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Seismic Evaluation of RC Building With AAC Block Infill Walls

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Abstract: ***In countries like India, masonry infill is the most common structural system of construction of RC frame who behaves as the exterior walls as well as partition walls. So it is important to study the significance of infill in the structure. Various researches on RC buildings with masonry infilled walls was carried out by many researchers using brick masonry in most cases and AAC in some cases. In this study, AAC block is selected as material for the infill since it has less density, larger block size, lightweight, porous nature and other useful properties. A bare frame model and AAC block masonry infilled frame model with and without openings are modelled using the software ETABS. The infills in the structure are modelled as equivalent struts. The assumed structure is an apartment building of G+3 storeys in seismic zone III with a medium soil strata. Seismic coefficient method of analysis is adopted. Influence of AAC blocks on various responses of RC framed structure is studied. Values of base shear, storey displacements and inter-storey drift are derived and compared to evaluate the effect of infill on the structure.***

Keywords: Infill frame, AAC block, Equivalent strut model, bare frame, fully infilled

1. Introduction

Lots of studies has been completed by various researchers for obtaining the significance of infill on the behaviour of RC building under earthquake effects. Most of the studies was based on the brick infill and very few studies relied on AAC infill.

Kumbhar S.S and Rajguru R.S[1] concluded that infill walls increases base shear, while displacement and story drift were reduced. Completely filled, unfilled, soft story models of L shaped irregular building with G+14 storeys were studied for brick and AAC block infill walls.

Ji-Wook Malik and etal[2] concluded that the bare and fully infilled RC frames present stable collapse mechanism and the RC frames with partially infilled masonry walls will have short column effect and will collapse in more brittle manner. Models for building with varying heights of masonry walls were created and were compared by nonlinear static and dynamic analyses.

Geo Davis[3] concluded that the masonry brick infill walls influence the response of RC framed structures. A bare frame and RC frame with masonry infill wall of a slender structure was created and the results were compared for static analysis, modal analysis and time-history analysis.

Dr. Suchita Hirde and Ms. Dhanshri Bhoite[4] concluded that the masonry infill contribute significant lateral stiffness, strength, overall ductility and energy dissipation capacity.Nonlinear static pushover analysis of multi-story frame was carried out considering it as bare frame. Then the pushover analysis of same frame was carried out by modeling the infill walls for throughout the height and for modeling the infill walls excluding ground story so as to make it as soft story, since the soft story feature is very common in multi-story building to provide the parking place. The results of bare frame analysis and frame with infill effects are compared in the form of capacity spectrum curve, performance point and hinge formation at performance point and conclusion are made.

Wakchaure M.R and Ped S.P[5] concluded that it is essential to consider the effect of masonry infill for the seismic evaluation of moment resisting reinforced concrete frame.Linear dynamic analysis of G+9 R.C.C. framed building was modelled and earthquake time history was applied to them. The width of strut was calculated by using equivalent strut method. Base shear, story displacement, story drift is calculated and compared for all models. The results showed that infill walls reduce displacements, time period and increases base shear.

It is observed from the various research studies that the infill walls contribute in enhancing the structural strength and therefore it is important to undergo various researches to find the better options in providing infills.

2. Objectives

1) To analyze the significance of AAC block infill wall in a multistorey building by static analysis.
2) To analyze the influence of AAC block infill on storey drift, storey displacement and base shear.
3) To compare the response of bare frame and AAC block infill walled structures with various infill provisions at a particular seismic zone.

3. Methodology

Methodology employed is seismic coefficient method of analysis. Modeling of the G+3 storey reinforced concrete frame and frame with AACblock infill walls done using ETABS and static analysis is carried out and results are compared with each other.

4. Building Plan and Dimensions

A building of plan 15.16m x 12.78m(i.e. 194m^2) is considered with 4 storeys in zone III. Floor height of each floor is 3.2m and total height of building is 12.8m. Medium soil strata is considered at the location.

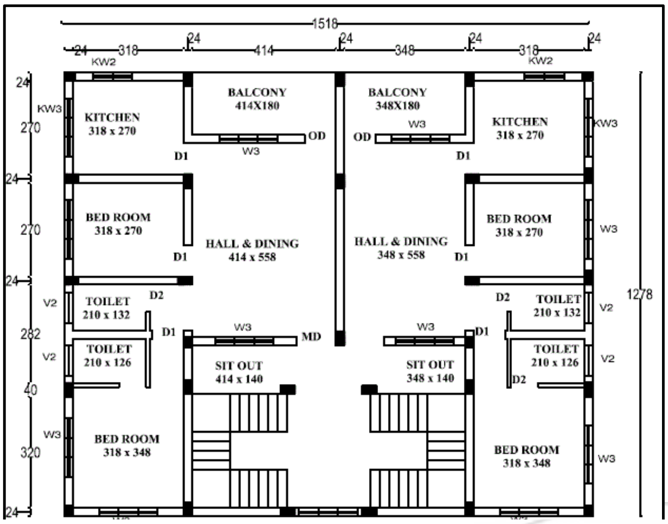


Figure 1: Building Plan

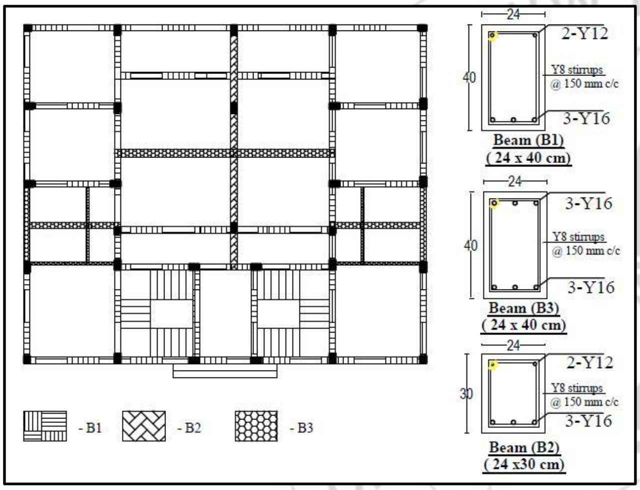


Figure 2: Beam Details

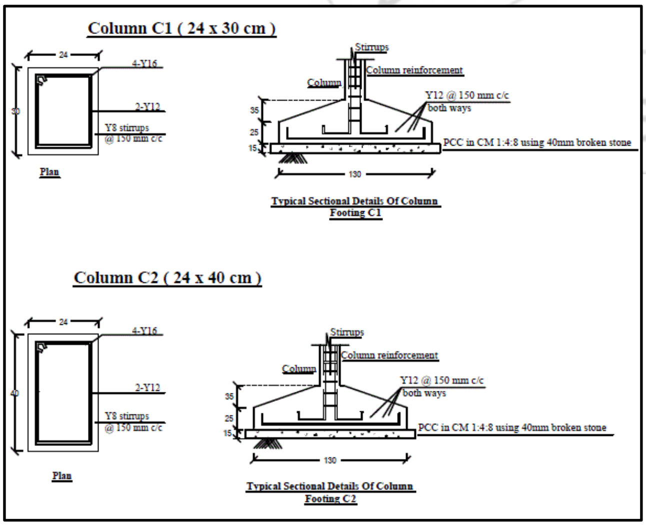


Figure 3: Column Details

Table 1: Slab and infill wall details

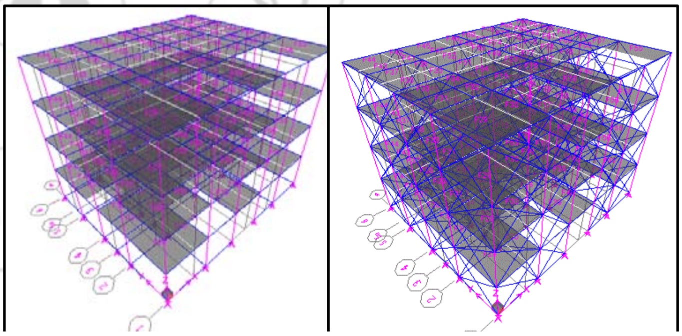
Slab details:	Infill walls details:
Slab type : Membrane	Material : AAC Block
Thickness = 120mm	Thickness = 230mm
Concrete Density=25kN/m^3	Density = 7kN/m^3
Comp.strength =25 N/mm^2	Comp.strength = 4 N/mm^2
Poisson Ratio = 0.2	Poisson ratio = 0.25
Opening Details:	
Size of opening	As per the required sizes

5. Modeling of Infill Walls

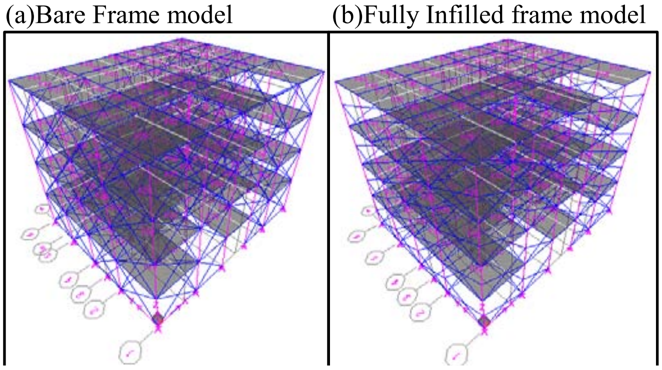
In this study AAC blocks are selected as infill material which has less density and therefore it is of lightweight. For modelling infill walls in ETABS, FEMA 356 is referred so that the wall load is calculated and is applied as uniform distributed load on the corresponding beams. Diagonal length of equivalent strut according to the wall height to be provided is calculated, and 0.25 of this length is adopted as width of the strut. These struts are released at its ends to avoid the moment acting on them. Stiffness of AAC block is provided to the struts and the strut is made as a compression only member such that the compressive limit is set to the compressive strength of AAC. Bare frame, fully infilled frame and infilled frame with opening was modelled by seismic coefficient method.

4.1 Why AAC?

AAC block as aerated concrete blocks have a porous structure making it a lightweight block and also fire resistant. They are ecofriendly blocks which behaves as an energy saver and lasts long. Its bigger size leads to quick assembly and fast masonry work. They normal concrete blocks as well as clay bricks.



(a)Bare Frame model (b)Fully Infilled frame model



(c)Infilled frame with opening (d) Partially infilled model

Figure 4: Models created using ETABS

6. Results and Discussions

From the output of ETABS, various results obtained are evaluated by preparing various graphs and is compared to find most effective infill provision against lateral loads. The effects of AAC infill on the storey displacement, storey shear and storey drift is studied

6.1 Storey Shear

Table 2: Story shear in X direction

Model	Storey shear in X direction			
	Storey 1	Storey 2	Storey 3	Storey 4
(a)	136.9	131.67	112.62	68.88
(b)	161.02	154.53	131.6	81.11
(c)	139.94	134.59	116.35	70.81
(d)	138.24	132.57	114.5	69.32

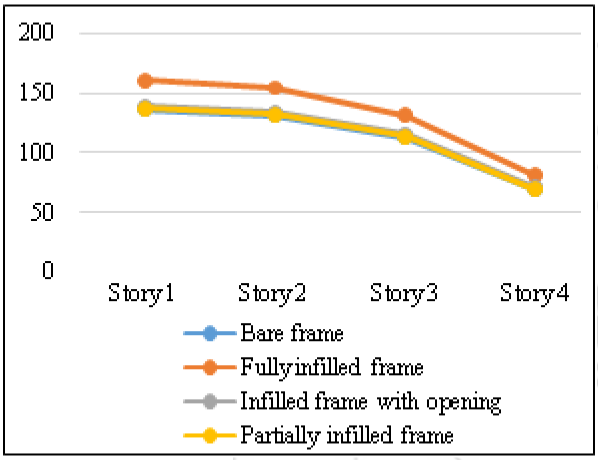


Figure 5: Storey shear in X direction

Storey shear increases from bare frame, partially infilled frame, infilled frame with opening and finally fully infilled frame.

6.2 Storey Displacement

Table 3: Story displacement in X direction

Model	Storey Displacement in X direction			
	Storey 1	Storey 2	Storey 3	Storey 4
(a)	1.62	3.53	5.13	6.13
(b)	0.02	0.04	0.07	0.1
(c)	0.02	0.05	0.08	0.12
(d)	0.41	0.86	1.29	1.6

Table 4: Story displacement in Y direction

Model	Storey Displacement in Y direction			
	Storey 1	Storey 2	Storey 3	Storey 4
(a)	0.2	0.45	0.67	0.83
(b)	0.01	0.01	0.01	0.01
(c)	0.01	0.01	0.01	0.02
(d)	0.06	0.1	0.16	0.22

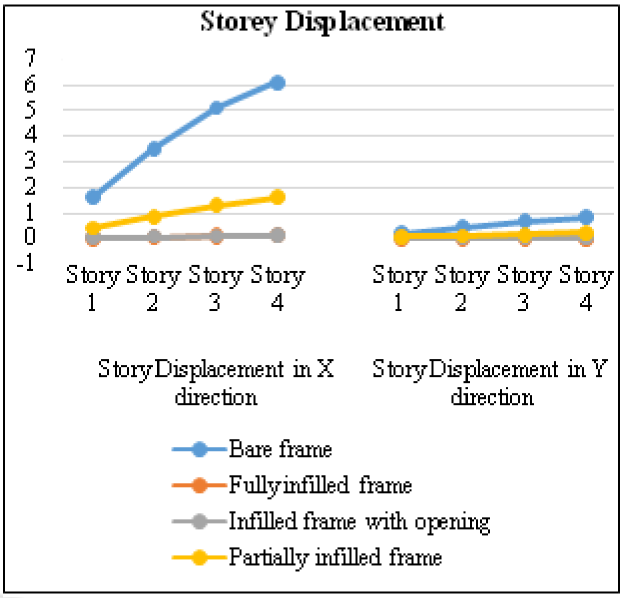


Figure 6: Storey displacement in X and Y direction

Storey displacement decreases from bare frame to fully infilled frame. Partially infilled frame itself shows a great decrease in storey displacement. Infilled frame with opening shows almost same values to that of fully infilled frame. And so storey displacement decreases from bare frame to partially infilled frame, infilled frame with opening and finally to fully infilled in both X and Y directions.

6.3 Storey Drift

Table 5: Story drift in X direction

Model	Storey Drift in X direction(x 10^{-3})			
	Storey 1	Storey 2	Storey 3	Storey 4
(a)	0.5076	0.5874	0.509	0.322
(b)	0.005	0.008	0.01	0.01
(c)	0.0057	0.0091	0.011	0.012
(d)	0.1296	0.1409	0.144	0.135

Table 6: Storey displacements in Y direction

Model	Storey Drift in Y direction(x 10^{-3})			
	Storey 1	Storey 2	Storey 3	Storey 4
(a)	0.0527	0.083	0.0718	0.0495
(b)	0.003	0.001	0.002	0.002
(c)	0.003	0.001	0.002	0.002
(d)	0.016	0.018	0.0203	0.0199

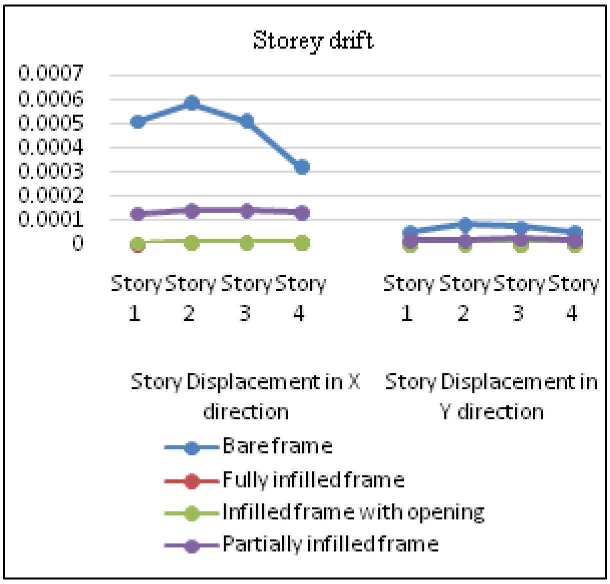


Figure 7: Storey drift in X and Y direction

Storey drift decreases from bare frame to fully infilled frame. Partially infilled frame itself shows a great decrease in storey drift. Infilled frame with opening shows almost same values to that of fully infilled frame. And so storey drift decreases from bare frame to partially infilled frame, infilled frame with opening and finally to fully infilled in both X and Y directions.

7. Conclusions

The following conclusions are drawn based on the analysis:

- AAC block has a significant effect on the performance of a RC building.
- Compared to bare frame, infilled frame has less storey displacement as well as storey drift.
- If partially infilled frame is compared with fully infilled frame, partially infilled frame is more subjected to storey displacement as well as storey drift.
- Infilled frame has more storey shear compared to bare frame.
- Storey shear is maximum in fully infilled and then infilled frame with opening, partially infilled frame and minimum in bare frame.

8. Future Scope

1) Response spectrum analysis can also be used for seismic evaluation of RC building.
2) Analysis by varying the opening size can be done.
3) Analysis for RC building with soft storey can also be done.

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