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Analysis of RC building in different seismic zones by moment resisting frame using IS 1893:2002

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Abstract— This paper includes analysis of a G+15 story RC building frame. The objective of this study is to investigate the seismic behaviour of reinforced cement concrete structure having SMRF (Special moment Resisting frame) in nature and compare the displacement, shear and bending behaviour of building located in seismic zones III and IV, for a Soil class I. For this purpose, the analysis was done using Etabs 2015 software and using the codes for analysis, IS 1893:2002, IS 456: 2000. The study assumed that the buildings were located in seismic zones III and IV, for a Soil class I.

Keywords— SMRF, etabs, seismic design, shear, Displacement

I. INTRODUCTION

The selection of a particular type of framing system depends upon two important parameters i.e. Seismic risk of the zone and the budget. The lateral forces acting on any structure are distributed according to the flexural rigidity of individual components. Indian Codes divide the entire country into four seismic zones (II, III, IV & V) depending on the seismic risks. OMRF is probably the most commonly adopted type of frame in lower seismic zones. However with increase in the seismic risks, it becomes insufficient and SMRF frames need to be adopted.

The main aims of the present study are as following:

- To model structures for analysing multi-storeyed frames having moment resisting frame (SMRF) configurations.
- To carry out the analysis of the selected buildings in seismic zones III and IV
- To make a comparative study with the help of results like bending moment, shear force, displacement

II. LITERATURE REVIEW

R. Sadjadi "Seismic performance of reinforced concrete moment resisting frames"
This study presents an analytical approach for seismic assessment of RC frames using nonlinear time history analysis and push-over analysis. The analytical models are validated against available experimental results and used in a study to evaluate the seismic behavior of these 5-story frames

Rosario Montuori
In this paper a simple and a more sophisticated design procedure to design moment resisting concrete frames, is presented. This methodology allows to design structures having a smart behaviour when subjected to seismic excitation. In fact, the structure develops the maximum number of dissipative zones by means of a particular collapse mechanism: the global one. The proposed procedure is based on the application of the kinematic theorem of the plastic collapse through the evaluation of the sum of the plastic moments of the columns required, at each storey, to prevent undesired failure modes such as softstorey mechanism. In this work the authors show how the classical design methodology based on the beam-column hierarchy criterion does not allow to obtain a global mechanism.

Amit Kumar Yadav, Prof. Anubhav Rai
The objective of this study is to investigate the seismic behaviour of reinforced cement concrete structure having SMRF (Special moment Resisting frame) in nature. For this purpose regular and irregular structures were modelled and analysis was done using STAAD.Pro software and using the codes for analysis, IS 1893:2002, IS 456: 2000. The study assumed that the buildings were located in all seismic zones.

Inchara K P, Ashwini G (2016)

The main objectives of this study were to study the performance and variation in steel percentage and quantities concrete in R.C framed irregular building in gravity load and different seismic zones. And to know the comparison of steel reinforcement percentage and quantities of concrete when the building is designed as per IS 456:2000 for gravity loads and when the building is designed as per IS 1893(Part 1):2002for earthquake forces in different seismic zones. In this study five (G+4) models were considered. All the four models were modelled and analysed for gravity loads and earthquake forces in different seismic zones. ETABS software was used for the analysis of the models. According to their research, it can be inferred that support reactions tended to increase as the zone varied from II to V, which in turn increased volume of concrete and weight of steel reinforcement in footings and in case of beams, percentage of steel reinforcement increased through zones II to V

III. PROBLEM STATEMENT

A residential building of G+15 storey, with following data:

Located in a Soil class I
Live load: 2.0 KN/m2 at typical floor, 1.5 KN/m2 on terrace
Floor &Terrace finish: 1.0 KN/m2
Water Proofing: 2 KN/m2
Wind Load: As per IS:875-part5
Floor: G.F. + 15 upper floors (all stories with 3 m height)
Slab: 150 mm thickness
Grade of concrete : M30 for Columns and beams
Steel: HYSD reinforcement of grade 415 for main bars and Fe 215 for confinement bars
Columns dimensions are 600 x600 mm, Main and Edge beams 400 x700 mm

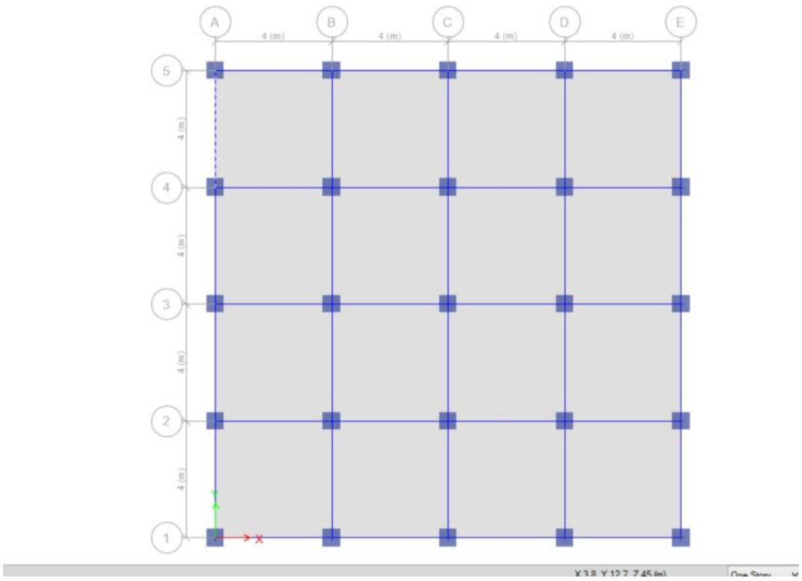

Fig 1- Pan of G+15 storey building

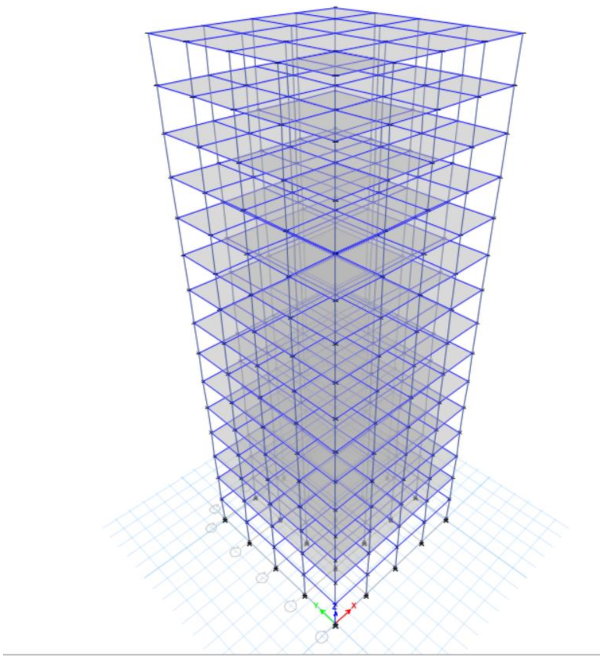

Fig 2- Elevation of G+15 storey building

IV. Methodology

Step-1: Creating and modifying grid lines and story height.
Step-2: Defining frame properties.
Step-3: Assigning beams, columns and creating 2d,3d models
Step-4: Defining load patterns, Response spectrum function, load cases (Response Spectrum function IS 1893-02 and ASCE 7-10 is used for seismic load cases).
Step-5: Creating load combinations by selection of default load combination option for concrete frame in both codes.
Step-6: Check model, run analysis,
Step-7: Design of RC frame model and finally checked that all members are passed out (with No failure)

V. Results

TABLE 1. Displacement behaviour of 15 storey for bare frame in Soil Class I for both Seismic Zone III and Zone IV

Storey Number	Storey height (m)	Storey Displacement (mm)	
		Zone III	Zone IV
15	45	25.5	38.3
14	42	25	37.5
13	39	24.2	36.4
12	36	23.3	34.9
11	33	22.1	33.1
10	30	20.7	31.1
9	27	19.2	28.8
8	24	17.6	26.4
7	21	15.8	23.8

6	18	14	21.1
5	15	12.2	18.3
4	12	10.3	15.4
3	9	8.3	12.4
2	6	6.1	9.1
1	3	3.4	5.2
0	0	0	0

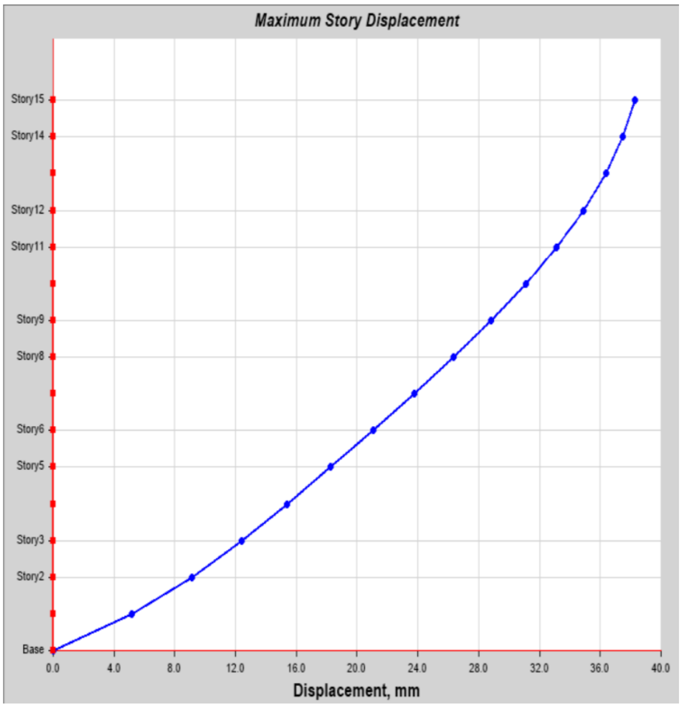

Fig 3-Displacement for Zone III

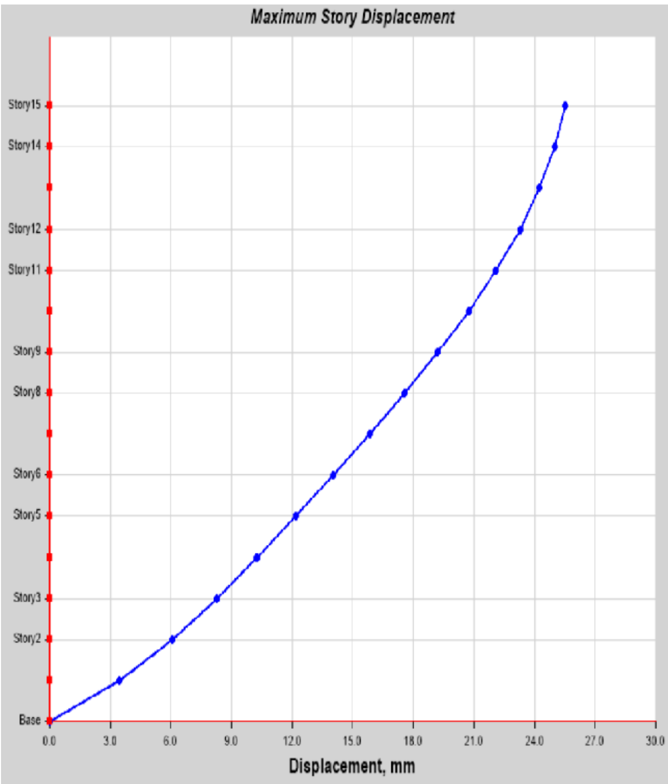

Fig 4- Displacement for Zone IV

TABLE 2. Shear behaviour of 15 storey for bare frame in Soil Class I for both Seismic Zone III and Zone IV

Storey Number	Storey height (m)	Storey Shear (KN)	
		Zone III	Zone IV
15	45	79.678	119.517
14	42	172.202	258.303
13	39	248.633	372.95
12	36	313.758	470.637
11	33	368.481	552.722
10	30	413.707	620.56
9	27	450.339	675.509
8	24	479.284	718.925
7	21	501.444	752.166
6	18	517.725	776.588
5	15	529.032	793.548
4	12	536.268	804.402
3	9	540.338	810.507
2	6	542.147	813.221
1	3	542.26	813.389
0	0	0	0

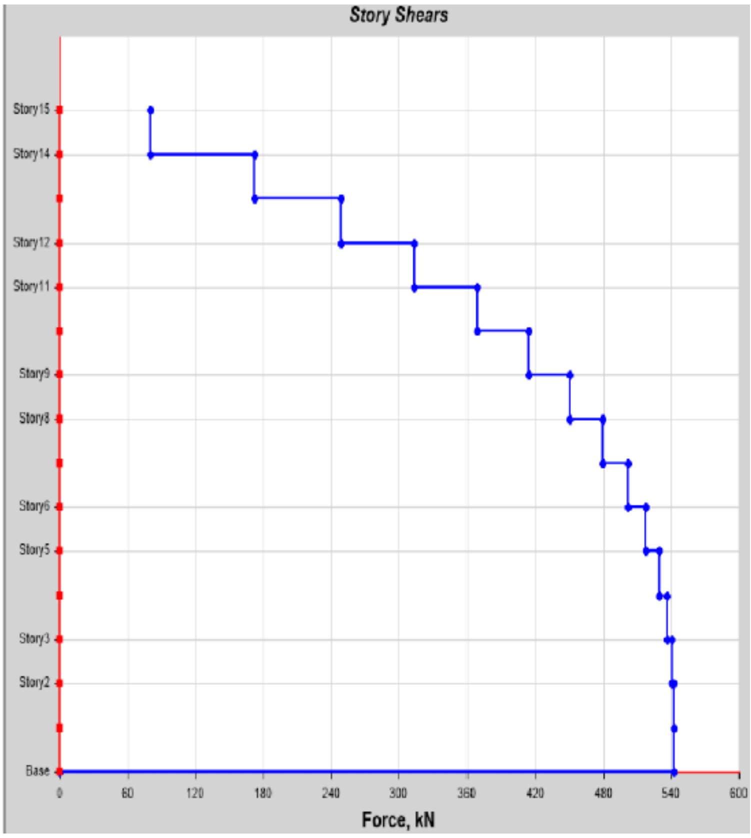

Fig 5- Shear for Zone III

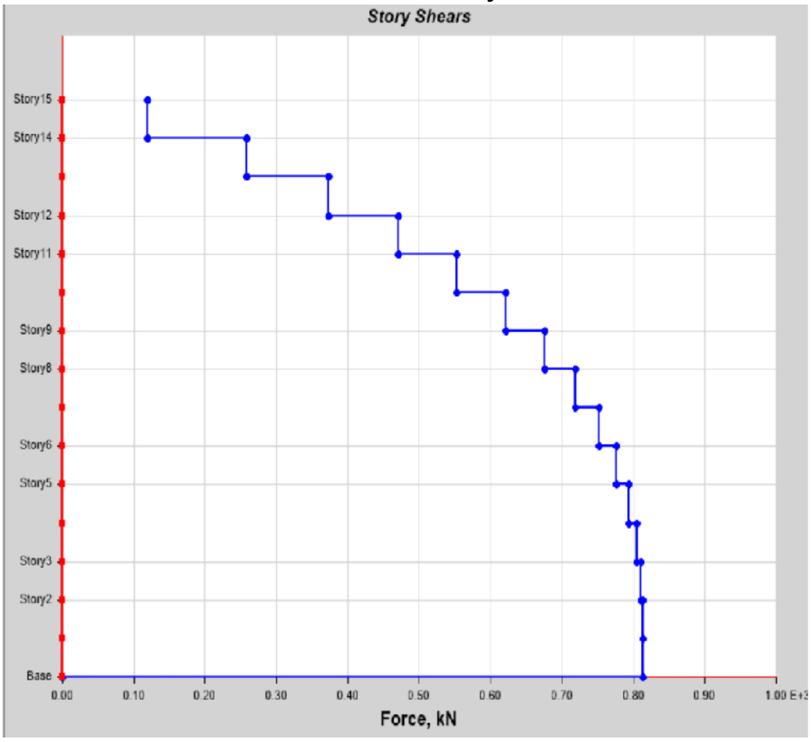

Fig 6- Shear for Zone IV

TABLE 3. Bending behaviour of 15 storey for bare frame in Soil Class I for both Seismic Zone III and Zone IV

Storey Number	Storey height (m)	Storey Bending (KN-m)	
		Zone III	Zone IV
15	45	23089.69	23089.69
14	42	60452.58	60452.58
13	39	94905.48	94905.48
12	36	129358.4	129358.4
11	33	163811.3	163811.3
10	30	198264.2	198264.2
9	27	232717.1	232717.1
8	24	267169.9	267169.9
7	21	301622.8	301622.8
6	18	336075.7	336075.7
5	15	370528.6	370528.6
4	12	404981.5	404981.5
3	9	439434.4	439434.4
2	6	473887.3	473887.3
1	3	482140.9	482140.9
0	0	487539.3	487539.3

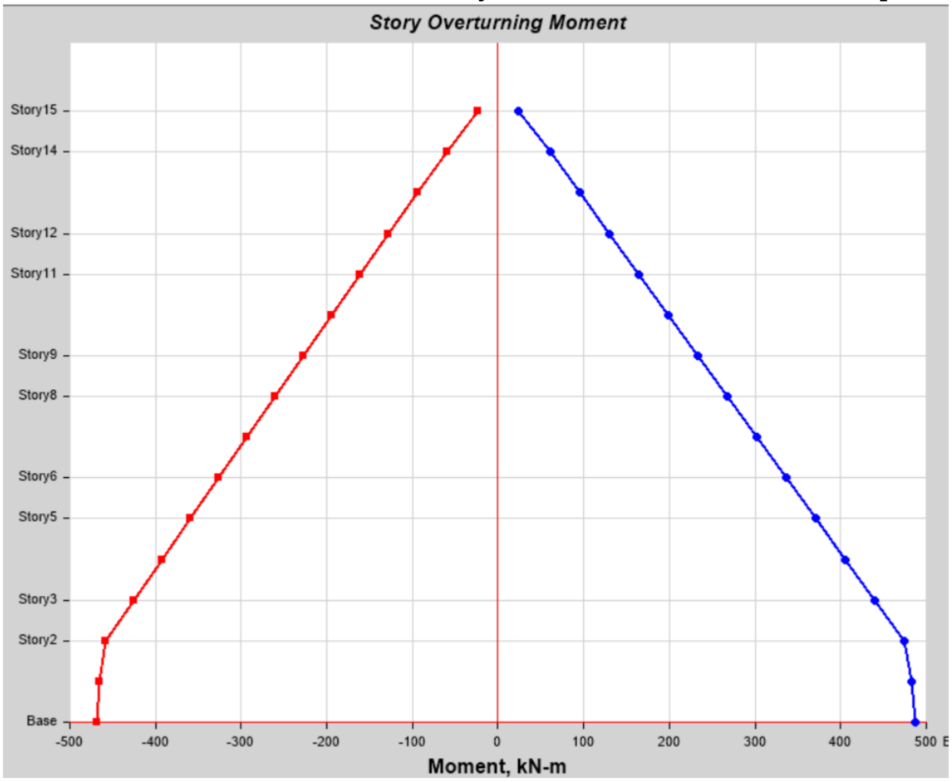

Fig 7- Bending moment for Zone III

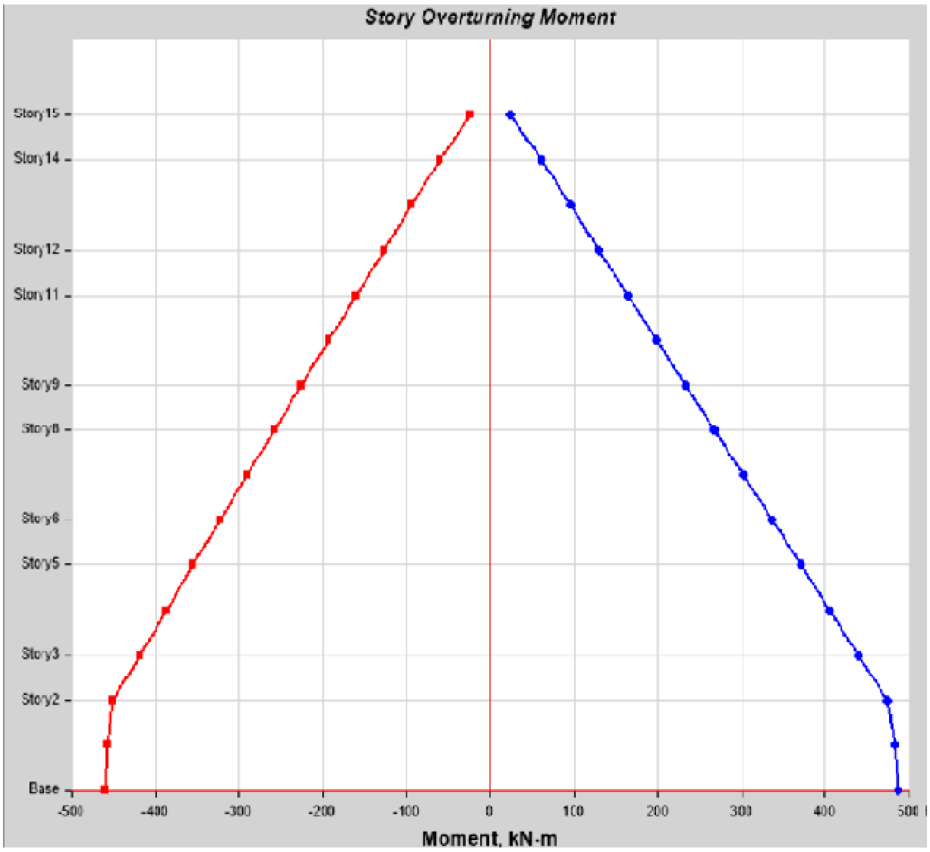

Fig 8- Bending moment for Zone IV

VI. CONCLUSIONS

The purpose of this paper is to assess the seismic performance of reinforced concrete moment resisting frames built in medium seismicity areas following current Indian seismic code IS 1893(part 1):2002 ..

The plot of maximum storey displacement storey Seismic base shear and storey bending at each storey height for bare frame for different seismic zones is done. Moreover, from the result obtain the following conclusions are drawn.

- Seismic base shear and bending moment at base of building for bare frame building increases as number of storey increases and maximum in seismic zone 4 for all soil class.
- A building which is designed to withstand moderate seismic forces can exhibit failure in case of high earthquake event.
- Bending moment behaviour does not vary with the variation of seismic zone III and zone IV.

REFERENCES

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[2] Amit Kumar Yadav, Prof. Anubhav Rai, *A SEISMIC COMPARISON OF RC SPECIAL MOMENT RESISTING FRAME CONSIDERING REGULAR AND IRREGULAR STRUCTURES*

[3] IS 456-2000 Code of practice for plain and reinforced concrete.

[4] IS 1893(part 1):2002 Criteria For Earthquake Resistant Design Of Structures.

[5] IS 875(part 3):1987 Code of practice for design loads (other than earthquake) for building and structures.

[6] R. Sadjadia, M.R. Kianousha, , S. Talebib, *Seismic performance of reinforced concrete moment resisting frames*

