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# Comparative Study on Asymmetric Structure with Different Infill Materials Using ETABS

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**ABSTRACT**

The study investigates the seismic behavior of irregular reinforced concrete (RC) frame structures with various infill materials using Response Spectrum Analysis (RSA). Infill walls, commonly made of brick or AAC blocks, are non-structural elements that influence the lateral stiffness and seismic response of buildings. The primary objective is to evaluate the effect of different infill materials on the lateral stability, displacement, drift, shear, and stiffness of an L-shaped asymmetric RC frame structure in a high seismic zone (Zone V), modeled using ETABS software. The analysis considers bare frames as well as frames with unreinforced masonry infills using two types of materials: brick and AAC blocks.The study demonstrates that the inclusion of infill materials significantly enhances the overall stiffness and base shear of the structure. Specifically, the brick infill models exhibited higher lateral resistance and lower displacement compared to the bare frame and AAC block models. However, the AAC block infill, with its lower weight and stiffness, showed increased displacements and reduced stiffness, particularly in the top stories of the asymmetric building. The results suggest that while masonry infill contributes to the structure's seismic resistance, material selection and the building's plan irregularities play crucial roles in determining the seismic performance.

**Keywords:** Seismic analysis, RC frame, infill materials, Response Spectrum Analysis, ETABS, asymmetric structure, masonry infill, brick, AAC block, lateral displacement, story drift, seismic performance, base shear, stiffness, plan irregularity, earthquake resistance.

# INTRODUCTION

## 1.1 General

Reinforced concrete (RC) frame structures are commonly used in modern construction due to their strength, flexibility, and resilience under various loading conditions, including vertical loads from gravity and horizontal loads from seismic events. These structures consist of a skeleton made from concrete and steel reinforcement, providing the necessary support for buildings in both normal and extreme conditions. Infill walls, which are typically made from non-structural materials like brick, masonry, or concrete blocks, are often incorporated into RC frame buildings to provide partitioning, privacy, and lateral stiffness[1]. While these walls are primarily considered non-structural elements, their role in the building's seismic performance is significant, as they influence the dynamic response of the frame during an earthquake.

The interaction between RC frames and infill walls is complex and critical for understanding the building's overall behavior during seismic events. Although infills enhance lateral stiffness and strength, their failure mechanisms, especially under earthquake loading[2], can lead to unexpected performance issues, such as the formation of cracks or collapse. Understanding the dynamic behavior of such interactions is essential for designing safer buildings in earthquake-prone regions. This research focuses on asymmetric or irregular RC frame structures, which are particularly vulnerable to seismic forces due to their uneven mass distribution and stiffness, and how different infill materials affect their seismic performance.

## 1.2 Method of Analysis

For the purpose of this study, Response Spectrum Analysis (RSA) was chosen to analyze the dynamic response of RC frame structures under earthquake loads. The RSA method is a widely used seismic analysis technique that considers the dynamic behavior of structures subjected to ground motion, without the need for complex time-history analysis. Instead of simulating the entire time-history of an earthquake[3], RSA uses response spectra, which represent the maximum expected structural response at different natural frequencies. This method is suitable for buildings located in seismic regions where the earthquake ground motions can be characterized by standard spectra. RSA provides an efficient way to calculate the peak forces, moments, displacements, and drifts of the structure, allowing for a clear understanding of the building's seismic performance. This research uses the ETABS software to model the RC frame structures, incorporating different infill materials and comparing their effects on the structural behavior, including lateral displacement, shear forces, and stiffness[4]. By analyzing the building's response to seismic loads through RSA, valuable insights into the impact of infill materials on building resilience can be gained.

## 1.3 Irregular Structure

Irregular structures, especially those with plan asymmetry, are known to have a higher vulnerability during seismic events. These irregularities may lead to torsional effects, where the building experiences rotation about its vertical axis due to the eccentric distribution of mass or stiffness. Plan irregularity typically manifests in shapes such as L, T, or U configurations, where the distribution of loads across the structure is uneven. Vertical irregularities, such as soft stories or mass irregularities, further complicate the seismic behavior, creating additional stress concentrations in specific areas of the building.

Buildings with irregular plans and vertical layouts are more likely to experience excessive lateral displacements, story drifts, and, in some cases, even collapse under strong seismic forces[5]. The importance of understanding and analyzing these irregularities in seismic design is crucial to minimizing the risk of damage or failure. This study focuses on a building with an L-shaped plan irregularity, which is modeled to evaluate the effects of such asymmetry on seismic performance.

### 1.4 Infill Wall Structures

Infill wall structures are commonly found in RC frame buildings, where non-structural masonry walls, such as brick or AAC block infills, are placed between the frame elements. These walls are typically not designed to bear any significant load other than their own weight but contribute to the lateral resistance of the building. While infills are not part of the primary load-resisting system, they still play an important role in the overall stability and performance of the structure during an earthquake. Infill walls interact with the surrounding frame, influencing the stiffness, strength, and natural frequencies of the structure. Depending on the type of material used for the infill, the effects on seismic behavior can vary significantly[6]. The presence of infill walls often increases the lateral stiffness of a building, leading to reduced lateral displacements and story drifts. However, improper connection between the infills and the frame, or the use of materials with low stiffness, can lead to brittle failure or torsional effects, particularly in asymmetric structures.

### 1.5 Seismic Behavior of Infill Wall Structures

The seismic behavior of infill wall structures depends heavily on the material and the interaction between the infill and the surrounding RC frame. Masonry infills, such as brick and AAC blocks, offer varying levels of strength and stiffness, which influence the building's overall seismic response. The positive effects of infill walls include enhanced lateral stiffness, reduced story drift, and the ability to resist lateral loads. However, these benefits are contingent on the correct design and connection of the infills to the RC frame.

In contrast, poorly designed or unconnected infill walls may cause localized damage, such as diagonal cracking or corner crushing, during an earthquake. These failure mechanisms are often brittle and lead to a rapid reduction in the structure's overall stability. Additionally, the mass distribution of the infill material affects the torsional response of asymmetric structures, leading to potential issues with uneven distribution of lateral forces. This study aims to explore the seismic behavior of RC frames with different infill materials, focusing on how these materials influence the dynamic response of irregular structures, particularly those with plan asymmetry.

## Literature Review

### 2.1 General

The seismic behavior of reinforced concrete (RC) frame structures with infill walls has been a subject of extensive research, especially in seismic regions where the building's ability to resist lateral forces plays a crucial role in ensuring structural integrity. Infill walls, which are often made from materials such as brick, concrete blocks, or AAC blocks, interact with the RC frame in ways that influence the overall seismic performance of a building. While these walls are typically not designed to carry gravity loads, their contribution to lateral stiffness and the redistribution of forces during seismic events cannot be underestimated[7]. Several studies have focused on modeling and analyzing the interaction between the RC frame and the infill walls during earthquakes. The incorporation of infill materials generally enhances the building's lateral resistance, reducing lateral displacements and story drifts. The effect of different infill materials on the seismic behavior of buildings, particularly in irregular configurations, has been explored through various computational methods, including response spectrum analysis and nonlinear static analysis[8]. Researchers have utilized software like ETABS, STAAD Pro, and ANSYS to model buildings with both regular and irregular plans, investigating how infills modify the natural frequencies, stiffness, and overall dynamic response. The interaction between the frame and infill materials is complex and can lead to both positive and negative seismic effects. On the positive side, masonry infills help resist lateral loads, improving the structure's stiffness and reducing inter-story drift. However, improper connections between the infill and the frame can lead to brittle failure mechanisms, such as diagonal cracking or the collapse of the infill panels. Additionally, the mass distribution of the infill material can induce torsional effects in asymmetric buildings, amplifying seismic forces in certain parts of the structure[9]. The role of plan and vertical irregularities in exacerbating these issues has also been widely studied, emphasizing the need for careful consideration of building geometry in seismic design.

### 2.2 Literature Gap

Despite the significant body of research on the seismic behavior of RC frames with infill walls, several gaps remain in the current literature. First, the study of irregular or asymmetric buildings with infill materials, particularly in high seismic zones, remains limited. Most research has focused on regular buildings, where the effects of infills are less pronounced. Asymmetry in plan configurations, such as L-shaped or T-shaped layouts, creates torsional effects that exacerbate seismic responses. This makes the study of irregular structures with infills a critical area for further exploration. Another gap lies in the comparative analysis of different infill materials used in irregular structures. While studies have investigated the effects of masonry infills like brick and concrete blocks, fewer studies compare these materials in terms of their performance under seismic loading in asymmetric buildings. Additionally, the impact of less commonly used materials, such as AAC blocks and fly ash bricks, on seismic performance remains understudied. The comparative analysis of these materials, especially in irregular configurations, can provide valuable insights into optimizing material choice for enhanced seismic resistance. Furthermore, there is a lack of research that integrates both wind and seismic loads on multi-story irregular buildings with infill materials. Most studies typically focus on seismic loads alone, neglecting the additional complexities introduced by wind forces, which can also have a significant impact on the overall stability and dynamic behavior of the building.

### 2.3 Summary

The literature on the seismic performance of RC frame buildings with infill materials highlights the important role that infills play in enhancing the building's lateral stiffness and strength. While masonry infills can significantly reduce lateral displacements and story drifts, their failure mechanisms, such as brittle cracking or torsional effects, must be considered during the design phase. Previous studies have used various modeling techniques, including the diagonal strut method and finite element modeling, to better understand the frame-infill interaction and its impact on the building's seismic response. However, gaps remain in the study of irregular structures, especially those with asymmetric layouts, where the effects of infills are more pronounced. There is also a lack of comparative studies on different types of infill materials in these irregular structures. Additionally, more research is needed to explore the combined effect of seismic and wind loads on multi-story buildings with infills. Bridging these gaps will provide a more comprehensive understanding of how different materials and building configurations influence seismic behavior, ultimately contributing to safer, more resilient building designs in earthquake-prone areas.

## Methodology

The objective of this study is to analyze the seismic behavior of asymmetric reinforced concrete (RC) frame structures with different infill materials under earthquake loads. Specifically, this research aims to compare the lateral stiffness, displacement, drift, shear, and overall seismic performance of buildings with and without infill materials, using brick and AAC blocks as infills. The study uses Response Spectrum Analysis (RSA) to evaluate the dynamic response of a typical L-shaped asymmetric RC frame structure modeled in ETABS software. The analysis will consider both bare RC frames and those with infills to assess the impact of the infill materials on building performance in high seismic zones.

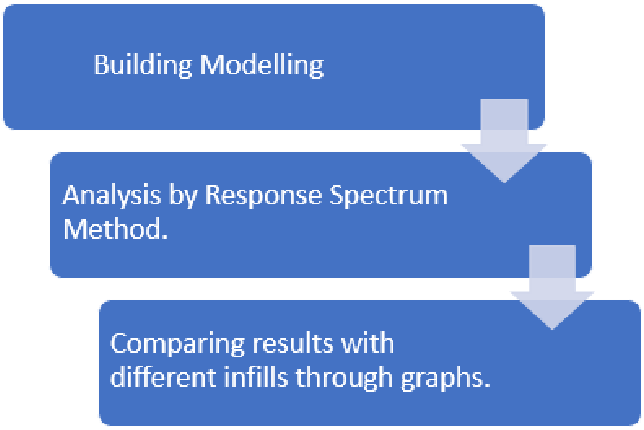


**Figure.1:** Flow Chart representing methodology

The scope of this study is focused on the seismic analysis of an L-shaped RC frame structure, modeled using ETABS software. The analysis involves two types of infill materials: brick and AAC blocks, and compares their impact on the lateral stability, displacement, drift, shear, and stiffness of the building. The study assumes standard gravity loads, following IS 875, and evaluates the dynamic response of the structure under earthquake forces according to IS 1893 (Part 1) 2002. This research is restricted to seismic analysis using Response Spectrum Analysis, and only considers bare frames and infills made of brick and AAC blocks.

For modeling the structure, ETABS software is utilized. The first step in the process involves creating the grid system and defining the structural layout, which includes the geometry of the L-shaped building.The grid system provides the framework for the beams and columns, ensuring accurate representation of the frame. Material properties, including concrete and reinforcement steel, are defined. The properties for both infill materials, such as compressive strength, modulus of elasticity, and density, are also specified. Once the materials are defined, the frame elements (beams and columns) are drawn using the ETABS drawing tool, accurately representing the structure's components.

Infill walls are modeled using the equivalent diagonal strut method, where each infill is represented as a compression strut. This approach simplifies the infill's contribution by modeling it as a diagonal strut within the frame, which transmits the forces between the beams and columns. The width of the diagonal strut is calculated based on the material properties of the infill and the dimensions of the structural components, as proposed by Mainstone's formula. The strut method allows for an efficient representation of the infill's impact on the structural behavior. The parameters such as the moment of inertia and the infill wall height are used to calculate the appropriate width of the strut.

Several researchers proposed the formula to calculate width of strut, In the present study the equation proposed by Mainstone is used to determine the width of equivalent strut.

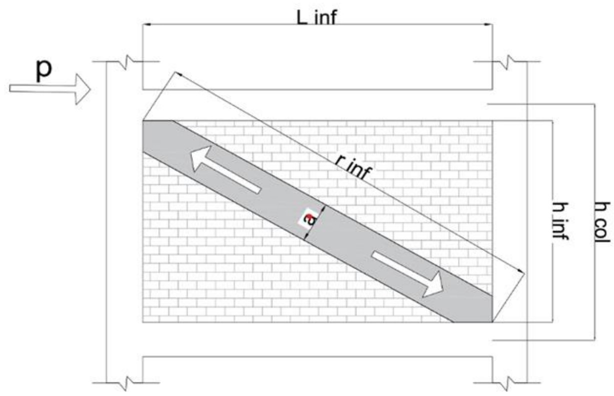


**Figure.2:** The parameters used to determine width of an equivalent structure

As per Mainstone, the width of strut is calculated using the below formula

$$\textbf{Width of Strut (a)} = \mathbf{0.175\left((\lambda 1 * h_{col})^{0.4}\right) * I_{inf}}$$

The co-efficient λ1 is determined using the following relation,

$$\boldsymbol{\lambda 1} = \left[\frac{\mathbf{E_m * t_{inf} * \sin 2\theta}}{\mathbf{4 * E_f * I_{col} * h_{inf}}}\right]^{0.25}$$

Where,

$E_f$ = Expected elastic modulus of frame

$E_m$ = Elastic modulus of infill

$t_{inf}$ = thickness of infill

$I_{col}$ = Moment inertia of Column

$h_{inf}$ = Height of infill wall panel

**Table 1:** Material Properties of Brick and AAC block infill

| Material type | Compressive strength | Density/ Unit weight | Poisson's ratio | Modulus of elasticity | Thickness of infill |
|---|---|---|---|---|---|
| Brick | 10.5 MPa | 20 kN/m3 | 0.2 | 2457.04MPa | 230mm |
| AAC Block | 4.5 MPa | 6 kN/m3 | 0.2 | 1428.587MPa | 230mm |

**Table 2:** Section Properties (Width of Strut) of Brick and AAC block infill

| Material type | Em =550fm MPa | Ef MPa | Tinf mm | Icol $mm^4$ | Hinf Mm | rinf | λ1 | a mm |
|---|---|---|---|---|---|---|---|---|
| Brick | 2457.04 | 27386.127 | 230 | $26.367x10^9$ | 2500 | 5182.82 | $5.07x10^{-4}$ | 766.41 |
| AAC Block | 1428.59 | 27386.127 | 230 | $26.367x10^9$ | 2500 | 6189.7 | $4.43x10^{-4}$ | 809.61 |

**Table 3-** Building properties Considered for RCC frame system

| Properties | Values |
|---|---|
| No. of storey | G+9 |
| Plan dimension area<br>No of bays in X and Y direction | L shape 400Sqm<br>25mx10m<br>5m |
| Height of each story | 3m |
| Spacing of bay in X and Y direction | 5m c/c |
| Size of column | 750mm x 750mm |
| Size of beam | 230mm x 500mm |
| Slab thickness | 120mm |
| Grade of concrete | M30 |
| Grade of steel | Fe550 |
| Seismic zone | V |
| Soil type | II Medium Soil |
| Importance factor | 1 |
| Reduction factor | 5 |
| Live Load | 3 kN/m2 |
| Floor finish | 1.5 kN/m2 |
| Method of analysis | Response Spectrum |

After completing the model, load definitions are assigned. Dead and live loads are applied according to IS 875, while seismic loads are modeled using Response Spectrum functions based on the guidelines from IS 1893: 2016. The Response Spectrum method is utilized to account for the seismic forces acting on the building, considering its location in seismic Zone V and the medium soil type . These load cases are assigned to the model in both the X and Y directions to evaluate the building's response under lateral forces. Fixed supports are applied at the base of the columns to represent the boundary conditions accurately. The final model is then analyzed to obtain results for displacement, drift, shear, and stiffness for the bare frame, brick infill, and AAC block infill models.

To assign boundary conditions, fixed supports are applied at the base of the columns to simulate the real-world constraints. These supports prevent any displacement at the base of the columns during analysis. Finally, load patterns, including seismic loads, are set up for the analysis using the Response Spectrum function, which provides a method for evaluating how the structure responds to ground motion during an earthquake. The final model is then analysed to obtain results for displacement, drift, shear, and stiffness for the bare frame, brick infill, and AAC block infill models.

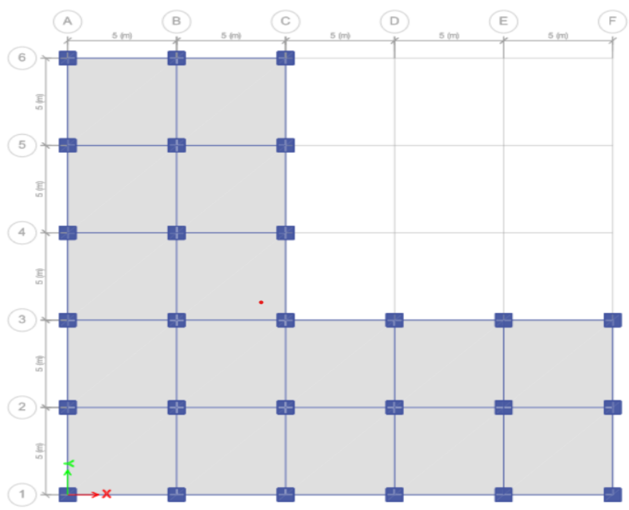


**Fig 3.** Plan of Building

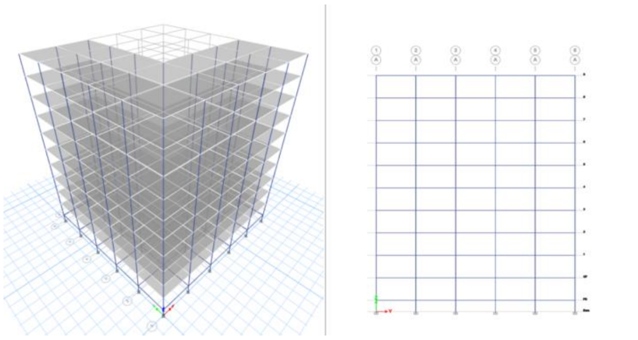

**Fig 4** Elevation of 3D Model of RC bare frame system

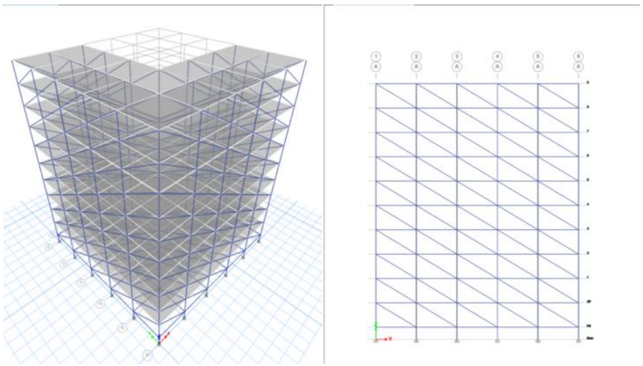

**Fig 5** Elevation of 3D Model of RC frame with infill

**Results and Discussion**

**4.1 Story Displacement in X and Y Axis**

The displacement of the building in the X and Y directions is a critical factor in evaluating its seismic performance. As observed from Table 1: Story Displacement along X and Y Axis, the displacement in the X direction is noticeably higher in the RC frame without infill (bare frame) compared to the models with infill walls. Specifically, the displacement in the bare frame is approximately 30.9% higher than in the model with brick infill and 27.3% higher than the model with AAC block infill, as shown in Figure 11: Story Displacement along X Axis. In the Y direction, the displacement is more uniform across the different models, with the displacement of the RC frame with brick infill being 2.7% less than that of the bare frame. Interestingly, the displacement of the frame with AAC block infill is 2.7% more than the bare frame, which is attributed to the plan irregularity of the L-shaped structure and the lower stiffness of AAC blocks.

The results indicate that the presence of infill walls, particularly brick infill, reduces the lateral displacement of the building, improving its lateral stability. The displacement reduction in the model with brick infill is more significant due to its higher stiffness and mass, compared to the lighter and less stiff AAC blocks. Figure 12: Story Displacement along Y Axis further supports these findings, illustrating the relative displacements along the Y direction for the different models.

**Table.4:** Story Displacement along X and Y Axis

| Story No | Elevation (m) | Location | BARE FRAME | | BRICK INFILL | | AAC INFILL | |
|---|---|---|---|---|---|---|---|---|
| | | | X-Dir | Y-Dir | X-Dir | Y-Dir | X-Dir | Y-Dir |
| | | | Mm | mm | mm | mm | mm | mm |
| 9 | 31.5 | Top | 18.81 | 3.94 | 13.00 | 3.84 | 13.67 | 4.03 |
| 8 | 28.5 | Top | 18.00 | 3.76 | 12.51 | 3.69 | 13.16 | 3.87 |
| 7 | 25.5 | Top | 16.90 | 3.53 | 11.83 | 3.49 | 12.44 | 3.66 |
| 6 | 22.5 | Top | 15.45 | 3.22 | 10.91 | 3.22 | 11.46 | 3.37 |
| 5 | 19.5 | Top | 13.67 | 2.84 | 9.76 | 2.88 | 10.23 | 3.01 |
| 4 | 16.5 | Top | 11.59 | 2.40 | 8.40 | 2.48 | 8.78 | 2.58 |
| 3 | 13.5 | Top | 9.25 | 1.91 | 6.87 | 2.02 | 7.14 | 2.09 |
| 2 | 10.5 | Top | 6.74 | 1.38 | 5.21 | 1.53 | 5.36 | 1.57 |
| 1 | 7.5 | Top | 4.21 | 0.86 | 3.46 | 1.01 | 3.50 | 1.02 |
| GF | 4.5 | Top | 1.90 | 0.38 | 1.72 | 0.50 | 1.69 | 0.49 |
| PB | 1.5 | Top | 0.27 | 0.06 | 0.31 | 0.09 | 0.28 | 0.08 |
| Base | 0 | Top | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

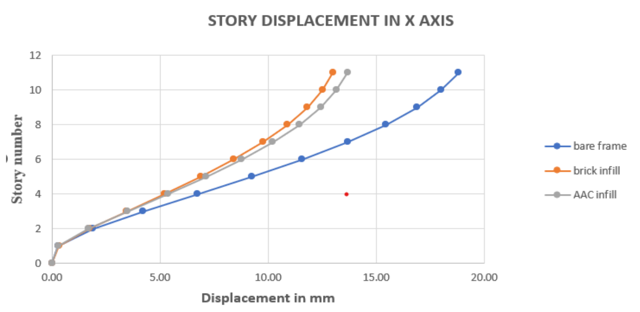


**Figure.6:** Story Displacement along X axis

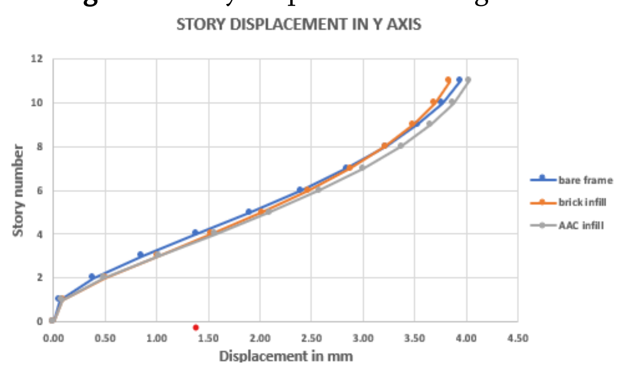


**Figure.7:** Story Displacement along y axis

## 4.2 Story Drift in X and Y Axis

Story drift is another critical parameter for evaluating the structural response during an earthquake. Table 2: Story Drift along X and Y Axis presents the drift values for each story in the X and Y directions. The maximum drift in the X direction occurs at the topmost story, where the bare frame experiences a drift of $2.97 \times 10^{-4}$, while the models with brick and AAC block infills exhibit reduced drift. The drift for the brick infill model is 31% less than the bare frame, and for the AAC block infill, it is 27% less. In the Y direction, the drift in the model with brick infill is 2% less than the bare frame, while the drift in the model with AAC block infill is 2% more, which can again be attributed to the plan asymmetry of the structure. Figure 13: Story Drift along X Axis and Figure 14: Story Drift along Y Axis provide visual representations of the drift behavior in both directions. These figures show that the infill walls, particularly the brick infill, reduce the drift, enhancing the building's overall stability during seismic events. The increased drift in the AAC block infill model in the Y direction indicates that the lighter material contributes to more flexibility, which in turn leads to higher drift in the presence of plan irregularities.

**Table.5:** Story Drift along X and Y Axis

| Story | Elevation | Location | BARE FRAME | | BRICK INFILL | | AAC INFILL | |
|---|---|---|---|---|---|---|---|---|
| | | | X-Dir | Y-Dir | X-Dir | Y-Dir | X-Dir | Y-Dir |
| | | | $10^{-4}$ | $10^{-4}$ | $10^{-4}$ | $10^{-4}$ | $10^{-4}$ | $10^{-4}$ |
| 9 | 31.5 | Top | 2.97 | 0.63 | 1.69 | 4.73 | 1.79 | 0.53 |
| 8 | 28.5 | Top | 3.97 | 0.83 | 2.37 | 0.69 | 2.52 | 0.74 |
| 7 | 25.5 | Top | 5.1 | 1.06 | 3.16 | 0.93 | 3.38 | 0.99 |
| 6 | 22.5 | Top | 6.18 | 1.29 | 3.92 | 1.15 | 4.19 | 1.23 |
| 5 | 19.5 | Top | 7.14 | 1.5 | 4.58 | 1.35 | 4.91 | 1.45 |
| 4 | 16.5 | Top | 7.91 | 1.66 | 5.14 | 1.52 | 5.5 | 1.63 |
| 3 | 13.5 | Top | 8.41 | 1.76 | 5.57 | 1.65 | 5.97 | 1.76 |
| 2 | 10.5 | Top | 8.46 | 1.76 | 5.84 | 1.73 | 6.21 | 1.83 |
| 1 | 7.5 | Top | 7.71 | 1.58 | 5.79 | 1.71 | 6.04 | 1.77 |
| GF | 4.5 | Top | 5.42 | 1.09 | 4.82 | 1.4 | 4.76 | 1.37 |
| PB | 1.5 | Top | 1.82 | 0.36 | 2.09 | 0.6 | 1.88 | 0.54 |
| Base | 0 | Top | 0 | 0 | 0 | 0 | 0 | 0 |

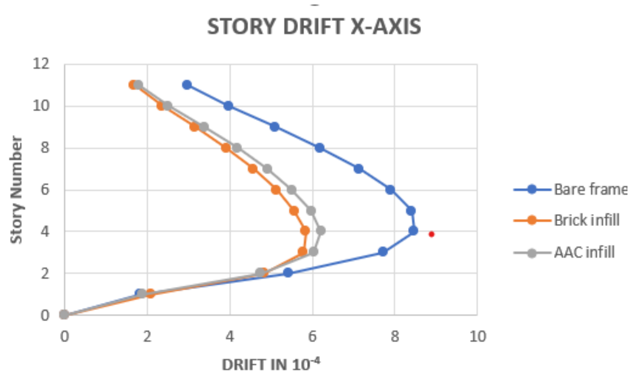


**Figure.8:** Story Drift along X- axis

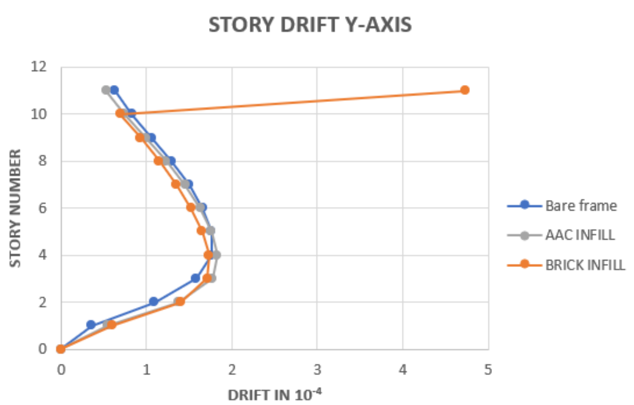


**Figure.9:** Story Drift along Y – axis

### 4.3 Story Shear in X and Y Axis

Story shear is the force transmitted across each story during an earthquake, and its analysis is crucial for understanding the structural response to lateral forces. Table 3: Story Shear along X and Y Axis shows the shear values in both the X and Y directions for the different models. The shear in the bare frame model is the lowest across all stories, as it lacks the added stiffness provided by the infill walls. In contrast, the models with infill show significantly higher shear values. The maximum shear in the model with brick infill is observed at the base, with a shear of 293.17 kN in the X direction, which is significantly higher than the shear in the bare frame (192.44 kN). The AAC block infill model also shows increased shear compared to the bare frame, though less than the brick infill model, with a shear of 251.54 kN in the X direction. Figure 15: Story Shear along X Axis **and** Figure 16: Story Shear along Y Axis demonstrate the distribution of shear along the height of the building. The figures indicate that infill walls, especially brick infill, increase the base shear, thereby improving the building's ability to resist seismic forces. However, the increased shear in the infilled models also suggests that the frame experiences greater forces, which could potentially lead to damage if the frame is not properly designed to accommodate these forces.

**Table.6:** Story Shear along X and Y Axis

| Story | Elevation | Location | BARE FRAME | | BRICK INFILL | | AAC INFILL | |
|---|---|---|---|---|---|---|---|---|
| | | | X-Dir | Y-Dir | X-Dir | Y-Dir | X-Dir | Y-Dir |
| | M | | kN | kN | kN | kN | kN | kN |
| 9 | 31.5 | Bottom | 192.44 | 6.86 | 293.17 | 32.99 | 251.54 | 24.13 |
| 8 | 28.5 | Bottom | 381.35 | 14.72 | 655.76 | 74.51 | 539.97 | 53.20 |
| 7 | 25.5 | Bottom | 534.04 | 21.83 | 981.97 | 113.45 | 795.33 | 80.13 |
| 6 | 22.5 | Bottom | 664.07 | 28.11 | 1273.38 | 148.82 | 1022.65 | 104.51 |
| 5 | 19.5 | Bottom | 775.48 | 33.59 | 1530.61 | 180.28 | 1222.84 | 126.12 |
| 4 | 16.5 | Bottom | 873.15 | 38.31 | 1753.72 | 207.54 | 1396.34 | 144.80 |
| 3 | 13.5 | Bottom | 959.49 | 42.24 | 1941.82 | 230.30 | 1542.64 | 160.32 |
| 2 | 10.5 | Bottom | 1032.13 | 45.30 | 2091.84 | 248.12 | 1659.14 | 172.38 |
| 1 | 7.5 | Bottom | 1088.74 | 47.34 | 2200.26 | 260.47 | 1743.03 | 180.59 |
| GF | 4.5 | Bottom | 1121.81 | 48.32 | 2260.31 | 266.91 | 1788.75 | 184.74 |
| PB | 1.5 | Bottom | 1124.61 | 48.40 | 2265.83 | 267.46 | 1792.66 | 185.07 |
| Base | 0 | Bottom | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

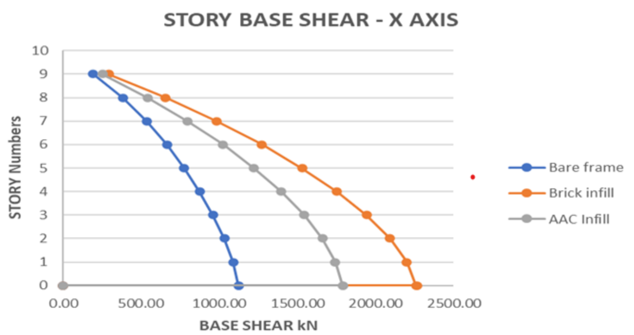


**Figure.10:** Story Shear along X- axis

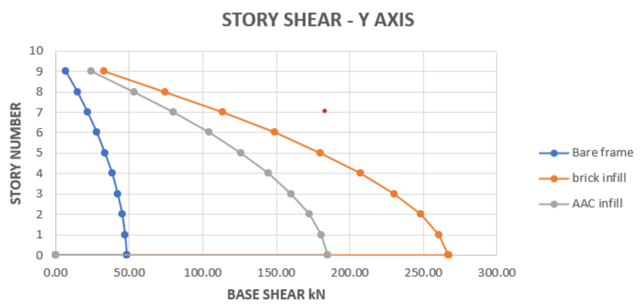


**Figure.11:** Story Shear along Y axis

### 4.4 Story Stiffness in X and Y Axis

Story stiffness refers to the resistance of the building to lateral displacement and drift under seismic loads. Table 4: Story Stiffness along X and Y Axis presents the stiffness values for the different models in both the X and Y directions. The model with brick infill exhibits the highest stiffness values across all stories, followed by the AAC block infill model, and the lowest stiffness is observed in the bare frame model. At the top story, the stiffness of the brick infill model is approximately 710,879.9 kN/m in the X direction, significantly higher than the 245,877.1 kN/m of the bare frame. The AAC block infill model shows stiffness values in between the brick infill and bare frame models, but still lower than the brick infill model. Figure 17: Story Stiffness along X Axis **and** Figure 18: Story Stiffness along Y Axis show the stiffness distribution across the height of the building. The figures indicate that the stiffness increases with the addition of infill materials, with brick infill providing the highest level of lateral resistance. The reduced stiffness in the AAC block infill model, especially in the Y direction, is attributed to the lighter and less stiff nature of AAC blocks compared to brick. The increased stiffness provided by the infill walls, particularly the brick infill, helps to reduce lateral displacements and drifts, thereby improving the overall seismic performance of the structure.

**Table .7:** Story Stiffness along X and Y Axis

| Story | Elevation | Location | BARE FRAME | | BRICK INFILL | | AAC INFILL | |
|---|---|---|---|---|---|---|---|---|
| | | | X-Dir | Y-Dir | X-Dir | Y-Dir | X-Dir | Y-Dir |
| | M | | kN/m | kN/m | kN/m | kN/m | kN/m | kN/m |
| 9 | 31.5 | Top | 245877.1 | 245877.1 | 710879.9 | 344187.2 | 562454.6 | 0 |
| 8 | 28.5 | Top | 360207.9 | 360207.8 | 1102057 | 561403.3 | 840168.2 | 0 |
| 7 | 25.5 | Top | 389929.6 | 389929.6 | 1217334 | 636547.5 | 914386.6 | 430453.1 |
| 6 | 22.5 | Top | 398574.1 | 398574.2 | 1266286 | 669090.3 | 942983.4 | 449748.8 |
| 5 | 19.5 | Top | 402292.3 | 402292.2 | 1296684 | 689086.5 | 959612.8 | 461217.1 |
| 4 | 16.5 | Top | 407931.3 | 407931.2 | 1320936 | 704547.7 | 973501.1 | 470264.2 |
| 3 | 13.5 | Top | 420453.7 | 420453.7 | 1344876 | 719167.7 | 989883.4 | 479960.5 |
| 2 | 10.5 | Top | 447820.9 | 447820.9 | 1377180 | 738502.2 | 1018409 | 495748.7 |
| 1 | 7.5 | Top | 516069.1 | 516069 | 1453751 | 783336.5 | 1095454 | 536268.3 |
| GF | 4.5 | Top | 751531.7 | 751531.8 | 1793733 | 977135.6 | 1420161 | 702457.6 |
| PB | 1.5 | Top | 4483150 | 4483150 | 8607952 | 4633563 | 7375542 | 3621754 |
| Base | 0 | Top | 0 | 0 | 0 | 0 | 0 | 0 |

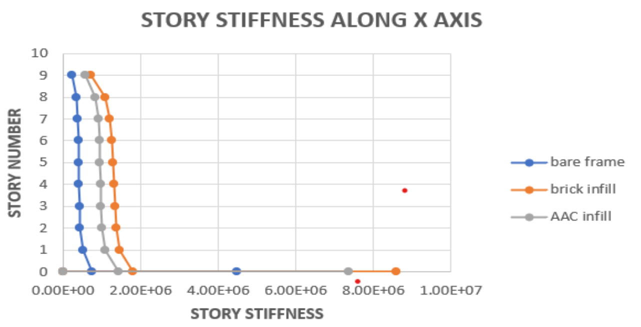


**Figure.12:** Story Stiffness along X axis


**Figure.13:**Story Stiffness along Y axis

## Conclusion

This study evaluated the seismic performance of L-shaped reinforced concrete (RC) frame structures with different infill materials, specifically brick and AAC blocks, using Response Spectrum Analysis. The results demonstrated that infill materials significantly influence the lateral displacement, drift, shear, and stiffness of the building. The addition of infill walls, particularly brick infill, enhanced the structure's lateral stiffness, reducing displacements and drifts compared to the bare RC frame. Brick infill provided superior seismic resistance, offering greater stiffness and base shear, while AAC blocks, though lighter, showed higher displacements and reduced stiffness due to their lower mass and rigidity. Additionally, the results indicated that the irregular plan of the structure exacerbated the effects of the infill materials, particularly in the Y direction. The findings underscore the importance of selecting appropriate infill materials for asymmetric buildings, as the type of infill directly impacts the structure's overall seismic performance. This research highlights the need for incorporating infill walls in the design process of seismic-prone buildings, particularly in irregular layouts, to optimize the building's resilience and reduce the risk of failure during earthquake events. Further studies can explore the performance of additional infill materials and their interaction with complex building geometries.

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