Comparative Analysis between Masonry and AAC Infilled wall Buildings under Dynamic Loading

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Abstract : A reinforced concrete building with masonry infill is most common type of construction in India. Traditionally, conventional clay bricks or concrete blocks which are heavy rigid materials have been used as Infill wall. Though, AAC (aerated light weight concrete) blocks which are lightweight, flexible building materials that provides insulation and fire resistance and have lower impact on environment, can be used as masonry infill (MI) material in buildings. AAC blocks are now also available in India. A number of researchers have studied the behavior of AAC in-filled reinforced concrete (RC) frames experimentally. The experimental result have shown that the AAC blocks infilled RC frame exhibits better performance subjected to lateral loads than that of conventional bricks infilled frames. The study of the effect of types of infill materials used on the performance of RC infilled frames is still limited. Hence in present report, comparative study of the effect of type of infill wall material on seismic response of structure has been presented. AAC blocks and conventional clay bricks materials are used for the comparison. To check the behavior of RC frames with both AAC block and conventional clay bricks infill, analysis has been done using ETABS. Two G+8 Storey building model are considered for Comparison. One is Bare frame with masonry infill and the other is Bare frame with AAC infill wall. The results have shown that AAC block as infill material performs better under seismic loading than conventional brick.

***Keywords* - AAC block, Masonry Infill frame, Regular Plan Building, Irregular Plan Building**

I. INTRODUCTION

Reinforced concrete building with masonry infill is the most common type of construction in India. Masonry walls are provided for functional and architectural point of view and thus they are generally considered as nonstructural elements. Hence interaction of infill with bonding frame is neglected in the design. Though an infill panel interacts with bonding frame and may induce a load resistance mechanism when subjected to lateral loads. Influence of infill is ignored in modeling of the RC structure which leads to inaccuracy in guessing the actual seismic behavior of framed structures. Infilled frame shows a composite structure which is made by the combination of both RC frame and Infill walls. The Infill walls in infilled frame may be of conventional clay brick, concrete block or AAC block. The study of the influence of types of infill materials on the seismic response of infilled RC frames is still limited. Thus, in present study focus is given on the effect of type of infill material on seismic performance. AAC blocks and clay bricks are used as infill in RC frame. AAC blocks are light-weight building materials that provide insulation and fire resistance and have lower impact on environment. The experimental results have shown that the AAC blocks infilled RC frame exhibits better performance subjected to lateral loads than that of conventional bricks infilled frames. Behaviors of in-filled RC frames have been studied by number of researchers experimentally and analytically. Conclusion is made by them that infill materials influence the seismic response of the in-filled frame significantly. Infill materials improve the performance of RC frame structure. An infill wall decreases lateral deflections, story drift and bending moments in the frame and increases axial forces in the column thus reduce the probability of collapse. Hence, considering the infill leads to slender frame members in design, reducing the overall cost of the structural system.

The study include modelling of G+8 story building having regular and irregular plan. For regular plan Square and rectangular Shape is considered, while in irregular plan L, C and E Shape is considered for comparison. The Analysis was done by Response Spectrum. Comparison of Story Displacement, Maximum Story Drift, Base Shear and Fundamental Time Period is carried out.

1.1 CONVENTIONAL BRICK INFILL STRUCTURES

In the world most commonly R.C. building with infill of brick masonry is used including in the region of earthquake zone. Reinforced concrete building with brick infill walls are analyzed and designed as bare frame neglecting strength contribution and infill stiffness. Moreover the infill acts along with the response of the structures infill behaviour is different from that anticipated for building without infill. The lateral force resisting capacity and stiffness of structure can be increase by infill also up to a same level of response. The structures initial period is decreased because of increased initial stiffness of structures. Infill with brick masonry is verge to brittle failure, for evaluation of seismic. The infill wall modeling should be proper within the structure is beneficial and also to reduce the damage and consequences for proper solution of retrofit.

1.2 AUTOCLAVE AERATED CONCRETE (AAC) BLOCK INFILL STRUCTURES

In the present practice of construction the architects, designers and owners prefer the eco-friendly and green building material. Now a day's AAC material is being used as replacement of conventional brick and AAC is most commonly used eco-friendly material. AAC is a light weight, durable, high insulating and load bearing material hence it is said to be eco-friendly material. AAC material improves the construction practice quality and simultaneously cost of construction decreases. The dead load of the structure is reduced by the use of AAC material and which intern decreases the seismic design base shear of the structure. Today AAC material is revolutionary precast and offers distinctive of high strength and durability, lower in weight unmatched ability and superior features of green ecology. In other part of country the AAC materials is used as replacing ordinary clay bricks and fly ash brick since the material in the state of art green ecological building. The panels and blocks are adopted in all types of walls, internal or external, load bearing and non-load bearing walls etc.

II. SCOPE AND OBJECTIVES OF STUDY

Following are the object of this study:

1. To study the effects of infill materials on the behavior of RC frame under lateral loading.
2. To find out green and environmentally safe materials such as AAC blocks which can be used in place of conventional bricks is perform better or not in seismic prone areas.
3. To evaluate the behavior of RC frames infilled with AAC blocks and clay brick simulating earthquake forces and compare the results in terms of Displacement, Column forces, Beam forces, Storey shear, Base shear and Storey drift.

Scope of the Study:

1. The present study involves the influence of types of infill materials used (i.e. AAC block versus conventional brick masonry) on the seismic response of infilled RC frames.
2. In this project, five different types of models have been analyzed for both brick masonry and AAC block masonry.
3. A nine storey building with Masonry and AAC infill is analyzed under seismic load which is located in seismic zone-III and Response Spectrum analysis is carried out using ETAB to find out the results.

III. MODELLING

3.1 Numerical Data

In the present study different types infill materials conventional brick and light weight concrete block is taken into consideration. The building models with different types infill materials is modeled and analyzed using the computer software ETABS-2017 and the results are compared.

Table 1 Primary Data

Primary Data	Square	Rectangular	L Shape	E Shape	C Shape
Plan Area (m^2)	12 m x 12 m	12 m x 20 m	20 m x 24 m	20 m x 32 m	20 m x 32 m
Story Height	3	3	3	3	3
Beam	230 mm x 460 mm	230 mm x 460 mm	230 mm x 460 mm	230 mm x 460 mm	230 mm x 460 mm
Base Column	450 mm x 450 mm	450 mm x 450 mm	450 mm x 450 mm	450 mm x 450 mm	450 mm x 450 mm
Column	300 mm x 300 mm	300 mm x 300 mm	300 mm x 300 mm	300 mm x 300 mm	300 mm x 300 mm
Live Load (kN/m^2)	3	3	3	3	3
Floor finish (kN/m^2)	1.5	1.5	1.5	1.5	1.5
Response Reduction Factor	5	5	5	5	5
Seismic Zone	III	III	III	III	III

3.2 Material property

Grade of concrete is taken as M-20 and for reinforcing steel, Fe 415 grade of steel is used for all the model cases considered in this study. The unit weight of concrete is taken as 25kN/m^3. The unit weight for brick masonry infill and AAC block masonry infill are taken as 20kN/m^3 and 9 kN/m^3 respectively. The modulus of elasticity for concrete is taken as [5000 (fck)$^{0.5}$] which is equal to 25000MPa (as per IS: 456- 2000) and poison ratio is 0.2. The modulus of elasticity for brick masonry infill and AAC block masonry infill are taken as 5300 MPa and 2700 MPa respectively. The poison ratio for brick masonry is 0.16 and that of AAC block masonry is 0.25. For seismic weight calculations, 25 % of the floor live loads are considered because live load on floor is equal to 3 kN/m^2 as given in IS code 1893:2016.

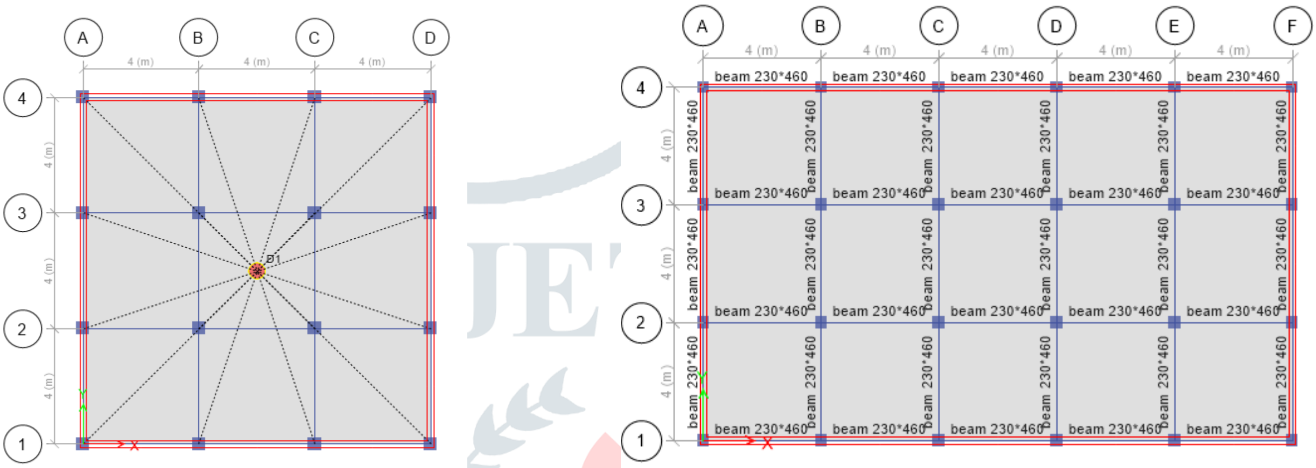


Fig.1 Regular Structure plan

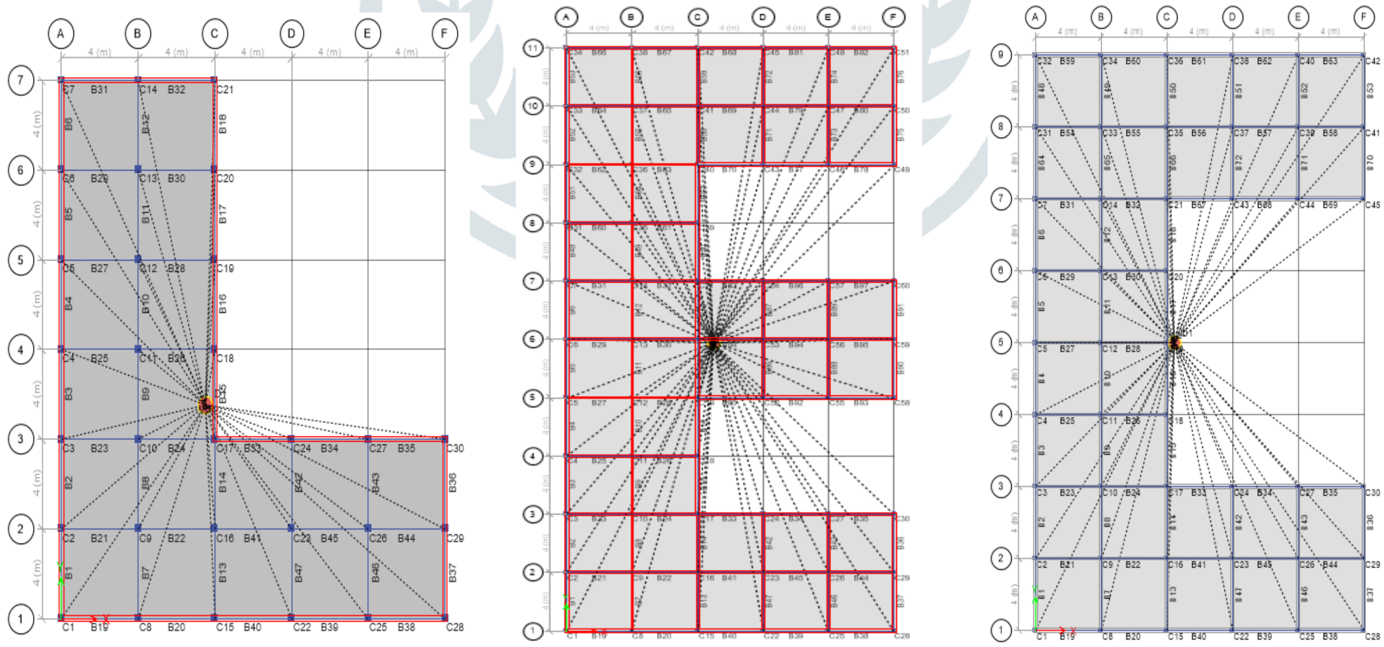


Fig.2 Irregular Structure plan

3.3 Analysis Methodology

The RC structures with infills were analyzed by Response Spectrum Analysis. The analysis were compared to study the behaviour of the structures. It is a linear dynamic statistical analysis method to indicate the likely maximum seismic response of an elastic structure. A response spectrum is simply a plot of the peak or steady-state response (displacement, velocity or acceleration) of a series of oscillators of varying natural frequency that are forced into motion by the same base vibration or shock.

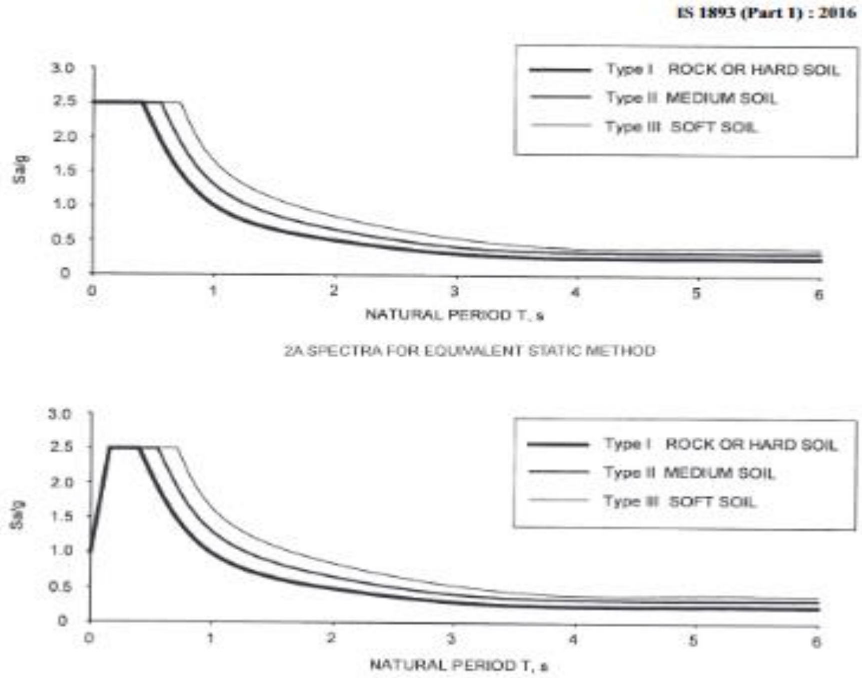


Fig.3 Response Spectrum Function

IV. RESULT

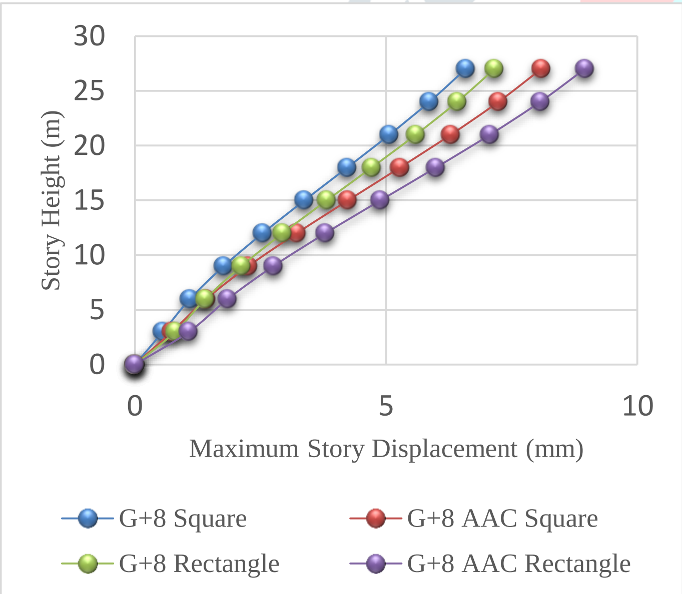


Fig.4 Maximum Story Diplacement

Building	**Max. Displacement(mm)**
G+3 Square	6.589
G+3 AAC Square	8.091
G+3 Rectangle	7.162
G+3 AAC Rectangle	8.957

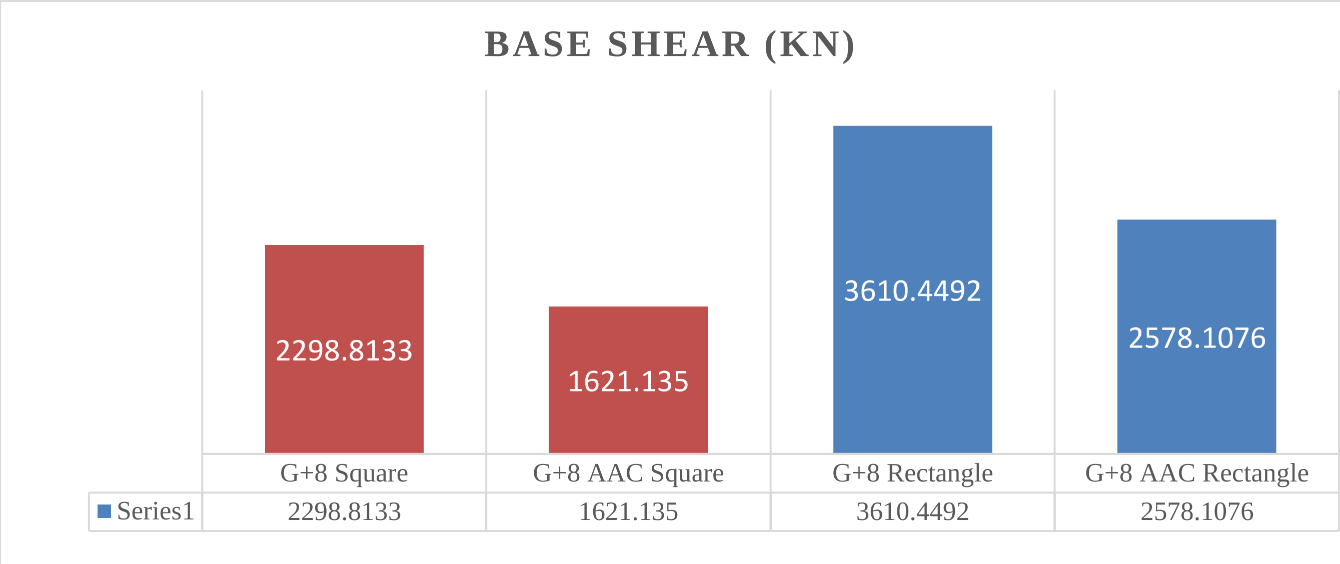
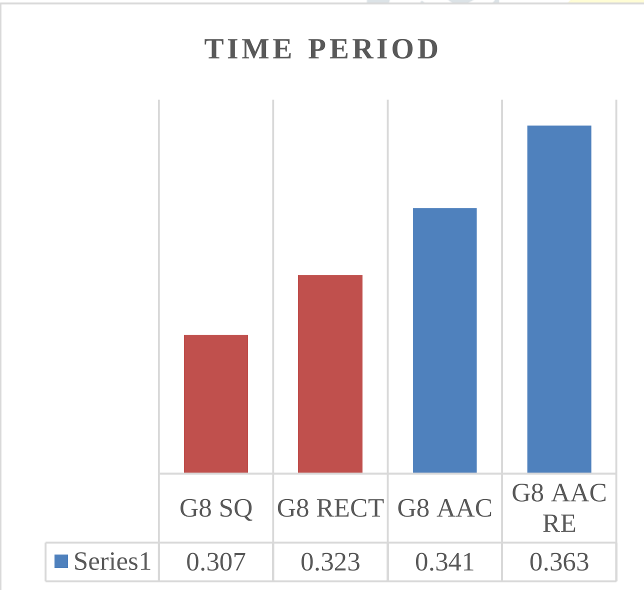


Fig.5 Base Shear for Regular Structure

Building	Percentage Reduction
G+8 Square	29.47 %
G+8 Rectangle	28.6 %



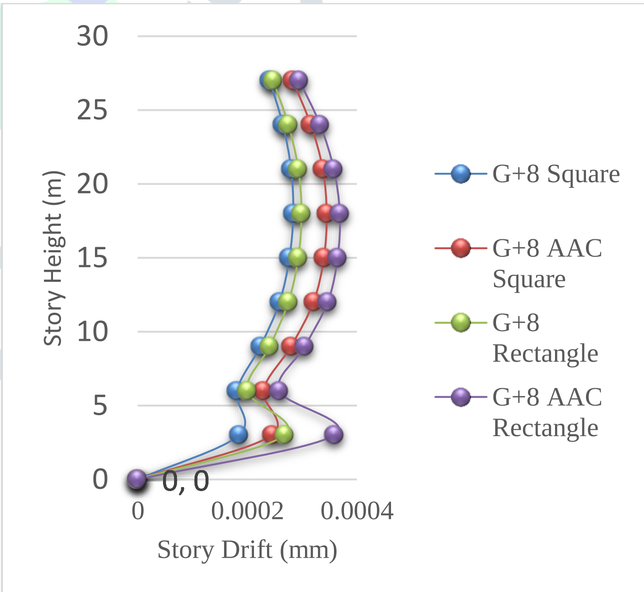


Fig.5 Time Period (sec)

Fig.6 Maximum Story Drift

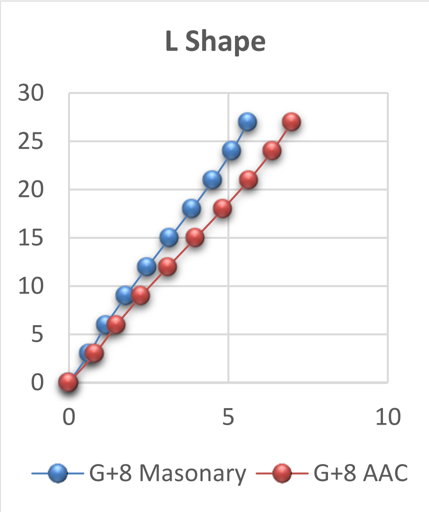


Fig.7 Story Displacement (mm)

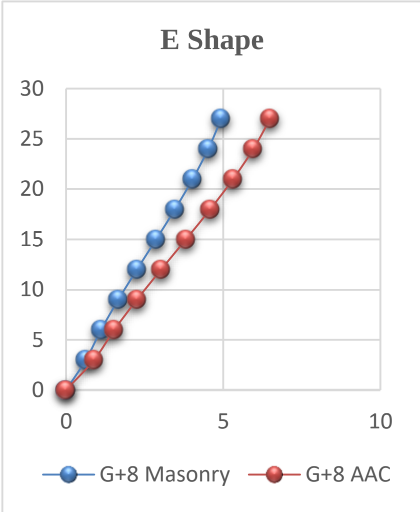


Fig.8 Story Displacement (mm)

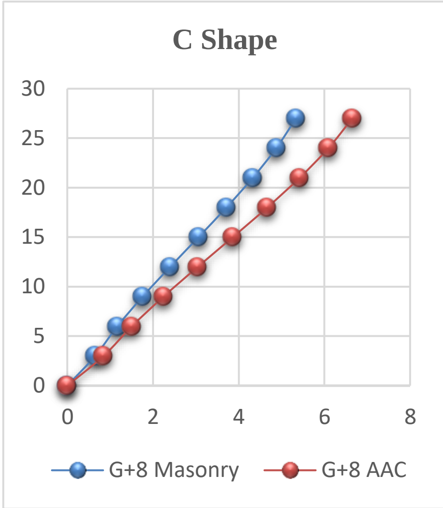


Fig.9 Story Displacement (mm)

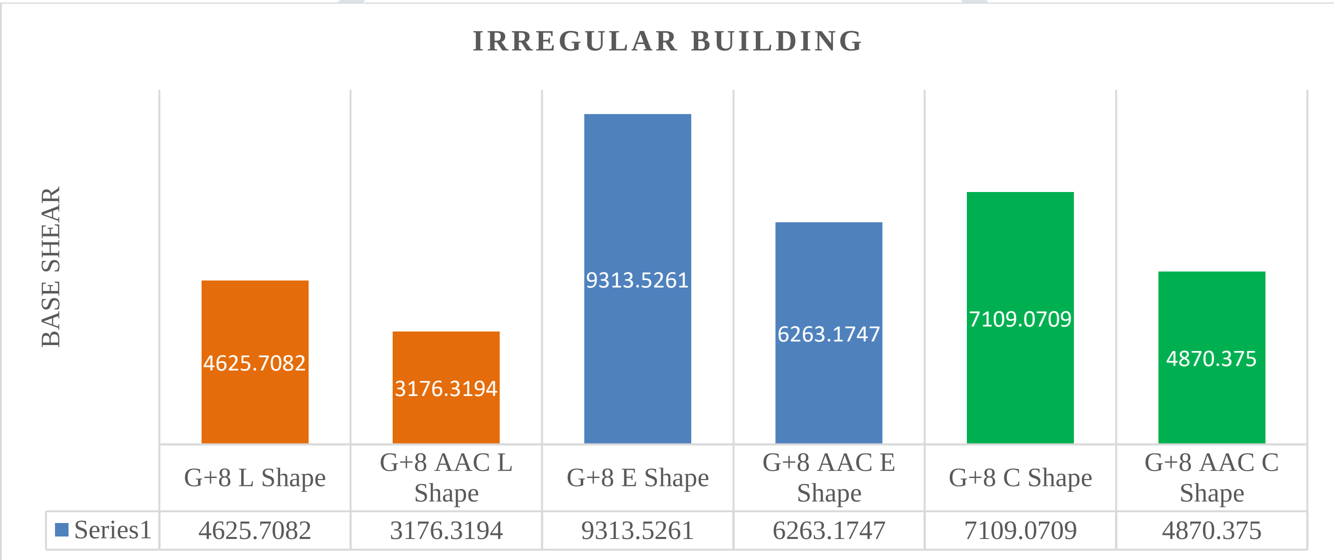


Fig.10 Base Shear for Irregular Building

BUILDING	% REDUCTION
G+8 L Shape	31.33 %
G+8 E Shape	32.75 %
G+8 C Shape	31.5%

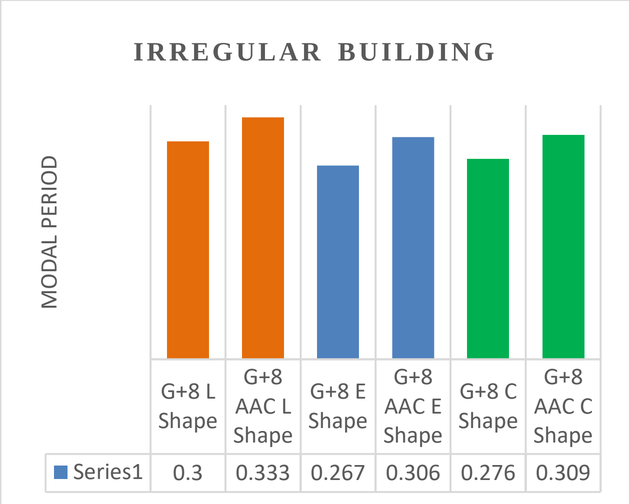


Fig.10 Time Period (sec)

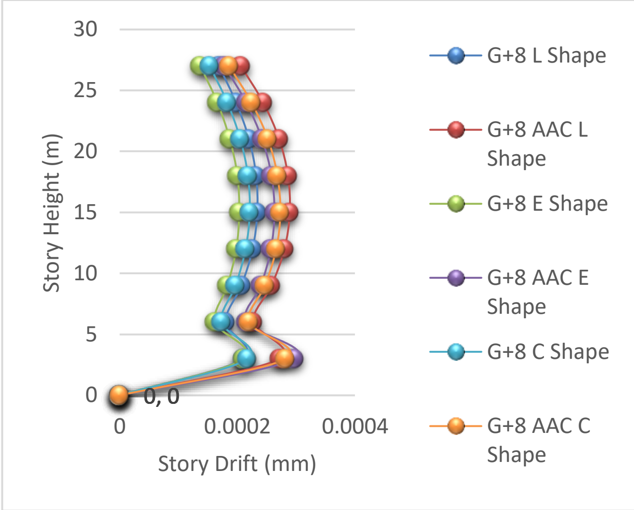


Fig.11 Story Drift (mm)

V. CONCLUSION

The present study of analysis makes an effort to understand the effect of brick infill and light weight block infill on the behaviour of RC structures. The analysis has been carried out using Non-linear analysis, with IS 1893:2016 code specified design response spectrum, using ETABS. The results of the study lead to the following conclusions.

1. From the observations larger the mass of the structure larger will be the seismic force acting on the structure. Hence the AAC block gives the lesser seismic force as compared with conventional brick. Hence it is better to use AAC block in seismic prone zones.

2. The AAC block infill model is having significantly smaller base shear as compared with conventional brick infill models which results in decrease in reinforcement to resist member forces, hence economy in construction can be achieved.

3. RC Frame Structure with Brick infill show better performance in Story Displacement and maximum story drift than structure with AAC block Infill. Story Displacement and Story Drift in AAC block infill is quiet higher than building with brick infill but it will still within permissible limit.

4. The study show that, percentage reduction in base shear for irregular structure is quite higher than regular structure. For all building AAC block give around 28-33 % reduction in base shear calculation.

5. The study show that, Building with brick infill has lower time period than building with AAC block infill. Therefore, Brick infill structure is stiffer than light weight block infill Structures.

6. The Study show that, percentage reduction in base shear for irregular structure is higher than the regular frame. Maximum reduction in base shear is obtain for E Shape plan which is 32.75 %.

VI. REFERENCES

[1] B. Bhageri, E.S Firoozabad and M. Yahyaei, March 2012, “Comparative study of static and dynamic analysis of multi storey irregular building,” *World Academy of Science Engineering and Technology*, Vol. 6, pp. 1847-1851
[2] Etabs tutorial
[3] IS 1893, “Indian Standard criteria for Earthquake Resistant Design of structures Part 1: General Provisions and Buildings”, SIXth Revision, Bureau of Indian Standards (BIS), New Delhi.
[4] J Zhou ,G. B Bu and K.N Li “Calculation Methods for Inter- Storey Drifts of Building Structures,Febuary 2010,” *World Conference on Earthquake Engineering*, vol. 1, pp. 835-843.
[5] Kiran Tidke1, Sneha Jangave, July 2016, International Journal of Innovative Research in Science, Engineering and Technology *(An ISO 3297: 2007 Certified Organization)* Vol. 5, Issue 7.

[6] Mohd Zain Kangda, Manohar D. Mehare and Vipul R. Meshram, February 2015,"Study of base shear and storey drift by dynamic analysis," *International Journal of Engineering and Innovative Technology*, Vol. 4, pp. 92-101

[7] S.K. Jain, and R. Navin,March 1995, "Seismic over strength in reinforced concrete frames," *Journal of Structural Engineering*, vol.121, pp. 580-585.

[8] S.S Patil, S.A Ghadge , C. G Konapur and C .A Ghadge, March 2013, "Seismic Analysis of High-Rise Building by Response Spectrum Method," *International Journal of Computational Engineering Research*, Vol. 3, pp. 272-275