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To Study the Effect of Lateral Loads on RCC Frame Building with Different Masonry Infills by Considering Masonry Infill as A EquivalentDiagonal Strut Element

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***Abstract*—Burned clay bricks are traditionally used construction materials for partition wall in load bearing as well as in RCC building, nowadays Autoclaved aerated blocks (AAC) block are used on large scale as a construction material for partition wall in RCC frame. Masonry infill in load bearing structure is considered as a structural element since it transfers direct load but in case of RCC frame where masonry infill is used only as a partition wall its structural behavior is neglected most of the time. This paper primarily focuses on the effect of masonry infill on RCC frame when subjected to lateral loading and comparison between two types of materials that is burned clay bricks and (AAC) block by comparing response of buildings. For this modelling of masonry infill is done as a equivalent single diagonal strut element in relevant computing software and response spectrum analysis is performed to analyze the buildings.**

Keywords—Masonry infill, AAC block, Burned clay brick, RCC frame, Response spectrum analysis, Ductility.

I. INTRODUCTION

Reinforced concrete (RC) frames have been used as primary gravity and lateral load resisting in buildings across the world for the past century. Masonry infill panels are also often used in these buildings for aesthetics and functional purposes. These panels do not participate in gravity load transfer. However, the panels interact with the RC frames when subjected to lateral loads (e.g., during earthquakes), thereby impacting the load path, share of load taken by frame and the response of the overall system. Since properties of the frame and infill panels are quite different, the interaction between frame and infill is complex. As a consequence, most design codes across the world ignore the contribution of masonry panel in strength and stiffness calculations or consider it inadequately.[2]

Earlier the effect of Masonry infill of burned clay bricks in RCC frame have been studied but nowadays (AAC) block masonry infills are being used on large scale due to the lightweight and fast mode of construction. In this paper the effect of AAC block masonry infill is also studied along with burned clay bricks masonry infills. [8]

The 3D model is drawn in ETABS software and modeling of masonry infill panels is done as a equivalent single diagonal strut element based on guidelines given in IS 1893 (2016) code.

A total of 6 models were drawn first 3 models are of RCC frames with burned clay brick infills (0% infill, 50% infill, 100% infill) and next 3 models are of RCC frames with AAC block infills (0% infill, 50% infill, 100% infill).Response spectrum analysis is performed to analyze the behavior of building with different masonry infills.

II. PROPOSED WORK

A. Methodology

The methodology includes 3D modelling of RCC frame in relevant computer software and analyzing its behavior with masonry infill and without masonry infill, for this research two types of masonry infills are considered one is unreinforced burned clay brick masonry infill and other one is the AAC block masonry infill. Accordingly, 6 3D models are drawn, and Response spectrum analysis is performed to study the behavior of RCC frames with two types of infills based on the results obtained.

B. Problem statement

Three, ten storied symmetric square RC buildings, 20m X 20 meters in plan as shown in Fig. 1 have been considered for each case that is for Building with brick infill and AAC block infill. In all buildings weight of brick infill has been considered but lateral strength and stiffness of infill is neglected in the first building. First building is 0% infill (Fig. 1(a)), second building with 50% infill in each direction placed symmetrically (Fig. 1(b)), and third building with 100% infill in both direction (Fig. 1(c)). External brick wall thickness is 230 mm and internal wall thickness is 150 mm and in case of AAC block external wall is of 200mm and internal wall is of 100 mm thickness. Live load intensity on all floors except on roof terrace is 3 KN/m2 and on roof terrace is 1.5 KN/m2 has been considered. The intensity of floor finishes is taken as 1KN/m2 and for roof water treatment is as 1.5 KN/m2. Site located in Indian seismic zone V. Building is resting on medium soil and Importance factor have been considered as 1.The building is designed as special moment resisting frame as per IS13920. The building is analyzed by linear response spectrum method for

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member optimization and designed for load combinations as in IS 456-2000 and IS 1893-2002, Indian design codes.

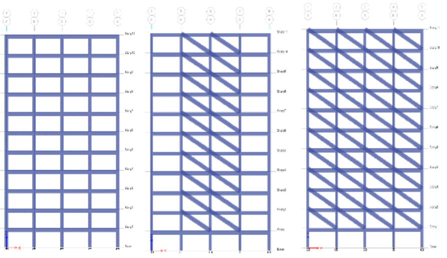

Fig.1(a). 0%infill**Fig.1(b).** 50%infil**Fig.1(c).**100% infill

Table 1 Building Data

Item	Dimension (mm)	Description
Span	20 x 20	Plan
Column	450 x 600	M25, Fe500
Beam	300 x 600	M25, Fe500
Slab	150	M25, Fe500
Supportcondition	-----	Fixed

C. Non linear modelling of brick infill

The analytical modeling of Infill frames is a complex issue because these structures exhibit highly nonlinear inelastic behavior, resulting from the interaction of the masonry infill panel and the surrounding frame. Several models have been proposed by various researchers. FEMA27310 has proposed the single diagonal strut model of infill by considering deformation-controlled action with specified properties. IS 1893 (2016) also has provisions to model brick infill into single diagonal strut to analyze the behavior of RCC frame with and without masonry infills. In the present study IS 1893 (2016) recommendations are used to model the brick infill into equivalent single diagonal strut. Two types of infills are considered based on materials one is Unreinforced brick masonry infill and other one is the Autoclaved aerated block (AAC) block infill. The ends of diagonal strut shallbe pin jointed to RC frame. [8]

The estimation of in-plane stiffness and strength of URM infill walls shall be based on provisions given hereunder. masonry infill and other one is the Autoclaved aerated block (AAC) block infill. The ends of diagonal strut shall consider to be pin jointed to RC frame.

The estimation of in-plane stiffness and strength of URM infill walls shall be based on provisions given hereunder.

The modulus of elasticity E_m (in MPa) of masonry infill wall shall be taken as:

$E_m = 550F_m$(Cl.7.9.2.1 IS 1893 2016)

WhereF_m is the compressive strength of masonry prism (in MPa) obtained as per IS 1905 or given by expression:

$f_m = 0.433 f_b^{0.64} f_{mo}^{0.36}$(Cl.7.9.2.1 IS 1893 2016) Where,f_b = Compressive strength of brick, in MPa: and

f_{m0} = Compressive strength of mortar, in MPa.

URM infill walls shall be modeled by using equivalent diagonal strut as below:

Ends of diagonal struts shall be pin jointed to RC frame:

For URM infill walls without any opening, width W_{ds} of equivalent diagonal strut shall be taken as:

$$w_{ds} = 0.175 \alpha_h^{-0.4} L_{ds}$$

Where,

$\alpha_h = h\left(\sqrt[4]{\frac{E_m t \sin 2\theta}{4 E_f I_c h}}\right)$ (Cl.7.9.2.2 IS 1893 2016)

Where E_m andE_f are the moduli of elasticity of the materials of the URM infill and RC MRF, $I_c$the moment of inertia of the adjoining column, t the thickness of the infill wall, and θ the angle of the diagonal strut with the horizontal:

For URM infill walls with openings, no reduction in strut width is required: andThickness of the equivalent diagonal strut shall be taken as thickness t of original URM infill wall, provided *h*/*t*<12 and *l*/*t*<12, where h is clear height of URM infill wall between the top beam and bottom floor slab, and l clear length of the URM infill wall between the vertical RC elements (columns, walls or a combination thereof) between which it spans.

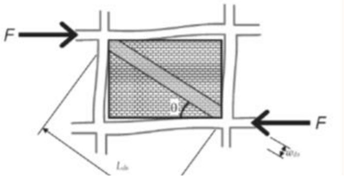

Fig.2. Equivalent diagonal strut of URM infill wall

D. Dynamic properties of three buildings

The dynamic properties of three buildings are obtained from modal analysis using ETABS 2000 software. It can be observed from table 2 that the time periods get reduced drastically, due to inclusion of infill in models. Time period obtained from empirical codal provisions shows that empirical formula gives much lower time periods, imposes larger base shear on the building and results in conservative design. In this case Unreinforced burned clay brick masonry infill is considered for the analysis.

Table 2 Dynamic Properties of three buildings

Building No.	Time period (sec) from		Modal mass participation factor			
	Software	IS 1893	Mode	Build1	Build2	Build3
1	1.43	0.96	1	79.09	80.86	82.56
2	0.89	0.602	2	6.19	9.17	6.11
3	0.70	0.602	3	2.09	2.09	3.03

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E. Axial forces and bending moment in columns

Figure 3(a) and 3(b) shows the values of axial force and bending moment (B.M.) in for specific values of seismic intensities. It can be observed from the Figs.that axial force due to earthquake gets increased and bending moment gets reduced (Figs. 3 (a), (b)) in the columns in buildings 2 and 3 for a particular level of earthquake. The column axial forces in infilled frame, due to earthquake forces, are large enough to cause net tension in columns on tension side and the failure of columns may occur due to tension. Similarly, on compression side, the column axial load increases, considerably, due to presence of infill's. This increase in axial load may result in failure of columns at a lower moment and it considerably reduces the ductility of columns. This may also result in yielding columns prior to yielding beams.

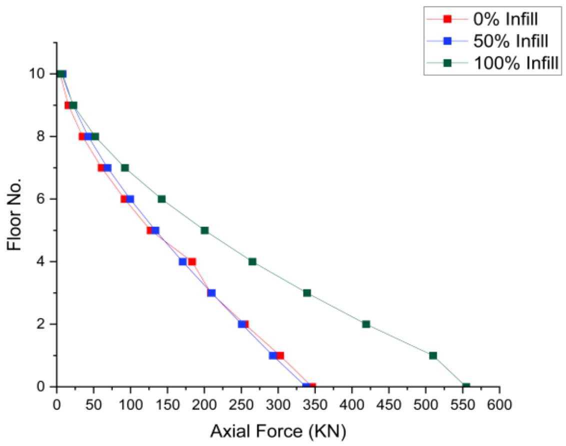

Fig.3(a). Axial forces in column

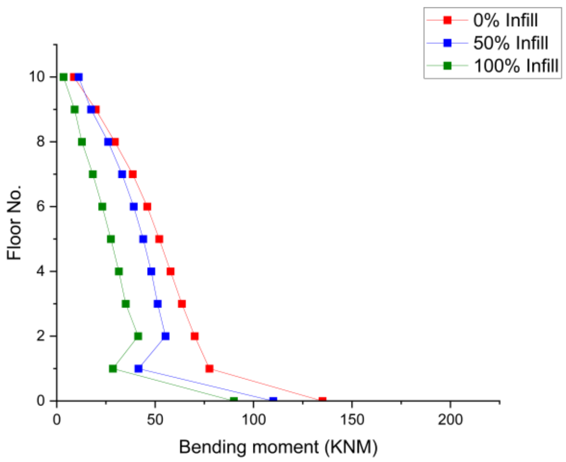

Fig.3(b). Bending moment in column

Theabove results are obtained after performing earthquake analysis on Buildings with Unreinforced burned clay brick masonry walls, the buildings with AAC block masonry infills show similar trend of increase in axial forces in columns and decrease in bending moments in columns after subjected to lateral loads but with less values as compared to URM infill.

III. RESULTS

Response spectrum analysis has been performed on both types of models viz. with Unreinforced burned clay brick infill and AAC block masonry infill. Basic parameters are chosen for determining the behavior of building and results are compared. To know the effect of masonry infills on ductile behavior of RCC frame.

Fig.4(a) compares the story displacements of the floor and shows that building with 100% infill has less displacement in X-direction than the building with 50% infill and 0% infill.

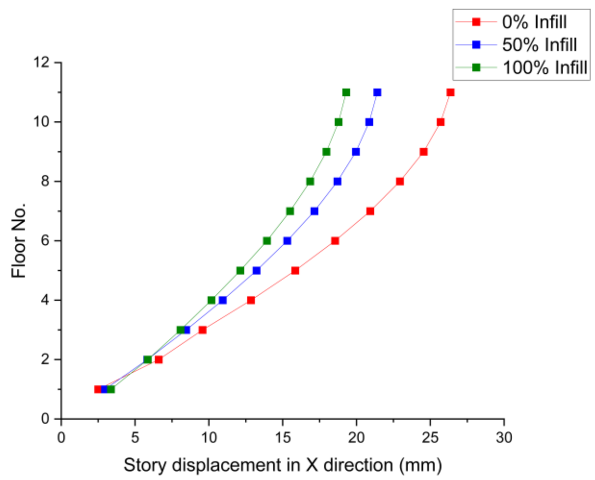

Fig. 4(a). Story displacement in X-direction in case of URM Infill.

Fig. 4(b) Compares the story displacements of the floor and shows that building with 100% infill has less displacement in X-direction than the building with 50% infill and 0% infill.

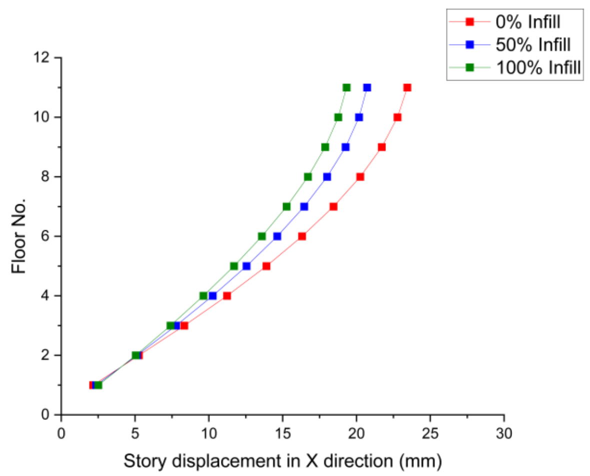

Fig.4(b). Story displacement in X-direction in case of AAC block Infill.

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Fig. 4(c) Compares the story displacements of the floor in case of AAC block infill (100%) and URM Infill (100%) and shows that building with AAC block infill has less displacement in X-direction than the building with URM Infill.

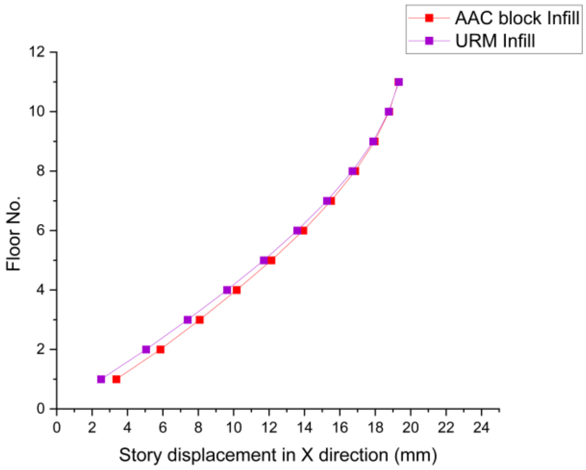

Fig.4(c). Story displacement in X-direction in case of AAC block Infill and URM Infill.

IV. Conclusion

The present study is based on response spectrum analysis performed on two types of models that is building with URM infill and building with AAC block infill. The infills when subjected to lateral loads interact with beam column frame and as a result stiffness of building increases, timeperiodgets reduced, axial forces in columns gets increased, bending moment in columns gets reduced. The increase in axial forces in columns may result in brittle failure, as a time period gets reduced a significant increase in base shear is observed upon inclusion of infills in bare frame. When we compare story displacements of both types of models, in each case the building with 0% infill has more story displacement at each floor as compared to building with 50% and 100% infill. From this we can conclude that infills in bare RCC frame increases the stiffness of structure when subjected to lateral loads and as a result the story displacements get reduced in case of building with 50% and 100% infill. When we compare the two types of buildings that is building with URM infill and AAC block infill subjected to response spectrum analysis story displacements in each case is somewhat like each other in building with 100 % infill.

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