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Influence of AAC and conventional brick infill walls on seismic performance of RC framed structure

Sandhiya G*, Gayathri S

M.E Structural Engineering, Department of Civil Engineering, Anna University Regional Campus Coimbatore, Tamilnadu, India.

Abstract : Our construction activities are growing day by day rapidly. The innovative materials used in the construction of reinforced concrete masonry infill are also developing at a higher rate. Mostly for construction bricks are used as their main material. A brick is a block or single unit of a ceramic material used in a masonry construction. It is a standard-sized weight-bearing building unit. This project deals with the investigation, planning, designing, and replacement of ordinary bricks with aerated autoclaved concrete blocks. The aim of this project is to use AAC instead of ordinary bricks which are environmental friendly and high energy efficient, fire safety and cost effectiveness. A number of researches have been carried out experimentally and analytically to study the behavior of in filled reinforced concrete frames. The study of effect of types of infill materials used (i.e. AAC block) on the seismic performances of in-fill R.C. frames is however still limited. In fact, the infill wall enhances considerably the strength and rigidity of the structure. In the present study seismic performance of AAC blocks & conventional brick infill panel (with and without opening) in R.C. framed structure are compared using the software ETABS.
Keywords : RC Framed Structure, RC Masonry Brick And AAC Infill With And Without Opening, Static Equivalent Method.

Introduction

Earthquake engineering has been come a long way since its birth and it seems to grow rapidly as we gain experience each turn earthquake happens; something new is available to learn Reinforce concrete building with masonry infill is most common type of construction in India. Masonry infill's are often used to fill the void between the vertical and horizontal resisting elements of the building frames. Infill wall enhance the strength and rigidity of the structure and mostly stiffening effect of infill frame that changes the basic behavior of buildings during earthquake that leads to failure mechanism. Stiffening effect is the major cause of failure occurs in RC frame building .It has been recognized that infill materials significantly affect the seismic performance of the resulting infill frame structure.

Aerated Autoclave Concrete

Aerated Autoclave Concrete was developed by an architect Dr.John Erikson in 1923 at the Royal technical institute in Stockholm, Sweden, and patented for manufacturing in 1924. Nowadays green building and ecofriendly materialist widely chosen. One of the most famous ecofriendly material used is AAC. It is a cellular structure nontoxic, reusable, renewable and recyclable. It is a alternative building material with good thermal insulation,solid structure, earthquake resistant and easy to work with. It is a light weight material used as infill material. It is well known that the lesser weight of infill material used the less will be the earthquake forces generated in the structure. Light weight blocks reduce mass of a structure, thus decreasing the impact of an earthquake on a buildings. Non combustible nature provides an advantage against fires, which commonly accompany earthquakes.

Objective of the Study

- Toreduce the stiffening effect of infill frame
- To reduce the cost of construction
- Usage reduces overall dead load of a building, thereby allowing construction of a taller building.

Methodology

Methodology employed is Equivalent static frame analysis for two different materials used as a infill walls. Consider G+7 Storey reinforced concrete frame with conventional brick infill and AAC infill materials using ETABS are shown in fig1 and fig2. Comparison done for infill walls with and without opening in the exterior walls of the building and the results are discussed.

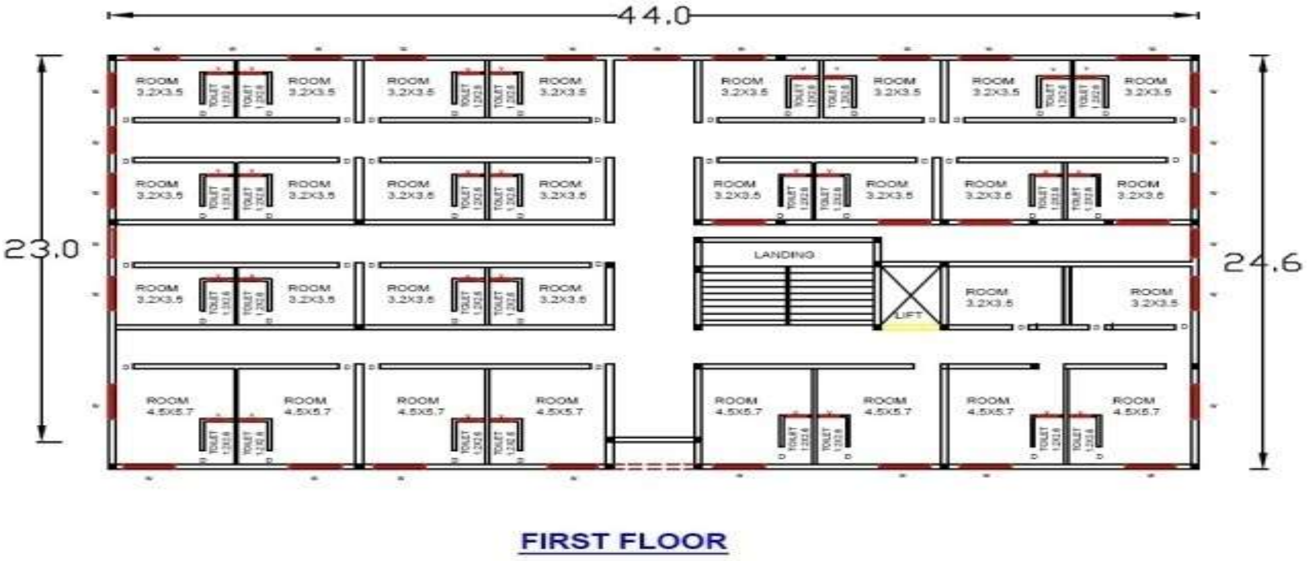

Fig 1 Plan obtain from AutoCAD

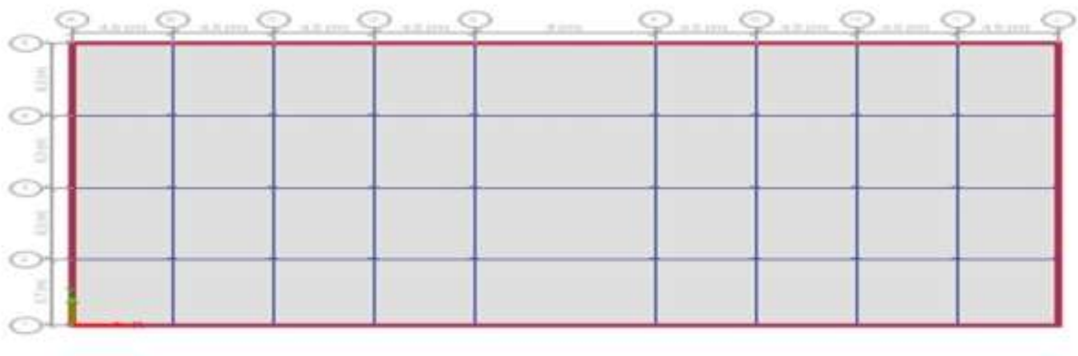

Fig 2 Plan obtain from E TABS

Description of Buildings:

Property of Building

a) Type of structure: Multistory RC frame fixed at the base.
b) Size of building: 44m×24.6m
c) Floor height :3m
d) Size of beam : 230×350 mm
e) Size of column : 230×450 mm
f) Depth of slab : 150 mm
g) Materials : M30 & Fe415

Data of Infill Frame

a) Thickness of infill wall:230mm
b) Density of brick infill:20kN/m^3
c) Density of AAC infill:10KN/m^3
d) Poisson ratio of brick masonry:0.2
e) Poisson ratio of AAC masonry:0.25
f) Modulus of elasticity of brick masonry:3.6KN/m^2
g) Modulus of elasticity of AAC masonry: 2KN/m^2

Description of Loading

a) Dead load

i) Self weight comprises of the weight of the beam, column and slab of the building.
ii) Wall load for brick masonry:13.8KN/m
iii) Wall load for AAC masonry:6.77KN/m

b) Live load

i) Imposed load: 4KN/m^2
ii) Roof load: 1.5 KN/m^2

c) Earthquake load

i) Types of soil: Hard
ii) Seismic Zone: III
iii) Zone factor, Z=0.16
iv) Response reduction factor:3\
v) Importance factor, I=1
vi) Damping of structure:5%

Modeling

The RC Framed structure is modeled by using ETABS software for the following cases.The cases are shown in fig3 and fig4.

Case 1: conventional brick infill frame without opening.
Case 2: AAC infill frame without opening.
Case 3: conventional brick infill frame with opening.
Case 4: AAC infill frame with opening.

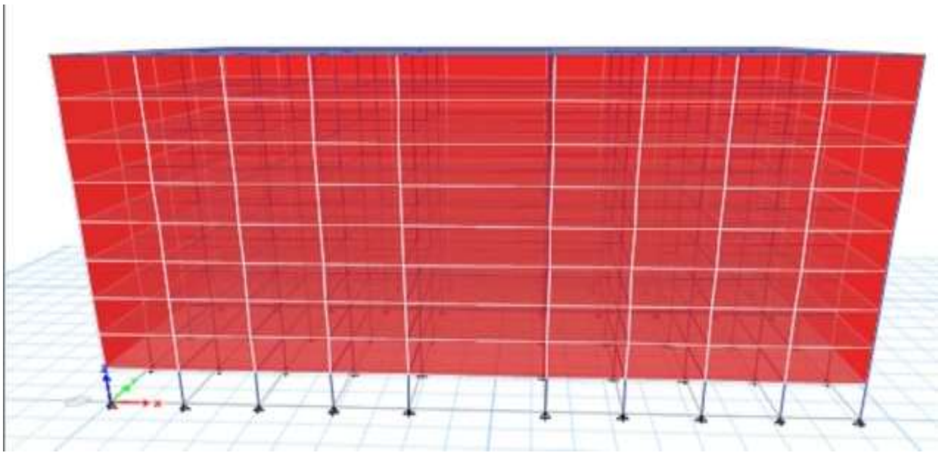

Fig 3 3D View of the Structure without Opening

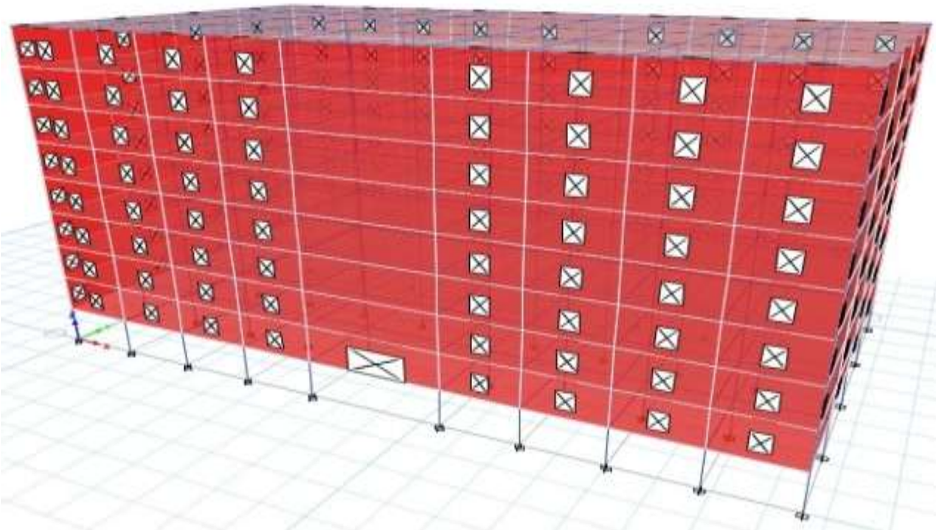

Fig 4 3D View of the Structure with Opening

Results and discussions

Storey Stiffness

The Storey Stiffness For (G+7) Frame Structure Are Analyzed Using ETABS Software And The Stiffness Value Of AAC And Brick With And Without Opening Are Compared. The Table 1 And Table 2 Indicate the Storey Stiffness in X and Y Direction and fig5, fig6 shown the comparison.

Table 1.Storey stiffness in x direction

Storey	Case 1 X10^6 (KN/m)	Case 2 X10^6 (KN/m)	Case 3 X10^6 (KN/m)	Case 4 X10^6 (KN/m)
8	15.61	2.84	32.75	5.58
7	32.75	3.91	71.82	7.95
6	50.65	4.43	110.73	8.97
5	71.90	4.74	149.44	9.58
4	100.53	4.97	187.93	10.02
3	111.94	5.10	211.40	10.32
2	102.39	5.95	111.13	10.41
1	30.57	3.25	40.12	39.61
Base	0.23	0.21	0.89	0.80

Table 2.Storey stiffness in y direction

Storey	Case 1 X10^6 (KN/m)	Case 2 X10^6 (KN/m)	Case 3 X10^6 (KN/m)	Case 4 X10^6 (KN/m)
8	11.58	1.32	20.83	2.42
7	21.18	1.87	40.89	3.60
6	29.69	2.14	58.20	4.18
5	36.65	2.29	72.24	4.50
4	40.05	2.39	75.28	4.72
3	35.47	2.46	59.33	4.85
2	25.84	2.39	39.16	4.47
1	16.93	1.69	19.83	1.98
base	0.64	0.61	0.26	0.25

Table 3.Storey shear in x direction

Storey	Case1 X10^3 (KN)	Case 2 X10^3 (KN)	Case 3 X10^3 (KN)	Case 4 X10^3 (KN)
8	21.12	16.80	6.13	5.59
7	44.64	34.90	13.47	11.84
6	68.42	53.25	20.80	18.10
5	92.17	71.60	28.13	24.55
4	115.90	89.95	35.46	30.61
3	139.69	108.00	42.79	36.86
2	163.45	126.64	50.12	43.11
1	187.20	144.99	57.55	49.36
base	209.75	162.60	63.78	55.15

Table 4.Storey shear in y direction

Storey	Case 1 X10^3 (KN)	Case 2 X10^3 (KN)	Case 3 X10^3 (KN)	Case 4 X10^3(KN)
8	3.66	2.89	1.06	0.96
7	6.88	5.37	2.06	1.82
6	9.37	7.29	2.83	2.45
5	11`19	8.70	3.39	2.95
4	12.46	9.67	3.78	3.28
3	13.27	10.29	4.04	3.49
2	13.73	10.65	4.18	3.61
1	13.94	10.80	4.24	3.66
base	13.98	10.84	4.25	3.68

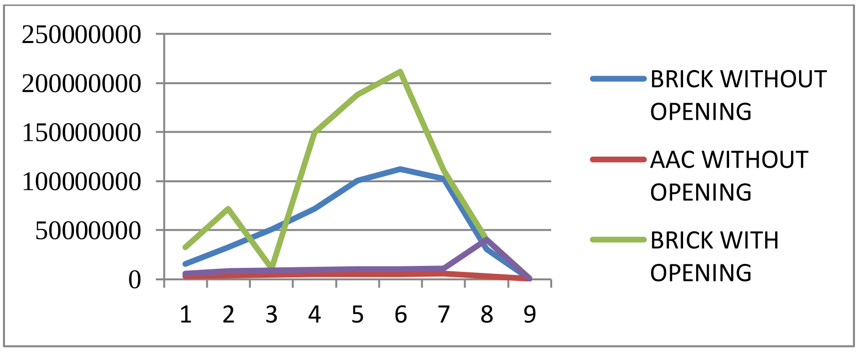

Fig 5 Graph Showing Storey Stiffness In X Direction

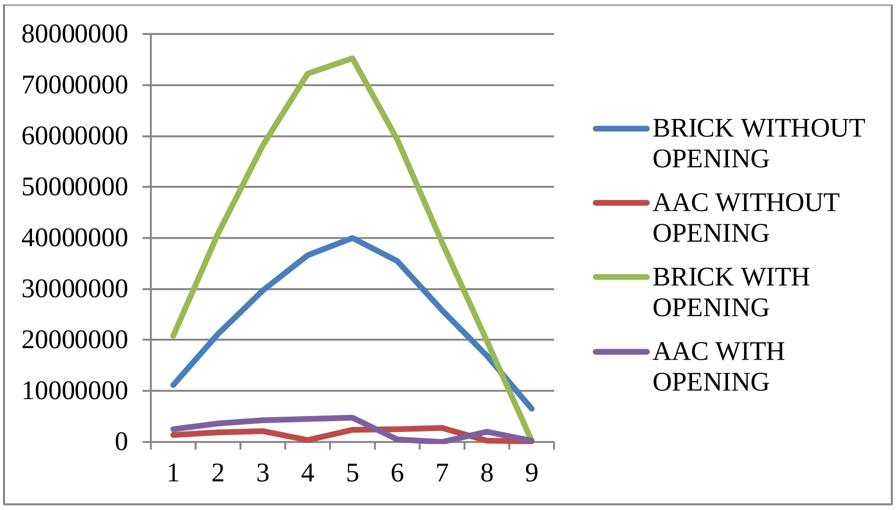

Fig 6 Graph Showing Storey Stiffness In Y Direction

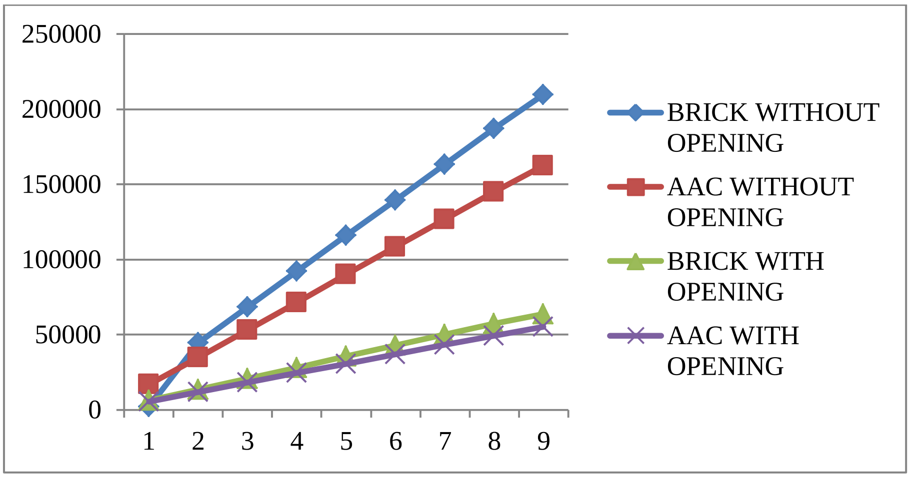

Fig 7 Graph Showing Storey Shear In X Direction

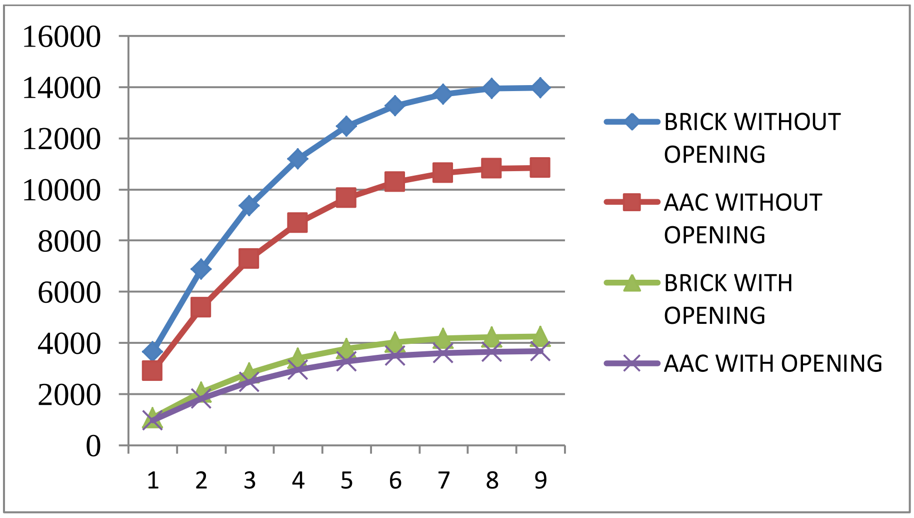

Fig 8 Graph Showing Storey Shear In Y Direction

Storey Shear

The Storey Shear For (G+7) Frame Structure Are Analyzed Using ETABS Software And The Stiffness Value Of AAC And Brick With And Without Opening Are Compared. The Table 3 And Table 4 Indicate the Storey Stiffness in X and Y Direction and fig7, fig8 shown the comparison.

Conclusion

The analytical study on RC infill framed structure for conventional bricks and AAC (with and without opening) are performed using ETABS software and the following results were drawn. The stiffening effect for the infill frame modeled using AAC without opening in X direction is reduced by 93.15% than conventional brick without opening. Likewise, for Y direction it is reduced by 92 %.The infill frame with AAC in X direction with opening has reduction in stiffening effect by 88.73%. and for Y direction it is reduced by 91.9%The storey shear for the infill frame modeled using AAC without opening in X direction is reduced by 22.5% than conventional brick without opening. Likewise, for Y direction it is reduced by 22.32%.The infill frame with AAC in X direction with opening has reduction in storey shear by 13.5%. and for Y direction it is reduced by 11.6%.From the above results, it is concluded that the seismic performance of infill RC frame with AAC is better when compared to conventional brick.

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