zone II, III, IV and V, respectively. Thus, all building was found to be within safe limit for storey drift.

VI. ACKNOWLEDGMENTS

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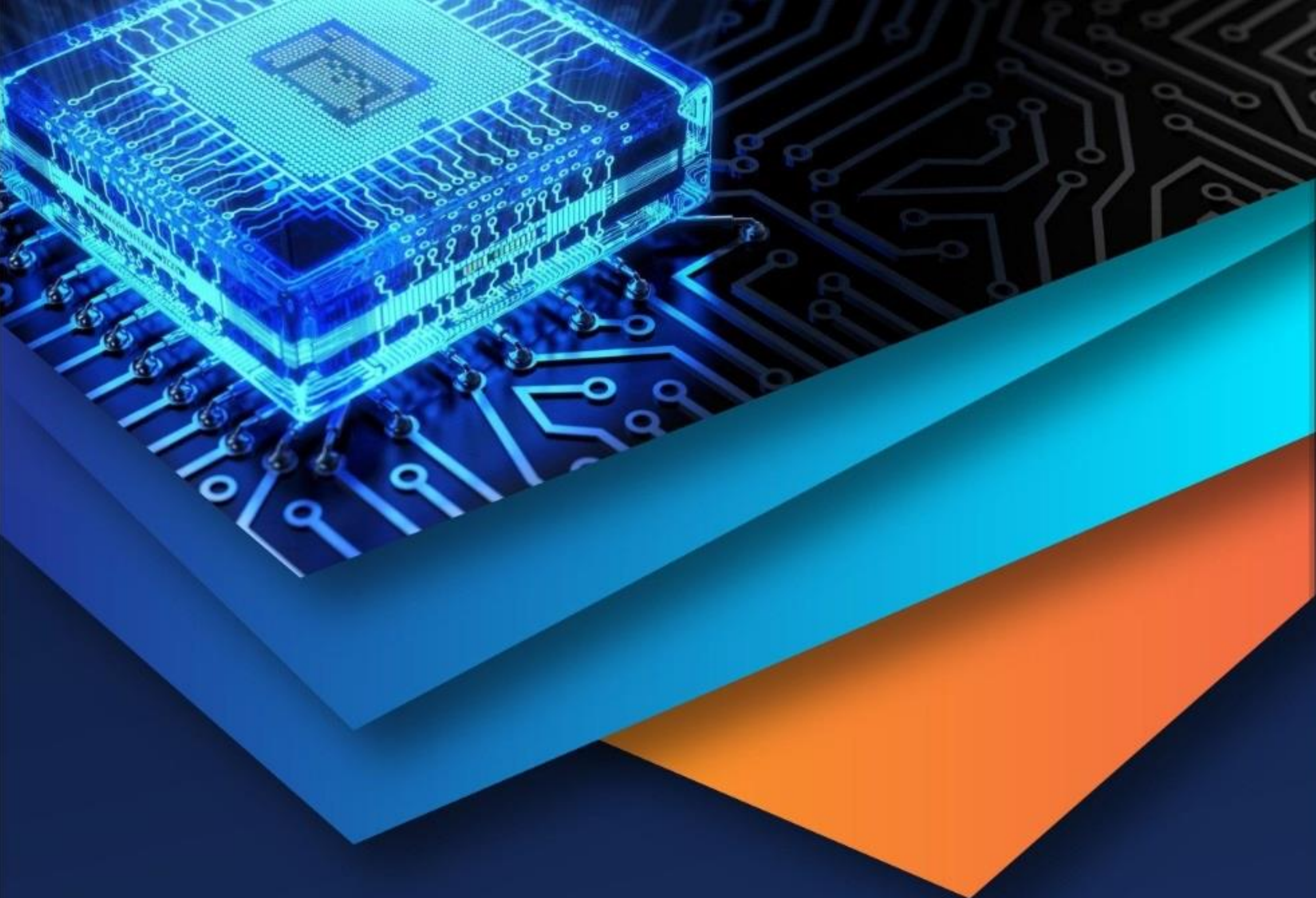
REFERENCES

[1] Chari K J and Naresh M V (2019) [5] "Study on Static and Dynamic Analysis of Multi-Storied Building in Seismic Zones". International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-6C2.
[2] Ajisha R. and Arun Babu M. (2018) [3] "Analysis of Multistoried Building in Different Seismic Zones with Different Soil Conditions". International Research Journal of Engineering and Technology (IRJET) (Volume-5, Issue-12 PRMITR, Vavanoor, India.
[3] Kolekar Dipak M. and Pawar Mukund M. (2017) [4] "Study of Base Shear, Storey Shear and Base Moment on Multistory Building for Different Seismic Zones". IJESC Research article Volume 7 Issue No.6. SVERI's COE, Pandharpur, India.
[4] Reddy A. Pavan Kumar (2017) [1] "Analysis of G+30 High-rise Buildings by Using Etabs for Various Frame Sections in Zone IV and Zone V" International Journal of Innovative Research in Science, Engineering and Technology an ISO 3297: 2007 Certified Organization) Vol. 6, Issue.
[5] Gupta M. Manish Kumar and Pandian Senthil (2017) [6] "dynamic analysis of multi-storey building" Jr. of Industrial Pollution Control 33(S3) (2017) pp 1405-1413 Review Article.
[6] Alhamd Farqaleet (2016) [2] "Dynamic Analysis of Multi-storey RCC Building". National institute of technology Rourkela- 2015. IJIRT Volume 3 Issue.
[7] Wensheng L. U. and Xilin L. U. (2000) [7] "Seismic Model Test and Analysis of Multi-Tower High-Rise Buildings". ISSN: 2454-132X Impact factor: 4.295 Volume 4, Issue 3 Nashik, Maharashtra.

[8] IS 13920," Ductile detailing of reinforced concrete structure subjected to seismic forces code of practice", 1993.
[9] IS 875(part 1-5)-code of practice for structural safety of Building loading standards.
[10] IS 875, "Code of practice for design loads (other than earthquake) for building and structures - Part 2: Imposed loads", Bureau of Indian Standards, New Delhi, 1987.
[11] IS 456, "Indian Standard Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi, 2000.
[12] IS 1893 (Part I), "Criteria for Earthquake Resistant Design of Structures", Bureau of Indian Standards, New Delhi, 2002.
[13] B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain (2003), "Soil Mechanics and Foundations", Published by Laxmi Publications (P) Ltd.
[14] S. Ramamrutham "Design of Reinforced Concrete Structure", Published by Dhanpat Rai Publishing Company.
[15] Agarwal. P. and Shirkhande.M, "Earthquake resistant Design of Structures" Printice- Hall of India Private Ltd. New Delhi, India.
[16] Shilpa S et.al (2021), Seismic Analysis of Residential Building for Different Zones Using E-tab, IJMTST, DOI: 10.46501/IJMTST0708034,

BIS CODE (reference)
[17] IS 13920," Ductile detailing of reinforced concrete structure subjected to seismic forces code of practice", 1993.
[18] IS 875(part 1-5)-code of practice for structural safety of Building loading standards.
[19] IS 875, "Code of practice for design loads (other than earthquake) for building and structures - Part 2: Imposed loads", Bureau of Indian Standards, New Delhi, 1987.
[20] IS 456, "Indian Standard Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi, 2000.
[21] IS 1893 (Part I), "Criteria for Earthquake Resistant Design of Structures", Bureau of Indian Standards, New Delhi, 2002.



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