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# **Comparative Study of Multistoried Building having Different Infill Materials using ETABS**

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**ABSTRACT:** Infill materials play a crucial role in the structural behavior of multi-storied buildings, influencing their stability, strength, and overall performance. This study aims to conduct a comparative analysis of multi-storied buildings incorporating different infill materials using ETABS software, focusing on the impact of these materials on key structural parameters. The research involves the modeling of a multi-storied building with a standard structural framework and varying infill materials, including brick masonry, concrete block masonry, glass panels, and lightweight panels. The selected infill materials are integrated into the building model to evaluate their effects on the building's performance under various loading conditions, such as dead loads, live loads, seismic forces, and wind loads. The study uses ETABS for both static and dynamic analysis to assess critical performance metrics, including lateral load resistance, drift and deformation, internal forces in structural members, and overall stability. By comparing the results across different infill materials, the study provides insights into how each material affects the structural integrity and safety of the building. Key findings indicate the performance variations associated with different infill materials, with implications for design and construction practices. The study concludes with recommendations for selecting optimal infill materials based on their performance characteristics and practical considerations. This comparative analysis offers valuable guidance for engineers and architects in making informed decisions regarding the use of infill materials in multi-storied buildings, contributing to improved structural efficiency and safety in construction practices.

**KEYWORDS:** Infill Materials, Seismic Analysis, Bending moment, stress, displacement, Story drift.

## **I. INTRODUCTION**

### **1.1 General**

Shelter is one of the most basic human needs. The exponential raise of the population has widened the need of quick and stable methods of construction with low cost. Due of population growth, high-rise buildings were invented. One way of introducing innovation into the construction process is by finding alternative materials for a certain part of the project. Innovative or enhanced items usually require many components to complete. More components implies more effort, money, and time. Since very beginning, forces of nature have influenced the day-to-day life of the mankind. Even on facing the continuous great damaging natural phenomenon, humans are making an effort to bring back the nature to the normal state and coexist with it hand in hand. Earthquakes, floods, tornadoes, hurricanes, droughts, volcanic eruptions etc are few examples of natural disasters. Among all these, the least understood and the most destructive natural disaster are the earthquakes. Every structural engineer has a challenge to design very strong structures which remain intact with strength and stability even during very harsh climatic conditions. Whether the damage caused maybe full or partial, strengthening is the better option than the total replacement of the structure. In general, any structure has to mainly resist 3 kinds of loads, they are loads in vertical direction, loads in horizontal direction and longitudinal loads. Vertical loads include dead, living, impact, and snow. Wind load, earthquake load and blasting load comes under horizontal loads. Tractive loads and braking forces come under longitudinal loads. Different loads are precisely calculated using Indian Standard Code 875-1987(Part I-V).

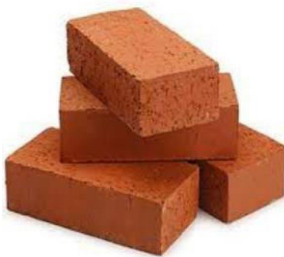
India's most popular structure is reinforced concrete with brick infill. Masonry walls provide practical and architectural purposes and are non-structural. Therefore, infill-bonding frame interaction is ignored in design. When subjected to lateral loads, an infill panel may cause load resistance with the bonding frame. Modeling the RC structure without infill leads to inaccurate seismic predictions for framed structures. The composite construction of an infilled frame is formed



of RC frame and infill walls. Infilled frame infill walls might be clay brick, concrete block, or AAC block. The RC frame is filled with AAC blocks and clay bricks. Insulating and fire-resistant AAC bricks are environmentally friendly and lightweight. Researchers have experimentally and analytically researched in-filled RC frame behavior. Their conclusion is that infill materials considerably affect the frame's seismic response. Infill improves RC frame performance. Infill walls lower frame lateral deflections, storey drift, and bending moments and increase column axial forces, reducing collapse risk. Designing with infill results in slender frame members, lowering structural system costs.

## 1.2 Infill Materials Used

Wall infills come in several materials. The following infill materials were compared



**Fig1.1:** Burnt bricks



**Fig 1.2:** Solid concrete blocks



**Fig 1.2:** Hollow concrete blocks



**Fig 1.4:** AAC blocks

## II. LITERATURE SURVEY

**Mr Khomdram Vijayraj Singh et. al., (2024) [1]:** Their study 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. Cost of construction is reduced and it will be safe and economical in earthquake forces also. The seismic Parameter Lateral displacements are also compared. 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.

**Mr Deepak Kumaran. G et. al., (2023) [2]:** They studied the seismic performance of red brick walls vs AAC block walls in a G+5 RCC structure. This model was examined using ETABS for displacement, storey drift, and base shear. The AAC block has lesser displacement than red brick hence the stiffness will be less in red brick building while high in AAC block building. Due to its lower self-weight and dead load, AAC blocks may endure more earthquake shocks than red bricks. Usage of AAC blocks in seismic prone areas is considered to be more efficient due to the lower occurrence of displacements, drift and base shear. Also the usage of AAC blocks reduces the beam & column reinforcement, size, labour force and time which leads to savings.

**Mr. Ankur Thakur et. al., (2023) [3]:** They examined seismic performance of constrained masonry walls with various infills. This study presents the comparison of four contemporary materials, viz. AAC blocks, LWC panels, fly ash bricks and clay bricks concerning their suitability as infill materials in the confined masonry of a four-storey frame using SAP 2000, static linear analysis. Their conclusion said, although stronger infill material is preferable from a strength perspective and it may attract more earthquake force as it tends to be denser, hence giving rise to conflicting situations. With the increasing use of these new innovative materials, it becomes imperative to carry out more numerical and experimental studies to redress this contradictory situation and to improve the overall seismic behaviour of CM walls.

**Ms G. Ranganayagi et. al., (2021) [4]:** They studied multistorey RC frames with different masonry infill bricks' seismic performance. They analyzed a G+11 building using ETABS and compared the parameters such as storey drift, storey stiffness, storey displacement and storey shear. The results showed that the performance of AAC block infill was better than Conventional brick infill in RC framed structures. Therefore, the AAC block material can basically be used to replace conventional bricks as infill material for RC framed structures built in the earthquake zone region.

**Ms Preet Patel et. al., (2021) [5]:** They have made a comparative study of brick infill wall and AAC blocks using response spectrum analysis. They compared the results for following parameters such as storey displacement, inner storey drift and cost of construction. The outcome was ACC blocks are Lightweight, Earthquake resistant, Environment friendly, faster in construction, Superior fire resistance and thermal insulation should be preferred as a green substitute of conventional clay brick.

### III. METHODOLOGY

#### 3.1 OBJECTIVES OF THE WORK

- 1) To analyze a G+15 residential building models using various infill materials in earthquake zone-II using ETABS.
- 2) To determine whether a alternative to conventional bricks such as AAC blocks performs better under seismic conditions.
- 3) To determine the parameters like bending moment, shear force, storey shear, storey drift and storey displacement.
- 4) To assess the cost and material savings from reduced column and beam steel, as a result of decreased axial forces and bending moments, after comparing different infill materials.

#### 3.2 METHODOLOGY OF WORK

In the present study a building which is G+15 is considered and is analyzed for different infill materials using ETABS software.

##### 3.2.1 Model details

**Table 3.1:** Structural details of the building

Building type		RCC framed residential building
Plan dimension		40.6 m x 19.5 m
Total height of the building from base		49.5 m
Each storey height		3.0 m
Plinth		1.5 m
Grade of concrete	Slabs and beams	M30
	Columns and shear walls	M30
Grade of steel	Longitudinal bars	Fe-500
	Confinement bars	Fe-415
Size of beams		300 mm x 450 mm
Size of columns		300 mm x 450 mm & 300 mm x 600 mm
Slab thickness		125 mm (Typical floors) 150 mm (Terrace floor)
Wall thickness		230mm(brick),200mm(block)
Slab live load		2 kN/m <sup>2</sup>
Sunken slab load		2.5 kN/m <sup>2</sup>
Slab floor finish		1 kN/m <sup>2</sup>
Concrete density		25 kN/m <sup>3</sup>

### 3.2.2 Seismic Details

Table 3.2: Seismic Details

Seismic zones	Zone-II
Zone factor, Z	0.10
Response reduction, R	5
Type of soil	II (Medium)
Importance factor, I	1
Time period, $T_a$	X Direction = 0.697 s Y Direction = 1.008 s
Scale factor	$I_g/R = 1962$

### 3.2.3 Wind Load Details

Table 3.3: Wind load details of the building

Windward coefficient	1.2(X-direction), 1.3(Y-direction)
Leeward coefficient	0.9(X-direction), 0.6(Y-direction)
Wind speed, $V_b$ (m/s)	39
Terrain category	2
Risk coefficient ( $K_1$ )	1
Topography ( $K_3$ )	1

### 3.2.4 Floor plan and modeling

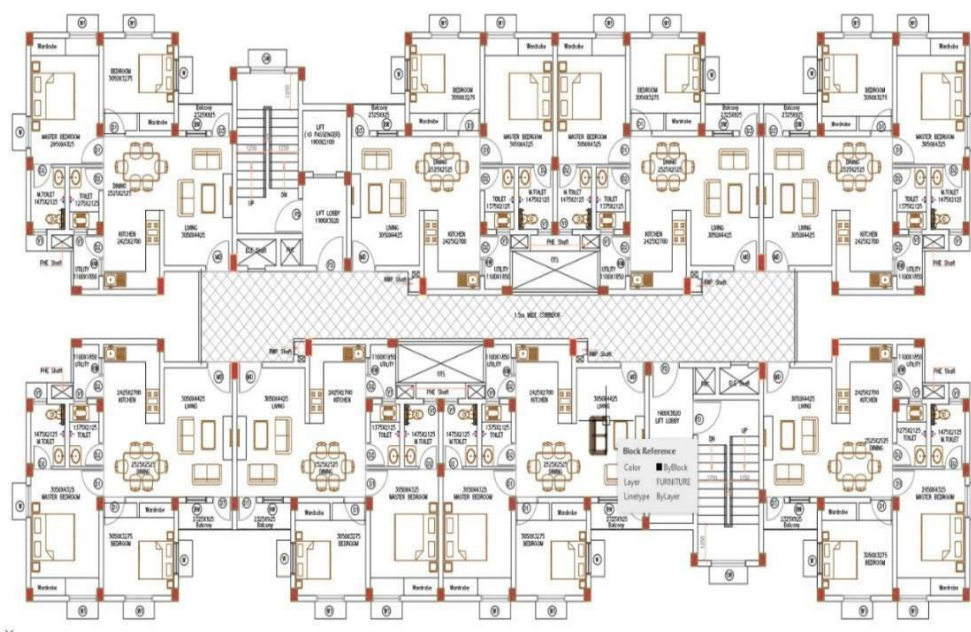


Fig.3.1: Typical floor plan

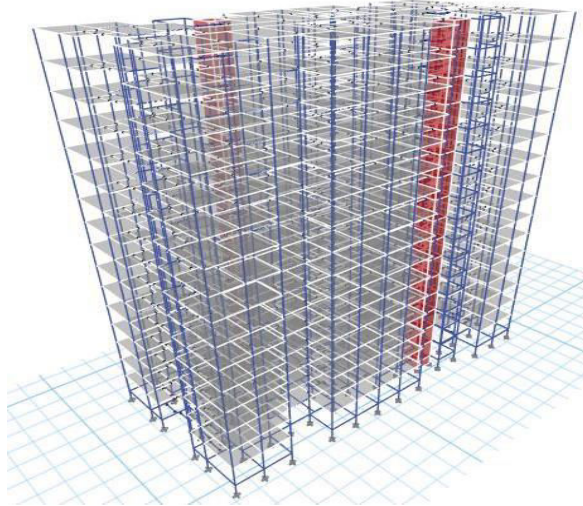


Fig 3.2: 3D View of Building

#### IV. EXPERIMENTAL RESULTS

##### 4.1.1 Case-1: Brick used as Infill

Table 4.1: Max Bending moment & Shear Force for column Brick Infill

Infill Case	Max. Axial Force in kN	Max. Shear Force in kN	Max. Bending moment in kNm
Brick	2437.37	40.50	63.00

Table 4.2: Max Bending moment & Shear Force for Beam for Brick Infill

Infill Case	Max Shear Force in kN	Max Bending moment in kNm
Brick	69.82	98.34

Table 4.3: Max Storey Shear under EQX & EQY for Brick Infill

Infill Case	Max Storey Shear Under EQX in kN	Max Storey Shear Under EQY in kN
Brick	7127.68	4928.56

Table 4.4: Max Storey Drift under EQX & EQY for Brick Infill

Infill Case	Max Storey Drift Under EQX	Max Storey Drift Under EQY
Brick	0.0035	0.0025



Table 4.5: Max Storey Displacement under EQX & EQY for Brick Infill

Infill Case	Max Storey Displacement Under EQX in mm	Max Storey Displacement Under EQY in mm
Brick	136.6	102.37

#### 4.1.2 Case-2: Solid Block used as Infill

Table 4.6: Max Bending moment & Shear Force for column Solid Block Infill

Infill Case	Max. Axial Force in kN	Max. Shear Force in kN	Max. Bending moment in kNm
Solid Block	2325	39.60	61.60

Table 4.7: Max Bending moment & Shear Force for Beam for Solid Block Infill

Infill Case	Max Shear Force in kN	Max Bending moment in kNm
Solid Block	65.18	93.16

Table 4.8: Max Storey Shear under EQX & EQY for Solid Block Infill

Infill Case	Max Storey Shear Under EQX in kN	Max Storey Shear Under EQY in kN
Solid Block	6728.35	4652.44

Table 4.9: Max Storey Drift under EQX & EQY for Solid Block Infill

Infill Case	Max Storey Displacement Under EQX in mm	Max Storey Displacement Under EQY in mm
Brick	136.6	102.37

Table 4.10: Max Storey Displacement under EQX & EQY for Solid Block Infill

Infill Case	Max Storey Drift Under EQX	Max Storey Drift Under EQY
Solid Block	0.0033	0.0024

#### 4.1.3 Case-3: Hollow Concrete Block used as Infill

Table 4.11.: Max Bending moment & Shear Force for column Hollow Concrete Block Infill

Infill Case	Max. Axial Force in kN	Max. Shear Force in kN	Max. Bending moment in kNm
Hollow Concrete Block	2025	34.10	53.00

**Table 4.12: Max Bending moment & Shear Force for Beam for Hollow Concrete Block Infill**

Infill Case	Max Shear Force in kN	Max Bending moment in kNm
Hollow Concrete Block	57.95	83.00

**Table 4.13: Max Storey Shear under EQX & EQY for Hollow Concrete Block Infill**

Infill Case	Max Storey Shear Under EQX in kN	Max Storey Shear Under EQY in kN
Hollow Concrete Block	5889.26	4072.24

**Table 4.14: Max Storey Drift under EQX & EQY for Hollow Concrete Block Infill**

Infill Case	Max Storey Drift Under EQX	Max Storey Drift Under EQY
Hollow Concrete Block	0.0029	0.0021

**Table 4.15: Max Storey Displacement under EQX & EQY for Hollow Concrete Block Infill**

Infill Case	Max Storey Displacement Under EQX in mm	Max Storey Displacement Under EQY in mm
Brick	136.6	102.37

#### 4.1 .4 Case-4: AAC Block used as Infill

**Table 4.16.: Max Bending moment & Shear Force for for column AAC Block Infill**

Infill Case	Max. Axial Force in kN	Max. Shear Force in kN	Max. Bending moment in kNm
AAC Block	1900	31.95	49.60

**Table 4.17: Max Bending moment & Shear Force for Beam for AAC Block Infill**

Infill Case	Max Shear Force in kN	Max Bending moment in kNm
AAC Block	54.00	78.00

Infill Case	Max Storey Displacement Under EQX in mm	Max Storey Displacement Under EQY in mm
Hollow Concrete Block	113.70	85.16

**Table 4.18: Max Storey Shear under EQX & EQY for AAC Block Infill**

Infill Case	Max Storey Shear Under EQX in kN	Max Storey Shear Under EQY in kN
AAC Block	5415	3744.30



**Table 4.19: Max Storey Drift under EQX & EQY for AAC Block Infill**

Infill Case	Max Storey Drift Under EQX	Max Storey Drift Under EQY
AAC Block	0.0027	0.0194

**Table 4.20: Max Storey Displacement under EQX & EQY for AAC Block Infill**

Infill Case	Max Storey Displacement Under EQX in mm	Max Storey Displacement Under EQY in mm
AAC Block	104.87	78.56

## V. CONCLUSION

- 1) According to the data, brick infill has the highest bending moment, shear force, storey shear, drift, and displacement, while AAC blocks have the lowest. The overall average percentage decrease in all the above criteria in case of AAC block when compared with the brick is almost 20%.
- 2) From the results, it is observed that axial forces in columns are reduced with AAC block masonry than that of conventional brick masonry.
- 3) As the density of the infill materials decreases, the cross-sectional dimensions of elements such as columns and beams can be reduced for structures using AAC as Infill.
- 4) As the density of the infill materials increase, the loads on each column also increases, which in turn increases the size of footings to effectively distribute these loads, we can reduce that by light weight infill like AAC.
- 5) Lighter infill materials like AAC blocks can lower construction costs while still being effective.
- 6) Thus, the AAC block Infill can perform superior to that of brick Infill therefore AAC blocks can be used to replace the conventional brick which is usually used in India in seismic prone area.

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