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A Structural Analysis of Solid and Hollow Rectangular Building
A Review

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Abstract:- Generally, building frames are analyzed for gravity loads in vertical direction and lateral loads like earthquake loads and wind loads in lateral direction. The analysis of structure depends on idealization of geometry of structure and idealization of load system on the structure. ***ETABS*** **is the abbreviation of "Extended3D** Analysis of building System**". ETABS is commonly used for analysis of skyscraper, High rise building as well as small heighted building. This paper is intended to compare the structural analysis of solid rectangular with hollow rectangular high rise building by using ETABS. The parameters checked for the analysis of the buildings were shear, drift and displacement by using response spectrum method.**

I. INTRODUCTION

India had witnessed several major disasters due to earthquake over the past century. In fact more than 50% of the country is considered prone to severe earthquakes Earthquake is the most dangerous and disastrous cause of destruction to the buildings as well as to human life due its unpredictability and huge power. Building structure collapse during severe earthquakes, and cause direct loss of human lives. The north-east region of the country as well as the Himalayan belt is susceptible to earthquake of magnitude 8.0 the main cause of this earthquake is the movement of the Indian plate towards the European plate at the rate of about 50mm per year. Earthquake being a natural phenomenon the effects caused by it cannot be neglected but can be minimized to some extent by adopting proper designs of buildings. The main purpose of this paper is to compare solid rectangular building with hollow rectangular building considering the earthquake, wind, collapse load on the building using ETABS (response spectrum method.

II. BUILDING CONFIGURATION

The height and length of the building in a particular pattern are in multiple of blocks (in vertical and horizontal direction). The size of the block is maintained at 4m*4m*4m. Fixed foundation is provided. Spacing considered in both direction (X and Y) and for both structure is 4m each. Size of beam is uniform for both the structure and is considered to be 400mm*400mm. size of column is also uniform and considered as 500mm*500mm. Grade's considered for both column and beam are M30 for concrete and rebar of Fe415. Floor to floor height is restricted to 4m for all stories. Slab thickness is assumed as 125mm with concrete grade M25.

- Response reduction factor: - 5
- Seismic zone factor: - 0.24
- Site type: - 2
- Wind speed: - 50m/s
- Terrain category: - 2
- Risk coefficient (k_1): - 1
- Topography (k_3): - 1
- Windward coefficient: - 0.8
- Leeward coefficient: - 0.5
- Dampness: - 5%

- *For solid rectangular building:-*

Total length	32m
Total width	16m
Total height	48m
Built up area	$512m^2$
No. of bays along X	8
No. of bays along Y	4

Table 1

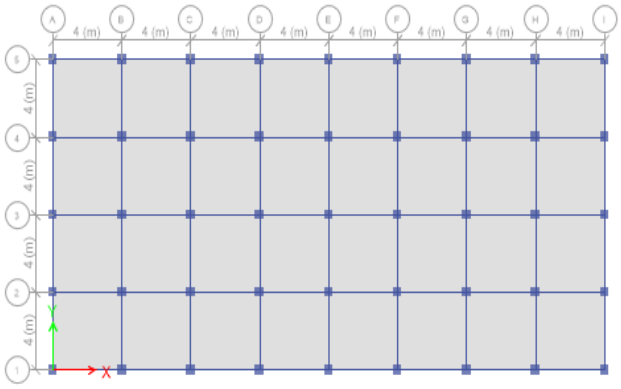

Fig 1

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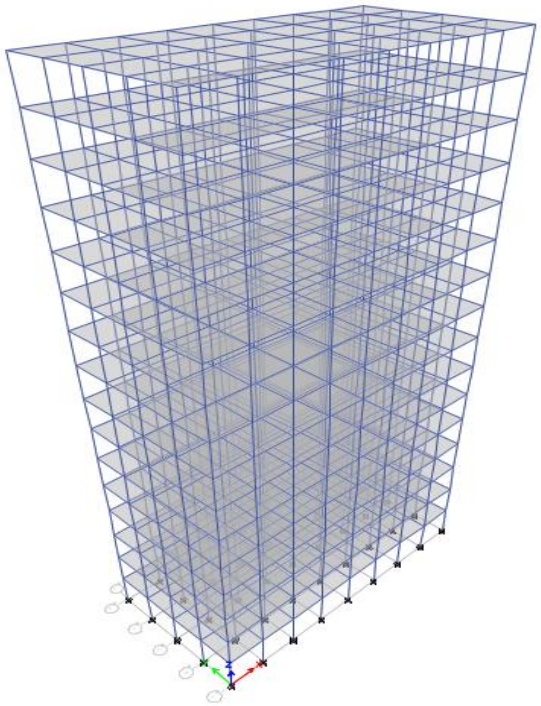

Fig 2

- *For hollow rectangular building:-*

Net built up area = 640-128=512m^2

	overall	Hollow
Total length	40	16
Total width	48	8
Total height	48	48
area	640	128

Table 2

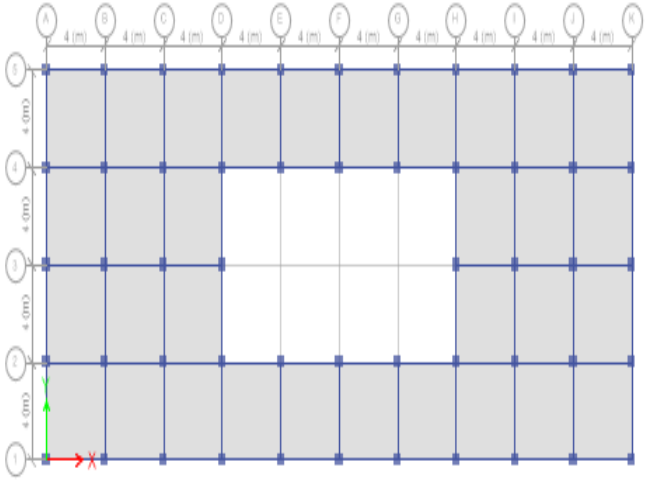

Fig 3

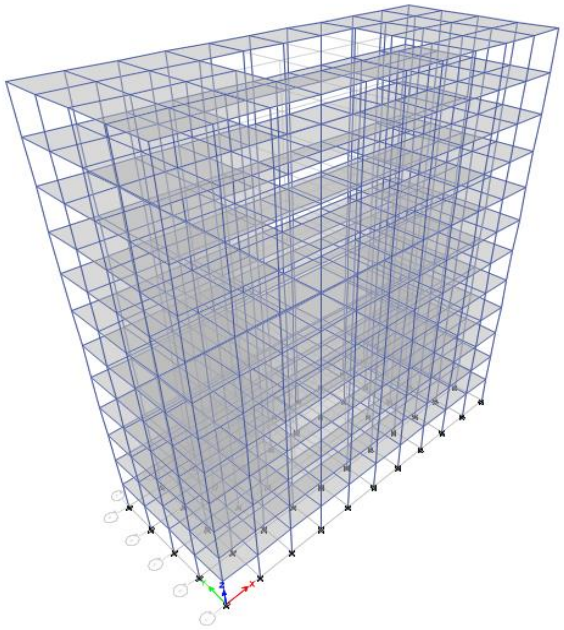

Fig 4

III. LITERATURE REVIEW

A brief review on analysis and design of various structure's by researcher's are summarized below:

➢ *k. Naga Sai Gopal:*

In this paper k. Naga Sai Gopal and N. Lingeshwaran, discussed about the analysis and design of G+5 residential building using ETABS. In this paper the building is tested with respect to stress, shear force, bending moment, and deflection. For the analysis of building we can use Indian standard code 875. The whole structure is designed based on the ETABS and theory of limit state method. The plan of the building model was taken from the architecture in Bangalore and ETABS software was used for analysis.

➢ *Sayyed Javed (2018):*

In this paper, Sayyed Javed and Prof. Hamane Ajay A. discussed about the comparative study of seismic analysis of various shape of building by Indian code and American code. They compared Indian code (IS 1893 part 1 :2002) and American standard code (ASCE 7-10) using G+10 building. They perform the seismic analysis on square type and C-shape building using STADD-pro. They use response spectrum method for the analysis of structure. They considered three parameter for the analysis i.e. 1) base shear, 2) displacement and 3)storey drift for analysis of the structure. They conclude that if the storey height is increased there is increase in weight of the structure. Displacement for square type model is more in Indian standard code while displacement of the C-type is more in American standard code.

➢ *Akhil R (2017):*

In this paper, Akhil R and Aswathy S Kumar discussed about the seismic analysis of regular and irregular building with vertical irregularity using STADD-pro. In this paper they compare regular square building and irregular H shaped building. They discussed the comparison between base shear and node displacement, time period, frequencies of different types of irregular shape of building. They used G+10 special moment resisting frame for the analysis. They use response spectrum method for analysis. They conclude that the base shear for both regular and irregular building. The maximum displacement occurred on regular shaped building. The displacement of the U-shaped vertical irregular building is more as compared to other shapes.

➢ *Pushkar Rathod (2017):*

in this paper, Pushkar Rathod and Rahul Chandrashekar discuss about the seismic analysis of multistoried buildings for different plans using ETABS-2015. In this paper they have considered different shapes of structures like T-shape, I-shape, L-shape. They compared these buildings on parameters like shear force, moments, displacement.

Story	hollow	solid
0	0	0
1	1.541	2.408
2	3.911	5.515
3	6.283	8.496
4	8.511	11.276
5	10.562	13.846
6	12.428	16.197
7	14.105	18.315
8	15.584	20.18
9	16.848	21.768
10	17.872	23.05
11	18.619	23.988
12	19.076	24.546

Table 3

In this paper, the testing of the building is done with respect to storey shear, storey stiffness and displacement parameters. They used response spectrum method for the analysis of the structure. They concluded that the storey shear is inversely proportional to the storey height. Centre of mass displacement is directly proportional to the number of stories.

➢ *Abhay Guleria(2014):*

In this paper, Abhay Guleria discussed about the structural analysis of multistoried building using ETABS for different shapes of structures like rectangular, C-shaped, L-shaped. They also changed dimension of the column i.e. for 1-5 storey the dimension of the column is taken as 600mm*600mm and for rest 6-12 storey the dimension of the column is taken as 500mm*500mm. they considered shear forces, bending moment, and maximum storey displacement for the analysis of the structure. They used response spectrum for the analysis of the building. They concluded that the storey overturning moment is inversely proportional to the storey height and storey drift is directly proportional storey height up to 6^{th} floor.

➢ *Saeed Kia Darbandsari (2017):*

Saeed Kia Darbandsari and Maryam Firoozi Nezamabadi discussed about a comparative study on seismic performance of Hexagrid, diagrid and tubular structural system. They used response spectrum method for analysis of the structure. They considered three parameter such as stiffness, displacement and shear. They carried out non linear static and dynamic analysis of the structure. In this paper they concluded that the diagrid structure has the most stiffness which is about 3 times greater than the stiffness of the tube system. Horizontal hexagrid, system and combined hexagrid system, have the medium stiffness between tube and diagrid structural system.

➢ *Milind V. Mohod (2015):*

In his paper Milind V Mohod discussed about the effect of shape and plan configuration on seismic response of structure. In this paper he performed the seismic analysis on square, E-shape, H-shape, T-shape, L-shape, C-shape, plus shape, plus with core and rectangular with core building using STADD-Pro V8i. he used parameter such as storey drift, displacement in X and Y direction for the analysis of the structure. He concluded that simple shaped building such as core rectangular, core square, rectangular building have displaced less in both direction in comparison to plus shaped, L-shaped, H-shaped, E-shaped, T-shaped and C shaped buildings as compared to other structure L-shaped and C-shaped model shows longer drift.

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IV. RESULTS

➢ *Storey displacement*

Fig 5

➢ *Storey drift*

Story	hollow	solid
0	0	0
1	0.000385	0.000602
2	0.000593	0.00078
3	0.000598	0.000756
4	0.000569	0.00072
5	0.000536	0.000682
6	0.000503	0.000641
7	0.00047	0.000595
8	0.000432	0.000544
9	0.000386	0.000486
10	0.000326	0.000416
11	0.000247	0.000321
12	0.000152	0.000193

Table 4

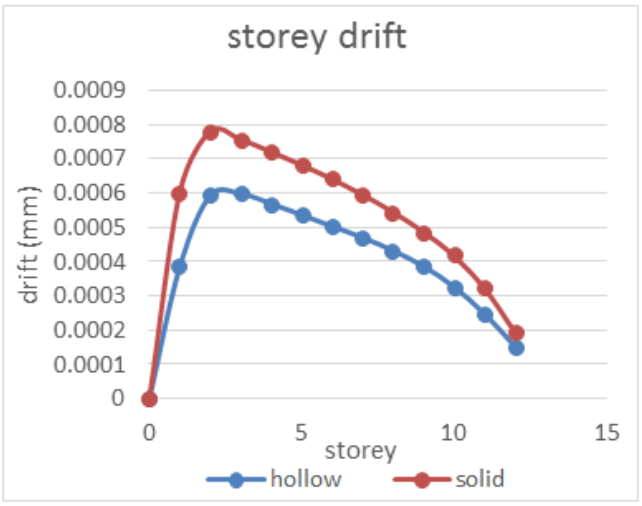

Fig 6

➢ *Storey shear*

Story	hollow	solid
0	0	0
1	1025.5382	759.906
2	993.1632	727.4822
3	939.7498	684.9836
4	880.1829	644.7114
5	822.0273	606.7289
6	766.746	566.8443
7	711.8554	522.8516
8	652.4039	475.4705
9	581.3707	424.6221
10	489.6573	364.4034
11	366.5291	281.1772
12	200.9049	157.0769

Table 5

Fig 7

V. CONCLUSION

From the results obtained we conclude that

- The displacement in hollow structure is less by 22.82% as compared to solid structure.
- The storey drift in hollow structure is less by 23.974% as compared to solid structure.
- The storey shear in hollow structure is more by 26.75% as compared to solid structure.
- As from the result, storey drift and storey shear is found to be decreasing as the number of stories increases i.e. inversely proportional.
- While storey displacement is found to be increasing as the number of stories increases. i.e directly proportional.
- So we would prefer hollow rectangular structure considering storey shear and storey drift.

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