A review of the study of the fundamental natural time period of the AAC block infill wall under seismic conditions

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Abstract - *Nowadays, the growth of construction work is increasing rapidly compared to the last decade. And increase the usage of the AAC block as infill material in the infill wall for the high-rise building. traditionally, because masonry is a non-structural element, its impact on the building under seismic load has often been ignored, but some studies have found that infill wall panels affect the structure under seismic load. In an earthquake. In the research paper research about the various parameters that were studied were base shear, story displacement, story drifts, frequency, and time period.*

***Key Words*: AAC blocks, Fundamental period, bare frame, infill wall, infill with opening, RC frame, MRF frame, seismic analysis**

1. INTRODUCTION

In contemporary architecture and construction practices, the role of infill walls has evolved beyond mere structural support to become a critical component influencing the overall performance, sustainability, and energy efficiency of buildings. As the global construction industry seeks innovative solutions to address the challenges of environmental impact and energy consumption, there is a growing interest in exploring alternative materials and technologies for infill wall systems.

Traditionally relegated to the spaces between structural elements, infill walls are now recognized as integral contributors to a building's overall structural stability and energy efficiency. The choice of materials and design considerations for infill walls can significantly impact a structure's load-bearing capacity, thermal insulation, and environmental sustainability. In this context, the infusion of ion-based materials presents a novel approach, drawing inspiration from the unique properties of ions to potentially enhance both the structural and thermal attributes of infill walls.

The integration of ions in construction materials has gained attention for its potential to influence various material properties, including strength, thermal conductivity, and environmental sustainability. By harnessing the principles of ion interaction, this research seeks to explore the feasibility and benefits of incorporating ion-infused materials in infill walls, aiming to contribute valuable insights to the evolving landscape of sustainable construction practices.

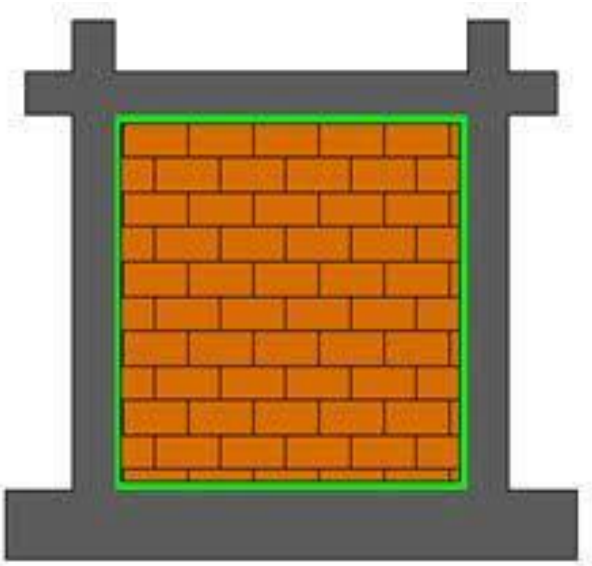

Figure 1 red brick infill wall

1.1 Objective of infill wall

The objective of an infill wall in construction can vary based on the specific context and requirements of a building or structure. Infill walls are non-load-bearing walls that are constructed between structural elements such as columns or beams. Here are some common objectives of infill walls:

1. Space Division: Infill walls are often used to divide the internal space of a building into different rooms or areas. They provide a means to create separate rooms for various functions without affecting the overall structural integrity of the building.

2. Thermal Insulation: Infill walls can contribute to the thermal performance of a building by providing insulation. Insulation in infill walls helps in maintaining a comfortable indoor temperature and reducing energy consumption for heating or cooling.

3. Sound Insulation: Infill walls can act as barriers to sound transmission, helping to minimize noise transfer between different parts of a building or between adjacent buildings. This is particularly important in residential and commercial constructions.

4. Fire Resistance: Infill walls may be designed to enhance the fire resistance of a building. The materials used in the construction of these walls can be chosen for their fire-retardant properties, helping to contain the spread of fire.

2. LITERATURE REVIEW

[1] Jalaeefar, A., & Zargar, A. (2020, December). Effect of infill walls on behavior of reinforced concrete special moment frames under seismic sequences. In *Structures* (Vol. 28, pp. 766-773). Elsevier

In this research paper study, the behavior of the RC frame under the influence of main shock and aftershock in a certain time period was calculated. For this purpose, firstly the numerical procedure in opensees was used, and then 3 special RC frames with 4,8 and 12 layers were examined. In this case, models with infill walls, without infill walls, and with openings with infill walls were modeled. Later, research and current studies were conducted to examine the response patterns of the structure to examine the impact of the earthquake on the response structure, especially later.

For the numerical modeling process, the first mode periods of the 4, 8, and 12 story frames are analyzed by the software ETABS and Opensees. From the result time period is the most match. Hence the verification is O.K.

After the verification, three types of the RC moment frame including four bays and 4, 8, and 12 stories, are taken into account. The buildings are designed in compliance with seismic provisions of ACI318 and ASCE/SE17. After the analysis results are obtained from the nonlinear time history analyses. (Pushover analysis, displacement ductility demand, rotational ductility demand, and energy dissipation)

- The results of the pushover analysis show that the addition of the infill walls increases the stiffness and strength, and also reduces the duration of the first vibration mode.
- The presence of infill walls reduces the ductility of the structure. in addition, a comparison of the ductility (displacement and rotational) of the structure with walls with and without opening shows that the ductility is higher when openings are provided since the smaller ones are all the tight model
- As the number of floors increases the ductility and rotational ductility decrease.

[2] Bârnaure, M., Ghiţă, A. M., & Stoica, D. N. (2016). Influence of the infill panels masonry type on the seismic behaviour of reinforced concrete frame structures. In *The 1940 Vrancea Earthquake. Issues, Insights and Lessons Learnt: Proceedings of the Symposium Commemorating 75 Years from November 10, 1940 Vrancea Earthquake* (pp. 319-331). Springer International Publishing.

The research paper compares the behavior of Bare frame and masonry infilled frame and the influence of masonry types is assessed. They compare the base shear and story displacement and stiffness of the following types of Bare frame, and influences of masonry types of infilled

1. Bare Frame
2. Full infill Solid Bricks
3. Full infill perforated bricks
4. Full infill AAC blocks
5. Soft story solid bricks
6. Soft perforated bricks
7. Soft AAC bricks

Analysis of the frame is using the ETABS software. For the analysis consider the following data. G+3 frame structure, 2,3,4 type of the bay frames.

The first Configuration corresponds to the Bare frame, and in the second Configuration, the infill is considered using a pin-joined diagonal frame. For the third configuration, full infill is taken into account for the upper stories while at the ground floor level, only the bare frame is considered.

The infill is also modeled as an equivalent diagonal strut; the height of the diagonal is defined as 0.1D; where D is the length of the diagonal and they are used P100-1/2013 seismic design code for the following forces; 1. Sliding shear along horizontal joints, diagonal tension, and crushing in the corners that are in contact with the frame.

As a result, Considering the low strength and stiffness values (like ACC blocks) does not have a significant impact on the behavior of the structure.

Considering the high strength and stiffness values (like solid and perforated bricks) does not have a significant impact on the behavior of the structure.

[3] Kose, M. M. (2009). Parameters affecting the fundamental period of RC buildings with infill walls. *Engineering Structures*, *31*(1), 93-102

This study is about the basic parameters like the height of the structure, number of bays, no. of stories, story height, etc. affecting the fundamental period of RC building of infill wall.

The following article states that the research plots three types of different buildings identical to 1. Bare frame, 2. Without an open first floor, 3. With an open first floor and also different parameters like percentage of shear wall; percentage of infill wall etc., Analysis of the structure is using the SAP2000 and ETABS software, for the following parameters; column size is 450x450mm, 4 No. of bays.

For the estimation, the fundamental period of the moment resisting frame has been given by the

1. Uniform Building code: $C_t h^{\frac{3}{4}}$; where., h=height of the building in feet, Ct = 0.03
2. FEMA 450: $C_r h_n^x$; where., hn is the height in feet, Cr = 0.016, x = 0.9
3. Eurocode 8: $0.075H^{\frac{3}{4}}$; where H = height of the building in meter
4. National Building code of Canada: 0.1N; where N is the number of floors above the exterior base

And compare the result of the above codes to the proposed equations.,

The Proposed equations of the fundamental period are

$T = 0.0935 + 0.0301H + 0$.0156B +0.0039F -0.1656S-0.0232I

A comparison of the proposed multiple linear regression model with UBC, Eurocode 8, FEMA 450 and NBC is presented in the chart. 1.

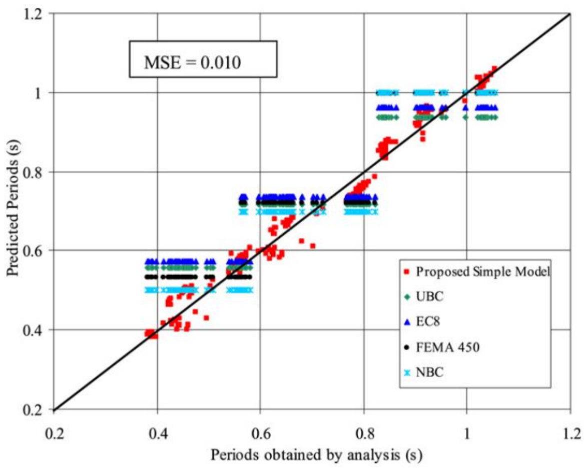

chart 1. Comparison of fundamental periods obtained by analysis with proposed full equation and code equations

conclusions, building height is the primary parameter that affects the fundamental period of the structure. The percentage of the shear wall is the second most important parameter that affects the fundamental period of the structure. The percentage of the infill wall and the number of the bay have the same effect on the fundamental period of the structure.

[4] Fasil Mohi ud din (2017). Behaviour of Infill Wall under Seismic Loading in RC Framed Structure, International Journal of Engineering and Technical Research 7(7):65-70

This study is based on the comparative study of frames in the same plane but with different stiffness and strength configurations. Fundamental period, frequency, displacement, story drift, and base shear are the different parameters studied in that research paper. For the research three types of the model were selected. First is the with shear wall model, second is the without shear wall model, and third is with infill wall model (bricks used as masonry infill materials). Analysis of the model is using structural engineering software CSI ETABS software. and follow the earthquake resistance code (IS 1893(part-1) : 2016). And used the Response spectrum Analysis method for the seismic analysis.

As a result, the Decrease in the period, with a shear wall is 42.06 % when compared with without a shear wall. With infill wall 84.33% when compared to without shear wall. An increase in frequency, with a shear wall is 42.04% when compared with without a shear wall. With infill wall 82.39% when compared to without shear wall.

[5] Patel, P., & Shah, D. (2021). Comparative Study of Brick Infill Wall and Autoclaved Aerated Concrete (AAC) Blocks Using Response Spectrum Analysis

In the research paper, research about the comparison of AAC block and Clay bricks. These are more suitable for construction as infill materials also know which are green and suitable for conventional bricks such as AAC blocks can perform better or not under seismic conditions. In this study the G+6 story RC building is analyzed by using the response spectrum analysis method and infill walls are modelled and analyzed by equivalent diagonal strut method using Etabs software.

For the research, prepared the six models which are mentioned in the given table.,

CASE 1 BRICK INFILL	Model 1	Brick infill without struts
	Model 2	Brick infill with 230mm wall struts
	Model 3	Brick infill with 230mm and 115mm wall struts

CASE 2 AAC INFILL	Model 4	Brick infill without struts
	Model 5	Brick infill with 230mm wall struts
	Model 6	Brick infill with 230mm and 115mm wall struts

the research paper compares the story displacement, the story drifts, the bending moment, and the axial and shear force.

As a result, all the models satisfied the condition of the story displacement and story drifts as per clause 7.11.1.1 of IS 1893-2016 (part 1) maximum story drift in a building should not exceed 0.004 times the story height.

When The stiffness of the building is increasing, story displacement and story drift are decreasing in the case of the strut model. When the analysis of the building using the diagonal strut method shows a lesser bending moment, lesser shear force, and lesser axial force compared to the bare frame model with the same frame sections under similar seismic conditions. Also, we can say that the AAC block is a green substitute for conventional clay brick due to the following reasons. 1. Without considering infill struts → 25.67% concrete, 16.89% reinforcement, and 18.94% cost can be conserved by adopting AAC. 2. Considering 230mm infill struts → 10.68% concrete, 9.78% reinforcement, and 9.99% cost can be conserved by adopting AAC. 3. Considering 230mm+115/100mm infill struts → 10.68% concrete, 6.91% reinforcement and 7.78% cost can be conserved by adopting AAC.

3. Objective of review

To find which time period formula is taken for the infill (AAC block) of the RC and MRF building. As per earthquake resistance code (IS 1893:2016 part 1).

To check whether the behavior of the Bare frame and with infill wall (AAC block as infill materials) is the same or not.

To study the behavior of drift pattern of different percentages of opening wall

To find the base shear of different model

To check the behavior of RC and MRF frame with AAC block infill by modeling infill as diagonal strut.

4. CONCLUSIONS

In summary, the reviewed literature emphasizes the positive impact of infill walls on the stiffness and strength of reinforced concrete frames under seismic loads. The studies reveal nuances, such as the influence of openings on ductility and variations in structural response based on masonry types. Building parameters, like height and shear wall percentage, are identified as key factors affecting fundamental periods. Comparative analyses suggest economic and environmental considerations in choosing infill materials. Overall, the findings provide valuable insights for seismic design and retrofitting, highlighting the need for a comprehensive understanding of various parameters in structural behavior.

REFERENCES

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[5] Patel, P., & Shah, D. (2021). Comparative Study of Brick Infill Wall and Autoclaved Aerated Concrete (AAC) Blocks Using Response Spectrum Analysis