

Seismic Analysis of Multi Storied Building in Various Zones for Different Types of Soils

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Abstract

The major challenge faced by any structural engineer around the world is to design a structure which is resistant to lateral forces. Because an earthquake with smaller intensity can result in severe damages to structures, cause death injuries and economic loss if not designed by considering earthquake forces. It is not possible to stop the earthquakes, so design of effective and efficient earthquake resistant building plays key role in design of structures. In this project, 5 models of G+10 storied buildings with one normal plan (Rectangular shape) and left over are irregular plans (C, H, Hollow Rectangle and M5 shapes) will be taken. Plinth area for each model is same but there is change in geometry. The analysis is carried out by considering different seismic zones (namely II, III, IV and V) with three types of soils namely soft, medium and hard for each zone separately using ETABS. Finally, the behavior of these models is assessed by comparing the results obtained for each model. The results like storey drift, lateral displacements, base shear, etc., are considered.

Keywords: earthquake forces, structural engineer, building plan .

I. INTRODUCTION

Earthquake is a word that describes about seismic event occurs in nature or as a result of human actions. Earthquakes are mostly occurred due to geological rupture of faults, volcanic activities, nuclear tests, landslides and mine blasts.

Table 1.1 Seismic Zones of India

Seismic Zone	II	III	IV	V
Seismic Intensity	Low	Moderate	Severe	Very Severe
Z	0.10	0.16	0.24	0.36

A. Types of Soils

The type of soil present in the site of construction of building also affects the structure during earthquakes. So, it is necessary to know about the type of soil present at the site and the classification type as per IS 1893(part-1):2016. From the clause 6.4.2.1 of IS 1893(part-1):2016, the soils are divided as follows:

- Soil Type I – Rock or Hard soils;
- Soil Type II – Medium or Stiff soils; and
- Soil Type II – Soft Soils.

B. Upright Layout of Buildings

The Seismic forces grown at different floors in a dwelling need to be reduced by the shortest way to

elevation; any deviation or discontinuity in this load transfer path can lead to poor performance of the building.

II. LITERATURE REVIEW

Naresh. M V and K J Brahma Chari (2019), “were considered the seismic response of a private G + 10 RC line plane breaks through direct testing methods of equivalent static tangential potency and response spectrum methods, utilizing ETABS by considering different seismic zones, and lateral force, story drift, displacement, base shear And dynamic permeability. Think about the consequences. Due to response band examination and stagnant study the bottom shear value will be extensively improved at elevated stories and static study bring storey shear near stack. For high rise buildings static study is not sufficient it’s compulsory to provide active investigation. It was observed that max displacement is move up from starting storey to ending storey. Among the more unexpected shapes earthquake zones affected by the quake. Sanisha Santhosh and Linda Ann Mathew (2017) were made a tried on the seismic recital of dwelling with shear walls of W, U, H and T shape. Based on the origin of base shear and storey drift value G+14 dwelling with U and W shape shear walls showed healthier recital (X - direction) in both zone III and V. H type shear wall was high-quality in stipulation of storey drift (Y – direction) in zone III and V, T type shear wall shown high-quality in base shear (Y – direction) in zone and III. Based on the base shear and storey drift importance G+29 dwelling with H and W created shear wall showed an improved presentation (X and Y direction) in both zone III and V and T type shear wall was high-quality in base shear and storey drift (both X and Y direction) in zone III and V. In both zones there is no present in the enhanced summary of the shear wall. Pardeshi Sameer and Prof. N. G. Gore (2016), were made the effects of various vertical manipulations on the seismic return of an array by using the Reaction Spectrum Analysis(RSA) of irregular and regular RC dwelling frames and the investigation of time history regular RC dwelling frames and ductility based design using

IS 13920. Response Spectrum Analysis in terms of displacement, story drift, story shear and story shear force was found to be maximized to the first floor and in all cases reduced to a minimum on the top floor and the response values observed is found to be higher than the lection and within the allowable limits. Mohammed Rizwan Sultan and Gouse Peera (2015) were made a study has evaluated the story overturning moment, story drift, displacement, and lateral strengths of the design. For this purpose a 15-story-high raised dwelling with four types, such as the rectangle, H, C and L shaped, are used for comparison. Complete models were examine in cooperation with ETABS 9.7.1 version and concluded that extreme manipulation building is more bizarre, especially in low seismic zones, with less manipulation.

III. MODELING AND METHODOLOGIES

The structure selected for the investigation is a G+10 storied Institutional dwelling. The dwelling is considered to be situated in every seismic zone (II, III, IV, and V) in all types of soils (soft, medium, hard). Models are generated in ETABS 17software. Floor diagrams are assumed to be rigid. Using ETABS 17 software, all these models are analyzed and results like storey shear, storey displacement and storey drift are taken for further assessment.

Model-1:

Rectangular shaped G + 10 storied building having plan and built up area of 600m².

Model-2:

Hollow rectangular shaped G + 10 storied building having plan area of 600m²and built up area of 400m².

Model-3:

C shaped G + 10 storied building having plan area of 600m²and built up area of 350m²

Model-4:

H shaped G + 10 storied building having plan area of 600m²and built up area of 350m².

Model-5:

M5 Shaped G+10 storied building having plan area of 600m²and built up area of 450m².

Table 2: Total Number of Models

SEISMIC ZONE	SOIL TYPE	MODEL NO				
		1	2	3	4	5
II	Hard or Rock Soil					
	Stiff or Medium Soil	3	3	3	3	3
	Soft soil					
III	Hard or Rock Soil					
	Stiff or Medium Soil	3	3	3	3	3
	Soft soil					
IV	Hard or Rock Soil					
	Stiff or Medium Soil	3	3	3	3	3
	Soft soil					
V	Hard or Rock Soil					
	Stiff or Medium Soil	3	3	3	3	3
	Soft soil					
Total number of Models: 60						

Table 3: Structural Details of Models

Plan Dimension	30 x 20 m
Number of Storey	G+10
Type of Building	Institutional Building
Floor height	3 m
Bottom Storey Height	3.5 m
Slab Depth	150 mm
Beam Size	300 x 450 mm
Column Size	300 x 450mm
Concrete Grade	M30
Steel Grade	TMT500
AAC blocks Density for walls	6 kN/m ³
External Walls Thickness	230 mm
Internal Walls Thickness	120 mm
Seismic Zones	II, III, IV, V
Type of Soil	Hard, Medium and Soft soils

Importance Factor, I	1.5
Response reduction factor	5
Dead Load on floors	0.52 kN/m ²
Live Load on floors	3 kN/m ²
Wall loads @ 230 mm	3.519 kN/m

A. Plans and 3D Views

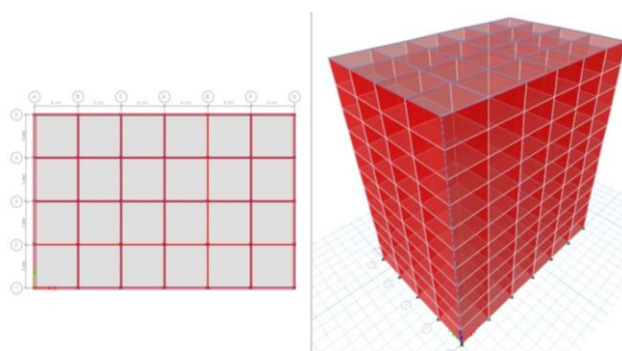


Fig 1: 3-D Rectangular Shaped G+10 Storied Building

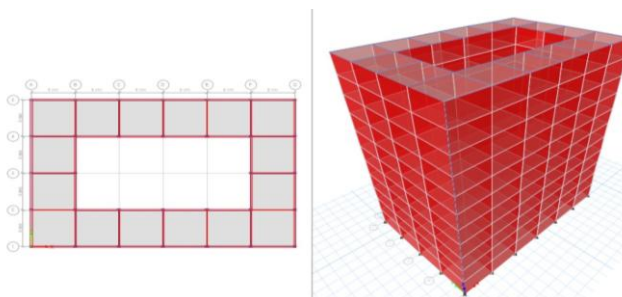


Fig 2: 3-D Hollow Rectangular Shaped G+10 Storied Building

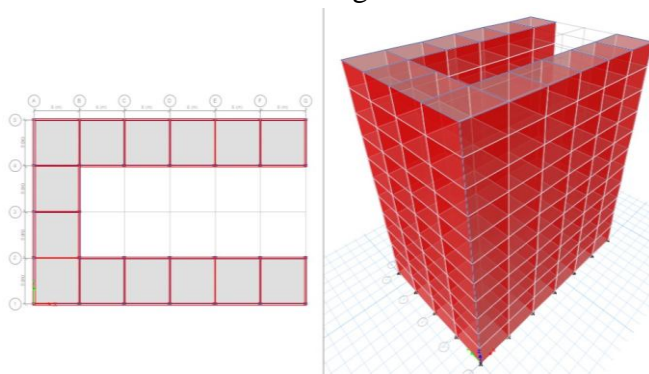


Fig 3: 3-D C shaped G+10 Storied Building

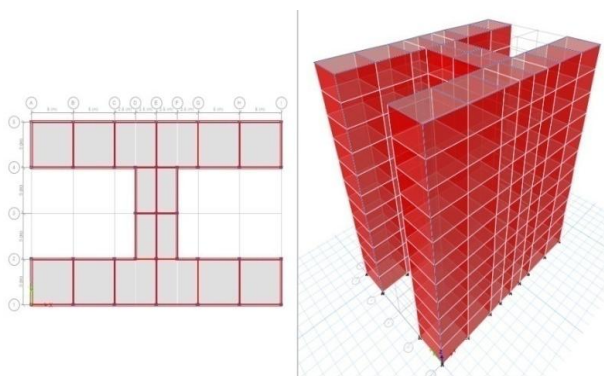


Fig 4: 3-D H shaped G+10 Storied Building

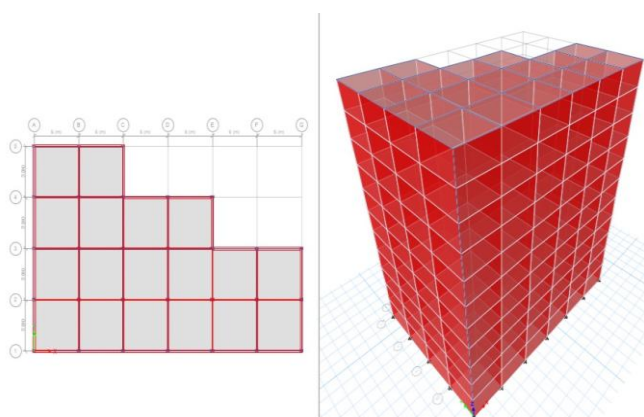


Fig 5: 3-D M5 Shaped G+10 Storied Building

IV. RESULTS AND DISCUSSIONS

All models have been performed by "Response spectrum analysis" using ETABSs. The calculation of the loads is done IS: 2016, IS: 875 (Part 1, Part 2)-1987, IS: 456:2000 using ETABS 17. A comparative study has been done on five shapes of buildings in various seismic zones for different types of soils. In the present work we have taken the various results like base story displacements, story drift and base shear for all the models. The investigated results were obtained in the ETABS are shown in below form of the table's and graphs:

A. Comparison of Story Displacement

Table 4: Story Displacement along X - Direction

S NO	MODEL NAME	Z2	Z3	Z4	Z5
1	RECTANGLE	0.302	0.494	0.724	1.086
2	HOLLOW REC	0.222	0.3	0.45	0.675

3	C	0.317	0.509	0.763	1.145
4	H	0.231	0.367	0.555	0.833
5	M5	0.345	0.552	0.828	1.243

In the Direction of X it is observed that M5 having max displacement and Hollow rectangle is having min displacement. The displacement values are increased from zone 2 to zone 5 for all models.

Table 5: Story Displacement along Y-Direction

S NO	MODEL NAME	Z2	Z3	Z4	Z5
1	RECTANGLE	0.437	0.716	1.048	1.572
2	HOLLOW REC	0.377	0.51	0.765	1.147
3	C	1.202	1.928	2.892	4.339
4	H	0.474	0.751	1.137	1.705
5	M5	0.567	0.908	1.361	2.042

In the Direction of Y it is observed that C having max displacement and Hollow rectangle is having min displacement. The displacement values are increased from zone 2 to zone 5 for all models.

From the above tables, it is observed that the displacement is more in direction X when compared with direction Y

B. Comparison of Base Shear

Table 6: Base Shear along X-Direction

S NO	MODEL NAME	Z2	Z3	Z4	Z5
1	RECTANGLE	2075	3319	4980	7470
2	HOLLOW REC	1630	2212	3318	4977
3	C	1666	2672	4009	6013
4	H	1480	2348	3553	5330
5	M5	1621	2594	3891	5836

In the direction of X it is observed that Rectangle having max base shear and Hollow rectangle is having min base shear. The base shear values are raised as of zone II to zone V for all models.

3	C	4.10E-05	6.50E-05	9.80E-05	0.000146
4	H	1.70E-05	2.70E-05	4.00E-05	6.00E-05
5	M5	1.90E-05	3.10E-05	5.10E-05	7.00E-05

Table 7: Base Shear along Y-Direction

S NO	MODEL NAME	Z2	Z3	Z4	Z5
1	RECTANGLE	2023	3237	4856	7284
2	HOLLOW REC	1592	2160	3240	4860
3	C	1420	2277	3416	5125
4	H	1467	2328	3522	5284
5	M5	1582	2531	3797	5696

In the direction of Y it is found that Rectangle having max base shear and C is having min base shear. The base shear values are increased from zone 2 to zone 5 for all models.

C. Comparison of Story Drift

Table 8: Storey Drift along X-Direction

NO	MODEL NAME	Z2	Z3	Z4	Z5
1	RECTANGLE	1.50E-05	2.40E-05	3.60E-05	5.30E-05
2	HOLLOW REC	1.30E-05	1.80E-05	2.60E-05	4.00E-05
3	C	4.10E-05	6.50E-05	9.80E-05	0.000146
4	H	1.70E-05	2.70E-05	4.00E-05	6.00E-05
5	M5	1.90E-05	3.10E-05	5.10E-05	7.00E-05

IS 1893 (Part 1): As per Rule 7.11.1 of 2016, the floor flow in any story must not exceeded 0.004 times the floor height. Thus it can be observed that the Story Drift was within the allowable limit of the X-direction.

Table 9: Storey Drift along Y-Direction

NO	MODEL NAME	Z2	Z3	Z4	Z5
1	RECTANGLE	1.50E-05	2.40E-05	3.60E-05	5.30E-05
2	HOLLOW REC	1.30E-05	1.80E-05	2.60E-05	4.00E-05

IS 1893 (Part 1): It may be noted that Story Drift is in the Y-direction permissible limit as per Rule 7.11.1 of 2016.

D. Comparison of Story Displacement using Charts

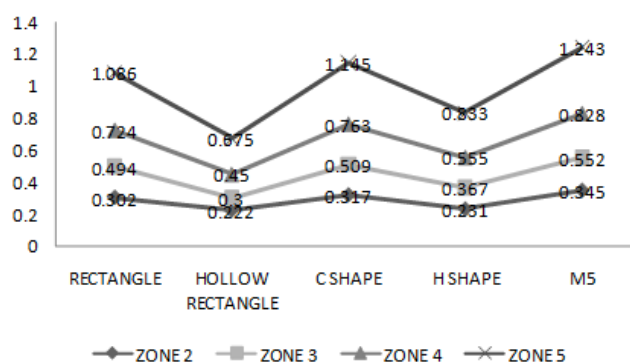


Fig 6: Story Displacement in X-Direction

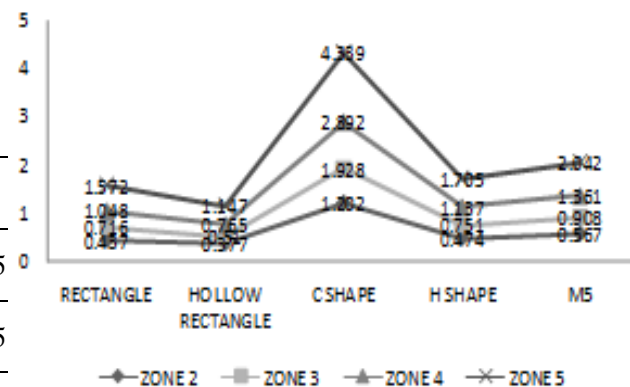


Fig 7: Story Displacement in Y-Direction

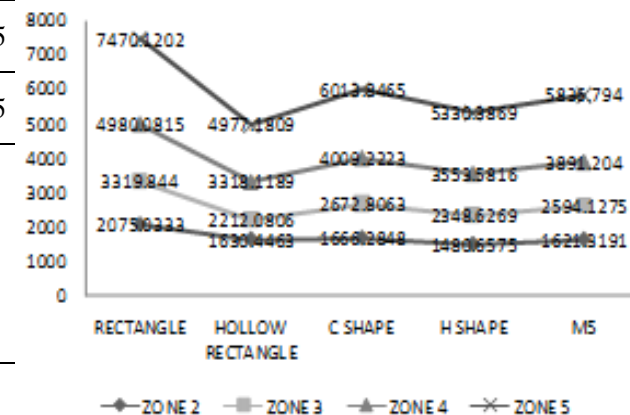


Fig 8: Base Shear in X-Direction

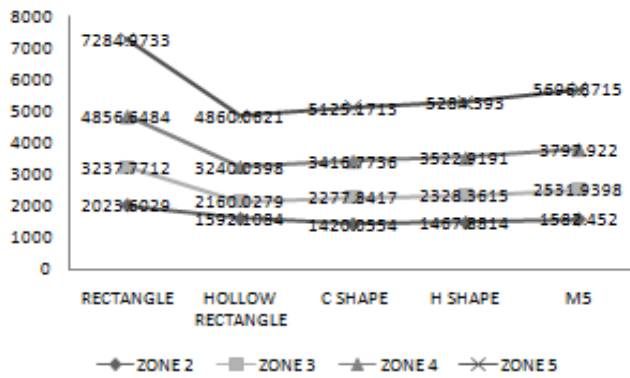


Fig 9: Base Shear in Y-Direction

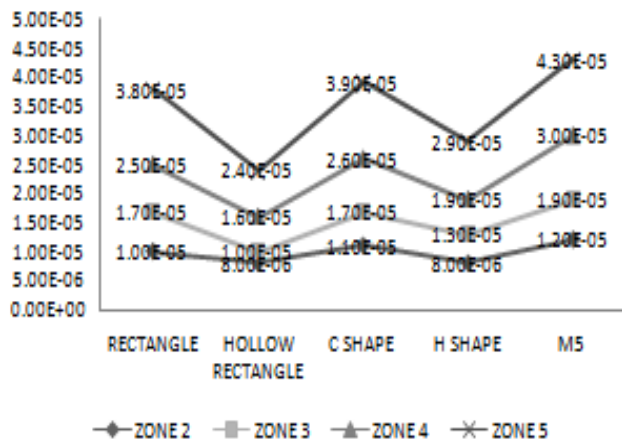


Fig 10: Storey Drift in X-Direction

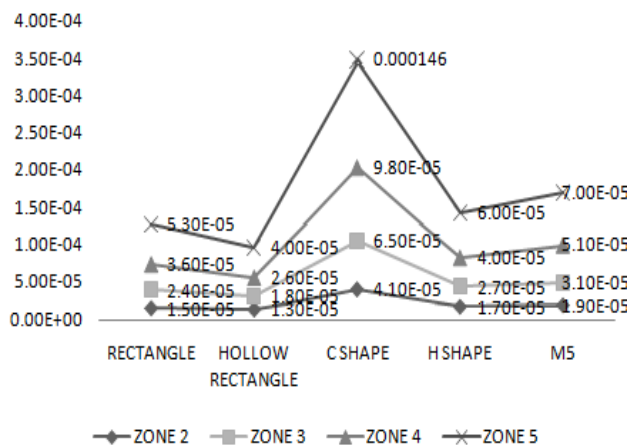


Fig 11: Storey Drift in Direction-Y

V. CONCLUSION

From the above consequences, it was found that

1) The story displacement is highest in direction-Y as compared to direction-X because the plan is having lesser dimension in Y-direction.

2) In all these 5 shapes, the C shape and M5 are having maximum displacement values and Hollow rectangle is having minimum displacement values.

3) Story displacement is observed to be increased from bottom to top storeys and from Zone 2 to Zone 5.

4) Story shear is observed to be increased from top to bottom as the bottom supports are fixed

5) In all these 5 shapes, Rectangle shape is observed to be having maximum base shear in both the directions and H&C shapes are having minimum base shear values in X&Y directions respectively.

6) The story drift values are observed to be very less and are within the permissible limits.

7) The results observed are almost same for any type of soil in a particular zone.

8) Finally, Hollow rectangle shape is observed to be the best among all these 5 shapes as it is having lesser displacement in both directions and is having average storey shear.

VI. THE SCOPE OF FUTURE WORK:

1) The study can be carried out by taking more different shapes of models for better understanding and behavior of buildings during earthquakes based on their shape.

2) The current investigation is based on linear dynamic analysis using Response Spectrum Analysis. Hence the outcomes need to be verified with the non-linear dynamic analysis.

3) The investigation can be further extended by considering both wind and seismic forces.

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