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ANALYSIS AND DESIGN OF MULTI STOREY BUILDING SUBJECTED TO SEISMIC LOAD USING E-TABS

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ABSTRACT

The study, design, and estimate of multi-story buildings that are susceptible to seismic conditions are the topics of the current work. Along with the dead load and live load, seismic loads are also applied, and beams, columns, and footings are designed. With its additional capabilities, the E-Tabs programme has gained popularity since it outperformed its predecessors in terms of data exchange for design and analysis. In the current situation, a G+2 construction with a ground floor, first floor, and second floor that is located in Gangavati (Koppal District) is taken into consideration for analysis. The seismic zone 2 is used for the analysis. According to IS 1893-2002, the building model has been examined and contrasted for the seismic zone for static load analysis and reaction spectrum analysis. The project's primary goal is to complete the analysis, design, and estimating of a multi-story building while guaranteeing that the economic and safety elements under seismic circumstances are satisfied while also achieving the intended use of the structure. Kani's approach is used in manual analysis to check the accuracy of the E tabs software's output. The analysis' findings are used to confirm that the building is suitable for its intended usage. A complicated structural system's forces, bending moment, stress, strain, and deformation or deflection are all calculated using E tabs software. For Storey Displacement, Storey Shear, and Base Shear, the results are compared. For the seismic zone, the results are obtained and displayed as graphs and tables.

Keywords: Seismic Analysis, Storey Displacement, Storey Shear, Storey Drift.

I. INTRODUCTION

The first known buildings most likely began as simple forms of construction used to provide shelter from the sun, wind, and rain. As the adage goes, "NECESSITY IS THE MOTHER OF INVENTION," the necessity for a safe home arose among all parties, leading to the gathering of essential and readily accessible resources for the building of different techniques. However, there is a push for development to increase vertically as well, leading to high rise buildings like sky scrapers and other multi-story structures, despite the fact that development is primarily spreading horizontally due to the rapid population growth. Basically Buildings nowadays are of two types of building systems,

- Load bearing masonry buildings
- Framed buildings

Buildings with load-bearing masonry walls are designed in accordance with IS 1905-1980, the Indian Standards Code of Practise for Building Structural Safety. Wall made of masonry (second version). This kind of framework is suitable for buildings with little more than four storeys, as well as for small dwellings with fewer pillars, RCC-cast chunks, and load-bearing block stonework partitions. Framed buildings: These are the kinds of structures that have reinforced concrete frames built into them so that beams and columns may bear and transmit loads across them. The walls made of brick are regarded as non-load bearing walls. This form of building constructions solely uses filler-type brickwork. The slabs in framed structures vary in thickness from 150 to 200 mm depending on the weights passing over them. This kind of construction makes it feasible to have thin walls. This framed kind of system is accepted and ideal for multi-story structures where the number of storeys is large or the loads anticipated on the structure are higher. Seismic Zones:

The geological survey of India (G.S.I.) first published the seismic zoning map of India in the year 1935. After a number of modifications and alterations, this map was initially based on the amount of damage suffered by different regions of India because of earthquakes. The color is coded in different shades of red, this map shows the four distinct seismic zones of the nation, which are prominently shown in the map:

- Zone 2: least active seismic zone

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- Zone 3: moderate seismic zone
- Zone 4: high seismic zone
- Zone 5: highest seismic zone

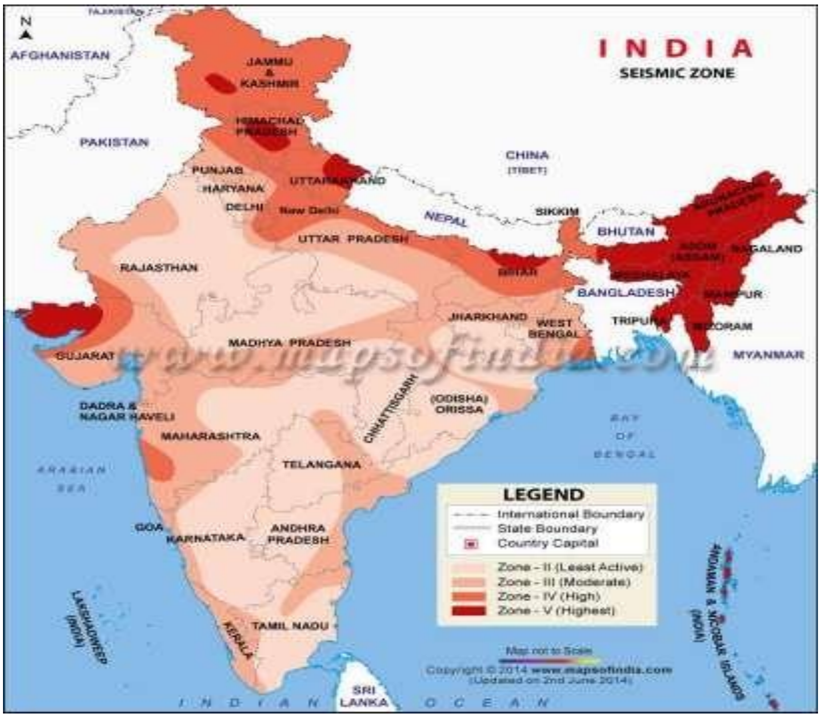

Fig-1: Seismic zone representation on Indian Map

Before designing any structure in a given zone, it is helpful to research the potential damage before doing so using the map with seismic zoning data. Any architect or engineer can guarantee the safety of that structure in that specific zone in this way.

Seismic Loads:

Buildings should be designed and constructed in accordance with the standards outlined in the national building code and the "criteria for earthquake resistant design of structures" bearing IS 1893-2002 published by the bureau of Indian standards in order to make them earthquake-resistant. These buildings should have at least two floors above the ground or be at least 15 metres tall.

II. MODEL DESCRIPTION

- G+2 MULTISOREY BUILDING
- SEISMIC ZONE 2
- Plot area = 2699.66 Sqm.
- Ground floor area = 890.70 Sqm
- First floor area = 884.04 Sqm
- Second floor area = 884.04 Sqm
- Total built up area = 2658.78 Sqm

PROBLEM IDENTIFICATION

1. Based on historical earthquake records, there is a need for earthquake-resistant structures, which may be met by studying and designing earthquake-prone buildings.

2. Tall buildings are being built more often these days, which increases the impacts of lateral stresses like wind and seismic loads. As a result, it is becoming more difficult for designers to reach the right level of safety, strength, and stiffness.

III. OBJECTIVES

1. To use E tabs to compare the storey drift, shear, and displacement for multi-story buildings.
2. To examine how multi-story buildings behave in different earthquake zones 2. 3) Evaluation of a multi-story building exposed to all potential loading situations, including seismic load, to determine if the structure is safe under such conditions.
3. To use Kani's approach to analyse various frames.

IV. MATERIALS, METHODOLOGY AND MODELS

The following Indian code for reinforced concrete design, issued by the bureau of Indian standards, New Delhi, should be followed and satisfied in the design of the building's structural parts. All nations have established a number of national building codes that serve as general guidelines for the planning and construction of all structures within their borders. These codes are created and developed by qualified structural engineers who research, evaluate, and make decisions based on their years of expertise. They are frequently updated to reflect modern trends. The code of practise is IS 456:2000, plain and reinforced concrete.

Methods of Analysis:

When comparing the results of manual analysis using Kani's method and software analysis using ETABS, it can be seen that there is a 5–10% error.

The following are the analysis methods used from E Tabs software.

- Linear Static
- Linear Dynamic
- Non-linear Static

Linear Static:

For the building study in a seismic zone, the linear static analysis approach is used, and it is predicated on the notion that the structure is reacting in its basic mode. The analysis approach, which is commonly described by a seismic design response spectrum analysis when a number of factors are operating on the structure, reflects the behaviour of the building during the earthquake ground motion. The building should not twist and should be a low rise structure when the behaviour of the building is in its basic mode. For high rise buildings with minimal degrees of twisting, several building regulations have expanded the applicability of this strategy. Many building codes that lower the design forces use modification factors, also referred to as reduction factors, as a tool to analyse the effects of a structure due to "yielding".

Linear Dynamic:

Two approaches are specified in IS:1893,2002 (Part 1) for doing the analysis for earthquake forces: the Seismic Factor method and the Response Spectrum method. The approach to be utilised will be determined by the structure's elevation and seismic zone using one Table (see Clause 4.2.1). The bottom of this table clearly states that the Response Spectrum technique should be used to analyse constructions with irregular form and/or uneven distribution of mass and stiffness in the x and/or y plane. No construction is uniform in all aspects (such as mass/stiffness, shape distribution in x and y planes) for all practical purposes. This indicates that the Seismic Coefficient approach will be useful for no constructions. Being a time-consuming and exhausting operation, Response Spectrum techniques are often achievable via computer software.

Non-linear Static:

The building model directly incorporates the nonlinear force deformation characteristics of individual components and parts owing to inelastic physical response in a nonlinear static analysis approach. The Pushover curve, or PO curve of base shear vs. top translation, obtained by exposing the building model to monotonically increasing lateral forces or augmenting translations, distributed over the peak of the building in correspondence to the first mode of vibration until the building disintegrates, is shared by several existing methods (ATC40, FEMA273). Using either strongly damped or in elastic response spectra, the greatest translation expected to be felt during a certain earthquake is calculated.

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DIFFERENT TYPES OF LOADS AND THEIR COMBINATIONS

Loads and properties of materials constitute the basic parameters affecting the design of a R.C. Structure. The various types of loads acting on the structure which need consideration in building design are as follows:

The loads that are considered for the structural design are as below,

- Dead load (IS 875:1987 PART-1)
- Imposed/Live load (IS 875:1987 PART-2)
- Wind load (IS 875:1987 PART-3)
- Seismic load (IS 1893(PART-1): 2002)
- Combination of loads (IS 875:1987 PART-5)

Hence the design is done for this load combination number 5 i.e. 1.5(DL+LL).

STRUCTURAL ANALYSIS

The architectural plans and an elevation of the commercial complex are included in the annexure. The commercial complex's three-dimensional structural frame is used to make initial estimates about the size of the beams and columns. The bottom ends of the columns are assumed to be fixed for the purposes of analysis.Tie beams are offered for the basement level to reduce the columns and sustain any required wall loads. 1) The loads included in the study are the dead loads. seismic loads, live loads, and loads. All of these loads have been calculated based on IS 875. A live load of 3KN/m2 will be applied on floor and roof slabs. Additionally, calculations are made for the dead loads caused by walls, floor finishes, and one's own weight.

E Tabs Results Figures

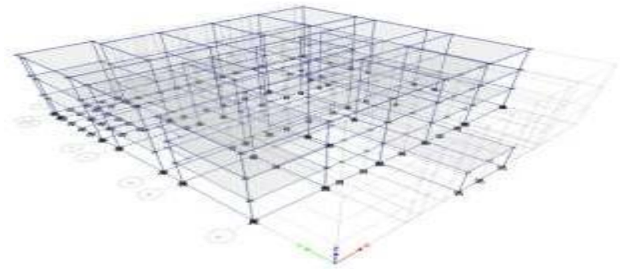

Fig-2: 3D View Of Building

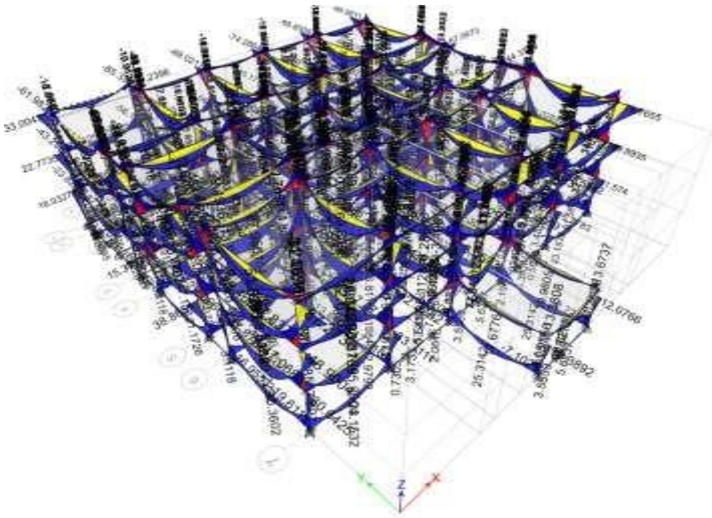

Fig-3: 3D View of BENDING MOMENT DIAGRAM

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Fig-4: Maximum and Minimum Bending Moment And Shear By E-TABS

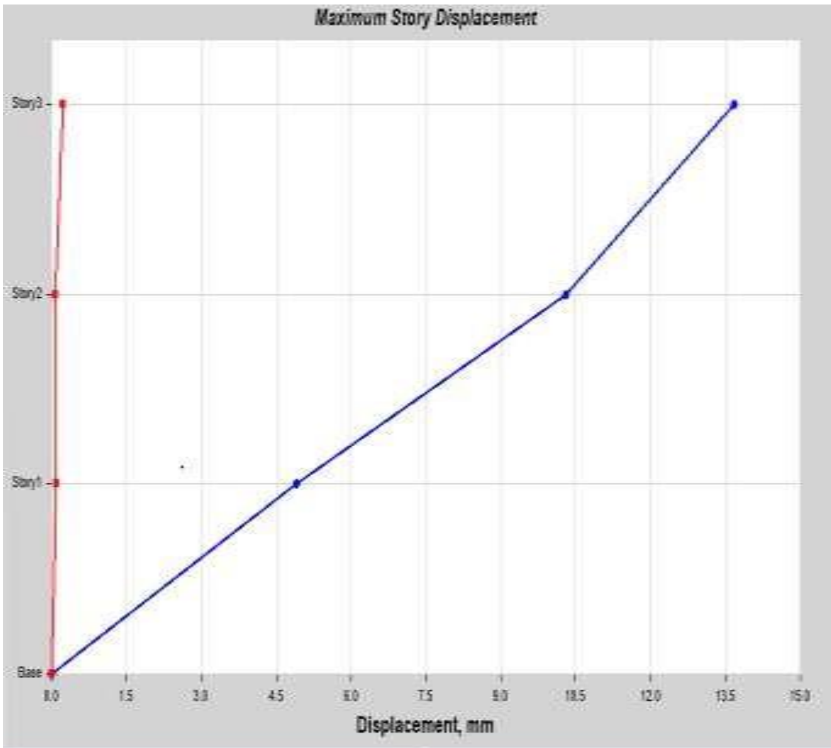

Chart-1: Maximum Storey Displacement in EQ-X

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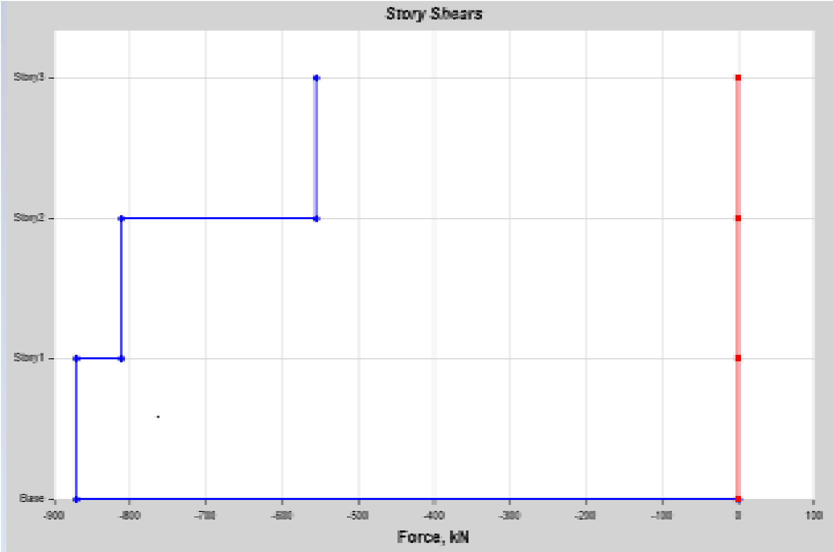

Chart-2: Maximum Storey Displacement in EQ-Y

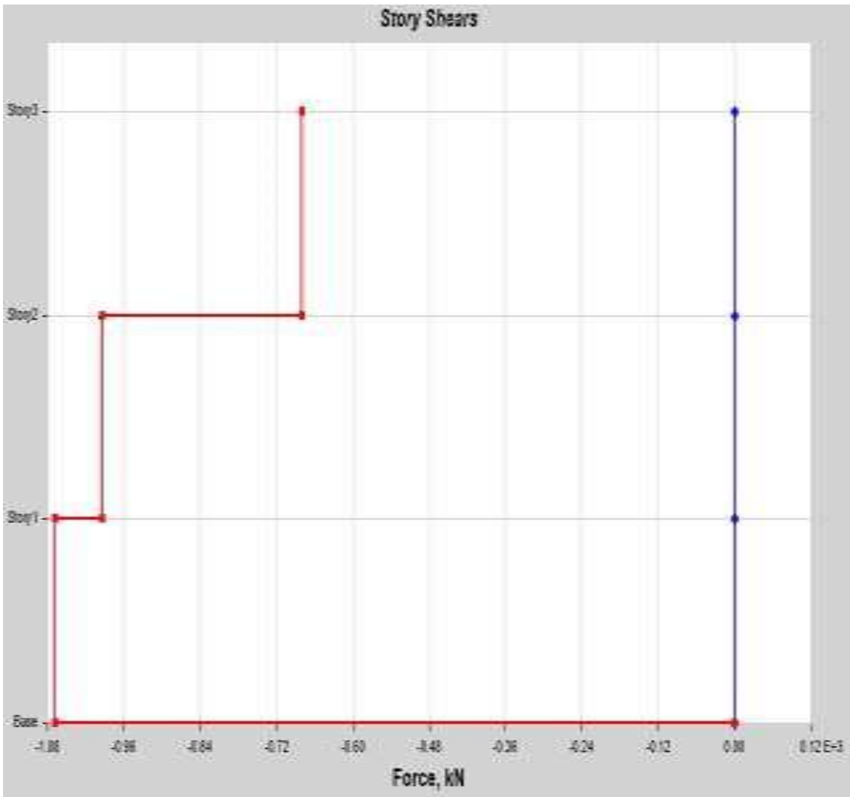

Chart-3: Storey shear in EQ-Y

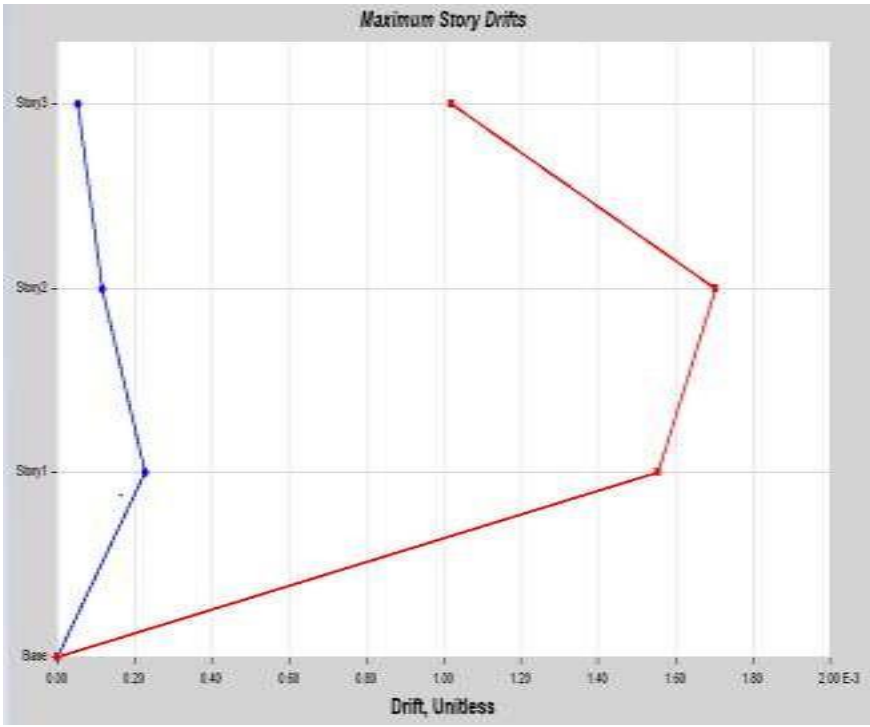

Chart-4: Storey Drift in EQ-Y

V. RESULT AND DISCUSSION

Maximum Storey Displacement:

With the building's height rising, the maximum storey displacement also rises. The graph's Y-axis denotes the height of the storey, while its X-axis denotes the displacement in millimetres. The models' representation of the greatest displacement is as follows, i.e.

Table 01: Storey Displacement (mm)

SL NO.	STOREY	STOREY DISPLACEMENT(mm)	
		MODEL IN EQ-Y	MODEL IN EQ-X
1	BASE	0	0
2	STOREY 1	4.6	4.6
3	STOREY 2	9.5	10.2
4	STOREY 3	12.5	13.7

Maximum Storey Drift:

The maximum story drift simulates a spring motion, in which the drift value rises and then falls. "The Y-Axis of the graph represents the storey height and the X-Axis represents the amount of storey drift from its initial position"; storey drift value is less than one unit.

Table 02: Storey Drift

SL NO.	STOREY	STOREY DRIFT	
		MODEL IN EQ-Y	MODEL IN EQ-X
1	BASE	0	0
2	STOREY 1	1.58	1.62
3	STOREY 2	1.70	1.82
4	STOREY 3	1.10	1.17

Storey Shear:

The X-Axis of the graph depicts the amount of force in KN, while the Y-Axis represents the plane at which the material is anticipated to cut, shear, or break. Storey shear is quantified in terms of FORCE and KN.

Table 03: Storey Shear

SL NO.	STOREY	STOREY SHEAR (kN)	
		MODEL IN EQ-Y	MODEL IN EQ-X
1	BASE	-1.08	-880
2	STOREY 1	-0.99	-820
3	STOREY 2	-0.68	-550
4	STOREY 3	-0.68	-550

VI. DISCUSSION

- It has been noticed that as a building's height grows, so does its STOREY DISPLACEMENT in the model. The EQ-X direction is where the highest and smallest displacements are discovered to be.
- The STOREY DRIFT in the MODEL is shown to be HIGH at STOREY2 and to decrease as the building's height rises.
- It has been noted that the model's STOREY SHEAR values for EQ-X and EQ-Y are negative.

VII. SCOPE FOR FUTURE WORK

The study of buildings in seismic zone condition can be extended for future study in a wide variety of conditions amongst which few are as follows:

- The amount of reinforcement needed for a structure with seismic load may be examined to determine how much steel is needed and how much the construction will cost.
- Wherever necessary, lightweight construction materials may be included into structural components to lighten the overall structure and lower the project's cost.
- As is well known, the world is changing extremely fast, and a negative construction that negatively impacts society has just come to light. Major natural disasters like earthquakes have occurred.
- To ensure quick and effective implementation, the aforementioned project might be further planned utilising project management tools like Microsoft Project.
- When the structures are situated on rugged terrain.
- Loading combinations and load type.
- Depending on the height and number of storeys of the structure.
- Depending on the seismic regions in which the building is anticipated to be located.
- Steel or composite sections are examples of alternative materials utilised in building.
- Evaluation of several manual techniques of analysis.
- Comparison with other analytical software programmes as CYPE, STAADPRO, and SAP, among others.

VIII. CONCLUSION

The seismic characteristics such as storey displacement, storey drift, and base shear in both the X and Y directions are taken into consideration in the current scenario of analysing the multistory structure. These seismic parameters are based on the gravity situation for the live load, dead load, and dynamic loads. When comparing the results of manual analysis using Kani's method and software analysis using ETABS, it can be seen that there is a 5–10% error.

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