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Survey on Study and Comparison of Structure Having Different Infill Material Using E-Tabs

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ABSTRACT: Due to recent development in structural analysis and design, high rise structures have become a popular one. The functional requirements and structural safety of a structure can be obtained from building laws, building codes and by adopting appropriate design methods. But in a developing country like India, the economy of construction is also of major importance. A frame system becomes structurally less efficient when subjected to large lateral loads such as a strong wind, earthquake or explosion. The situation becomes worse when the structural height is increased. In the current study the focus is on the investigation of the effect of infill in building and their behaviour in structure. There are different types of infill materials used in buildings, like brick infill, AAC block infill, Hollow concrete blocks infill etc. In this study focus is on behaviour of structure with different types of infill materials used. In this study four different types of model used- (1) RCC frame taking infill masonry weight, neglecting effect of stiffness. (2) Effect of stiffness is considered in addition to taking weight of infill (3) (Effect of stiffness is considered in addition to weight of infill excluding soft ground storey (4) (Effect of stiffness is considered in addition to weight of infill including soft ground storey effect. For each infill four cases studied. In this study three types of infill material used first is brick infill, second is AAC block infill and third is Hollow concrete block infill. So there for three types of infill material in which models have been prepared in ETABS. In this study 10 storey building is considered for analysis which is located in zone 4 earth quake region. Static analysis is done using ETABS software, soil conditions are to be medium and importance factor is to be taken as 1.2. Various parameters studied like lateral displacement of building, axial load in column, storey drift, storey shear, base shear, and moment's diagrams for a particular beam for all three types of material and for all four cases. Results are represented in graphical as well as in tabular form. The structural members are modelled with the ETABS software package. Rigid end conditions are assumed for the frame members and the floor slab is assumed to act as diaphragms which ensure integral action of all the lateral load-resisting elements. The floor finish is taken to be 1.5 kN/m2 on the floors. The live load on floor is taken as 2 kN/m2. In the analysis, 25% of the floor live load is considered in seismic weight calculations as per code IS 1893:2002.

KEYWORDS: Soft storey, masonry infill, RC frame, earthquake, displacement, drift, base shear AAC blocks, Hollow concrete blocks.

I. INTRODUCTION

1.1 Introduction

Reinforced concrete structures with masonry infill's are very common type of construction in India. Masonry walls provide good architectural finish as well as it is quite useful with functional point of view. They are considered to be nonstructural elements. It is considered that these in fills do not have bonding with the frames in the design. Although an infill panel interacts with the frame when it is subjected to the lateral forces. As per now a days designs for the calculations of the seismic behavior of the RC frames the infill are not considered as their structural part and only as a load providing element but this leads to an inaccurate results and hence actual seismic behavior of structure is not guessed properly. The infill walls could be filled with various elements some of them are conventional bricks, AAC blocks, solid concrete blocks, hollow concrete blocks etc. Still this field has to go through a lot of study and research to understand properly the use of the various infill. In present study focus is about the response of various infill to the seismic activities. Hollow concrete, AAC blocks, and clay bricks have been used as the infill in the RC frames. AAC blocks are light- weight building material and provide insulation and fire resistance; they also have lower impact on the environment.

Hollow concrete blocks are also very light weight but not light as AAC blocks .Hollow concrete blocks provide much better insulation to the building and is a good material to construct a green structure. The experimental results have

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shown that the hollow concrete blocks infilled RC frame exhibits better performance subjected to lateral loads than that of AAC and conventional bricks infilled frames. Infill materials improve the performance of the RC frame structures as they somehow participate in frame structural part also. An infill wall decrease lateral deflections, storey drift, and the bending moment in the frames, and it also increase the axial loads in the columns hence the possibility of collapse of the structure decreases. As infill leads to design of slender members in design and makes the building more economical. Present IS code IS 1893(Part-I): 2000 doesn't provide provisions for considering the effect of infill, hence the strength and stiffness of the infill walls are not considered in the general design practices in India. As we are neglecting the structural strength of the infill walls, it can cause inadequate information and can lead to the failure of the structure. The failure can take place due to excessive stiffening of the infill walls and hence unequal transfer of lateral forces at various stories. Further failure modes can be due to

1. short columns column effect
2. torsional forces
3. Cracking of the infill walls.

Lateral Load Resisting System Lateral force resisting elements must be provided in every structure to brace it against wind and seismic forces. The principal types of resisting elements are as follows and the details are shown in Figure 1.1¬ Moment frames ¬ Shear walls ¬ Braced frames Infilled frames.

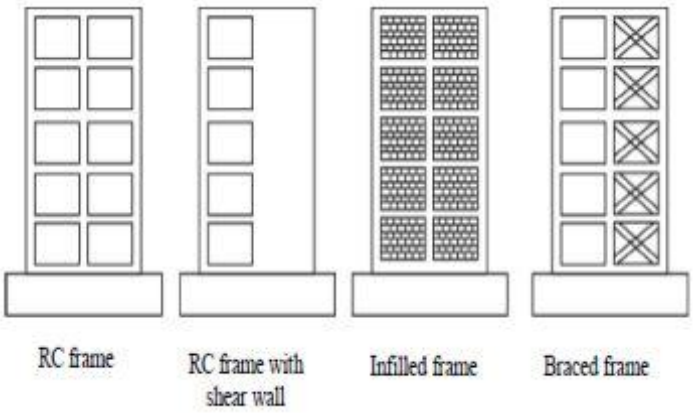

Fig. 1. Lateral load resisting system

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1.2 Drawbacks of Clay Bricks

1 Continuous use of clay bricks leads to extensive loss of fertile top soil in construction industry. This is not eco-friendly; a big loss to the environment takes place due to this.
2. We should use alternative building materials like Fly ash bricks, AAC blocks and hollow concrete blocks to keep the cost of building materials in reasonable range.
3. Use of alternative building materials like Fly ash bricks, AAC and hollow concrete blocks will decrease the rate of deforestation. Vast area of land is going under deforestation only in the search of top soil.
4. Old technology is used for manufacturing of Burnt clay bricks; quality testing facilities are not available at manufacturing sites. Most of bricks are inferior in quality with low compressive strength, manufactured using old technology. They are not recommended for use in multistory buildings.

1.3 AAC Blocks:

1.3.1 Overview:

India is having a tropical climate and most of the time during the year the temperature remains quite high and hence we require materials which are highly insulating in nature. Hence the designers go for green and ecofriendly material .One of the widely use material is AAC blocks

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Dr. Johan Eriksson developed Autoclaved Aerated Concrete block in 1923 and was patented for manufacturing in 1924. These blocks lower the environmental impact. It is very new to Indian markets. The density of AAC is around 1/3rd of conventional clay bricks hence reduces the seismic forces on the structure. Experiments show that much lesser deflections takes in the structure when AAC blocks are used instead of clay bricks. Fly ashes are used as the raw material for manufacturing of the AAC blocks. Fly ashes are the waste generated from the thermal power plants and their disposal is a major issue these days, hence the AAC blocks could help significantly in this direction. AAC blocks are far more durable when compared to clay bricks.

1.3.2 Advantages of Using Autoclaved Aerated Concrete Blocks

(A) Lightweight:AAC Blocks are about 3 times lighter than conventional bricks resulting less dead weight of buildings and therefore reduces the amount of concrete and steel uses in the building. As a result it has following advantages
1. Saving the cost of handling and transportation.
2. Better earthquake resistance due to light weight of the structure.
3. Savings in foundation and structural costs due to less dead load. .

(B) Economical:
1. AAC blocks are bigger in size of conventional bricks which results fewer joints thus savings in cement and mortar.
2. AAC blocks are factory made with finished edges & shapes which results reduction in cost of plaster.
3. Reduced dead load due to low density results saving in consumption of structural steel.
4. Greater area is covered for the same mass of brick by AAC block, results saving in transportation costs.

(C) Thermal Insulation: AAC has got a lot of air bubbles in between them hence they do not conduct the heat much and hence provides better thermal insulation, it results in reduction of cost for cooling and heating. 1. It keeps interior cool in summer and warm in winters. 2. It reduces air conditioning loads by 25-30% and hence save energy.

(D) Fire Resistance: 1. AAC block is noncombustible and has a melting point of approx. 1500 degrees Centigrade which is much higher than other building materials. 2. During a fire, No toxic fumes are generated, thus saves precious lives during a fire.

(E) Sound Insulation: AAC blocks have better sound insulation properties than conventional brick.

(F) Easy Workability: The workability of AAC blocks better than wood. Hence it is easy to cut, reducing the amount of waste generated from cutting.

(G) Environment Friendly: Due to light weight of AAC, energy is saved in transportation which reduces the CO2 emissions by transport vehicles. AAC uses Fly ash waste and solve the problem of disposal. Thus it is Environment Friendly material in construction industry.

(H) Earthquake Resistance: AAC blocks provides less dead load on the structure and hence reducing earthquake forces as it is function of mass.

(I) Less Maintenance: AAC blocks doesn't suffer from the salt efflorescence while there is a lot of problem in the clay bricks regarding this hence it is good to use the AAC blocks where there is lot of slats present in the top soil .

(J) Easy Transportation: As the density of clay bricks is higher they suffer a lot of breakage during transportation while this is not a major issue in transportation of AAC blocks.

(K) Long Term Use: AAC does not deteriorate over time and thus routine repairs are not required.

(**L) Shorter Project Duration:**Due to bigger size of AAC blocks, construction is fast compared to clay brick which leads shorter project duration.

(M) Precision: Precise architectural design dimension are attained in AAC blocks due to machine finished precast AAC elements.

1.4 Concrete Hollow Blocks: Hollow concrete blocks are good substitutes for conventional bricks and stones in building construction. These are made of concrete but these are kept hollow in between to reduce the material and make

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the block lightweight. They are lighter than bricks, easier to place and also economical in foundation cost and consumption of cement. In comparison to conventional bricks, they offer the advantages of uniform quality, faster speed of construction, lower labor involvement and longer durability. In view of these advantages, hollow concrete blocks are being increasingly used in construction activities.

1.5Behavior in the Presence of Infill Wall

Under lateral load condition the frame and the infill wall tends to stay intact initially. As the lateral load is increased the infill wall gets separated from the surrounding frame at the unloaded (tension) corner, but at the compression corners the infill walls remaining still intact in position as previously. The length over which the infill wall and the frame are intact in position is called the length of contact. Load transfer in the wall occurs through an imaginary diagonal which acts like a compression strut member. Due to this behaviour of the infill wall, they can be modelled as an equivalent diagonal strut by connecting the two compressive corners diagonally. The property of the stiffness should be such that the strut is active only when subjected to compression. Thus, only under lateral loading one diagonal will be operating at a time.

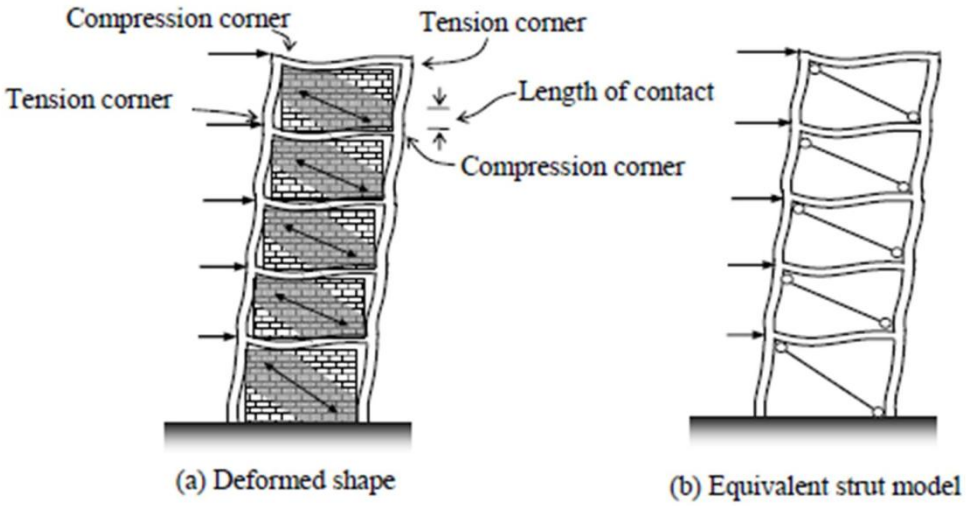

Fig.2 Showing the behavior of infill frame

1.6 Structural analysis and modelling

Various literatures and previous studies were conducted to obtain the idea about the modelling process and the representation of infill in particular. Modelling of structures as a 3-Dimensional computer model generally creates no additional problems due to the irregularities in structure and soft storey effect (E L Wilson 2002). Strength, stability and rigidity are the important factors that are to be considered while modelling the distinct structural system to resist gravity and lateral loading. The building is considered to be a vertical cantilever as far as seismic loading is concerned and hence the influence of horizontal loading caused by the earthquake is more effective as the height of the structure increases, (Smith and Coull, 1991). Moment resisting rigid frame system that mainly comprises of beam and columns connected by a moment resisting system is extensively used for the modelling of low rise building .In this modelling the joints created by each beam and column carries 6 degree of freedom . For most of the buildings the stiffness of the frame members are generally considered low as compared to in-plane stiffness of the floor systems. Because of this the in-plane deformations of all the beams are neglected and the walls and columns are constrained to move as an isolated single unit in lateral directions. By using this property in the modelling we can reduce the dimension of the system of the equations of the building.

1.7 Problem Statement

The high rise buildings now-a-days are provided with soft storey's for parking purpose. When such building is located in the earthquake prone area, can be subjected to heavy lateral forces. Due to the presence of soft storey in a building, the lateral load resisting capacity of building decreases, thereby the stiffness of building decreases. This leads to sudden failure of structure. To increase the lateral strength and stiffness of a structure, AAC BLOCK is introduced in a structure, such that the building can sustain under the seismic loads and decrease the overall cost of building.

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1.8 Objectives

The brick masonry is a brittle material and it has been found to fail prematurely by shearing along the bedding panels or by diagonal splitting. Structural limitations of brick masonry like poor shear and tensile strength, brittle characteristics, potential damages from debris and vulnerability to out of plane loads restrict their role as an effective infill in resisting lateral loads. The main objectives of this project is to overcome the above limitations, traditional brick infill has been changed by using hollow blocks and aerocon blocks masonry infill as well as by using reinforced masonry infill to find the effectiveness of reinforced masonry in resisting lateral loads.

The aim of the present work is

1. To Study Various Parameters - Lateral Displacement of Building, Axial Load in Column, Storey Drift, Storey Shear, Base Shear and Moment's
2. To Create Analytical Model using Equivalent Strut Concept Using ETAB Software.
3. To Compare the Analytical Results Value.

II. LITERATURE REVIEW

Sachin Surendran and Hemant B. Kaushik et.al.(1) Reinforced concrete (RC) frames in-filled with unreinforced masonry walls are quite commonly constructed all across the globe since many decades. Past researchers have tried to find out experimentally and analytically the influence of several parameters, like opening size and location, aspect ratio of openings, connection between frame and infill wall, ductile detailing in frame members, material properties, failure modes, etc. on behaviour of masonry infill RC frames. Accordingly, several analytical models have been proposed in the literature and seismic codes of some countries to model the stiffness and strength properties of infill walls. Most of the past studies and seismic codes recommend modelling the in-fills as equivalent diagonal struts, and cross sectional area of the struts are reduced appropriately to account for openings in the walls.

Prof. P.B Kulkarni1, Pooja Raut , Nikhil Agrawal et.al (2) Many urban multi-storey buildings in India today have open first story as an unavoidable feature. This leave the open first storey of masonry in-filled reinforced concrete frame building primarily to generate parking or reception lobbies in the first storeys. Masonry infill walls are mainly used to increase initial stiffness and strength of reinforced concrete (RC) frame buildings .It is mainly considered as a non-structural element. In many cities of India, it is very common to leave the first storey of masonry in-filled reinforcement concrete (RC) frame building open preliminary to generate parking space or any other purposes (Ex-Reception lobbies) in the first storey. This Open First storey is also termed as "Soft Storey". The upper storeys have brick in-filled wall panels with various opening percentage in it.

Ms. Rajashri A. Deshmukh et.al (3) Earthquakes represent the largest potential source of causalities and damage for inhabited areas due to natural hazard. The construction of RC buildings with unreinforced infill wall is a regular practice in India. Infill panels have usually been made of heavy rigid materials, such as clay bricks or concrete blocks. However, more lightweight and flexible infill options such as AAC (aerated light weight concrete) blocks are now obtainable in India to be used as masonry infill (MI) material in reinforced concrete (RC) framed buildings. It has been accepted that infillmaterials considerably influence the seismic performance of the in-filled framed structures. Number of researchers studied the behaviour of in-filled RC frames experimentally and analytically.

Nusfa Karuvattil1, Priyanka Dilip P. et.al(4) Many urban multi-storey buildings in India today have open first storey as an unavoidable feature. This leave the open first storey of masonry in-filled reinforced concrete frame building primarily to generate parking or reception lobbies in the first storey . Masonry infill walls are mainly used to increase initial stiffness and strength of reinforced concrete (RC) frame buildings .It is mainly considered as a non-structural element. In many cities of India, it is very common to leave the first storey of masonry infilled reinforcement concrete (RC) frame building open preliminary to generate parking space or any other purposes (ExReception lobbies). This Open First storey is also termed as "Soft Storey". The upper storeys have brick in-filled wall panels with various opening percentage in it.

István Haris1, Gyorgy Farkas et.al. (5) In many countries it is a common practice to infill some of the bays of the steel and/or concrete frame. Traditionally infill walls are usually considered as non-loadbearing, non-primary structural elements The main goal of this paper is to present an executed research experiment, planned to include a group of 15, onethird scale, one-bay, two-storey reinforced concrete (RC) frame specimens in-filled with masonries with different stiffness. The aim of the complete research experiment was to analyse, in accordance with the international scientific research trend, the behaviour of masonry in-filled concrete frames for earthquake action, particularly for cyclic lateral loading under and over the appearance of the main continuous diagonal, corner- to-corner cracks. In the first step the

in-filled frames were loaded in one direction with monotonic increasing lateral loads. In the second step of the research the in-filled frames were investigated in two lateral directions in cases of cyclic top loading with different load histories. This paper shows the conclusions of the experimental programme.

Ugur Albayrak, Eşref Unluogl, and Mizam Dogan et.al.(6) Infill walls are considered to non-bearing structural members but affect not only structure masses also lateral rigidities which may cause free vibration behaviour of the buildings. Although infill walls are not considered structural members, they are acting together with the frame when subjected to seismic loads. Analyse and calculation models including infill wall contribution are difficult and complex especially on major construction projects. Behaviour of masonry in-filled R.C. frames under seismic loads should be modelled to consider the effect of the infill walls on the seismic performance of the structure. In this study an overview of the modelling methods of infill walls in reinforced concrete frames is presented. The advantages or disadvantages of the presented methods are discussed and an easy and effective procedure is suggested for using in practice design.

III. CONCLUSION

From the results, it has been noticed that displacement of the structure with AAC block in all the three Model cases is found less than that of conventional brick masonry. When displacement results of Model 1 and Model 2 and Model 3 in the both type of masonry infill as AAC blocks and brick infill hollow concrete block are compared, Model 2 is preferred than Model 1 because displacement is least in case of Model -2. This is because, In Model 2 strength and stiffness of the masonry panel is considered by modeling infill panel as equivalent diagonal strut which reduces the lateral deflection of the structure. The results of Model 2 and Model 3 are comparable with very less increase in displacement in Model 3 compared to Model 2 because of soft ground storey. From the results, it can be observed that storey drift of the structure is found less in AAC block masonry infill in all the three model cases with the corresponding model cases of brick masonry. Model 1 shows highest storey drift then the other models in both types of masonry infill panels. Storey drift in model 2 is less than model 1 and 3 because stiffness is taken into consideration in model M-2. The results of model 2 and model 3 are comparable expect ground storey. The storey drift of first storey in model M-3 is very large than the upper stories due to absence of infill walls in the first storey. It is observed from the results that storey shear with AAC is significantly less as compared to brick masonry infill panel. It is because of light weight of AAC blocks. Model M-2 has more storey shear than M-1 and M-3 because Storey shear is depend on stiffness of the frame. The struts in masonry infill resist the lateral seismic forces through axial compression along the strut. The contribution of infill increases the stiffness of the frame this resulting increase in seismic forces. Model M-1 has the least value of storey shear with both type of infill materials because stiffness has not been considered in case M-1. Base shear in case of AAC block masonry is also less in all the three models compared to brick masonry panels. This is because of light weight of AAC blocks. Less base shear results lesser lateral forces.

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