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Comparison of Seismic Performance of Solid and Hollow Reinforced Concrete Members in RCC Framed Building with Plan Irregularity

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Abstract: **Hollow (Box-type) reinforced concrete beams and columns help in decreasing superstructure weight and hence seismic mass is minimized as compared to conventional solid reinforced concrete beams and columns. ETABS is commonly used to analyses: Skyscrapers, parking garages, steel & concrete structures, low and high rise buildings, and portal frame structures. The case study in this paper mainly emphasizes on structural behavior of R.C.C. framed building having hollow and solid reinforced concrete members. Modelling of G+6 and G+13 R.C.C. framed building is done on the ETABS software for analysis. Post analysis of the structure, maximum storeyshear ,maximum storey drift will compute and then compared for all the analyzed cases.**

Keywords: Structural behaviour, Hollow reinforced concrete member; ETABS; Storey shear; Storey overturning moment

I.INTRODUCTION

Continuous rise in the prices of steel reinforcement and cement leads, to the search for ways to reduce the weight of the concrete. This reflects on the total cost of the construction project. This also has a significant effect on environmental problems caused by use of huge amounts of cement and steel. Hollow (Box-type) members are lighter in weight and help in decreasing superstructure weight and hence seismic mass is minimized as compare to conventional solid reinforced concrete beams and columns. The economical convenience in the use of hollow reinforced concrete member is due to the cost saving afforded by reduced section area (up to 70%).An RCC framed building is basically an assembly of slabs, beams, columns and foundation inter-connected to each other as a unit. The load transfer mechanism in these structures is from slabs to beams, from beams to columns, and then ultimately from columns to the foundation, which in turn passes the load to the soil. A columns is a structural member that transmits through compression the weight of the structure above to other structural elements below.In other words column is a compression member.

A beam is structural element that primarily resists loads applied laterally to the beam's axis. Its mode of deflection is primarily by bending. The loads applied to the beam result in reaction forces at the beam's support points. The total effect of all the forces acting on the beam is to produce shear forces and bending moments within the beam, that in turn induce internal stresses, strains and deflections of the beam. The construction of tall bridge piers using rectangular hollow reinforced concrete column is attractive means in which superstructure weight and hence seismic mass is minimized. The column strength and stiffness is maintained whilst significantly reducing the construction cost. There is currently a reluctance among bridge designers to specify the use of ductile hollow columns for tall bridge piers due to the unknown performance of the plastic hinge regions under severe seismic disturbances

II. OBJECTIVE

1. To carry out the seismic analysis of RCC framed building using solid and hollow concrete members and comparing results of both.

2. To find out how number of stories influence the RCC framed building ,subjected to solid and hollow concrete members

3. To find out the seismic behaviour of RCC framed buildings in two different seismic zones

III. METHODOLOGY

Methodology employed is response spectrum method

Modelling of Building

Here study mainly deals with the structural behaviour of G +13 and G+6 RCC framed building with Hollow (Box- type) and Solid reinforced concrete members under Seismic load using ETABS software. An RCC framed building having 4m x 4m bays is considered and storey height is taken as 3.5m.. Loads considered are taken in accordance with the IS-1893(2002). ETABS is more user friendly and versatile program that offers a wide scope of features like static and dynamic analysis, non-linear dynamic analysis and non-linear static pushover analysis, etc.

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Building Plan and Dimension Details

Table below shows the details of building

Table 1: Building details

Total height of building	49 m and 24.5 m
No. of stories	14 and 7
Height of each storey	3.5 m
Grade of concrete	M30
Grade of steel	Fe415
Depth of slab	150 mm

The figure below shows the model of a RCC framed building with plan irregularity.

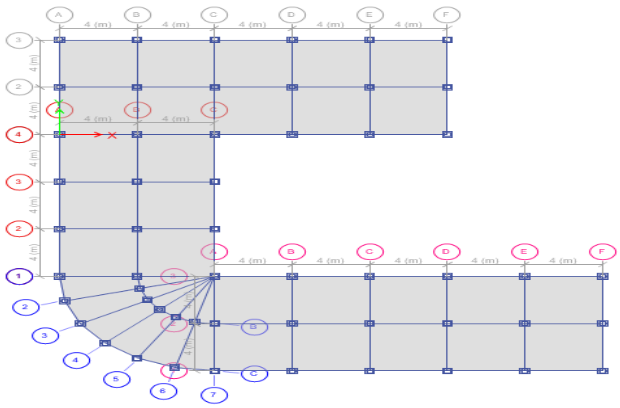


Fig 1. Plan of the RCC framed building

T ABLE II. Column Details

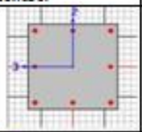
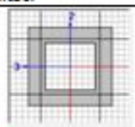
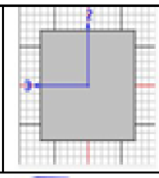
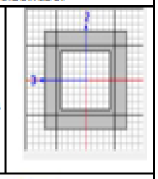
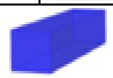
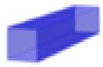
Column			
Solid Member		*Hollow Member*	
500 x 500 mm		500 x 500 mm Thickness - 100mm	
			

TABLE III. Beam Details

Beam			
Solid Member		*Hollow Member*	
450 x 450 mm		450 x 450 mm Thickness=100mm	
			

IV. COMPARISON OF RESULTS

After analysing the results obtained then it will be compared and find the seismic performance of the building. Graphical representation of storey drift and base shear values are shown in figure below.

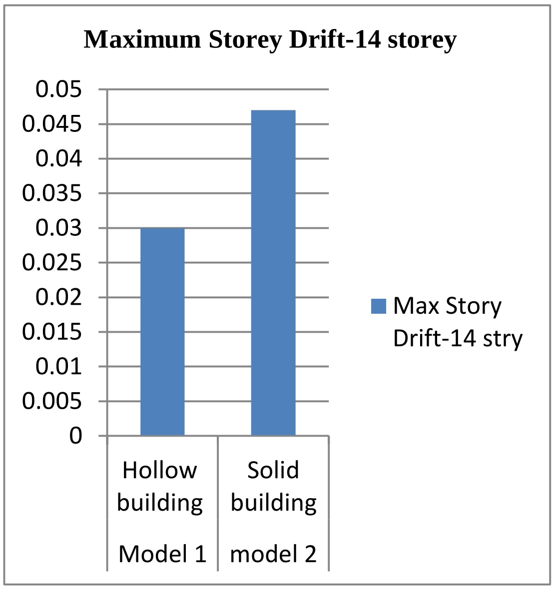


Fig 2:Maximum storey drift for seismic zone V

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From figure 3 it is observed that Hollow beams and columns in RCC framed building help in reducing storey drift as compared to solid beams and columns. There is 37% reduction in the storey drift due to Hollow members.In the case of seismic zone III also building with hollow nembers have less storey drift.There is 21% reduction in storey drift when hollow members are used.The same pattern is observed in the case of 7-storied building.ie,story drift is less for RCC building with hollow members.

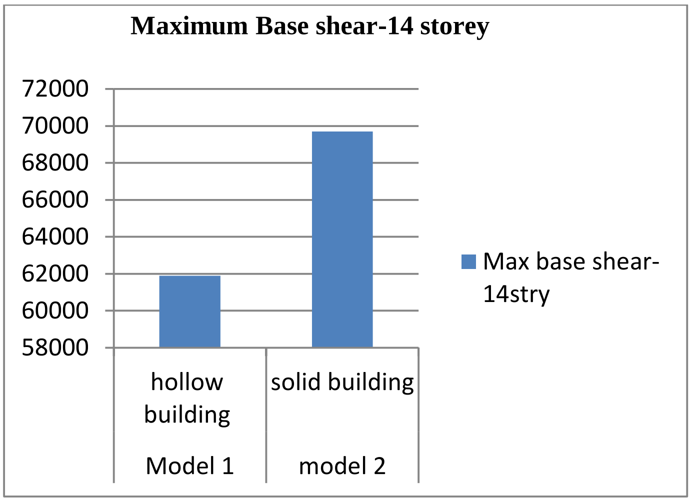

Fig 3 :Maximum base shear for seismic zone V

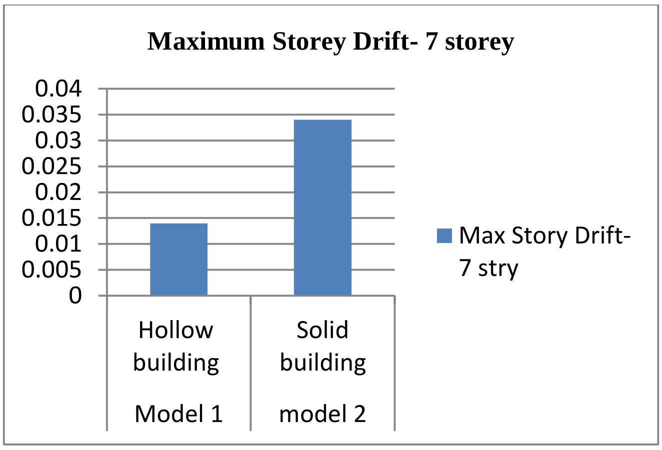

Fig 4 :Maximum storey drift for seismic zone V

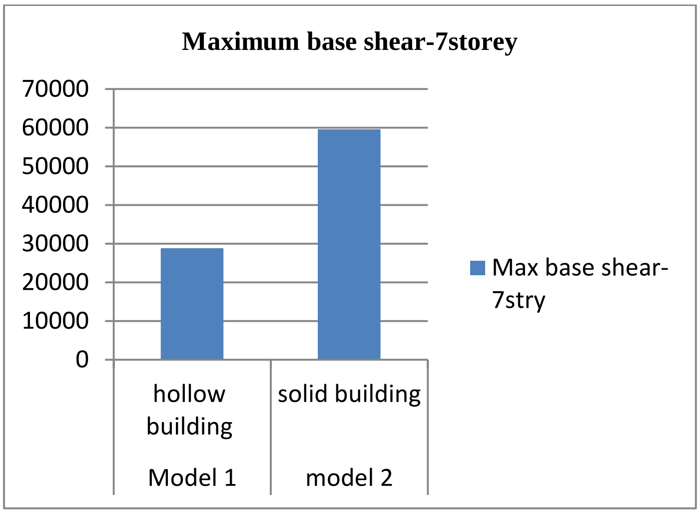

Fig 5 :Maximum base shear for seismic zone V

Base shear is less in case of Hollow members than solid members in RCC framed building. It is observed that the storey shear for RCC framed building having hollow members is decreased by 12% as compared to solid member in 14 –storied building. It is observed that the storey shear for RCC framed building having hollow members is decreased by 27% as compared to solid member in 7–storied building.

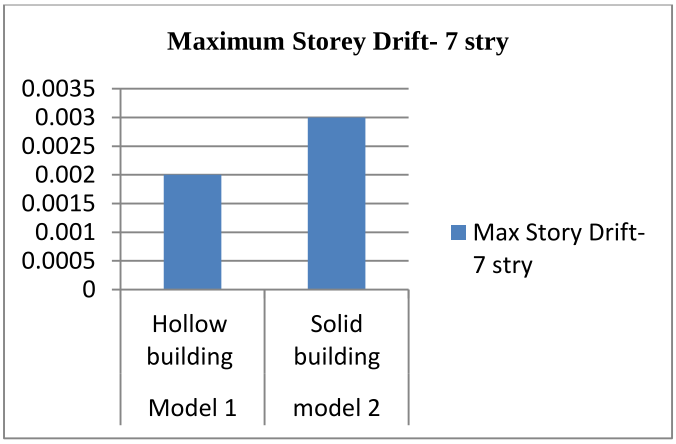

Fig 6. Maximum storey drift for seismic zone III

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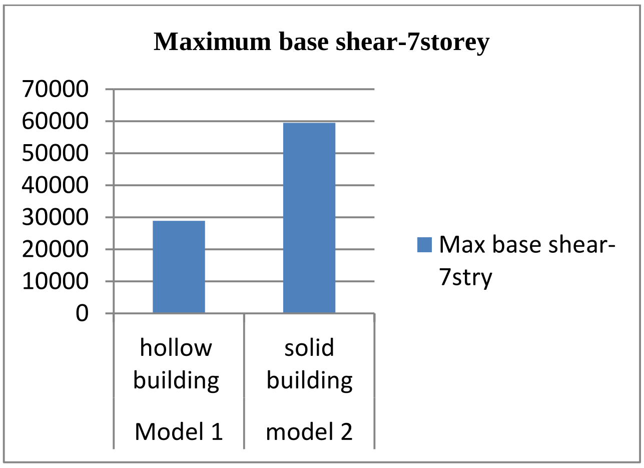

Fig 7. Maximum base shear for seismic zone III

V. CONCLUSIONS

On the basis of results obtained from structural analysis of R.C.C. framed building using ETABS the following conclusions can be drawn:

- There is 27% to 37% reduction in maximum storey drift (seismic zone V) and 21%-33% reduction in maximum storey drift (seismic zoneIII) due to Hollow members in RCC framed building.
- There is 12% to 29% reduction in base shear(seismic zone V) and 2%-11% reduction in base shear (seismic zoneIII) due to Hollow members in RCC framed building .
- Maximum storey shear ,storey drift increases as number of stories increases in the case of both solid and hollow members provided
- The value of storey drift ,storey shear is more in seimic zone V when compared to seismic zone III.
- In storey shear,storey drift point of view buildings with hollow members performs better than buildings with solid members

VI. FUTURE SCOPE

Further study can be carried out by changing the shape of columns provided Also study can be carried out in seismic zones II and IV

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