ISSN No:-2456-2165

Design and Analysis of Multi-Storeyed Residential Building in Different Seismic Zones

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Abstract: - An earthquake is a natural phenomenon that occurs in high-rise buildings, and if the structure does not have enough strength, that is, the structure must be designed and constructed correctly. To ensure the safety of high-rise buildings, it is necessary to consider seismic analysis to design seismic structures. India has four seismic zones: Zone II, Zone III, Zone IV, Zone V. Zone II is an area with low risk of earthquakes, but Zone V is an area with high risk. The building is designed according to the norm I 1893 part I: 2002. The main objective of this study is four seismic zones (Zone II, Zone III, Zone IV) using the ETABS 2015 software. The results are interpreted using different values of coefficient of zone. The response spectrum method was adopted for the analysis.

***Keywords*:-** Seismic Zones, Steel Percentage, Displacement, Shear Force, Bending Moment, ETABS 2015.

I. INTRODUCTION

Earthquake is natural phenomenon occurred due to vibrations in earth's crust. The main cause of earthquake is volcanic eruption. Study of seismology says that about 90% of earthquake happens due to tectonics. Earthquakes are caused by the sudden release of energy within some limited region of the rocks of the earth. Earthquakes have different effects, including changes in geologic features, damage to man-made structures, and impact on human and animal life. To reduce the effect of earthquake on human life, structures should be designed as per safety criteria. The job of structural engineer is to provide maximum safety in the designed structure.

In India there are four different seismic zones: zone II, zone III, zone IV and zone V. They are categorized by their intensity: mild, moderate, severe, very severe. Zone II comes under low risk zone while zone V comes under high risk zone. IS 1893:2002 provides the information about seismic design. North-eastern India, some part of Jammu and Kashmir and Himachal Pradesh, Uttaranchal, Rann of Kutch in Gujarat, some part of North Bihar and Andaman & Nicobar Islands are high risk zones comes under zone V. Zone V the area suffers earthquake of intensity MSK IX (Medvedev-Sponheuer-Karnik scale) or greater.

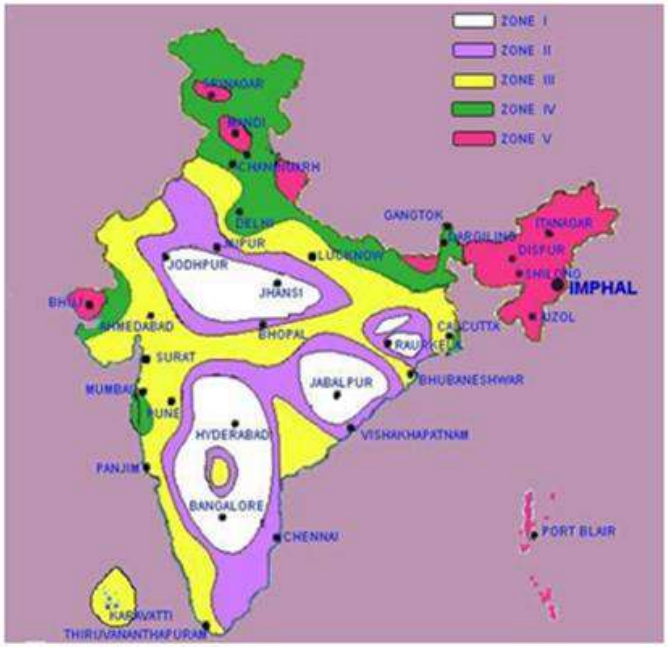

Fig 1:- Seismic Zones of India Map
Source: IS 1893: 2002

II. REVIEW FOR DESIGN OF BUILDING

A. General

The design and analysis of building is done by ETABS 2015 software. To design a building there are some structural properties which are required. Maintaining the Integrity of the Specifications

Structural properties of RCC	Framed structure
No. of stories	G+15
Floor to floor height	3.1 m
Plinth height	1.65 m
Column size	Varying
Beam size	Varying
Wall thickness	0.100m and 0.150m
Slab thickness	0.115m
SBC	200kN/m
Seismic zones	All five seismic zones of India
Loads	As per IS 875 all parts
Concrete grade	M30
Steel grade	Fe415 & fe500

Table 1

This is the architectural drawing of the first floor of the building. All the floors are same. The floor to floor height of the building is 3.1m. IS 1893:2002 is referred for the design purpose. Modal analysis is done by response spectrum method.

Different values of zone factor are taken and their values are interpreted in the results. In this study software has been used to analyze the RC building under earthquake loads. The software calculates base shear which resists the design lateral load of the building. In this study equivalent static analysis method is used for seismic evaluation for the existing residential building is carried out for different seismic zones using ETABS 2015 software.

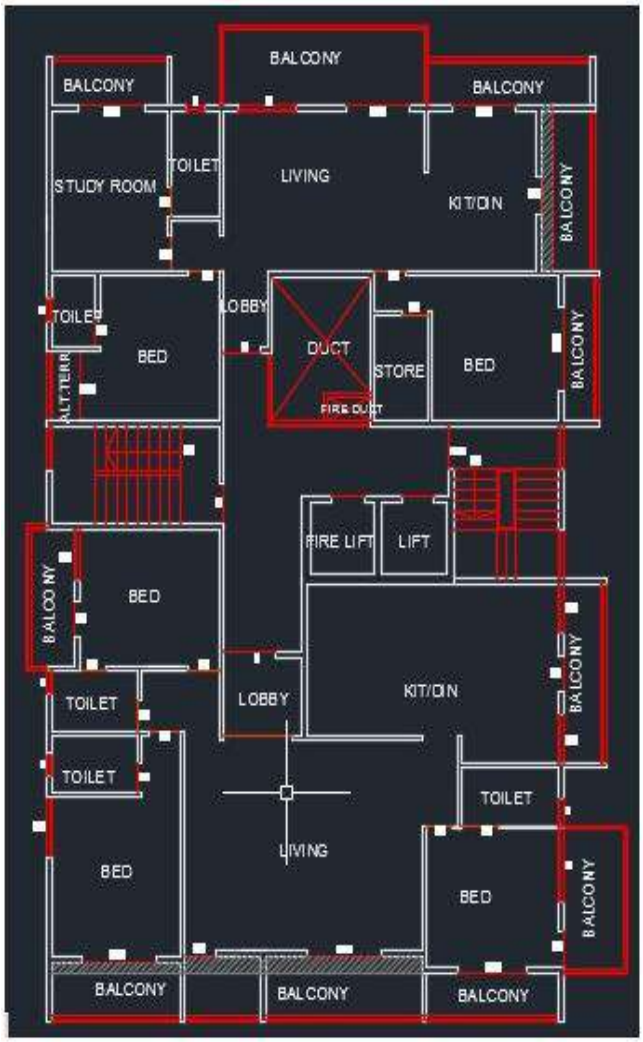

Fig 2:- Architectural Plan

B. *Modelling of the Structure*

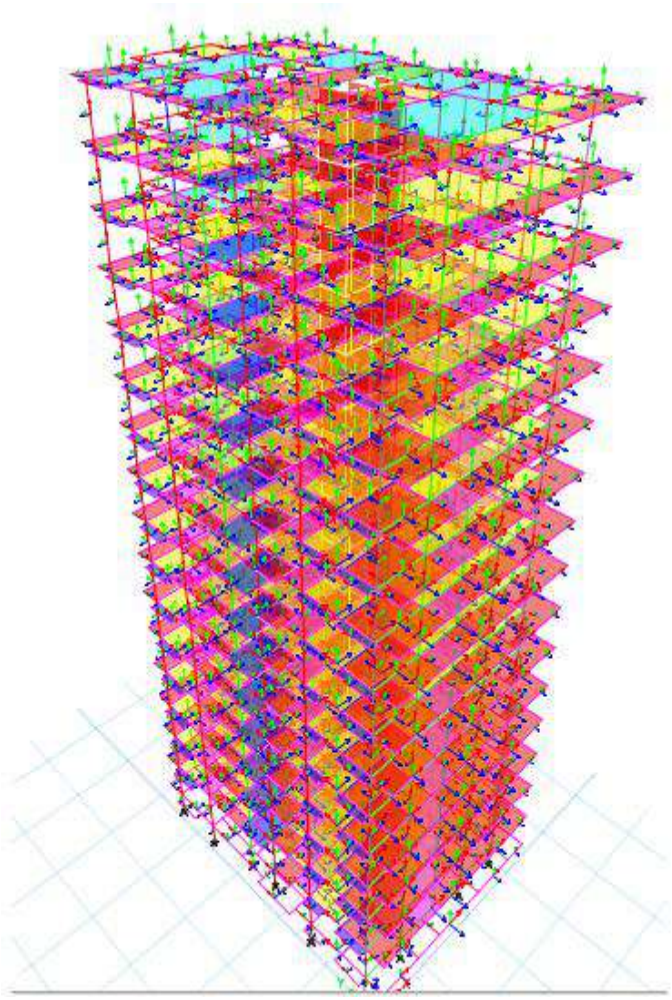

Fig 2:- 3D Model

C. Design of the Structure

Design of the building is done to compare the % steel reinforcement, maximum shear force, maximum bending moment and displacement for all four seismic zones. Different values of zone factor are used for the design. The beams and columns have to be adding to the model. After adding beams and columns, adding loads is next step and then we have to check the model. The software gives us all the data which is required for the design of the building.

The main objective of the study is to compare % steel reinforcement, maximum shear force, maximum bending moment and displacement for all four seismic zones. By comparing this we get to know that which zone requires more steel to be safe and which requires less. We have to check that variations for this are drastically high or low. After giving all the inputs design will be done.

III. RESULT

➢ *Maximum Displacement:*

STOREY	ZONE II	ZONE III	ZONE IV	ZONE V
BASE	1.5	1.9	3.5	5.8
PL	3.2	5.7	7.1	10.4
1	5.3	8.2	12.2	16
2	9.9	15.5	22.9	30.1
3	15.1	23.6	34.8	46.1
4	20.7	32.3	47.7	63.3
5	26.6	41.4	61.1	81.3
6	32.7	50.8	74.9	100
7	38.9	60.3	88.9	118.8
8	45.1	69.8	102.7	137.5
9	51.1	79.1	116.3	155.9
10	58.4	86.7	125.1	178.2
11	62.7	96.7	142	190.8
12	68	104.8	153.7	206.9
13	73	112.2	164.5	221.7
14	77.5	118.9	174.2	235.1
15	81.5	124.8	182.7	246.9
ROOF	85	130	190.1	257.3

Table 2

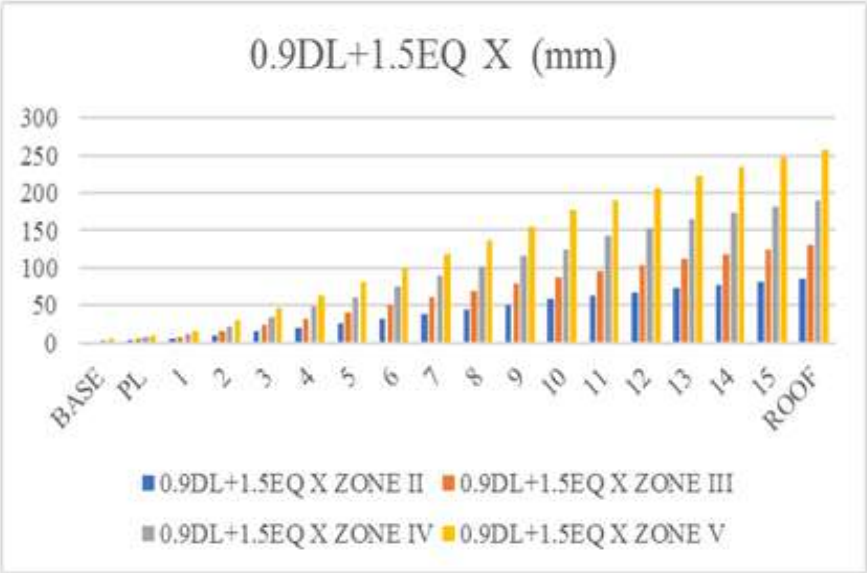

Fig 4

➢ *Maximum Steel Percentage*

COLUMN NO	ZONE II	ZONE III	ZONE IV	ZONE V
C1	1.59	1.62	2.11	2.82
C2	2.48	2.48	2.75	3.45
C3	2.49	2.63	3.36	4.97
C4	2.35	2.96	3.91	5.13
C5	2.05	2.08	2.08	2.6
C6	1.88	1.88	1.88	2.55
C7	3.61	3.61	3.61	3.65
C8	2.51	2.51	2.51	2.74
C9	1.77	1.77	2.28	2.58
C10	2.14	2.14	2.22	3.11
C11	1.36	1.4	1.81	3.88
C12	2.15	2.15	2.28	2.72
C13	2.95	2.95	3.13	3.84
C14	2.8	2.8	3.07	4.11
C15	2.83	2.83	2.83	3.08
C16	2.8	2.8	2.8	2.89
C17	2.22	2.22	2.22	2.85
C18	3.06	3.06	3.67	4.49
C19	3.95	3.95	3.95	3.62
C20	3.15	3.13	3.13	2.82
C21	3.75	3.97	4.9	5.61
C22	2.92	3.44	4.28	4.91
C23	4.13	4.11	4.45	4.95
C24	3.2	3.25	3.44	4.31
C25	3.03	3.03	3.65	4.58

Table 3

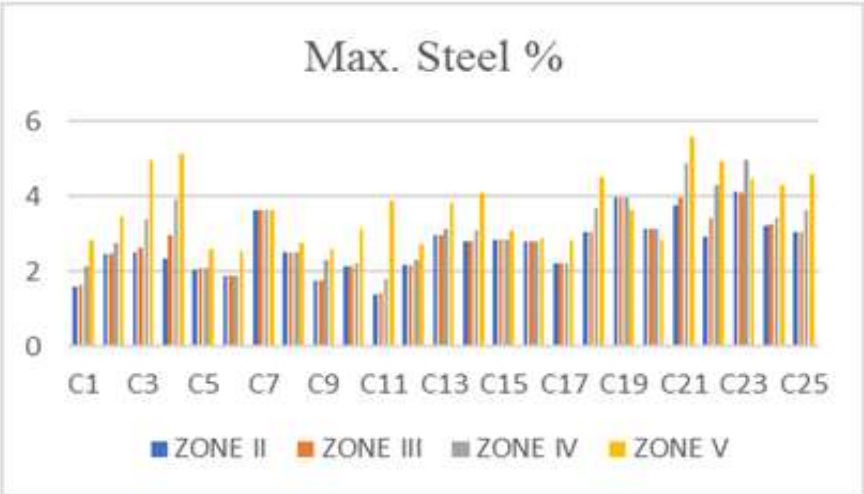

Fig 5

➢ *Maximum Shear Force*

STOREY	ZONE II	ZONE III	ZONE IV	ZONE V
PL	793.88	793.89	793.9	793.91
1	889.55	889.67	898.63	899.47
2	951.63	954.25	1049.72	1496.44
3	1173.17	1186.995	1324.83	1767.8
4	1314.17	1337.84	1511.96	1834.09
5	1416.81	1447.66	1643.63	1850.71
6	1487.54	1503.89	1726.18	1891.54
7	1532.32	1549.83	1780.58	1903.27
8	1556.99	1567.28	1811.47	1940.64
9	1558.78	1569.97	1814.34	1971.17
10	1562.02	1574.32	1772.93	1896.6
11	1558.07	1571.23	1736.76	1911.62
12	1576.41	1530.24	1660.22	1843.18
13	1492.56	1512.1	1603.25	1829.98
14	1515.1	1528.09	1530.96	1701.81
15	1565.9	1579.26	1590	1606.46
ROOF	979.06	988.75	989.57	990.54

Table 4

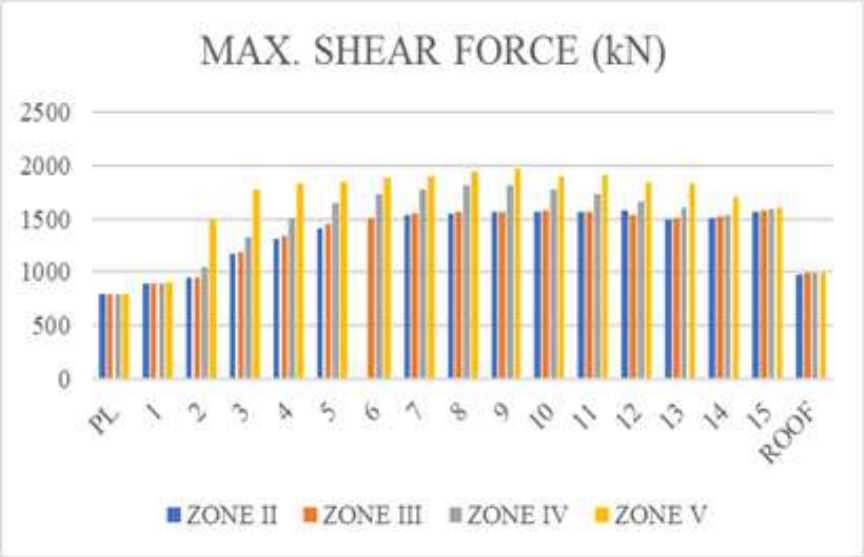

Fig 6

➢ *Maximum Bending Moment*

STOREY NO.	ZONE II	ZONE III	ZONE IV	ZONE V
1	32.27	32.95	33.86	33.96
2	33.82	34.03	35.14	35.24
3	35.24	35.49	36.82	36.89
4	36.45	36.74	38.27	38.29
5	37.48	37.79	39.49	39.5
6	38.35	38.68	40.52	40.56
7	39.07	39.43	41.38	42.53
8	39.67	40.05	42.1	44.23
9	40.18	40.57	42.7	44.72
10	40.58	40.99	43.2	46.15
11	40.92	41.34	43.6	46.6
12	41.19	41.69	43.91	46.81
13	41.38	41.82	44.17	47.28
14	41.48	41.92	44.31	47.59
15	41.67	42.2	44.52	47
ROOF	33.51	35.25	36.6	38.91

Table 5

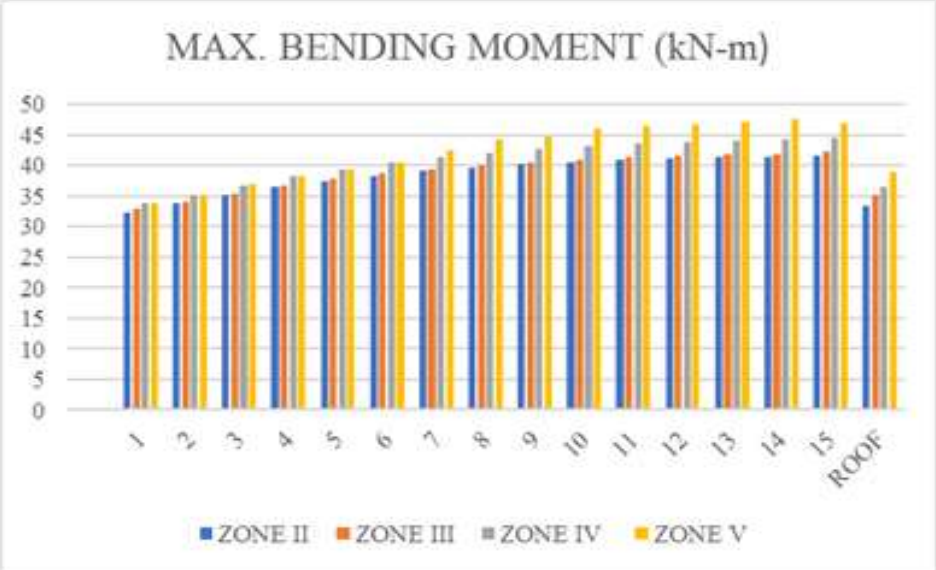

Fig 7

ISSN No:-2456-2165

IV. CONCLUSION

- The base shear of structure increases as we go to higher seismic zones. Base shear for seismic zone II is 472.58kN and for zone V is 1709.92kN. This means base shear increases by almost 360% if seismic zone changes from II to V.
- The storey displacement was calculated by using combinations. The storey displacement increases with increase in seismic zone. Storey displacement is very less at base while at roof it is very high. The storey displacement at zone II is 91.6 mm and at zone V is 268 mm. Hence storey displacement increases by 30%.
- Steel percentage increases from zone II to zone V. Maximum steel percentage at zone II is 4.13% and at zone V is 4.95%. This means steel percentage increases by 1.20%.
- Shear force varies from column to column. For zone II maximum shear force is 1576.41kN and for zone V it is 1971.17kN. Therefore, shear force increases by 125% if seismic zone changes from zone II to zone V.
- Maximum bending moment varies from 41.67kN-m, 42.2kN-m, 44.52kN-m, 47kN-m for zone II, zone III, zone IV and zone V.

ACKNOWLEDGMENT

I hereby express my heartiest gratitude towards, Associate Professor Rohan Kumar Choudhary for guiding me in my project, to understand the work conceptually and for encouraging me for the work. I am concluding this acknowledgement with thanking my parents and friends who helped and supported me for the work.

REFERENCES

[1]. IS 1893:2002 Criteria for earthquake resistant design of structure
[2]. IS 875:1987 (Part I, II and V) Indian standard code of practice for design loads
[3]. IS 456:2002 Plain and Reinforced Concrete- Code of Practice
[4]. Akash Panchal, Ravi Dwivedi, “Analysis and Design of G+6 Building in Different Seismic Zones of India”, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 7, July 2017
[5]. Narla Mohan, A. Mounika Vardhan, “Analysis of G+20 RC Building in Different Zones using ETABS”, International Journal of Professional Engineering Studies, Vol. 8, Issue 3, March 2017
[6]. Arun Babu, Ajisha R., “Analysis of Multi storied Building in Different Seismic Zones with Different Soil Conditions”, International Research Journal of Engineering and Technology, Vol. 5, Issue 5, May 2018
[7]. Tiriveedhi Saikrishna, V. Srinivasrao, “Earthquake Analysis and Design **of** Multi-Storied Building For Different Zones In India”, International Journal For Technological Research In Engineering, Vol. 4, Issue 4, December 2016
[8]. E. Pavan Kumar, A. Naresh, M. Nagajyothi, M. Rajasekhar, “Earthquake Analysis of Multi Storied Residential Building - A Case Study”, International Journal of Engineering Research and Applications, Vol 4, Issue 11 (Version 1), November 2014