COMPARATIVE ANALYSIS OF SPECIAL MOMENT RESISTING RCC FRAMED STRUCTURE IN SEISMIC ZONE IV AND V BY USING IS 1893:2016

Ulka.S.Mankare[1], Sd.Ubed Hashmi[2*], Vaibhav.B.Chavan[3]

[1-3]Department of Civil & Structural Engineering, Shreeyash College of Engineering and Technology Aurangabad, India,
Dr.Babasaheb Ambedkar Technological University Lonere, Maharashtra

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Abstract - The comparative of study was investigated to the seismic behaviors of Beam, columns in Special Moment Resisting Frames RCC Structure (SMRF) In Zone IV and V. For this purpose, G+30 story SMRF were designed according to the minimum design and reinforcement detailing requirements specified as per IS 456:2000I. This study assumed that the two buildings was located in seismic zone IV and V. According to IS 13920:1993 the Ductile detailing requirements Gives for SMRF Structure. seismic behaviors of SMRF In Zone IV and V columns using 2/3 scale model columns. Each column was considered as consisting of an upper part and lower part divided at the point of inflection. Quasi-static reversed cyclic loading was applied to the specimens with either constant or varying axial forces. So by comparing the analytical results between these two cases, we can conclude that whether the orientation of columns plays a role in the safety and economical consideration. Nowadays the elevation and interiors of the buildings need to be more attractive. So the architects and some engineers are locating and orient the columns within the wall thickness to avoid the projection of columns in or out of the structure to improve its aesthetical appearance. This method leads to reduce the column strength and creating some additional moments from beams to the column. So we need to orient the columns for the spans of the beams which are connected to the columns to reduce the moments and increasing the column's load-carrying capacity. . By comparing these two types of column oriented models, we can ensure the importance of column orientation in buildings. The Etabs software used because etabs offer a single user interface to perform modeling, analysis, design and reporting. There is no limit to the number of model windows, model manipulation views, and data views

1. *Up to 30 floored building subjected SMRF structure in zone IV as per IS 1893:2016*
2. *Up to 30 floored building subjected SMRF structure in zone V as per IS 1893:2016*

Key Words: Seismic analysis, SMRF RCC Structure, Zone IV and V, Response spectrum Method, Etabs, IS 1893:2016

INTRODUCTION -

SMRF RCC frames have been widely used for seismic Resisting systems due to their superior deformation and energy dissipation capacities. A moment frame consists of beams and columns, which are rigidly connected. The components of a moment frame should resist both gravity and lateral load. Lateral forces are distributed according to the flexural rigidity of each component. IS 1893:2016 states the design and reinforcement detailing requirements for each type of Zone and each earthquake risk level. The type of moment frame should be selected according to levels of seismic risk or seismic design category. Seismic risk levels can be classified into low, moderate and high according to seismic zones specified in IS 1893:2016. The minimum reinforcement details specified in IS 456:2000. SMRF is are the most popular type of moment frame in moderate to high seismic zones. When a large earthquake occurs, SMRF is expected to have superior ductility and provide superior energy dissipation capacity. Nowadays the exterior elevation and interior designs of the buildings need to be more attractive. So the architects and engineers are locating and orienting the columns within the wall thickness to avoid the projection of columns in or out of the structure to improve its aesthetical appearance. This method leads to reduce the column resisting capacity and create some additional moments from beams to the column. In a framed RCC structure columns are the major structural members, so the column should be properly designed and constructed. The concept of the weak beam and strong column should be adopted because in this method the beam fails first, this type of failure is known as a local failure and we can repair the structure. In the case of the strong beam and weak column concept, the column fails first due to heavy load from the beam, this failure is known as a global failure and this failure cannot be repaired, so this concept should not be adopted. Some contractors will not prefer the suggestions of the structural engineer and do not follow the basic rules for making profits for them, as a result, the structural members of the building fails and this leads to the failure of the whole structure. For example in Chennai in 2014 a building collapsed due to poor column design and orientation. This is one of the most common reasons for the failure of the framed structure all over the world. So we need to orient the columns for the spans of the beams which are connected to the columns to reduce the moments and for increasing the column's load-carrying capacity. By comparing the two types of the column-oriented model we can ensure the importance of column orientation in buildings.

1.1 Model Design as Per These Codes

1. IS 875 Part 1 Dead Loads
2. IS 875 Part 2 Live Loads
3. IS 1893:2016 Part 1 Seismic Loads
4. IS 456:2000 RCC
5. IS 13920 Ductility

The building structure modeled with a dimension of 25m x 16m and having a column & beam with the slab panel of 5m x 4m the model is made by using Etabs software.

1.2 History and Seismic Zone in India

India has divided according to the earthquake zone as per the Indian standard code which is considering according to the geological survey to the different location in the country. Earthquake zone map has shown in the fig. Earthquake map revised history in the year of 1962 1966 1970 2002

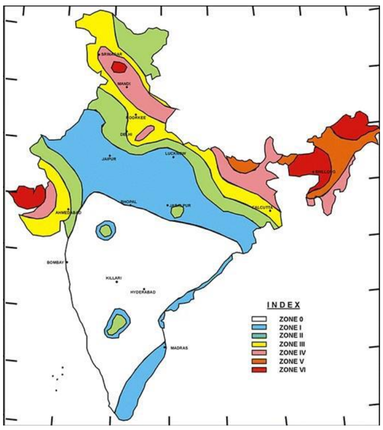


fig1. **Fig1. Seismic Zone Map of India 1962 IS 1893: 1962**

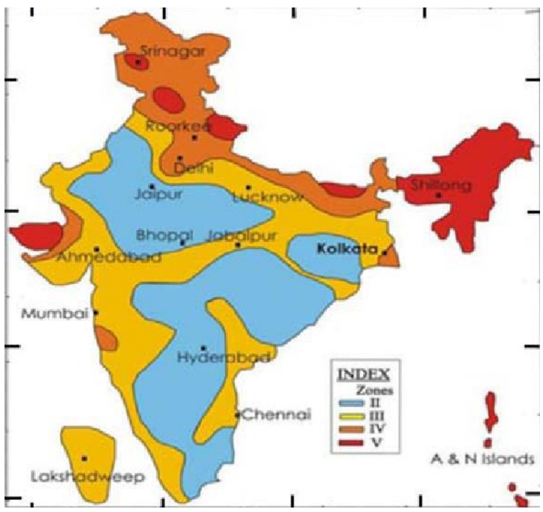


Fig.4 Seismic Zone Map of India IS 1893: 2002

Last map indicated for earthquake in india IS 1893:2002

1.3 The Main Goal of the Study Are as Follows

1. Seismic analysis of SMRF RCC framed structure for seismic zone IV & V

2. Difference between base reaction, base shear, story drift, story displacement and seismic weight in zone IV & V SMRF framed structure

3. Check the structural stability for high intensity earthquake load

2.1METHODOLOGY

Two different models were analyzed in software Etabs with the help of different load conditions. Seismic loads of different zones were represented in tabular form with its time acceleration graph. Different building structures separately were subjected to more intensity & classic earthquakes of seismic force to India's different zones. It was observed that the zone IV and V buildings combinations with either SMRF configuration were modeled which was further applied with proper boundary conditions. It was observed that seismic analysis was performed considering that the foot of the building was firmly placed in ground therefore end connections of the buildings were fixed. Gravity loads also was found to play a very significant role in the seismic analysis of the building. Analysis of SMRF were done by considering Response spectrum Method as per IS 1893-2016. The special type of mode superposition is on the base of response spectrum method. The idea is to provide an input that gives a limit to how much an Eigen mode having a certain natural frequency and damping can be excited by an event of this type. Method of Response spectrum analysis to get the estimate of the structural behavior to less, non-deterministic and transient dynamic program. Examples of such program are earthquakes and shocks. Since the perfect time history of the load is not known, it is difficult to run a time-dependent analysis.

2.2Discussion of Model Making

The basic step considered to the model making

1. Considered the earthquake past history of seismic zone iv and v

2. Considered basic model and specification

3. Force design and analysis as per IS 1893:2016

4. Comparison zone IV and V SMRF RCC frame structure

The model Plan and elevation details of the G+30 story structure are shown in fig. The analysis of determined structure frame demand knowledge measurement of beam column to all floor.

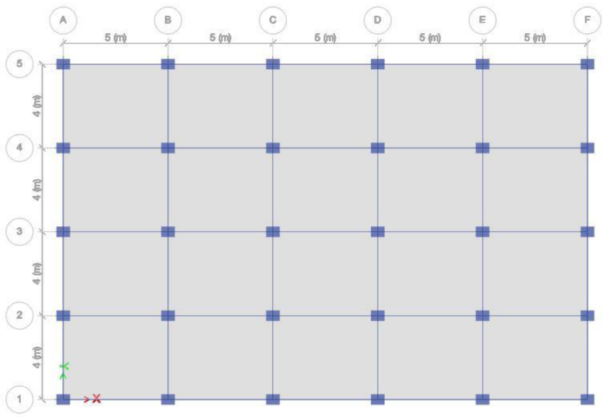


Fig. 3 Top view Plan

TABLE I Building Details

Particular	Zone IV	Zone V
NO OF STOREY	G+30	G+30
Total Height	94.5m	94.5m
Beam Size	300x300mm	300x300
Column Size	500x500mm	500x500mm
Slab/Deck	150mm	150mm

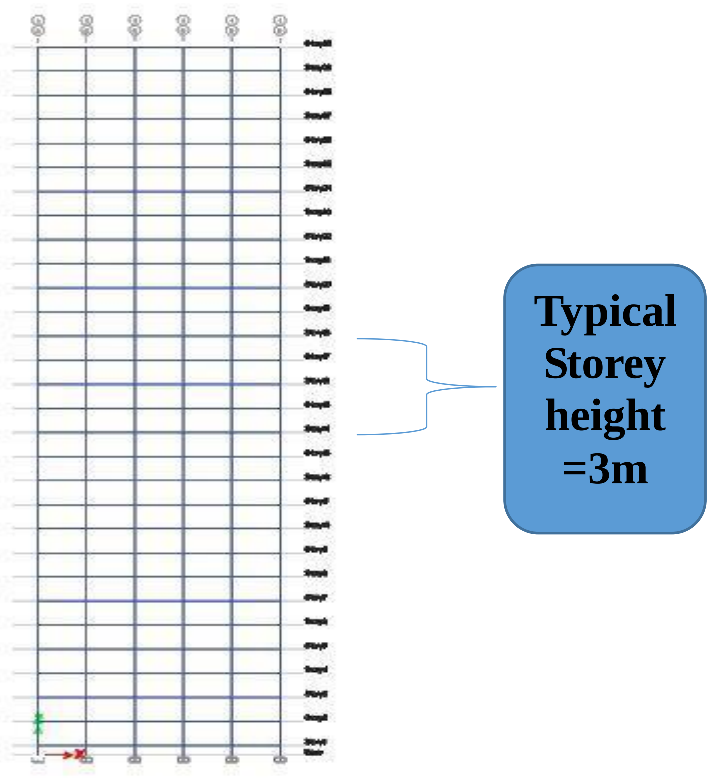


Fig. 4 Elevation for G+30 RCC Framed Structure

2.3The following load combinations are considered during the analysis of the model:

1. **DL1.5+WL1.5**
2. **DL1.5+LL1.5+WL 1.5**
3. **DL1.2+LL1.2+WL1.2+EQX1.2**
4. **DL1.2+LL1.2+WL1.2+EQX-1.2**
5. **DL1.2+LL1.2+WL1.2+EQY1.2**
6. **DL1.2+LL1.2+WL1.2+EQY-1.2**
7. **DL1.5+WL1.5+EQX1.5**
8. **DL1.5+WL1.5+EQX-1.5**
9. **DL1.5+WL1.5+EQY1.5**
10. **DL1.5+WL1.5+EQY-1.5**
11. **DL0.9+WL0.9+EQX1.5**
12. **DL0.9+WL0.9+EQX-1.5**
13. **DL0.9+WL0.9+EQY1.5**
14. **DL0.9+WL0.9+EQY-1.5**
15. **DL1.2+LL1.2+WL1.2+RSx1.2**
16. **DL1.2+LL1.2+WL1.2+RSy1.2**
17. **DL1.5+WL1.5+RSx1.5**
18. **DL1.5+WL1.5+RSy1.5**
19. **DL0.9+WL0.9+RSx1.5**
20. **DL0.9+WL0.9+RSy1.5**

TABLE II

MODEL SPECIFICATIONS

PARTICULARS	**Zone IV**	**Zone V**
	G+30	G+30
Type of frame	SMRF	SMRF
Total height of building	94.5m	94.5m
Bottom Story Height **Height of each storey**	1.5m 3m	1.5 3m
Plan of the building	25m × 16m	25m × 16m
Thickness of walls	230mm	230mm
Live load	3.0 kN/m^2	3.0 kN/m^2
Grade of Concrete	M-40	M-40
Rebar	HYSD500	HYSD500
Density of Concrete	40 kN/m^3	40 kN/m^3
Density of brick masonry	20 kN/m^3	20 kN/m^3
Zone	IV	V
Soil type	Type II medium soil	Type II medium soil
Importance factor	1.0	1.0
Response reduction	5.0	5.0
Seismic zone factor	0.24 For zone IV	0.36 For zone V

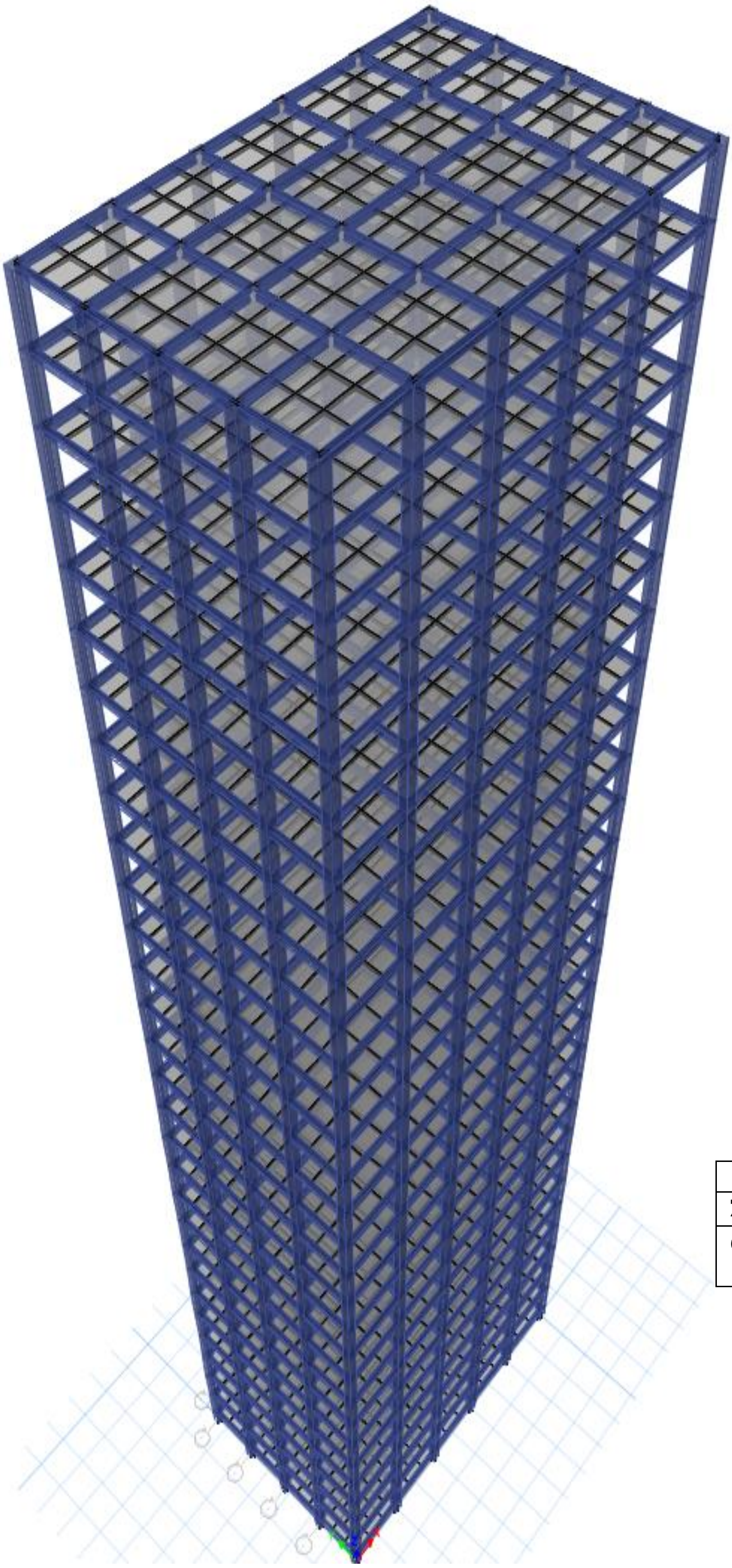


Fig 5. Details of Model & General Elevation

3.1 PERFORMANCE ANALYSIS

It was observed that buildings start to perform highly non-linearly on the application of highly dynamic seismic loads. Structural non-linearity occurs in the high rise buildings whatever may be the shape of building. Under seismic loads of structure due to various zones of earthquake non-linearity behavior of the structure almost remains the same only the magnitude of the deformation varies. It was observed that for tall or high rise building seismic analysis has to be performed by dynamic modes then only accurate results were possible while for small building even static seismic analysis could give us better results. The behavior of all the three framing systems took as a basic study on the modeled structure. Against the clause 7:11:1 of IS-1893:2016 i.e. under transient seismic loads lateral drift/deflection ratio is checked. The following parameters were considered

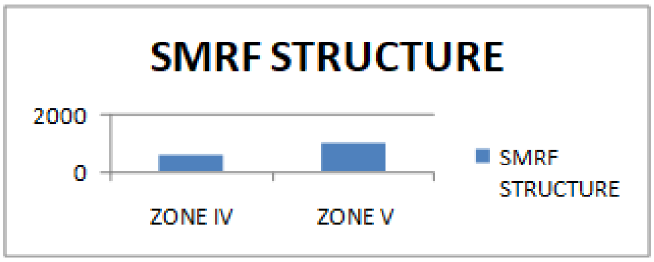
3.2 To Present a Comparison between Zone IV and V for SMRF stucture

1. Base Reaction
2. Base shear
3. Story Drift
4. Seismic Weight

Base Reaction

Base reaction of SMRF STRUCTURE in zone IV and V

SMRF Structure	
ZONE IV	ZONE V
612.68KN	981.69KN

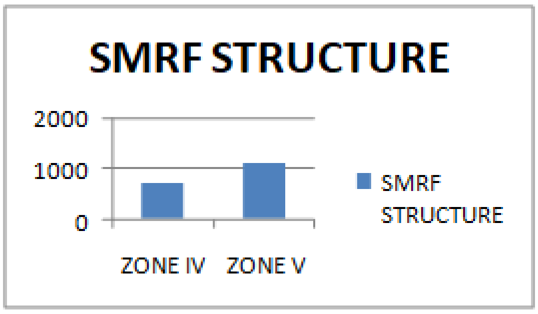


Base Shear

The value for base shear in SMRF is 1081.27 kN whereas for SMRF is 1802.131 kN. So percentage increase in base shear for SMRF is near about 66.68 % for G+30 framed structure.

TABLE IIV BASE SHEAR FOR SMRF ZONE IV&V

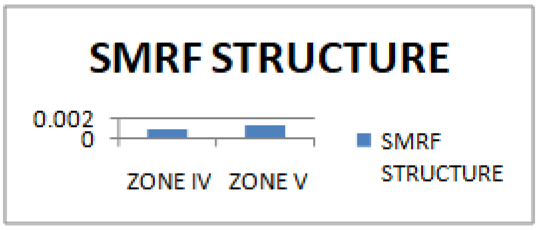
SMRF Structure	
ZONE IV	ZONE V
720.85KN	1081.27KN



Story Drift

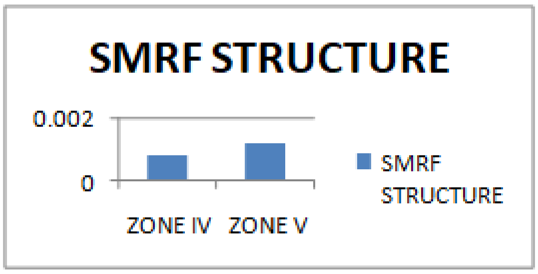
Max Story Drift in X direction

SMRF Structure	
ZONE IV	ZONE V
0.000801(RSx)	0.001202(RSx)



Max story drift in Y direction

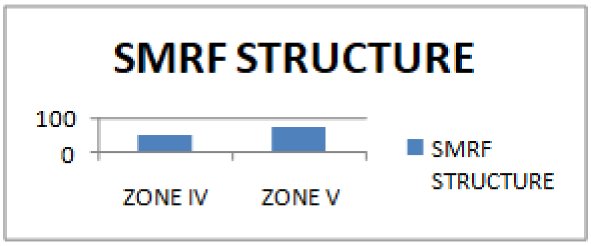
SMRF Structure	
ZONE IV	ZONE V
0.000742(RSy)	0.00113(RSy)



Story Displacement

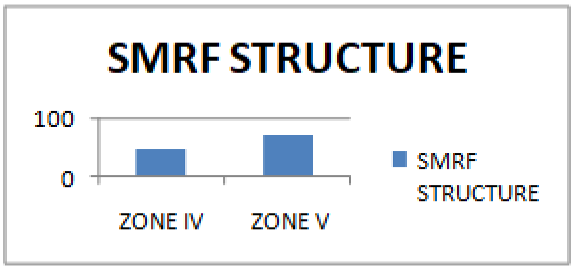
Max story Displacement in X direction

SMRF Structure	
ZONE IV	ZONE V
46.756mm	70.109mm



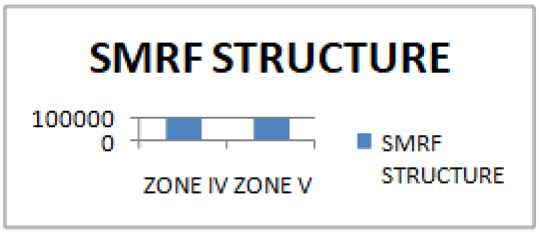
Max story Displacement in Y direction

SMRF Structure	
ZONE IV	ZONE V
45.72mm	68.56mm



SEISMIC WEIGHT

SMRF Structure	
ZONE IV	ZONE V
88.339.69KN	88339.69KN



3.2 SUMMARY AND CONCLUSION

The study includes the development of a new method and analysis of framing systems and a new model that compares the safety and cost-effectiveness of a structure for lateral loading System. In this project the behavior of SMRF structure in Zone VI & V under seismic load was studied. Lateral load, dead load, live load is taken for the design of the structure as per IS standards for Zone IV&V. This study is based on past history of earthquake zones. A specific models was done for serviceability of SMRF systems will be valuable tool for decision makers. Engineers In particular, it will be able to choose eco-economic framing systems resulting in structure safety and cost-effective structures. These structures are more competitive structures and challenging structures in the construction sector. Area maps currently falling in seismic.zone I has been merged with Seismic Zone

II. Also, the seismic zone map in the peninsular region is being revised. The National Seismic Zone Map is one of the seismic zone Offers a large-scale view of the region in the country. Local variations in soil types and geology cannot be represented at that scale. Therefore, important projects, such as major waterfall or nuclear power plant, the seismic hazard is assessed specifically for that site. In addition, for the purposes of urban planning, microzonation accounts for local variations in geology in metropolitan areas. analytical study done with 2 structures in 2 defferent zone using etabs software.

3.3 Following are the conclusions:

The conclusion driven with the help of response spectrum analysis by using IS 1893:2016 for G+30 RCC structure.

- ✓ The study gives a comparison of SMRF structure systems in ZONE IV&V under seismic loads. SMRF provides more protection for the designers to design the structure and it is less cost effective for builders who build waterfalls and tall buildings.
- ✓ Base reaction for G+30 SMRF Structure in zone V is 918.69KN where as for zone IV is to be 612.68KN.
- ✓ Base reaction for SMRF in zone V is increase by 49.95% as compare to zone iv.
- ✓ Base shear for G+30 SMRF in zone V is 1081.27KN where as for Zone IV is 720.85KN.
- ✓ Base reaction for SMRF in zone V is increase by 50% as compare to zone iv.
- ✓ Maximum story drift is bound more in zone V i.e 0.001202 as compared to zone IV i.e 0.000801 in X-direction.
- ✓ Maximum story drift is bound more in zone V is 0.000113 where as in Zone IV is 0.000742 for Y-direction.
- ✓ Story displacement for SMRF structure in zone V is 70.109mm where as in zone IV is 46.756mm in X direction.
- ✓ Story displacement for SMRF structure in zone V is 68.56mm where as in zone IV is 45.75mm in Y direction.
- ✓ So from above results interpretation we can conclude that for seismic zone V, RCC structure should be designed with SMRF Structure.

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BIOGRAPHIES OF AUTHOR

Ulka.S.Mankare
PG Guide
ME Structure, Assistant Professor
Shreeyash College Of Engineering
And Technology Aurangabad.

Sd.Ubed.Hashmi
M.tech Scholar
Structural Engineer
Shreeyash College Of Engineering
And Technology Aurangabad.

Vaibhav.B.Chavan
PG Coordinator ,
ME Structure, Assistant Professor
Shreeyash College Of Engineering
And Technology Aurangabad.