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Comparative Analysis of G+10 RCC Building with Conventional Blocks and AAC Blocks

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Abstract:- A building has be defined is an enclosed structure intended for human occupancy. Constructions work has be seen in most the countries developing. With the increases an material cost in the construction work, there is a need to find more cost saving alternatives so as to maintain the cost of construction houses , multi-storey etc, which can be affordable to people. In the manufacturing of burnt clay bricks, smoke evolved at a great extent and also some toxic gases which can harm an environment. So as to overcome with all these problem, Autoclaved Aerated Concrete (AAC) blocks are used which is more economical and eco-friendly. This project includes the analysis, design and estimates of structure, comparing between autoclave aerated concrete and conventional brick in the form of steel consumptions. Autoclaved Aerated Concrete (AAC) is a lightweight concrete building material cut into masonry blocks or formed larger planks and panels. Currently it has not seen widespread use in the United States. However, in other parts of the world it has been used successfully as a building material. Cost of construction is reduced and it will be safe and economical in earthquake forces also. The seismic Parameter Lateral displacements are also compared.

Index Terms- conventional blocks and AAC block ,diagonal strut, infill wall with opening , E-Tab software.

1.INTRODUCTION

Aerated Autoclave Concrete The use of autoclaved aerated concrete (AAC) load-bearing elements is diffusely used worldwide and they possess interesting material properties regarding earthquake engineering. Indeed their high deformability allied to their low weight reduces the inertia forces of these vertical elements and, in Addiction to their non-combustibility and fire-resisting nature of AAC (earthquakes are commonly associated with fires), they may be an alternative to reinforced concrete frame structures. On the other hand masonry structures are commonly associated with poor seismic performance as observed in past earthquakes. This negative perception is caused mainly by many non-engineered masonry structures, mostly stone masonry houses which, if not properly designed and/or strengthened regarding seismic provisions, will not behave satisfactory under seismic excitations. On the contrary, modern approaches to masonry constructions regarding seismic detailing with convenient conception or innovative materials and solutions, may lead to safer and economical constructions especially concerning small constructions. Therefore a complete methodological approach to the seismic performance assessment of unreinforced AAC masonry buildings is presented on this work, enhancing the possibility to use nonlinear static procedures in the reproduction of the dynamic behaviour of AAC masonry buildings.

EARTHQUAKE HAZARDS Earthquakes really pose little direct danger to a person. People can't be shaken to death by an earthquake. Some movies show scenes with the ground suddenly opening up and people falling into fiery pits, but this just doesn't happen in real life. Buildings can even sink into the ground if soil liquefaction occurs. Liquefaction is the mixing of sand or soil and groundwater (water underground) during the shaking of a moderate or strong earthquake. When the water and soil are mixed, the ground becomes very soft and acts similar to quicksand. If liquefaction occurs under a building, it may start to lean, tip over, or sink several feet. The ground firms up again after the earthquake has past and the water has settled back down to its usual place deeper in the ground. Liquefaction is a hazard in areas that have groundwater near the surface and sandy soil. Buildings can also be damaged by strong surface waves making the ground heave and lurch. Any buildings in the path of these surface waves can lean or tip over from all the movement. The ground shaking may also cause landslides, mudslides, and avalanches on steeper hills or mountains, all of which can damage buildings and hurt people.

ETABS SOFTWARE:- As our country is the fastest growing country across the globe so the need of shelter for highly populated cities where the cost of land is high and further horizontal expansion is not possible due to unavailability of space, so the only solution is vertical expansion. Structural design is the primary aspect of civil engineering. The foremost basics in structure is the design of simple basic components and members of a building like slabs, beams, columns, and footings. In order to design them it is important to first obtain the plan of the particular building. Thereby depending on the suitability plan layout of beams and the position of columns are fixed. Thereafter, the vertical loads are calculated namely the dead load and live load. Once the loads are obtained, the component takes the load first i.e. the slabs can be designed. Designing of slabs depends upon whether it is a one-way or a two-way slab, the end condition and the loading. From the slabs, the loads are transferred to the beam. The loads coming from the slabs onto the beam may be trapezoidal or triangular. Depending on this, the beam may be designed. Thereafter, the loads (mainly shear) from the beams are taken by the columns. For designing columns, it is necessary to know the moments they are subjected to for this purpose; frame analysis is done by Kanis method.

2. OBJECTIVES OF THE STUDY

- To reduce 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.

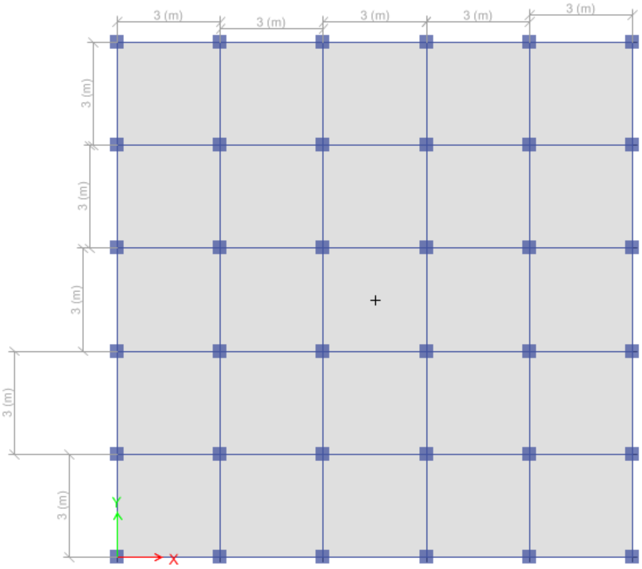
3. BUILDING MODELING

For this study, a 10-story building with a 3-meters height for each story, regular in plan is modeled. These buildings were designed in compliance to the Indian Code of Practice for Seismic Resistant Design of Buildings .The buildings are assumed to be fixed at the base and the floors acts as rigid diaphragms. The sections of structural elements are square and rectangular and their dimensions are changed for different building. Storey heights of buildings are assumed to be constant including the ground storey. The buildings are modeled using software ETAB Nonlinear v 9.5.0.Four different models were studied with different material use in building. Models are studied in conventional brick and AAC block for adopt in each model for comparing lateral displacement, story drift, % Ast in column, concrete quantity required, steel and total cost required in all zones for all models.

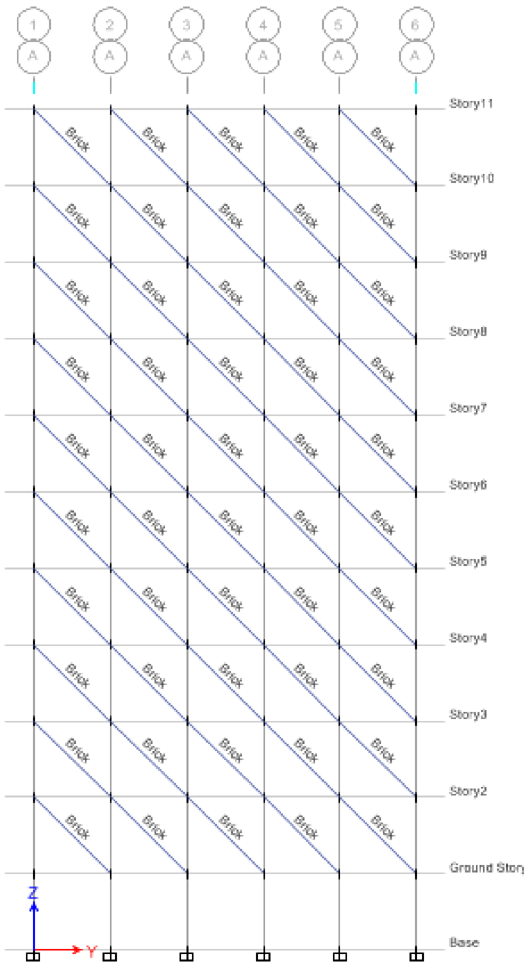
The plan of the building model are given below

Model 1 **-** RCC building with Conventional Clay bricks as infill material.

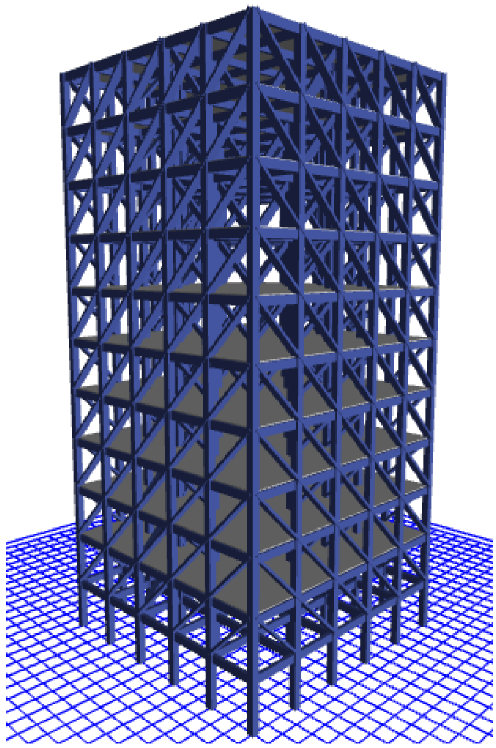
(Plan of building with Conventional Clay Bricks as infill material)



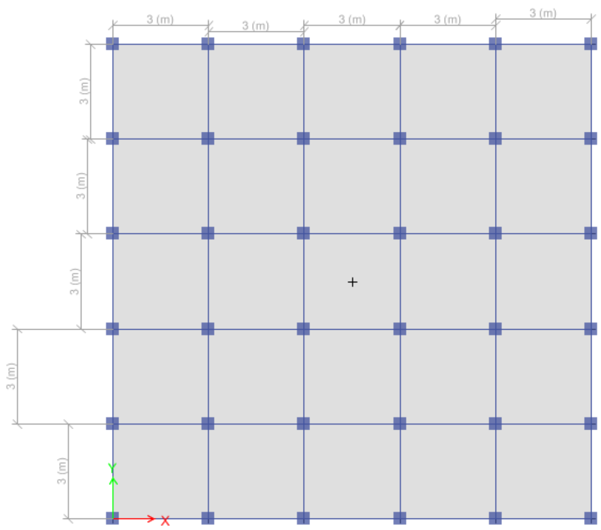
Elevation of RCC Building showing Conventional Clay Bricks modelled as inclined STRUT



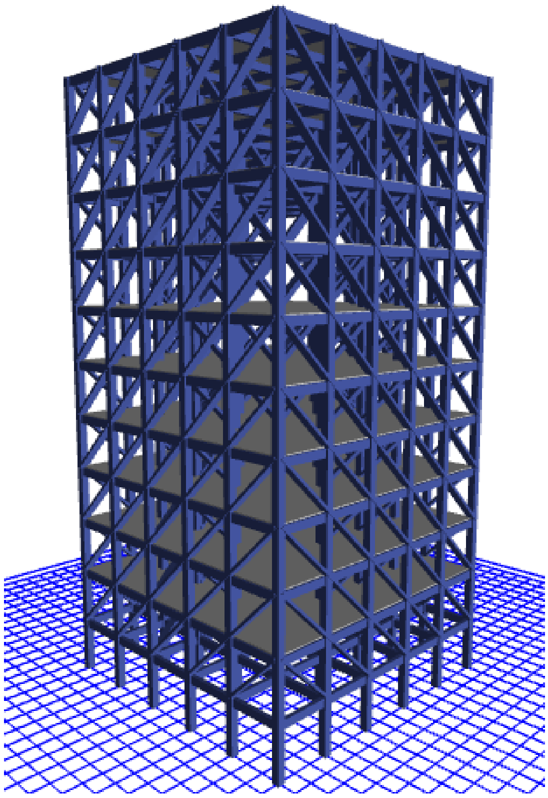
3D render view of building with Conventional bricks as inclined struts



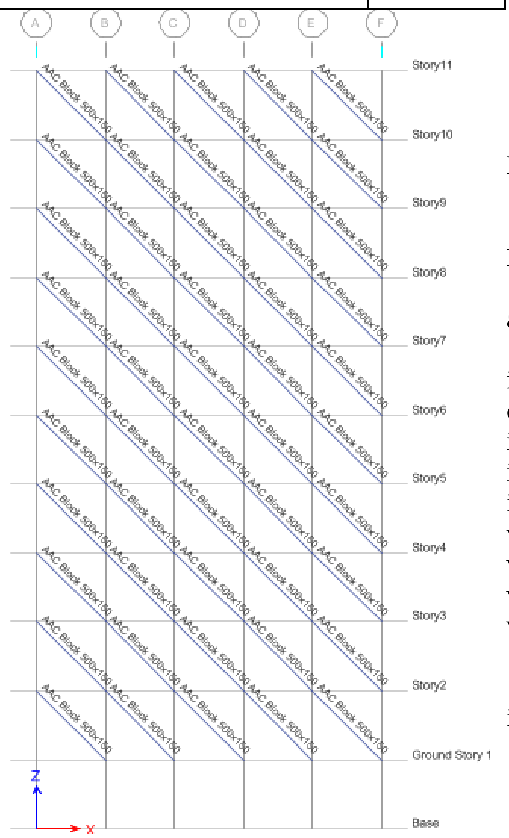
Model 2 – RCC building with AAC block as infill material (plan of aac block)



Elevation of RCC Building showing AAC blocks modelled as inclined Strut



NO OF STORIES	G+10
EACH STOREY HEIGHT	3m
THICKNESS OF SLAB	150 mm
GRADE OF CONCRETE	M20
GRADE OF STEEL	Fe415
SIZE OF BEAM	0.23m X 0.35m
SIZE OF COLUMN	0.3m X 0.3m
THICKNESS OF INFILL	0.150mm
DENSITY OF BRICK INFILL	20kN/m^3
DENSITY OF AAC INFILL	6.5kN/m^3



3D render view of building with AAC blocks as inclined struts

Building Configuration Data:-

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:7.35 kN/m
iii) Wall load for AAC masonry:3.675kN/m
iv)Floor finish load : 1kN/m^2
v) Floor finish load on roof : 3kN/m^2
vi) Unit weight of Brick: 20kN/cu.m
vii) Unit weight of AAC block 6.5 kN/cu.m
viii) Modulus of Elasticity
  a) Brick : 2640 N\sq.mm
  b) AAC Block: 2040 N/sq.mm
ix) Poissons Ratio
  a) Brick : 0.2
  b) AAC block : 0.25

c) Live load

i) Imposed load: 2KN/m2
ii) Roof load: 1.5 KN/m2

d) Earthquake load

i) Types of soil: Type I which means Hard soil
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%

Time Period calculation as per IS 1893-2002
Model 1

Tx = 0.09H / SQRT(Dx)
= 0.766 sec
Ty= 0.09H/Sqrt (Dy)
= 0.766 sec

4] Modelling of Infill Walls

In this work we are comparing reinforced concrete design using autoclave aerated concrete and conventional brick as a construction

material, as the weight of autoclave aerated concrete is m uch lesser than the conventional brick, by using this advantage we can reduce the weight of infill wall on beams, co lumns, footings if conventional bricks replace by AAC bloc

k and simultaneously we can save reinforced steel. The pla

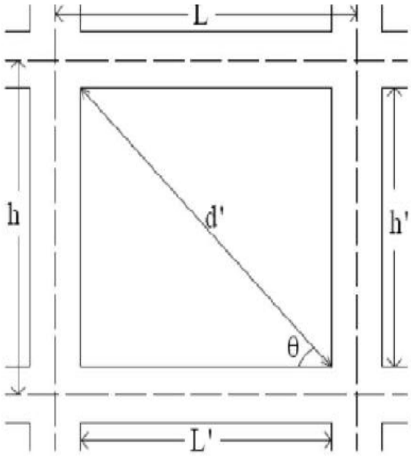


Fig.- Diagonal strut modeling of infill wall

$$W = 0.175(\lambda h)^{-0.4} d$$

Where,

$$\lambda = \left(\frac{E_i t \sin(2\theta)}{4 E_f I_c s}\right)^{1/4}$$

Ei = modulus of elasticity of infill material
Ef = modulus of elasticity of frame material
L = beam length between center lines of columns
L' = length of infill wall
h = column height between center lines of beams
s = height of infill wall Ic = moment of inertia of column
t = thickness of infill wall
d = diagonal length of strut
θ = angle between diagonal of infill wall and the horizontal in radian

The values of Width of the Diagonal strut is as follows:

of building is as follows

Diagonal Strut Formula As per Fema 360

Strut Material	Brick	AAC Block
Width of Strut	488 mm	500 mm
Thickness of Strut	150 mm	150 mm

RESULT AND DISCUSSION

The seismic analysis for the all RC frame models are consist of brick infill (M-1), model with full infill (modelling infill as a AAC block infill element) (M-2) and full infill with has been done for both the infill materials i.e. for brick masonry infill and AAC block masonry infill by using software ETABS and the results are presented below. The parameters which has to be studied are Base Shear, Displacement, Beam Forces, Column Forces, Storey Shear and Storey drift by changing the material of infill as Brick infill and AAC block infill.

Lateral Displacement

Model:-

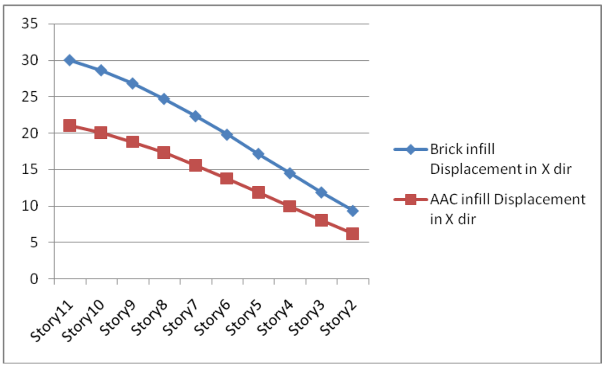
Model 1 Brick infill

TABLE: Diaphragm Center of Mass Displacements			
Story	**Diaphragm**	**Load Case/Combo**	**UX**
Story11	D1	EQX	29.977
Story10	D1	EQX	28.587
Story9	D1	EQX	26.791
Story8	D1	EQX	24.669
Story7	D1	EQX	22.303
Story6	D1	EQX	19.77
Story5	D1	EQX	17.142
Story4	D1	EQX	14.487
Story3	D1	EQX	11.865
Story2	D1	EQX	9.333

Model 2 AAC block infill

TABLE: Diaphragm Center of Mass Displacements			
Story	**Diaphragm**	**Load Case/Combo**	**UX**
Story11	D1	EQX	21.06
Story10	D1	EQX	20.089
Story9	D1	EQX	18.817
Story8	D1	EQX	17.304
Story7	D1	EQX	15.609
Story6	D1	EQX	13.787
Story5	D1	EQX	11.891
Story4	D1	EQX	9.968
Story3	D1	EQX	8.062
Story2	D1	EQX	6.208

Lateral displacement in X or Y direction for all model in all zones are as shown in fig.
Graph 1: story's wise of lateral displacement.



Therefore, The AAC block material can basically be used to replace conventional bricks as infill material for RC frames built in the earthquake prone region. The results shows that, the minimum cost of building and maximum strength of AAC brick wall in a building can helps to reduce the deflection and story drift in a building. Some studies deals with the evaluation of steel and cost of building required for the building provided with AAC BLOCK masonry wall.The seismic analysis for all the RC frame models which consist of full infill (modelling infill as a strut element) (M-1), full infill with soft ground storey (M-2). Model with infill ground storey has been done for two infill materials i.e. for brick masonry infill, AAC block masonry infill by using software ETABS and the results are presented below. The parameters which are to be studied are Base Shear, Displacement, Beam Forces, Column Forces, Storey Shear and Storey drift by changing the material of infill as Brick infill and AAC block infill. Hence The Comparison of displacement between brick in-filled frame, AAC block masonry in filled frame and hollow concrete blocks in-filled frame: The effect of infill materials on the lateral displacement is analysed for Brick masonry infill, AAC block masonry infill and hollow concrete block masonry.

CONCLUSION:-

This work is a small attempt towards the understanding of the effect of AAC infill masonry and brick infill masonry on the seismic behaviour of RC structures. In this work, the seismic behaviour of brick infill panels and AAC in-filled panel was studied and compared in a systematic manner. The main conclusions are summarized below:-
In column, considering AAC infill wall effect, the value of axial force, bending moment, Ast is less compared to brick infill frame. Because of infill wall effect, there is drastic decrease in

the value of axial force in column. Maximum Axial Force is at the foundation level.

It has been observed that the base shear, lateral forces and story shear for a structure with AAC blocks is significantly less as compared with the structure in-filled with brick masonry due to low weight density of AAC blocks. Lesser base shear will result in lesser lateral forces and as the weight density of AAC blocks is less as compare with brick masonry the dead load of AAC block masonry is less as compared brick masonry and hence economy in design can be achieved by replacing brick masonry with AAC block masonry.

The response of a structure in terms of bending moments is greatly improved in an infill model. The bending moments is reduced greatly by the introduction of infill panels. The bending moments for members of structure with AAC block in all cases were less as compared with corresponding cases of structure with brick masonry.

Therefore the corresponding benefits of construction cost is lower than conventional bricks material in RC frame structure.

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