Analysis and Design of G+5 RCC Building in Different Seismic Zones of India using ETABS

Omkar Phadtare[1], Prof Vikas K Chodankar[2]

[1] *Student, Civil Engineering, Goa College of Engineering, Goa, India*
[2] *Associate Professor, Civil Engineering, Goa College of Engineering, Goa, India*

ABSTRACT

Planning a design so that less harm during an earthquake makes the construction very uneconomical, as the earthquake would or probably won't happen in its lifetime and is an uncommon phenomenon. In this paper a G+5 RCC outlined structure has been analysed and planned utilizing ETABS software. The building is designed to withstand earthquake forces in various seismic zones in accordance with IS 1893-Part 1:2016. Comparing the variations in maximum shear force, maximum bending moment, maximum storey displacement, maximum storey drift in various seismic zones are the primary goals of this paper. The maximum shear force, maximum bending moment, maximum storey displacement, maximum storey drift all rise from zone II to zone V, causing significant variations.

Keyword: - ETABS, Maximum Shear force, Maximum Bending Moment, Maximum Deflection, Maximum Drift, Seismic zones.

1. INTRODUCTION

An earthquake is a visible movement of the earth's surface. Seismic waves are the result of a sudden and unanticipated release of a significant amount of energy from the earth's crust. The Indian earthquake zoning map breaks down India into four seismic zones. Zones II, III, IV, and V are the four seismic zones, with zone V having the highest seismicity and zone II having the lowest. Without damage, no structure can completely withstand seismic forces. The earthquake will cause minor or significant damage to the majority of the structures. The harm to the design might be minor assuming the greatness of the seismic tremor is little, though design might implode if the extent of the tremor is exceptionally high. As a result, every building today is built to withstand earthquakes.
The latest version of the seismic zoning map of India presented in the earthquake resistant design code of India IS 1893- Part1: 2016 assigns four situations of seismicity for India in terms of zone factors. In distinct words, the earthquake- zoning map of India divides India into four seismic zones, i.e. (Zone 2, 3, 4 and 5) unlike its former version, which consisted of five or six zones for the country. According to the current zoning map, Zone 5 expects the highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity.
Zone 5 covers the areas with the highest risk zone that suffers earthquakes of intensity MSK IX (Medvedev–Sponheuer–Karnik scale) or even greater. The IS code has assigned a zone factor of 0.36 for Zone 5. Structural designers use this factor for earthquake resistant structure design of structures in Zone 5. The zone factor of 0.36 is an indicator of effective (zero periods) level earthquakes in this zone. Zone 5 is referred to as the Very High Damage Risk Zone. The region of Kashmir, the North-East Indian region, the western and central Himalayas, Rann of Kutch North and Middle Bihar fall in this zone.
Zone 4 is also called the High Damage Risk Zone and suffers earthquakes of intensity MSK VIII. The IS code has assigned a zone factor of 0.24 for Zone 4. The capital of the country (Delhi), Jammu and Kashmir and the Indo-Gangetic basin fall in Zone 4. In Maharashtra, the Pataan area (Koyanager) is also in zone no 4. In Bihar, the northern part of the state Rakasaul, near the border of India and Nepal, is also in zone no 4.
Zone 3, parts of Kashmir, the Andaman and Nicobar Islands, Western Himalayas fall under this zone. This zone is classified as Moderate Damage Risk Zone, with earthquake intensity MSK VII. The IS code has assigned a zone factor of 0.16 for Zone 3.
Zone 2 is liable to MSK VI or less and is classified as the Low Damage Risk Zone. The IS code has assigned a zone factor of (maximum horizontal acceleration that can be experienced by a structure in this zone is 0.10 of gravitational acceleration) for Zone 2.

2. RELATED WORKS

Akash Panchal et al. (2017): -The author had analyzed and developed an existing G+6 RCC framed structure using STAAD Pro. The structure was designed for earthquake forces in several seismic areas according to IS 1893 (Part 1):2002. The main aims of the paper are to compare the change in the percentage of the steel, maximum bending moment, maximum shear strength and maximum bending in various seismic zones. The differences between zone II and zone V are dramatically higher. The percentage of steel, maximum shear strength and maximum moment from zone II to zone V for bending and deflection are increased.

Salahuddin Shakeeb S M, Prof Brij Bhushan S, Prof Maneeth P D, Prof Shaik Abdulla (2015): The work tries to determine the required percentages for various seismic zones by taking into account the effects of the infill and without the infill. The structure analysis software tool ETABS-2013 is used to analyze and design the study's 13-storey symmetrical building plan. Displacement, base shear, shear and moment are also measured, and the results are compared between gravity loads and various seismic zones. The impact of masonry infills has also been taken into account in these parameters. He came to the conclusion that, in comparison to gravity loads, the total variation in percentage of steel in columns for an infill case with maximum loading of seismic zone-2 to zone-5 is between 1.935% and 51.612%. Additionally, when compared to gravity loads, the total variation in percentage of steel in columns without infill case with maximum loading ranges from 1.24 percent to 9.12 percent. When compared to gravity loads, the percentage of steel in beams for the infill case with maximum loading from seismic zone-2 to zone-5 ranges from 2.7% to 16.21%, and when compared to gravity loads, the percentage of steel in beams for the non-infill case with maximum loading from seismic zone-2 to zone-5 ranges from 16.66% to 68.75%.

lnchara et.al (2016): The author conducted a study in RC Frame structure regarding seismic design in order to achieve the following aim:
1. To study the structural performance in various stainless-steel rates and concrete quantities in different seismic regions of India.
2. Contrast how much concrete and the percentage of steel reinforcement when drawn up in two different IS codes (IS 456:2000 for gravity load and 151893:2002 for earthquake forces). The author has made five models in this study. Four models of the five models are designed and analyzed using computer software ETABS in respect of seismic forces and gravity loads for various seismic areas in India. Research has concluded that the supportive reactions are increasing from zone 11 to zone V, resulting in an increase in steel weight and concrete volume. Likewise concentrated in the eastern United States to track down a correlation of seismic and wind plan. Seismic design forces are currently sufficient for low-level structures. The lateral forces of Chicago and New York are not vital to design basis shear for either seismic analysis and wind analysis soil order. Thus, just wind charge is the possible factor that is the main consideration when the wind forces are greater when the rocky foundation proportions.

Papa Rao and Kiran Kumar (2013): The author conducted research on the variations in the proportion of concrete and steel volume in the RCC-framed structure for various Indian seismic zones. The structure has been designed with seismic forces and gravity loads in mind, which could have an effect on the building. Their investigation led them to the conclusion that the variation in support reactions for exterior columns increased from 11.59 percent to 41.71 percent, while the variation in support reactions for edge columns increased from Zone II to Zone V by 17.72 percent to 63.7%, whereas the variation in support reactions for interior columns was much smaller. Concrete volumes have increased for exterior and edge columns from Zone III to Zone V due to an increase in support reactions caused by lateral forces, whereas interior columns have very little variation. Steel variations range from 0.54% to 1.23 percent in external beams, and from 0.78% to 1.4% in internal beams. The base support isn't changed for seismic and non-seismic plans

Dunnala Lakshmi Anuja et al. (2019): - In this context, the author thieves to plan, analyze and design a four-story residential building, each with eight apartments each consisting of a master bedroom, a bedroom, a dining room, a kitchen, a toilet, and a veranda. In order to analyze and design the framework, STAAD PRO is used to analyze the structural analysis. The designs, a staircase, columns and beam framing etc. are also used in AUTOCAD. The platforms, escalator, columns, footing, lintel. sun shadows, septic tank, high tank "Limit State Method" using the IS: 456:2000 code book is included in this project on comparison with drawing, manual design and the geometrical model using staad.pro the area of AST required for the slab beam, column and footing are comparatively similar to that of the requirement.

3. METHODOLOGY

This work was carried out to study the performance of multi storeyed buildings in gravity load and different seismic zones using ETABS software and determining storey displacement and storey drift in different seismic zones. Preliminary data of the structure considered for analysis and design are as follows.

Table -1: Preliminary data

Number of stories	G+5
Floor to floor height	3m
Size of column	0.30x0.30m
Size of beam	0.23x0.30m
Earthquake load	As per IS 1893:2016
Slab thickness	0.125m
Live load	$3KN/m^2$
Floor finish	As per IS 875:1987
Seismic zones	All five seismic zones of India
Type of soil taken	Medium
Importance factor	1.0
Response reduction factor	5.0

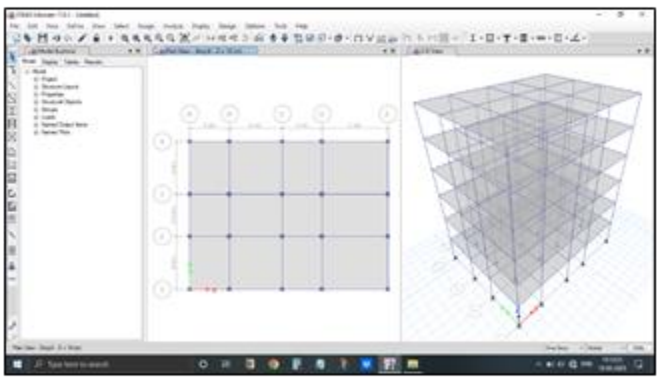

Fig -1: Model of the building

3. EXPERIMENTAL RESULTS

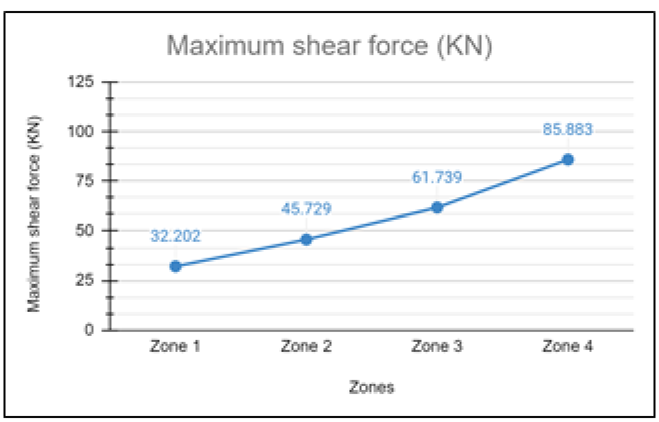

Fig -2: Maximum Shear Force (KN)

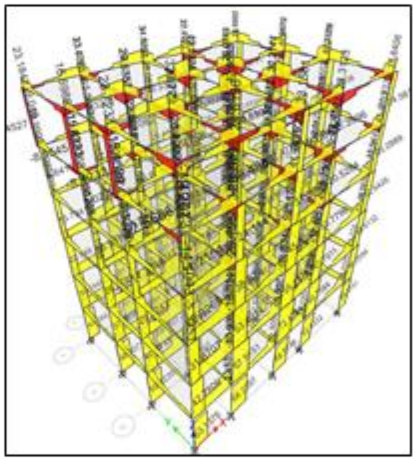

Fig -3: Shear Force diagrams (KN)

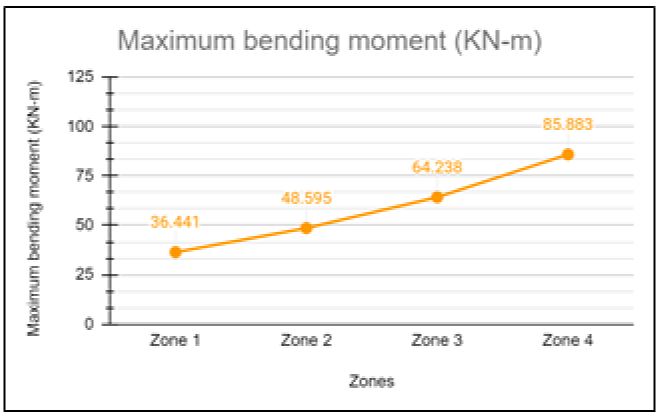

Fig -4: Maximum Bending Moments (KN-m)

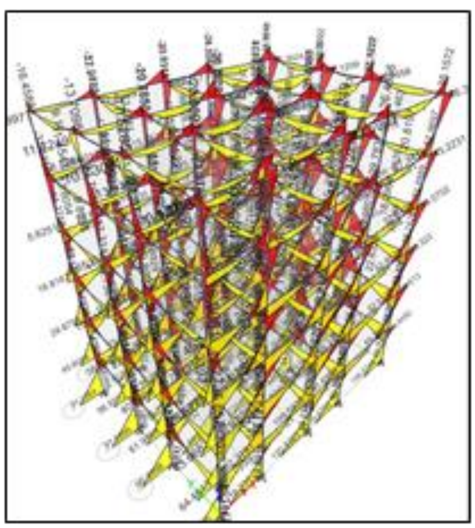

Fig -5: Bending Moment diagrams (KN-m)

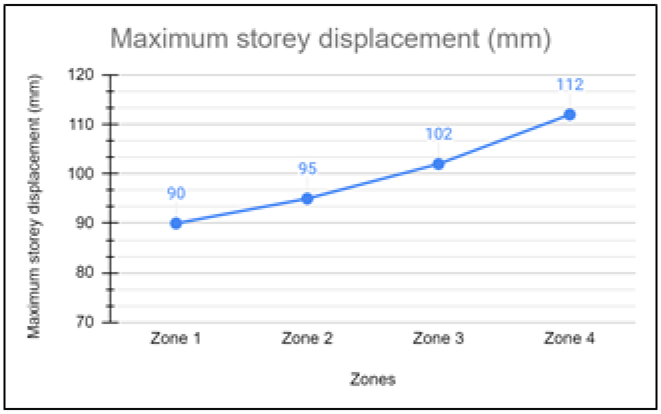

Fig -6: Maximum Storey Displacement (mm)

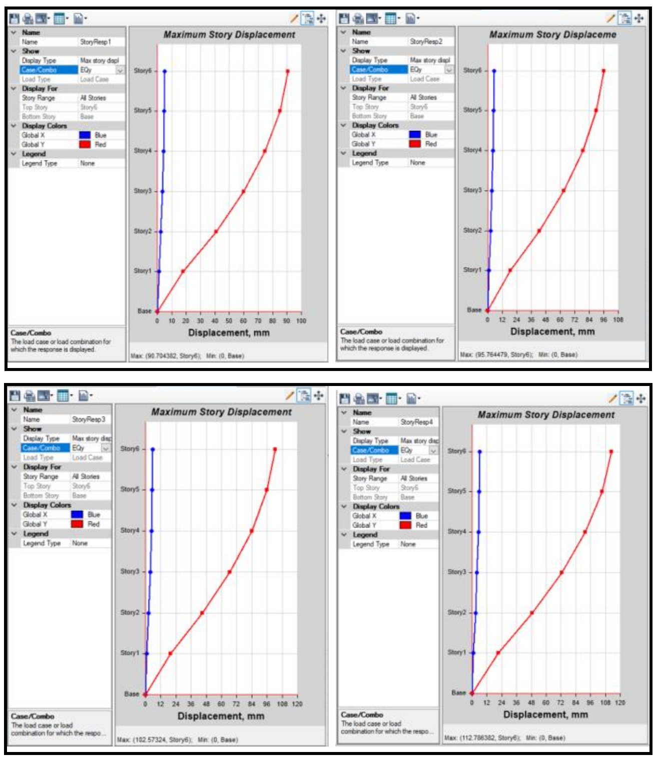

Fig -7: Storey Displacement diagrams (mm)

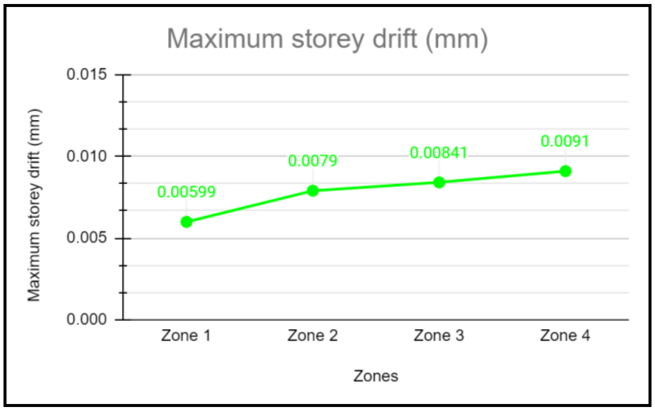

Fig -8: Maximum Storey Drift (mm)

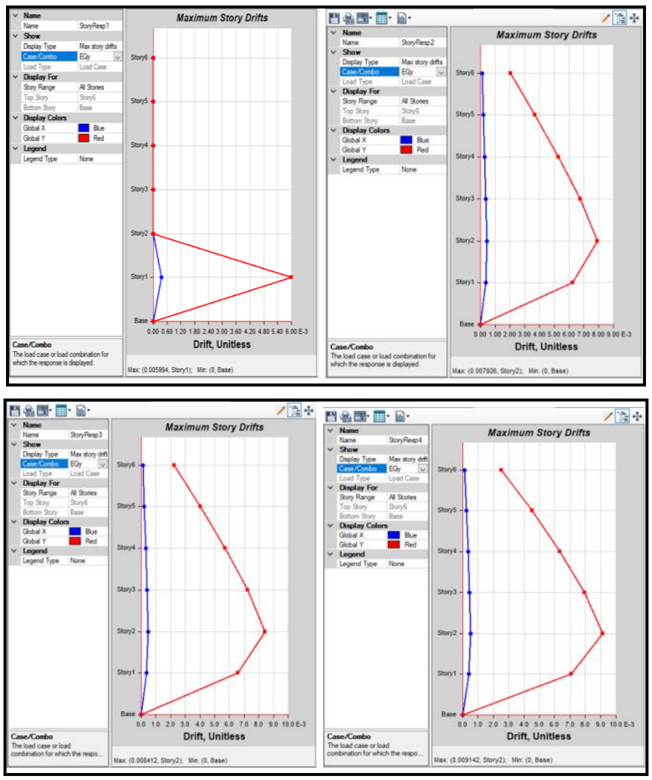

Fig -7: Storey Displacement diagrams (mm)

	Maximum shear force (KN)	Maximum bending moment (KN-m)	Maximum storey displacement (mm)	Maximum storey drift (mm)
Zone 2	32.202	36.441	90	0.00599
Zone 3	45.729	48.595	95	0.0079
Zone 4	61.739	64.238	102	0.00841
Zone 5	85.883	85.883	112	0.0091

4. CONCLUSIONS

The maximum shear force, bending moment, storey displacement, and storey drift in various seismic zones are used in the comparison. Lower-zone displacement values are lower in all models, while higher-zone displacement values continue to rise.
The maximum shear force tended to increase as the zone varied from II to V by a percentage difference of 90.91% .
The maximum shear bending moment tended to increase as the zone varied from II to V by a percentage difference of 80.83% .
The maximum storey displacement tended to increase as the zone varied from II to V by a percentage difference of 21.70% .
The maximum storey drift tended to increase as the zone varied from II to V by a percentage difference of 41.22%.

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6. REFERENCES

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