SEISMIC ANALYSIS OF INFILLING IN MULTISTORIED BUILDING

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ABSTRACT

Reinforced concrete frame buildings with masonry infill walls have been built all around the world, specifically in the high seismic zones such as Zone 4 to Zone 5. Annotations from past earthquakes show that these buildings can endanger the lives of their occupants and lead to momentous damage and loss. Masonry infilled frames built before the development of new seismic regulations are more susceptible to collapse given an earthquake event. These vulnerable buildings are known as non-ductile concrete frames. Therefore, there is a need for a comprehensive collapse assessment of these buildings in order to limit the loss in regions with masonry infilled frame buildings.

The main component of this research involves assessing the collapse performance of masonry infilled, non-ductile, reinforced concrete frames in the Performance Based Earthquake engineering framework. To pursue this goal, this study first develops a new multi-scale modelling approach to simulate the response of masonry infilled frames up to the point of collapse. In this approach, a macro (strut) model of the structure is developed. In the present work, the nature of RC frame buildings with G + 12 storeys with different masonry infill materials like brick masonry and AAC blocks masonry, is taken into consideration. A building, irregular in plan with L shape consider for analysis.

Key Words: *Multistoried building, Seismic analysis, Partial infill.*

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INTRODUCTION

RCC frames with masonry infill walls are a common practice in countries like India, where the region is prone to seismic activity. Generally the masonry infill walls are treated as non-structural elements in structural analysis and only the contribution of its mass is considered and its structural properties like strength and stiffness are generally not considered, although it contributes significantly to the lateral stiffness of the frame structures. There are no such specific references to infill walls in the Indian seismic standard (IS 1893:2002) that is currently used in India. One of the drawbacks of neglecting the infill as a structural member is the irregularity in the building caused by the uncertain position of infill and openings in them. The traditional modelling of Reinforced concrete frame structures in which the effect of infill is not considered, assumes the structures are more flexible than they really are. Because of this reason the building codes obtrude an upper limit to the natural period of a structure. The contradiction may occur in the analysis and proportioning of structural member in traditional modelling because it does not take strength and stiffness characteristic into account. Actually there is increase in the overall stiffness of the structure by the effect of infill walls which finally leads to the shorter time periods. A systematic model of force deformation response of infill is required to correctly analyse the infilled structures.

Number of finite element models has been evolved to foresee the behaviour of infilled frames (Asteris 2003; Shing et al.1992; Dymiotis et al 2001), such type of modelling is too time taking for the investigation of large structures. Hence the most popular approach is a macro-modelling substituting the entire infill as single equivalent strut.

The study of the complicated behaviour of masonry infill by Polyakov (1956) suggested that the infill and frame disparate excluding at two compression corners. He established the idea of equivalent diagonal strut and proposed that transformation of stresses from the frame to infill occurs only in the compression zone of the infill.

Another study conducted by Holmes (1961) suggested that the infill can be replaced by equivalent diagonal strut that is pin jointed at corners and is of same thickness and material and its width is equal to one third of the diagonal.

MATERIAL AND METHOD

Following data is used in the analysis of the RC frame building models

- Type of frame: Special RC moment resisting frame fixed at the base
- Seismic zone: 5
- Number of storeys: G+12
- Floor height: 3.5. m
- Depth of Slab: 125 mm
- Size of beam: (230 × 450) mm
- Size of column: (400 × 600) mm
- Spacing between frames: 5 m along X directions 3 m along Y directions
- Floor finish: 2 KN/m2
- Terrace water proofing: 1.5 KN/m2
- Materials: M 25 concrete, Fe 415 steel , Brick infill and AAC block infill
- Thickness of infill wall: 230 mm
- Density of concrete: 25 KN/m3
- Density of brick infill: 18 KN/m3
- Density of AAC block infill : 7 KN/m3

- Poisson Ratio of concrete : 0.2
- Poisson Ratio of brick masonry : 0.16
- Poisson Ratio of AAC masonry : 0.25
- Compressive strength of concrete 5000 = 25000 Mpa
- Compressive strength of brick masonry : 5 Mpa
- Compressive strength of AAC masonry : 4.5 Mpa
- Live load on floor: 3 KN/m3
- Type of soil: Medium
- Response spectra: As per IS 1893 (Part-1):2002
- Damping of structure: 5 percent

MODEL PROPERTIES

Bare frame model: In this model only frame is model. Effect of infill wall is not included in this model.

Modified infill model 1: In this model practical aspect is considered. Also 6th floor is kept vacant to meet any functional requirements.

Modified infill model 2 : In this model ground floor, 6th floor and 13th floor is kept vacant

After comparing conventional clay brick and AAC block model, it is found that base shear of AAC blocks is reduced in great amount which is in percentage (%) as below

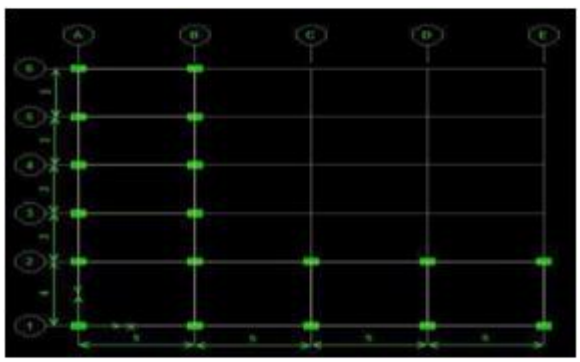

Fig No.1: Plan of frame

After comparing conventional clay brick and AAC block model, it is found that base shear of AAC blocks is reduced in great amount which is in % as below —

Table No. 1: Discussion on comparative study of Brick and AAC infill model for base shear

Direction	Bare frame	Modified infill 1	Modified infill 2
X static	40.37	35.21	30.20
Y static	39.30	35.13	30.19
X dynamic	20.00	25.71	27.37
Y dynamic	18.71	27.46	20.87

After comparing conventional clay brick and AAC block model found that storey drift of AAC blocks is reduced in great amount which is in percentage (%) as below —

Table No. 2: Discussion on comparative study of Brick and AAC infill model for storey drift

Direction		Bare frame	Modified infill 1	Modified infill 2
Static X	14th floor	35.29	23.07	9.61
1st floor		35.29	32.35	24.35
Static Y	14th floor	31.81	21.05	7.69
1st floor		43.93	34.09	30.43
Dynamic X	14th floor fifth floor	10.00	7.69	6.25
1st floor		17.64	20.00	17.39
Dynamic Y	14th floor	16.00	9.52	11.11
1st floor		16.00	16.00	27.02

After comparing conventional clay brick and AAC block model, it is found that top storey displacement of AAC blocks is reduced in great amount which is in percentage (%) as below —

Table No. 3: Discussion on comparative study of Brick and AAC infill model for top storey displacement

Direction	Bare frame	Modified infill 1	Modified infill 2
X static	50.00	50.00	50.00
Y static	42.85	33.33	33.33

Natural periods of vibration of buildings depend upon their mass and lateral stiffness. Presence of infill walls in buildings increases both the mass and stiffness of buildings; however, the contribution of latter is more significant. Consequently, the natural periods of an infill frame are normally lower than that of the corresponding bare frame.

Table No 4: Comparative study of time period in seconds of first three mode shape of brick and AAC infill model

Mode	Bare frame		Modified infill 1		Modified infill 2	
	Brick	AAC	Brick	AAC	Brick	AAC
1	2.5	2.1	1.2	1.1	1.3	1.2
2	2.3	2.0	1.0	0.9	1.1	1.0
3	2.0	1.7	0.9	0.8	1.0	0.9

CONCLUSION

1. The seismic requirement of the structure in terms of storey drift and the maximum average roof displacement of the structure are markedly enhanced by the introduction of infill. Top storey displacement is reduced of infill filled frame upto 50%
2. Primary frame action of a moment resisting frame is converted to the primary truss action due to the introduction of the infill leading to the increased axial forces in column in infill frame model.
3. The base shear experienced by models with AAC blocks was significantly smaller than with conventional clay bricks which results in reduction in member forces which leads to reduction in required amount of Ast to resist member forces. So economy in construction can be achieved by using AAC blocks instead of conventional clay bricks. The performance of AAC block infill was superior to that of Conventional brick infill in RC frame. Static base shear reduces upto 38% and 29% for dynamics.
4. Drift of structure is also reduced in great amount so that overall performance of frame with full infill as conventional clay bricks and AAC blocks was significantly superior to that of bare frame.
5. Increase in stiffness of the structure and addition to the self weight of the structure due to provision of masonry infills in the structure attract more seismic force than a bare frame. Base Shears and Peak storey Shears increase with the addition of infill walls to the bare frames. In case of soft storeys the storey shears tend to become uniform. The structure above the soft storey behaves as a stake like structure. However, the responses tend to approach the response of a bare frame as the structure grows in number of storeys and with the reduction in modulus of elasticity of the masonry.
6. Provision of masonry walls indicates to the enhancement in self weight of the structure. The increase in self weight adds to the seismic weight of the structure. As the structure grows in number of storeys the infill walls attract the peak storey shears at a lower rate with respect to the percentage increase in self weight due to adding up of infill walls. Infill walls with lower modulus of elasticity attract less seismic force and at a lower rate w.r.t. their self weight.
7. For bare frames dynamic base shear is minimised than the base shear based on basic time period in most of the frames packed with infill walls. There is considerable reserve strength in the bare frame designed based on fundamental time period. The influence of infills on the response reduces with the reduction in modulus of elasticity of masonry and with the increase in number of storeys of the structure.