Seismic Stability of Setback RC Structure with Change in Geometry

Dr. A. R. Gupta[1] Mr. Sachin G. Chopade[2]
[1,2]Department of Structural Engineering
[1,2]C.O.E.T. Akola, S.G.B.A.U, Amravati, India

Abstract— The aim of the study is to analyses the setback building for stability and seismic forces. Setback building design and analyses such structure with keen observation considering various factors affecting them. As it is again important to analyses such structure for major forces like earthquake. Keeping this in mind, in this project the study is done for finding out the result that makes setback building stable against forces acting on it with and without considering seismic forces. Setback constructions are a subset of vertically irregular structures the places there are discontinuities with recognize to geometry. However, geometric irregularity additionally introduces discontinuity in the distribution of mass, stiffness and energy alongside the vertical direction. Majority of the research on setback structures have centered on the elastic response. The action of these kinds of constructing is something different. There is a requirement of more work to be wiped out this regard. So this research work is an attempt to reach on more accurate conclusion to reduce earthquake effect on the structure.

Keywords: Setback, Torsion, Stability, Distortion

I. Introduction

A. Aim

The aim of the study is to analyses the setback building for stability and seismic forces.

B. Objective

- To Study different forces acting on RC Structure.
- To study the behavior of RC Building with setback at different locations.
- To study of analysis of seismic forces on RC Building.
- To study the seismic resistance of various setback units.
- To develop analytical model with seismic forces using STAAD-Pro.
- Comparing the results analyzed for different Setback model with seismic forces.

C. Scope

To study seismic stability of setback reinforcement concrete structure in different types of geometry at zone no. IV.

D. Need

Earthquake is one of the most unfavorable of herbal hazards. It is the unexpected motion of earth purpose due to the launch of pressure energy. It may cause various damages to buildings, earth surface, environment and life of common man. This occurrence of earthquake causes the severe damages to the buildings and destroys the life of peoples. Also, from the above graph we observed that, the magnitude of the earthquake is in between 6.0-6.9 and it is increased year by year which also may causes the damages and effect badly over environment. Thus to minimize this and to overcome the effect of earthquakes, building should be properly constructed by providing steel bars and elements like beam, columns, walls, footing as well.

Also, to minimize the effect of earthquake it is necessary to determine seismic responses of such buildings. There are exceptional methods of seismic evaluation of structure.

II. Research Methodology

A. Phase 1

- Aim, Objectives, Scope, Needs
- Detailed find out about of the requirements special for plan of pipeline

B. Phase 2

- Start of experimental work
- Verification problem consideration
- Manual calculation of loading

C. Phase 3

- Computational modelling and analysis of Various Setback RC building models
- Comparative study
- Observation and remark
- Conclusion

III. Detailed Study

A. Seismology of India

Seismology is the find out about of earthquakes and seismic waves that go thru and round the earth. A seismologist is a scientist who research earthquakes and seismic waves. Seismological study associated to estimating shallow and deep crustal buildings in a variety of tectonic domains of the India land mass. The earthquake occurrence processes in the Himalayas, the Burma plate, and the Sumatra trench, as well as crustal deformation measurements in the plate-boundary and plate-interior regions.

1) Seismological map of India

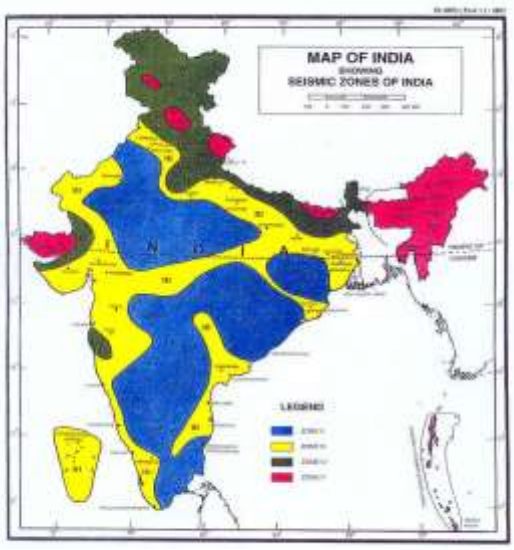


Fig. 3.1: India earthquake map

Earthquakes are the shaking, rolling or surprising shock of the earth's surface. These are the herbal potential of releasing stress. There are about 20 plates alongside the Earth's floor and these plates' strikes always and slowly previous every other, in the direction of every different & away from every different hence inflicting different phenomenon on Earth's surface.

India lies at the north-western stop of the Indo Australian Plate, which encompasses India, Australia, a most important element of the Indian Ocean and different smaller countries. This plate is colliding in opposition to the big Eurasian plate and going underneath the Eurasian Plate. This process of one tectonic plate getting under another is responsible for making India an earthquake prone country. A number of extensive earthquakes passed off in and round India over the previous century. Some of these passed off in populated and urbanized areas and therefore triggered great damage. The various geology at special places in the nation implies that the probability of negative earthquakes taking location at special places is unique Thus, a seismic quarter map is required to find out these regions.

Every state consists of out mapping of its territory primarily based on all natural mess ups like earthquake, cyclone, flood and volcano etc. This mapping is carried out on the groundwork of previous records and elements accountable for such catastrophe of current in that area. This mapping helps human beings to graph their domestic and different infrastructure so that they don't turn out to be the sufferer of such catastrophe and can face up to mess ups with as minimal as possible loss of life and property. Code of exercise of all international locations for sketch of constructions and different shape encouraged layout hints primarily based on such mapping or zoning.

In India, the country has been divided into four zones. Earlier there had been 5 zones then again after Bhuj Earthquake of 2001, the zone I have been eliminated each country in the world has such zoning for all such herbal disasters. India is split up into four seismic zones i.e. Zones II, III, IV and V. These zones are divided on the foundation of Maximum Considered Earthquake and carrier existence of shape in every seismic zone.

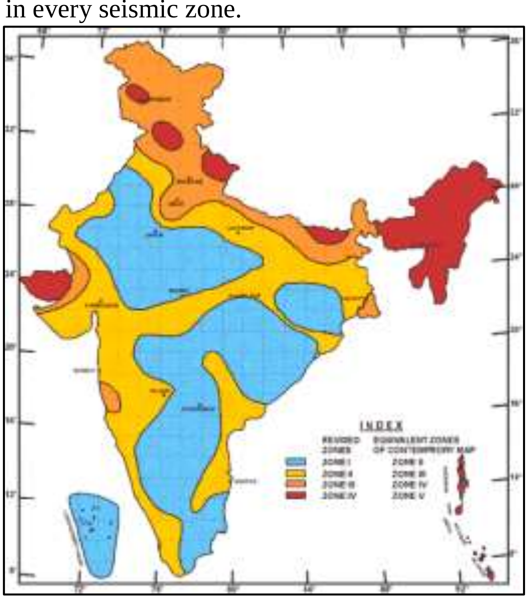


Fig. 3.2: Indian earthquake zone map

As per Bureau of Indian Standards {IS 1893(part 1): 2002}, grouped out the India into four seismic zones such as zone V, IV III II and I.

2) *Seismic zone have been categorized as follows:*

a) Zone V:

The areas of this quarter have the absolute best chance of outcomes by an earthquake. The earthquake intensity for this area is MSK-IX or greater. The area factor for this area is 0.36, which is indicative of effective (zero periods) level earthquake in this zone. This area is referred to as Very High Damage Risk Zone. Some of the areas which fall underneath this region are Ran of Kutch, Eastern areas etc.

b) Zone VI:

The areas of this region have the lesser hazard to effects by an earthquake as in contrast to region V. The earthquake intensity for this region is between MSK VIII to MSK-IX. The region factor for this region is 0.24. This region is referred to as High Damage Risk Zone. Some of the regions which fall below this region are Northern regions, North Eastern regions, Delhi etc.

c) Zone III:

The areas of this region have the lesser hazard by an earthquake. The earthquake intensity for this region is MSK VII. The region issue for this region is 0.16. This region is referred to as Moderate Damage Risk Zone. Some of the regions which fall beneath this region are some components of Gujarat & Maharashtra, Andaman Nicobar Islands etc.

d) Zone II:

The areas of this region have the least hazard of an earthquake. The earthquake intensity for this region is MSK VI. The region factor for this region is 0.10. This region is referred to as Low Damage Risk Zone. Larger components of India come underneath this zone.

e) Zone I:

Since the present day division of India into earthquake hazard zones does now not use Zone 1, no region of India is classed as Zone I. Future changes in the arrangement framework might possibly return this zone to utilize.

B. Effect of earthquake on RC structure:

Earthquake is the most risky herbal phenomenon that generates big destruction in structures. It is mentioned that two sources of errors which would severely endanger constructions are ignoring the methods an earthquake influences constructions and shoddy building practices. That is why a applicable grasp of the seismic consequences on a shape is extraordinarily important, and designers and contractors need to think about the effect of seismic forces on constructions in order to be able to set prevention measures against failures and collapses. As earthquake hits structures, it generates inertia forces which have to be distinctly unfavorable inflicting deformations and, horizontal and vertical shaking.

1) *Types of earthquake effects:*

– Inertia Forces in Structures
– Effect of Deformations in Structures
– Horizontal and Vertical Shaking
– Other effect

C. Seismic analysis methods

The seismic analysis type that should be used to analyses the structure depends upon

- External action
- The behavior of structure or structural materials
- The type of structural model selected

D. Seismic analysis methods can be split into the following five categories -

- Equivalent static analysis
- Response spectrum analysis
- Linear dynamic analysis
- Non-linear static analysis
- Non-linear dynamic analysis

IV. COMPUTATIONAL MODELING AND ANALYSIS OF VARIOUS SETBACK RC BUILDING MODELS

For computational modeling in STAAD Pro following building is considered with various setbacks in the plan above 4th floor. Up to fourth floor the same plan is considered. Other input parameters used for STAAD Pro modeling and analysis are given below:
Size of Beams: 230 X 550 mm,
Size of columns: 230 X 450 mm,
Thickness of Slab: 150 mm,
Height of Each Story: 3 m,
Seismic Zone: 4,
Importance factor: 1.5,
Soil Type: Soft Soil,
Ordinary moment resisting frame (OMRF),
Dead Load Applied:
Weight of wall on each floor = 11.27 KN/m
Weight of 1.2 m parapet wall = 5.52 KN/m
Floor finish = 0.2 KN/m2
Live Load = 4 KN/m2
But it is assumed that only 25% live load is acting on all floors except top floor.
i.e. Live load applied =1 KN/m2
Also it should be noted that floor finish and live load is applied on the building in the form of floor load

A. CASE I: For the Case I plan considered for all G+5 floors is shown below.

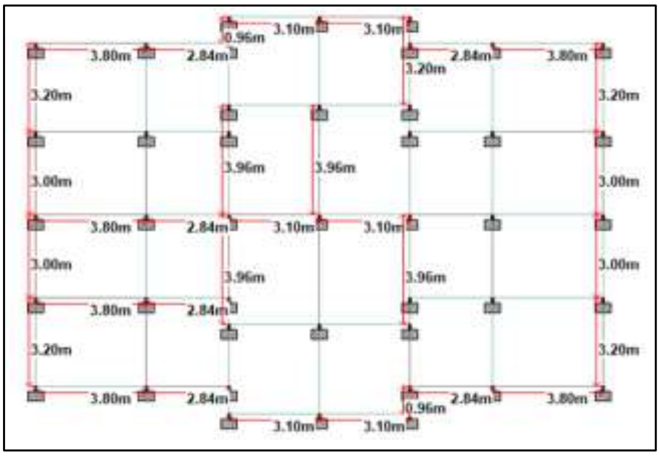


Fig. 4.1: Plan considered for Case I

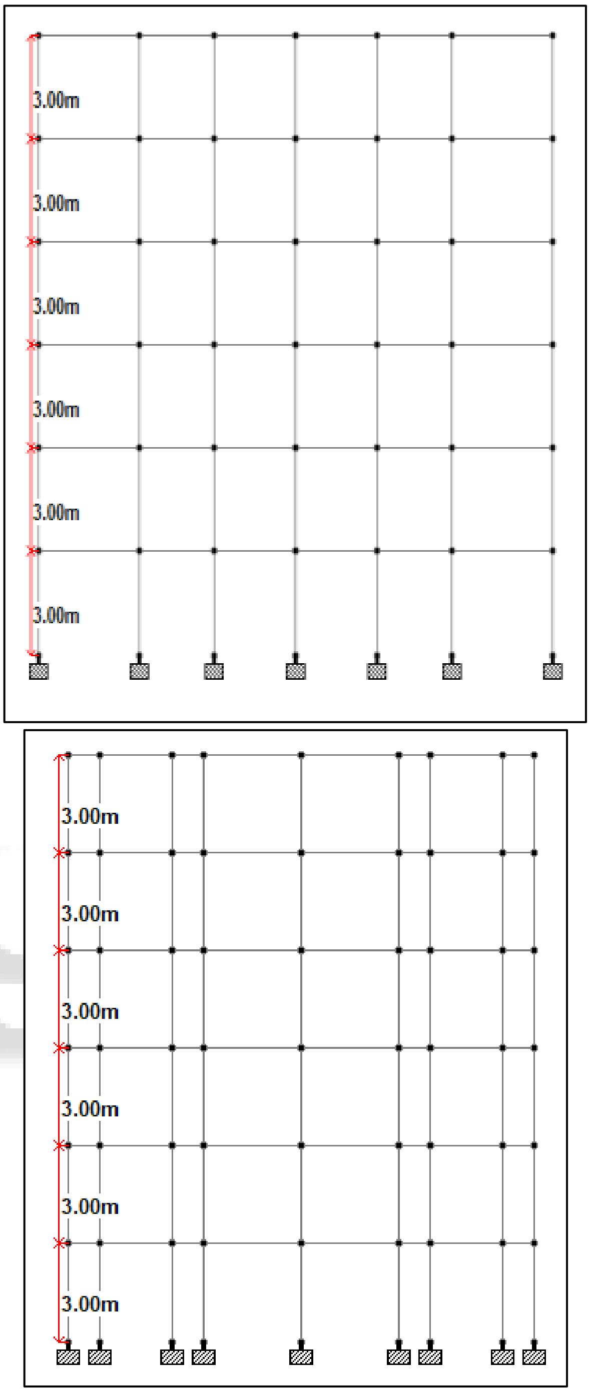


Fig. 4.2: Elevations for Case I

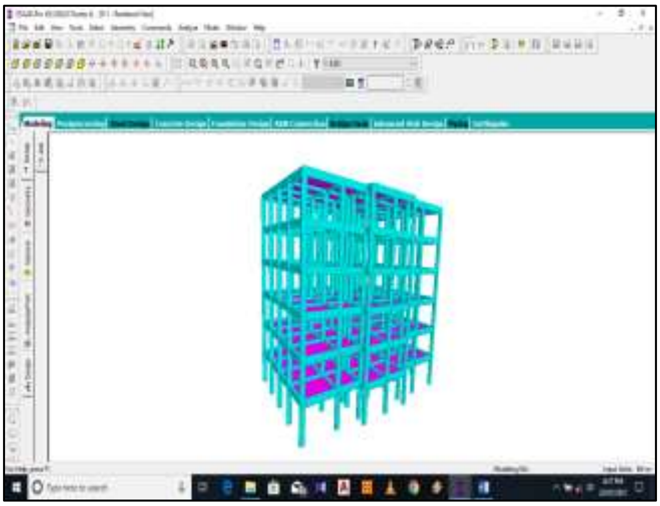


Fig. 4.3: STAAD Pro model for Case I

B. CASE II: For the Case II plan considered for all G+2 floors is same as shown above and for remaining 3 floores is shown below.

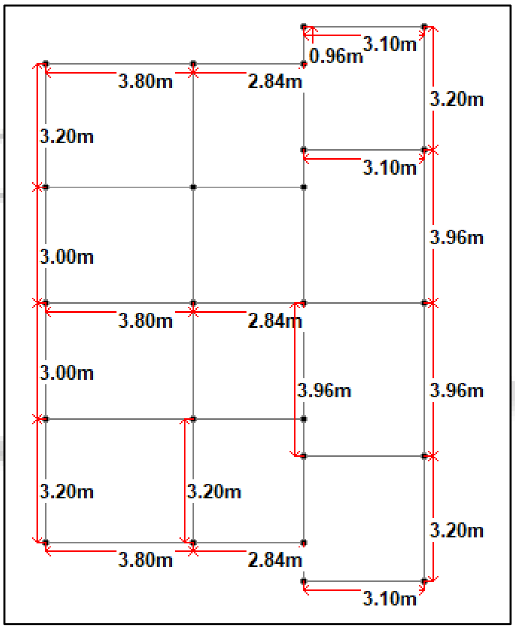
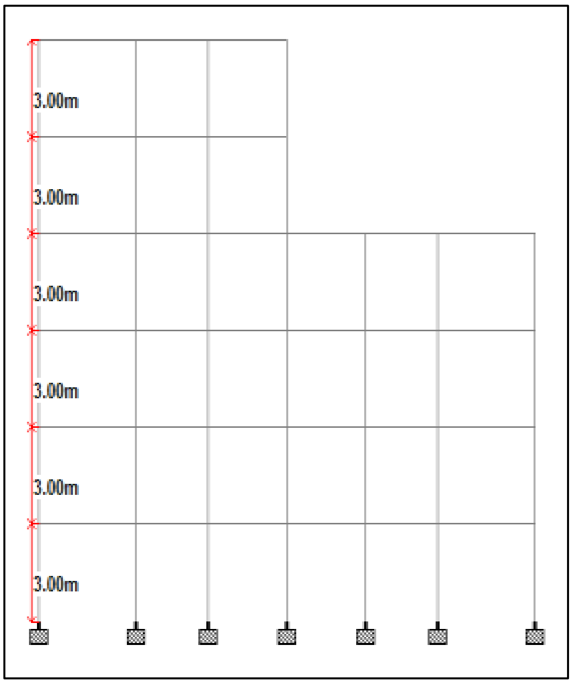


Fig 4.4 Plan considered for Case II above 3rd floor



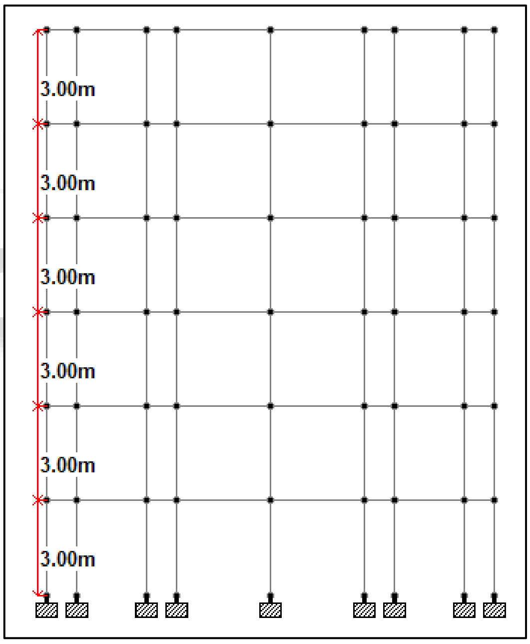


Fig. 4.5: elevation for Case II

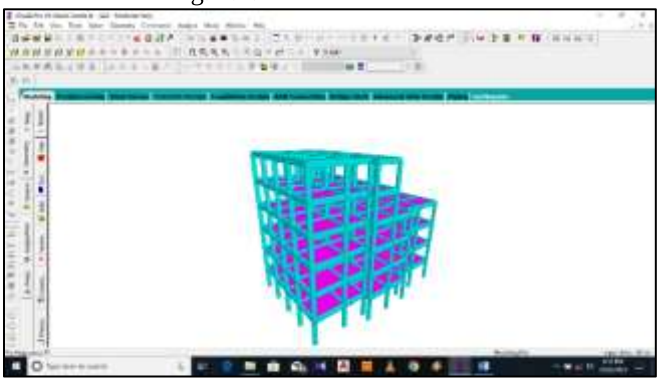


Fig. 4.6: STAAD Pro model for Case II

C. CASE III: For the Case III plan considered for all G+2 floors is same as shown for Case I and for remaining 3 floores is shown below.

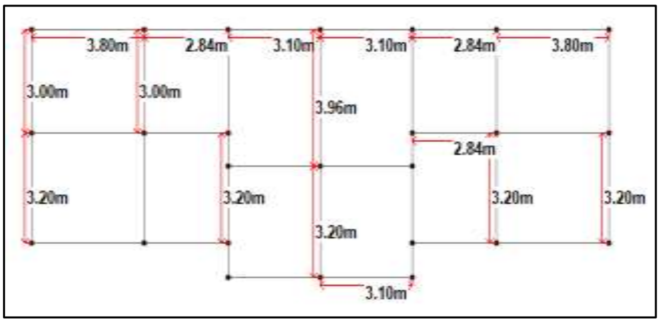


Fig. 4.7: Plan considered for Case III above 3rd floor

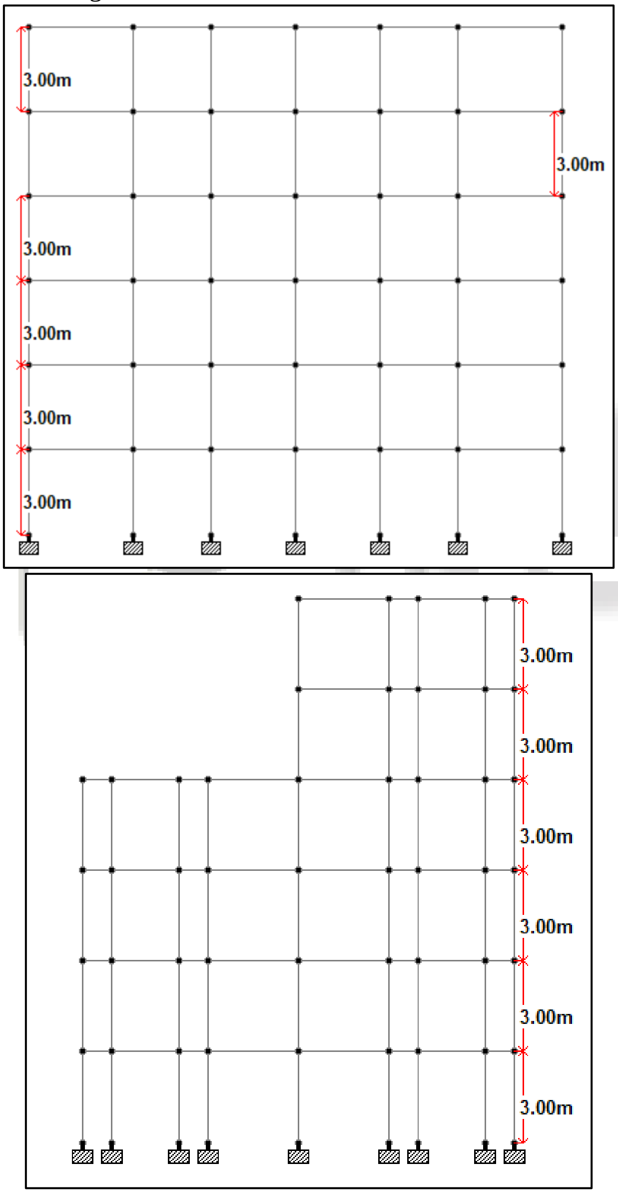


Fig. 4.8: Elevation for Case III

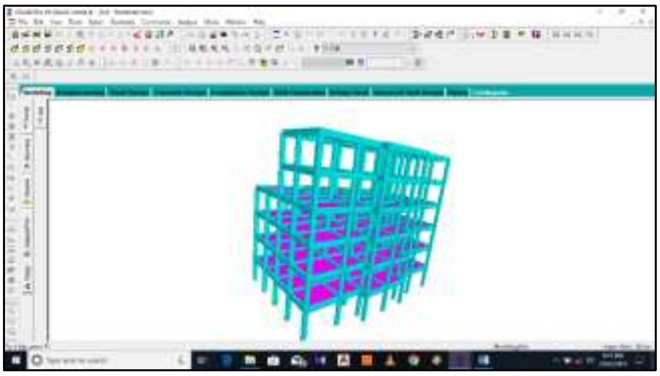


Fig. 4.9: STAAD Pro model for Case III

D. CASE IV: For the Case IV plan considered for all G+2 floors is same as shown for Case I and for remaining 3 floores is shown below.

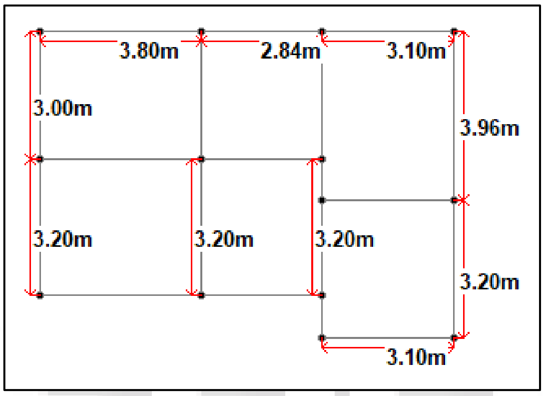
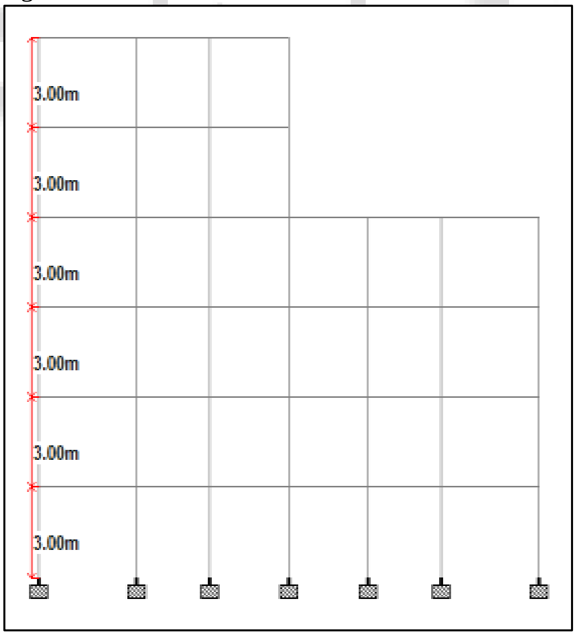


Fig. 4.10: Plan considered for Case IV above 3rd floor



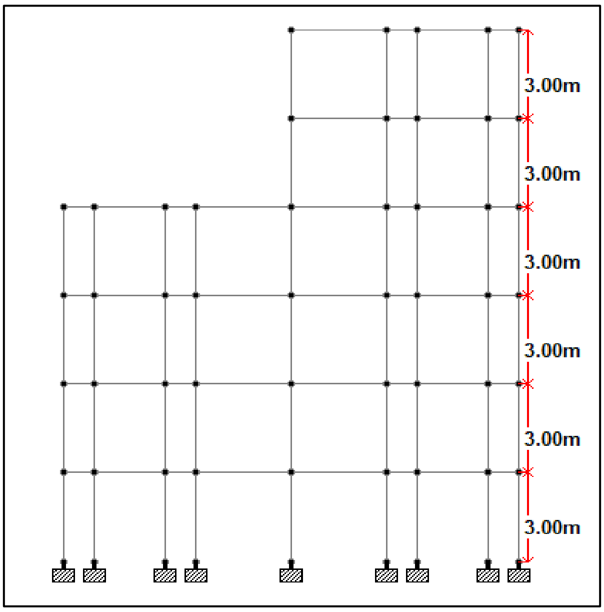


Fig. 4.11: Elevation for Case IV

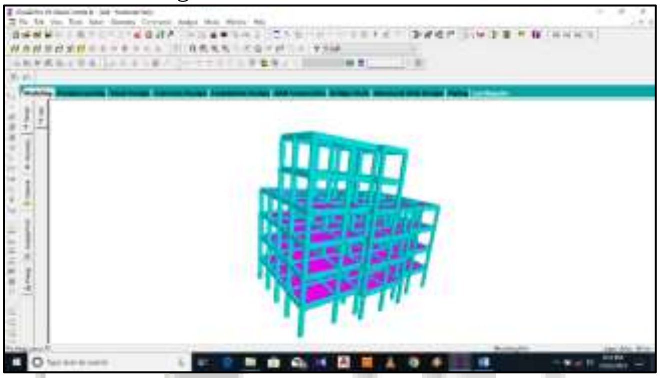


Fig. 4.12: STAAD Pro model for Case IV

V. OBSERVATION AND REMARK

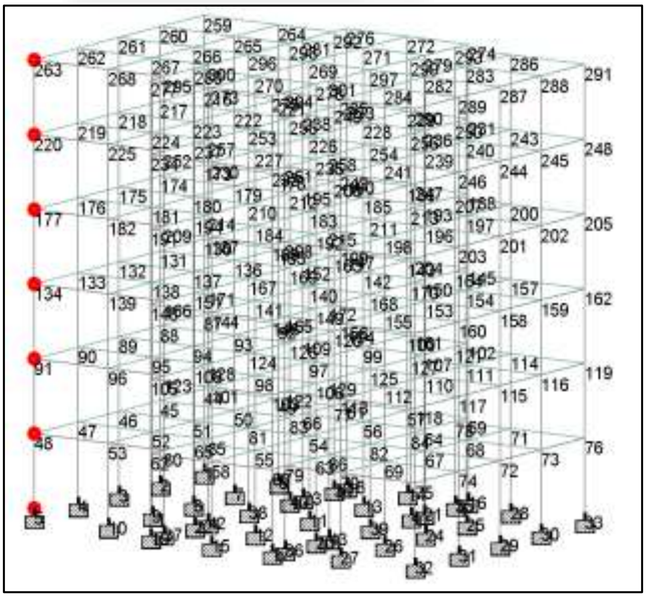


Fig. 5.1: Exterior Node for Observations Of displacements

Node No.	Location	Resultant Displacement (mm)			
		Case I	Case II	Case III	Case IV
263	6th Floor	146.566	156.768	133.549	142.714
220	5th Floor	137.001	145.939	121.745	129.479
177	4th Floor	117.149	123.114	99.814	104.078
134	3rd Floor	90.621	95.934	78.45	82.484
91	2nd Floor	60.506	64.081	52.791	55.619
48	1st Floor	29.115	30.549	25.472	26.685
5	Ground Floor	0	0	0	0

Table 5.1: Resultant Displacement Values for Exterior Nodes

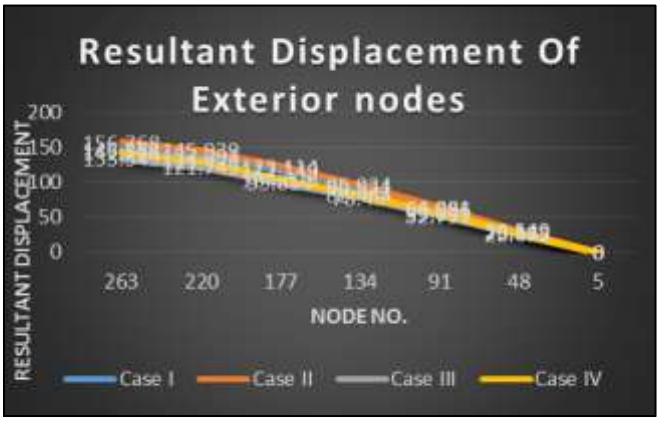


Fig. 5.2: Resultant Displacement of Exterior Nodes

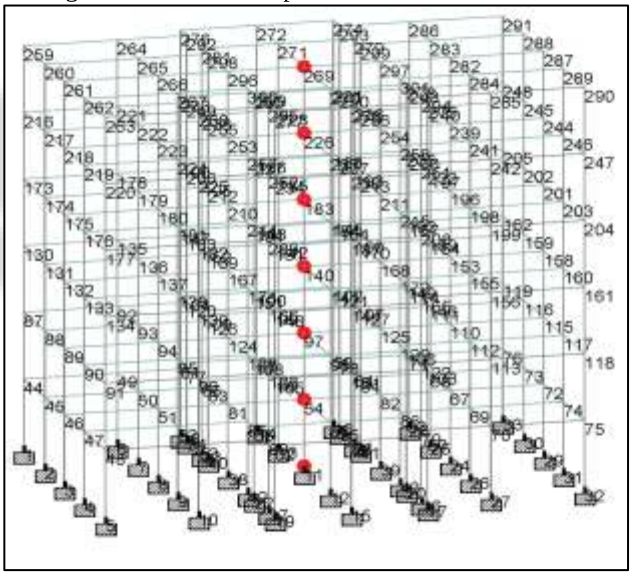


Fig. 5.3: Exterior Nodes for Observations of displacements

Node No.	Location	Resultant Displacement (mm)			
		Case I	Case II	Case III	Case IV
269	6th Floor	146.602	132.206	133.625	126.243
226	5th Floor	136.964	121.013	121.816	113.021
183	4th Floor	117.109	98.725	99.721	88.757
140	3rd Floor	90.576	77.639	78.373	70.992
97	2nd Floor	60.447	52.259	52.715	48.174
54	1st Floor	29.075	25.221	25.425	23.321
11	Ground Floor	0	0	0	0

Table 5.2: Resultant Displacement Values for Interior Nodes

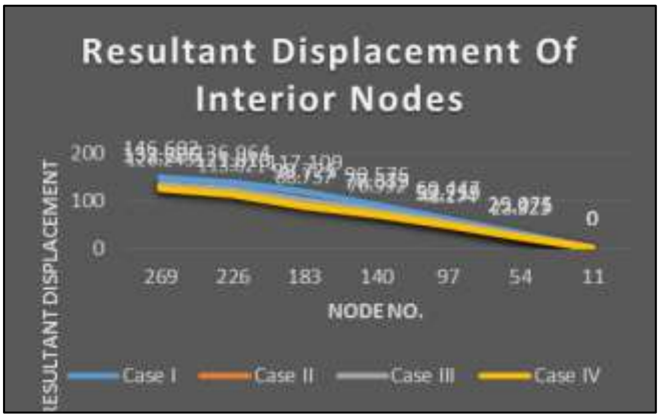


Fig. 5.4: Resultant Displacement of Interior Nodes

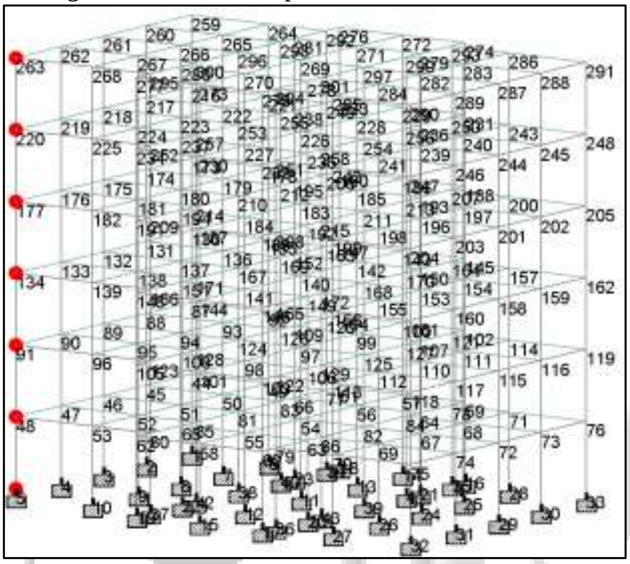


Fig. 5.5: Exterior Nodes for Drift Calculation

Node No.	Location	Drift (Δ) (mm)			
		Case I	Case II	Case III	Case IV
263	6th Floor	-	-	-	-
220	5th Floor	9.565	10.829	11.804	13.235
177	4th Floor	19.852	22.825	21.931	25.401
134	3rd Floor	26.528	27.18	21.364	21.594
91	2nd Floor	30.115	31.853	25.659	26.865
48	1st Floor	31.391	33.532	27.319	28.934
5	Ground Floor	29.115	30.549	25.472	26.685

Table 5.3: Drift Values for Exterior Nodes

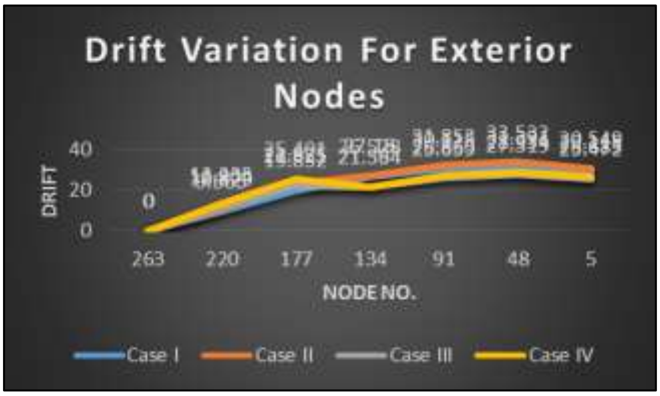


Fig. 5.6: Drift Values For Exterior Nodes

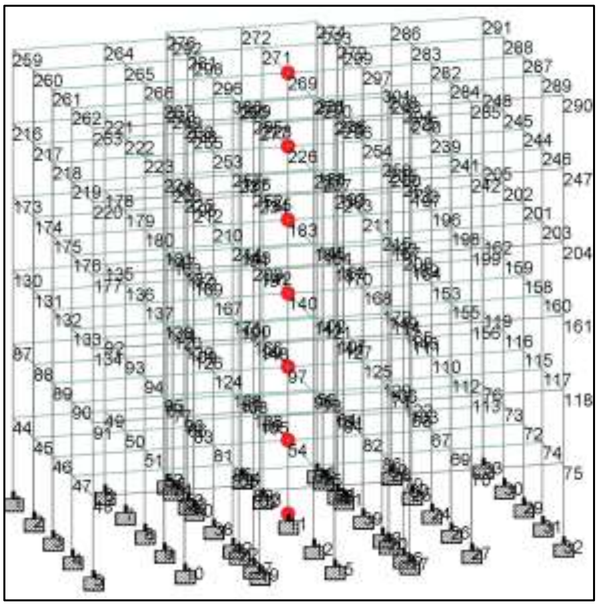


Fig. 5.7: Interior Nodes for Drift Calculation

Node No.	Location	Drift (Δ) (mm)			
		Case I	Case II	Case III	Case IV
269	6th Floor	-	-	-	-
226	5th Floor	9.638	11.193	11.809	13.222
183	4th Floor	19.855	22.288	22.095	24.264
140	3rd Floor	26.533	21.086	21.348	17.765
97	2nd Floor	30.129	25.38	25.658	22.818
54	1st Floor	31.372	27.038	27.29	24.853
11	Ground Floor	29.075	25.221	25.425	23.484

Table 5.4: Drift Values for Interior Nodes

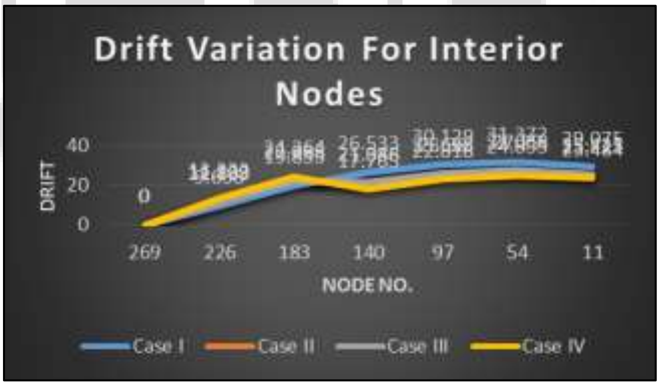


Fig. 5.8: Drift Variation for Interior Nodes

Storey Height from Bottom (m)	Storey Shear (KN)			
	CASE I	CASE II	CASE III	CASE IV
At 3m	44.959	53.799	53.67	62.404
At 6m	179.837	215.197	214.681	249.617
At 9m	404.634	484.194	483.033	561.638
At 12m	719.35	845.649	844.476	971.775
At 15m	1123.984	716.247	726.471	446.718
At 18m	833.354	554.367	570.137	362.982
Total Base Shear	3306.118	2869.453	2892.468	2655.134

Table 5.5: Story Shear values both in X and Z direction

Fig. 5.9: Storey Shear Variation

VI. CONCLUSIONS

In earthquake resistive structure the geometry of structure and continues load path along with uniform mass distribution plays very important rolls.

To find out the effect of setback the four structure where models & simulated using STAAD pro software. The structure is RCC frame, G+6 story and located in seismic zone IV. Case no I is complete G+6 story while in case no II the front half part as shown in fig no 5.7 is remove for upper 2 story. In case no III the other half part of structure was remove along the width along fig no 5.10. In case no IV the 1/3 part of upper story is remove the structure subjected to seismic forces & combination as in IS 1893-2016

Form the observation it is clear that the maximum deflection for case no II for exterior edge as in table no 6.1 however interior junction shows maximum value in case no I form table no 6.3 it can be seen that drift value is maximum in 2 & 3. the maximum drift value is for case no IV & minimum for case no I form table no 6.5 it can be seen that the shear value is maximum for case no IV & minimum foe case no I for this it can be clearly conclude that the shear value is displacement increases with change in geometry . It is maximum when quarter section of structure top floors removes while value are again high when half of upper story are removed. These structure stability decreasing with presence of setback geometry.

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