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Impact of AAC Block Masonry Infill in RC Structure Against Seismic Forces in All Zones of India

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Abstract
Due to the simplicity of construction and the rapid progress of work, framed structures are frequently used in building construction. Masonry infill panels are extensively used as interior and exterior partition walls due to their aesthetic and functional benefits. In India, a typical multistory building consists of reinforced concrete (RC) frameworks with Autoclaved Aerated Concrete (AAC) block masonry infills. Unreinforced masonry infill wall panels may not contribute to resisting gravity loads, but they contribute substantially in terms of increased rigidity and strength when earthquake-induced lateral loads are applied. In practise, however, the infill rigidity is typically disregarded in frame analysis, resulting in an underestimate of stiffness and natural frequency. In addition, the in-fills' energy dissipation characteristics contribute to enhanced seismic resistance.
For the purpose of analysing the effect of infill walls on seismic performance, this study considers three cases of multi-story buildings: a naked frame, a frame with infill walls, and an in- filled frame with central apertures. Modelling the infill walls using the equivalent strut approach. We performed static analysis (for gravity and lateral stresses). In this investigation, ETABS was used to execute linear finite element analysis in order to predict the behaviour of a R C high-rise frame with AAC block masonry filling. When infill stiffness is taken into account, it is observed that the seismic demand in a frame-only structure is substantially greater, with larger base shear and larger displacements. In this study, the results are described in detail.

Keywords: AAC Block, RCC, Seismic zones, Modeling, Analysis, Design and ETABS.

Introduction
Brick is most commonly used for constructing walls in construction. CO2 emissions from the manufacturing of bricks have an effect on the environment. Therefore, the emphasis should now be on eco-friendly solutions for a greener environment. Eco-friendly Autoclaved Aerated Concrete (AAC) block provides a viable solution for building construction. This paper attempts to supplant red pavers with environmentally favourable AAC blocks [1].
Autoclaved Aerated Concrete blocks are produced in a variety of sizes and strengths and are lightweight, load-bearing, highly insulating, and durable [2]. AAC Blocks are lightweight, being three times lighter than masonry. In reinforced concrete frame structures, masonry walls are frequently employed as interior partitions and exterior walls to form the building envelope [3]. Where these walls are intended to be non-load bearing, they are not designed to contribute to the structure's axial load-carrying or lateral load-resisting capacity [4].
For walls constructed within a structural frame, a distinct design decision must be made as to whether these infill walls will participate in resisting lateral loads and, if so, whether vertical loads will also be shared [5][6]. If axial load is shared by constructing an infill wall flush with the substructure of the floor system, the infill wall will also resist lateral load transmitted to it by relative displacement of successive floors [7]. Whether or not the wall is constructed tightly to the surrounding columns, friction or mechanical anchorage along the top will transmit lateral loads to the wall [8]. In contrast, walls constructed closely to columns will share in resisting lateral load but may not share in resisting vertical load, contingent on the presence of a movement joint at the summit of the wall [9].

Literature Review

N.Jayaramappa and Santhosh D - The purpose of this research paper is to gain a deeper understanding of earthquakes as natural hazards that primarily result in the destruction of buildings and other man-made structures. According to IS 1893 (2002) Part-I, between 70 and 80 percent of urban buildings in India fell under the classification of flexible storey. In general, in the analysis and design of high-rise buildings, the effect of the brick masonry infill is not taken into account; instead, the skeleton is considered. Here, we examine the effect of brick masonry infill versus analysis of a frame without infill. A portion of the work entails performing a pushover analysis on an RC frame structure and contrasting the results with an RC frame with masonry infill and an opening.

C V R Murty sudhir and K Jain - Their paper demonstrates Masonry infill in reinforced concrete buildings results in a number of undesirable effects under seismic loading, including the short-column effect, soft-storey effect, torsion, and out-of-plane collapse. Therefore, seismic regulations dissuade such constructions in seismically active regions. However, in a number of moderate earthquakes, these structures have demonstrated outstanding performance, despite the fact that the majority of them were not designed or detailed to withstand seismic forces. This paper presents experimental findings from cyclic testing conducted on RC frameworks with masonry infill. Masonry infill is observed to significantly contribute to lateral rigidity, strength, overall ductility, and energy dissipation capacity. With suitable provisions for masonry reinforcement that is firmly affixed to the frame columns.

Narendra A., Kaple V., and D.Gajbhiye - In seismic regions, reinforced concrete (RC) frame buildings with masonry infill walls are commonly used for commercial, industrial, and multi-story residential applications. Widespread usage of infill panels as partition walls and exterior building walls to occupy the space between RC frames. Bricks or concrete blocks are typically used as masonry infill between the beams and columns of a reinforced concrete structure. In most cases, however, ignoring this property of masonry during the design of an RC frame can result in a hazardous structure. Two methods are used to determine the effect of ground motion for safer design. With and without the rigidity of the infill wall, the effect of ground motion on an RC frame building has been determined. The objective of this analysis is to investigate the behaviour of RC structures, particularly when subjected to seismic pressures.

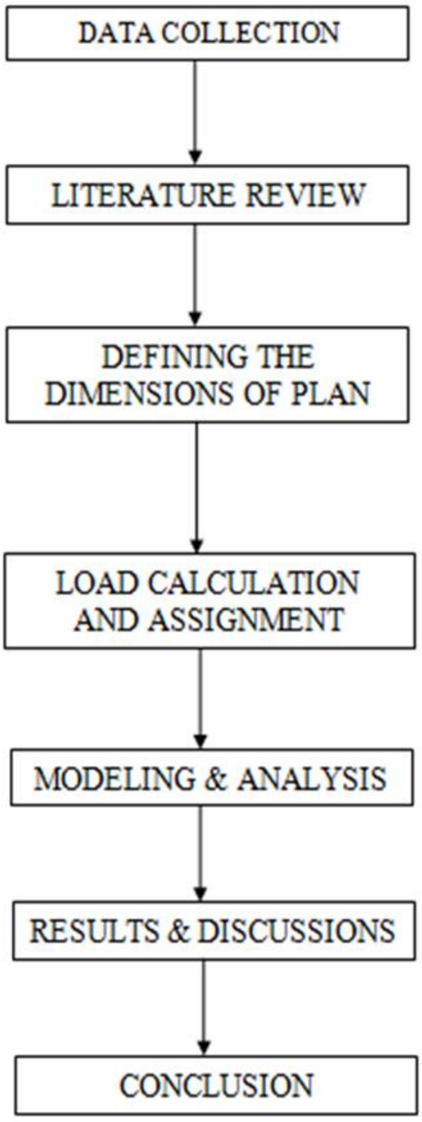
Shweta O. Rathi, P.V. and Khandve Brick is the most frequently employed building material. The CO2 emissions from the production of bricks have an impact on the environment. This paper attempts to supplant red pavers with environmentally favourable AAC blocks. As a result of the decreased inert strain of walls on beams, the use of AAC blocks can reduce construction costs by as much as 20%. The use of AAC blocks reduces the need for materials such as cement and grit by up to fifty percent.

Alim sheikh and Utkarsh jain - Brick is the most commonly employed construction material. AAC blocks are a novel, extremely lightweight building material. Compared to a clay brick of the same dimensions (200mm x 100mm x 100mm), this material is three times lighter, allowing it to cover a larger area with the same weight. In this paper, lightweight AAC blocks are proposed as a replacement for clay bricks. As a result of the reduction of inert strain on beams, the use of AAC blocks can reduce construction costs by as much as 25 percent. Using AAC blocks reduces the need for materials such as cement and grit by up to 55 percent.

Scope & Objectives

- The stiffness of the infill may be considered in the framed structures, and then the design of resulting structural elements may be significantly different and economical.
- To carry out the literature surveys on the behavior of AAC block masonry in-filled frame buildings.
- To study the behavior of AAC block masonry infill wall in reinforced concrete framed structures against seismic forces.
- To develop a simple model for the analysis of in-filled frames.
- To study the behavior of bare frame and in-filled frame with openings and infill frame without openings by modeling the AAC block masonry infill a finite element package ETABS will be used.

Methodology



Description of Building

The building used in the study is a G+8 storey cast-in-place reinforced concrete special moment resisting frame structure situated in All Zones. The detailed description of the building is as follows:

- Plan area of the building – 21 x 10m
- First Storey Height – 2.0m
- Typical Storey Height – 3.0m
- Total Height of the Building - 26m
- Typical Bay size – 3mx4m & 2mx3m.
- The building is considered as a Special Moment resisting frame.

Materials

Grade of concrete = M25
Grade of steel = Fe500

Load calculation

Dead Load

Floor Finishes	= 1.00 kN/m2
Partitions load	= 1.00 kN/m2
Total loads	= 2.00 kN/m2

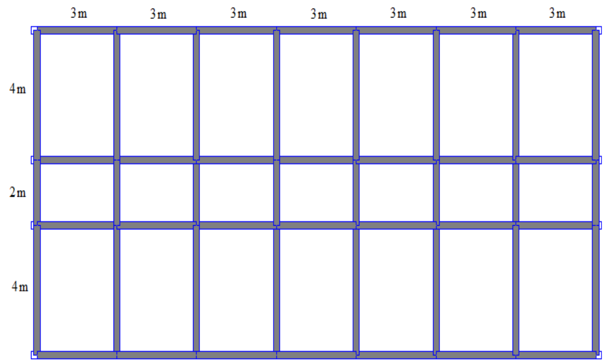
Live Load

Live load at floor levels = 3.0 kN/m2

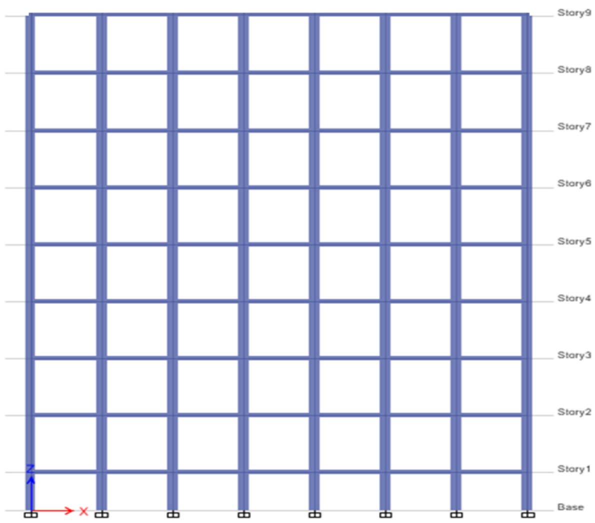
Seismic load

The following Seismic parameters were taken in accordance with IS: 1893 – 2002. For design consideration the building is situated All Zones of India.

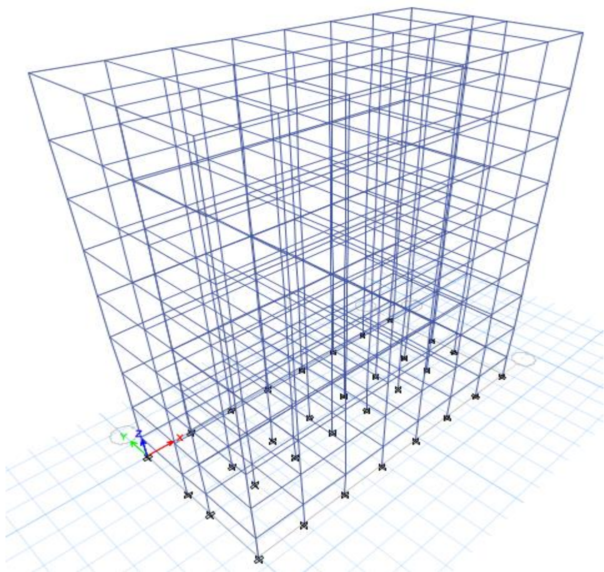
Plan of the Structure



Elevation of Bare frame



Isometric view of Bare frame

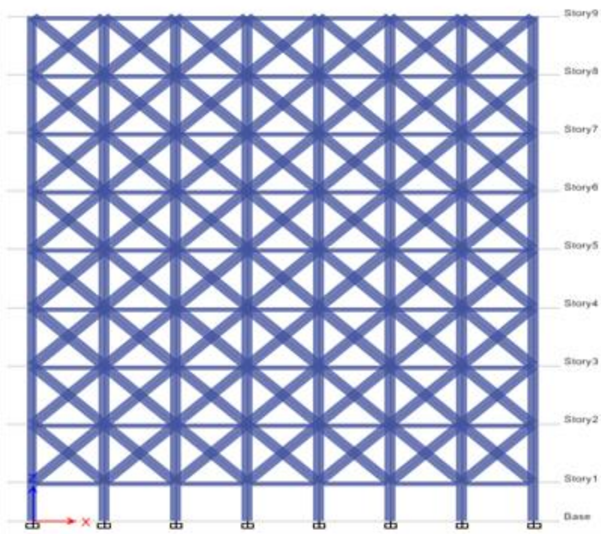


Application of equivalent diagonal strut method:

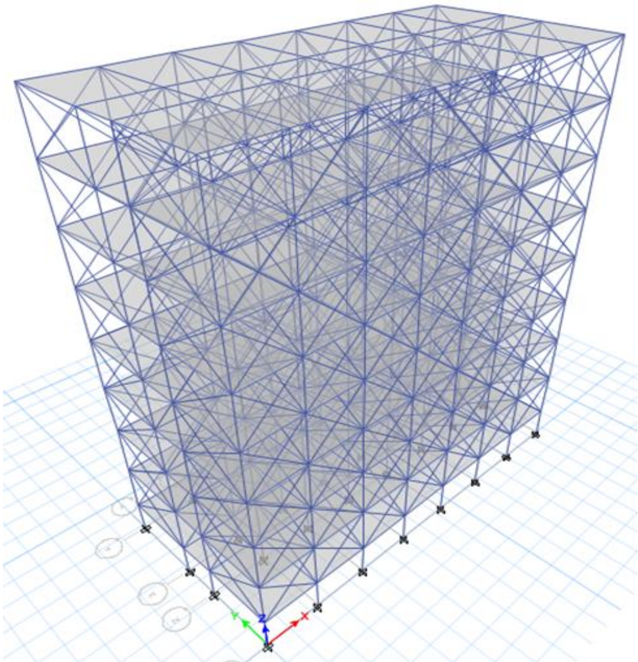
Equivalent Diagonal Strut is a method for inelastic analysis. It is a method commonly used to define an infill panel in a frame in a simple way. The Basic principle of the method is that an infill frame can be assumed as brace frame and it functions equivalent to the compression brace (equivalent diagonal strut). An equivalent diagonal strut can only handle compression force, therefore the effect of continuous lateral load due to an earthquake can be overcome by formation of two -ways diagonal strut. If the mechanic properties from an equivalent diagonal strut can be identified, the infill Frame can be analyzed as an open frame with Equivalent Diagonal Strut. In this present analysis, a trussed frame model is considered. This type of model does not neglect the bending moment in beams and columns. Rigid joints connect the beams and columns, but pin joints at the beam-to-column junctions connect the equivalent struts. A column interior to the perimeter column lines for facilities that have underground parking or public ground floor areas.

- Width of strut (X - Dir) – 0.468m
- Width of strut (Y - Dir) – 0.505m
- Width of strut (Opening) – 0.367m

Elevation of Infill frame



Isometric view of Infill frame



Results and Discussions

The analysis is run and the necessary data such as maximum storey drift and displacement of the structure are taken into account for comparison and the maximum storey displacement variations, all zone values in the buildings are also compared. From the seismic analysis, the results obtained in X and Y directions are illustrated. The result is found for two methods such as,

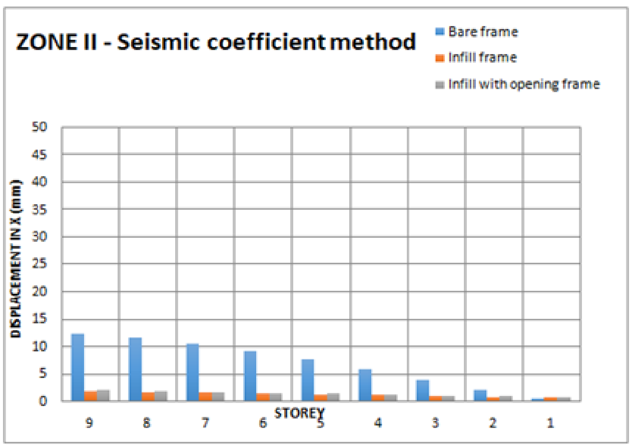
- Seismic co-efficient method
- Response spectrum method

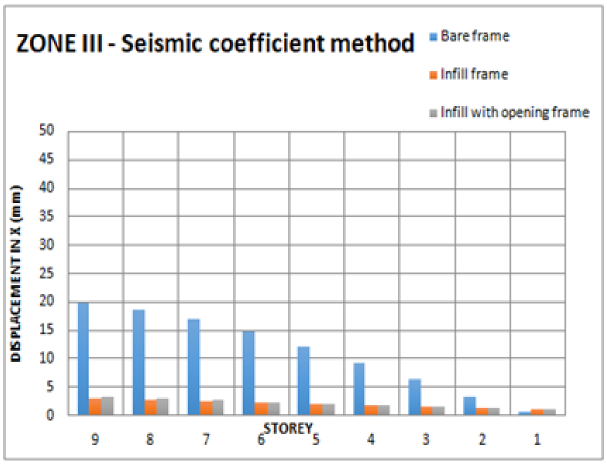
Maximum storey displacement

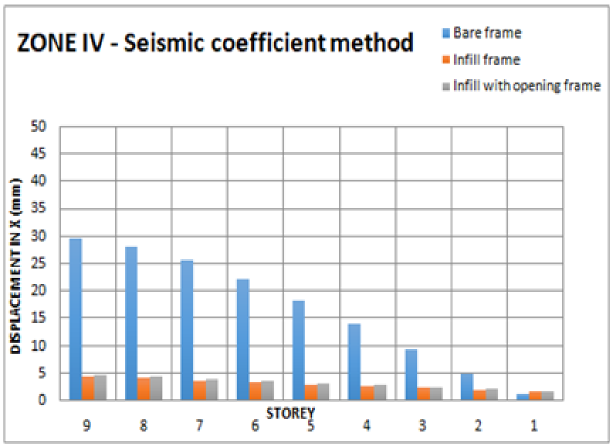
Maximum storey displacement is the maximum lateral displacement of a structure under seismic loads. Maximum storey displacement will usually occur at the top storey of building and the lateral displacement of building under seismic load using both methods shown in graphs.

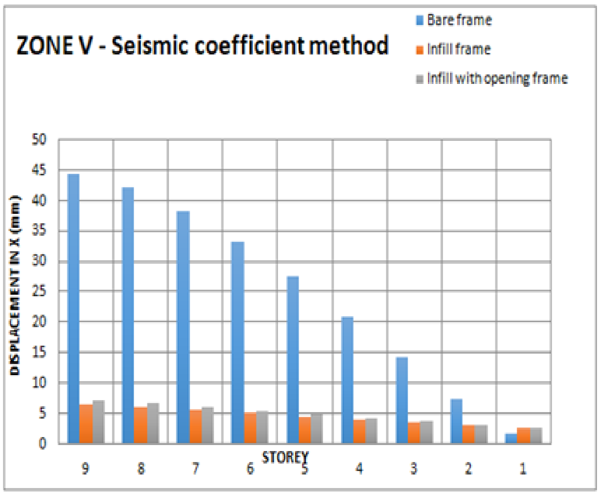
Storey drift

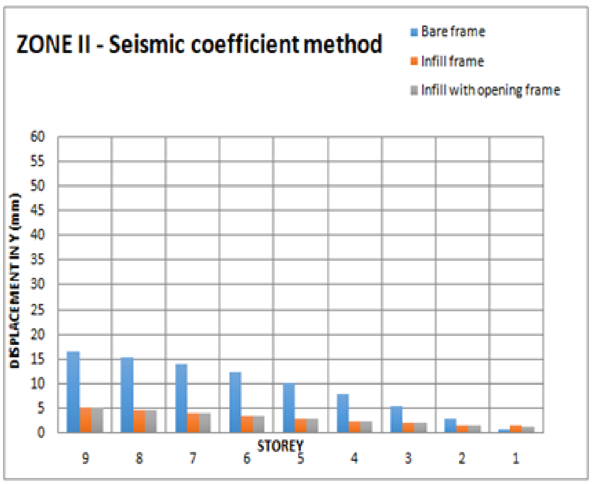
Storey drift is the displacement of one level relative to other level above or below. It was checked whether the structure satisfies maximum permissible relative lateral drift criterion as per IS: 1893-2002 (Part-I) which is 0.004H. The storey drifts of all models using both methods shown in graphs.

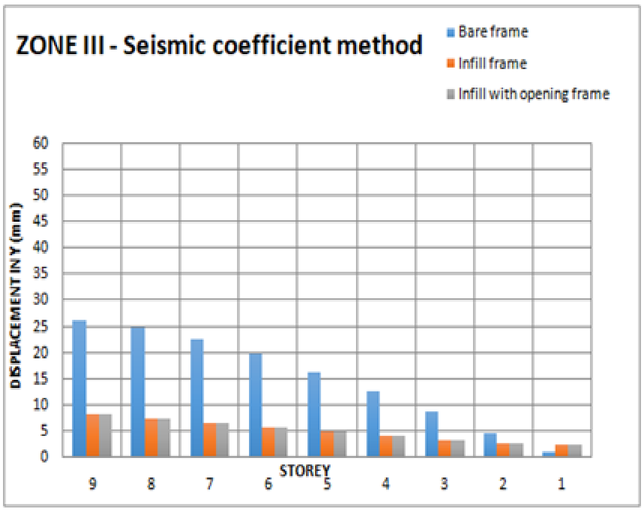


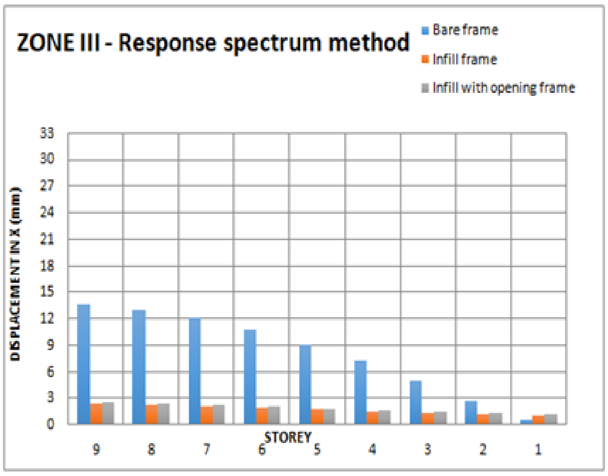









ZONE III - Seismic coefficient method
Bare frame
Infill frame
Infill with opening frame
DISPLACEMENT IN Y (mm)
60 55 50 45 40 35 30 25 20 15 10 5 0
9 8 7 6 5 4 3 2 1
STOREY


ZONE III - Response spectrum method
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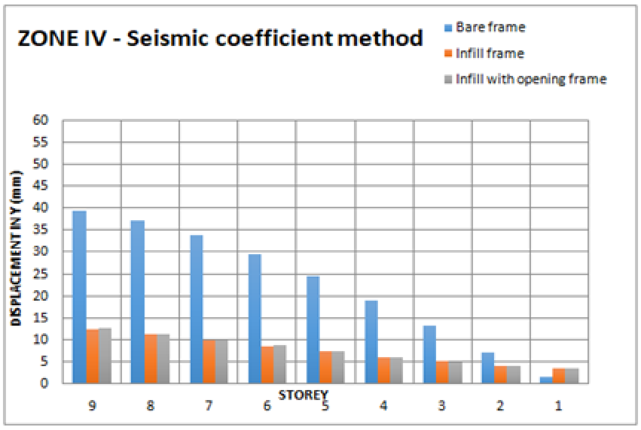
STOREY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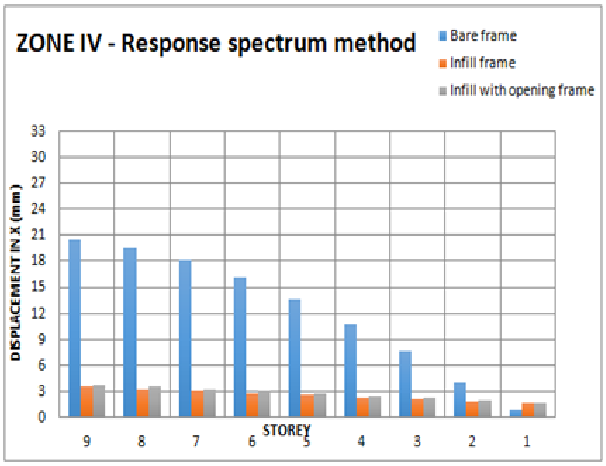
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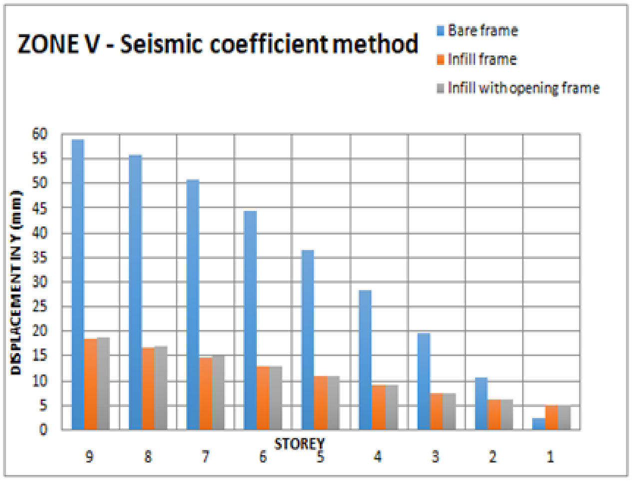
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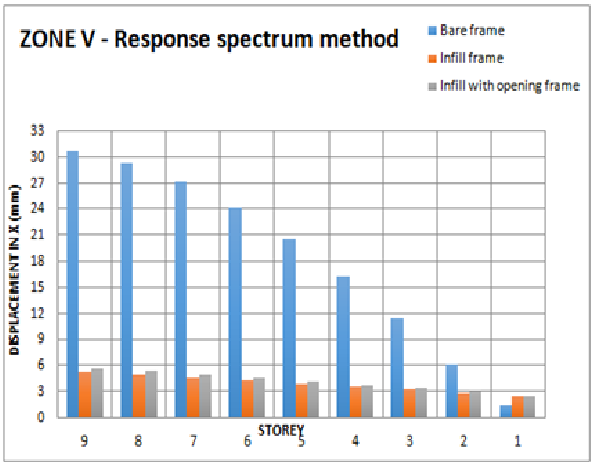
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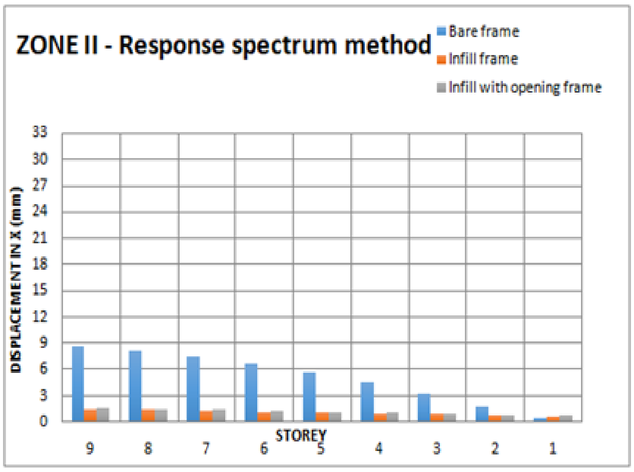
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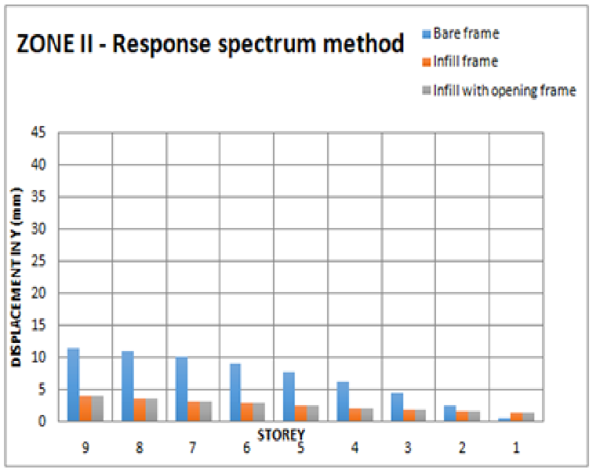
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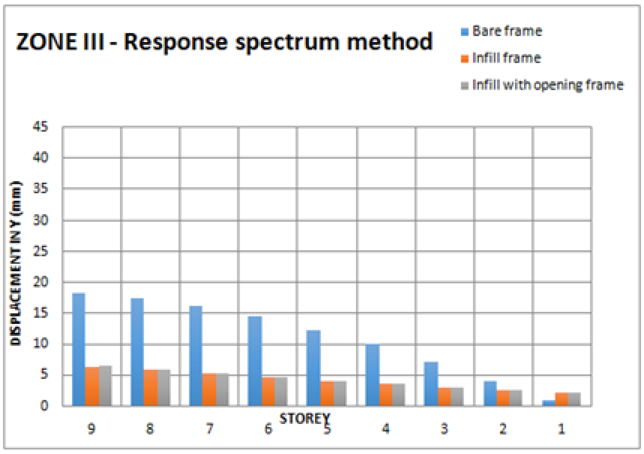
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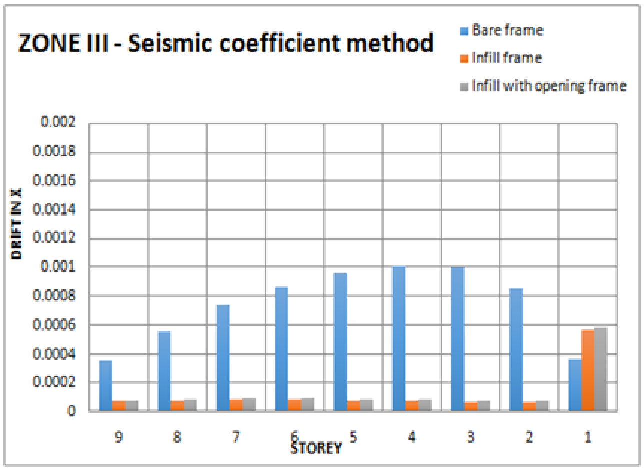
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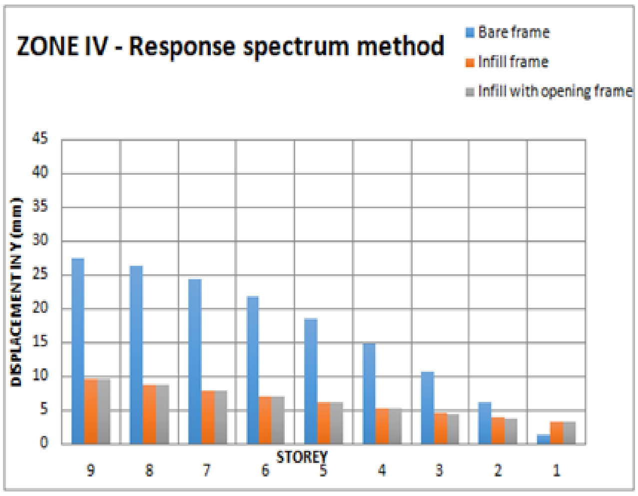
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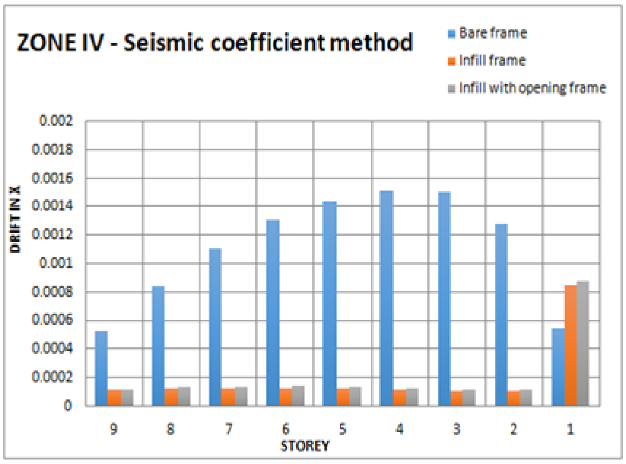
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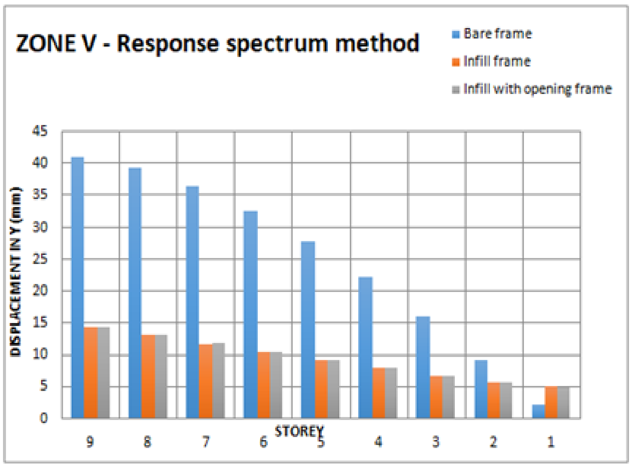
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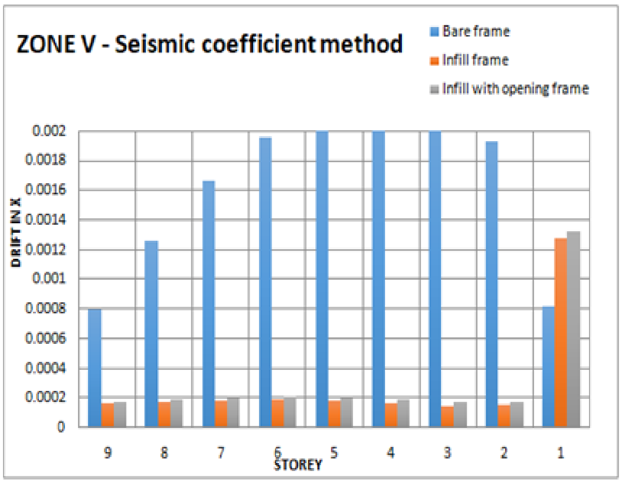
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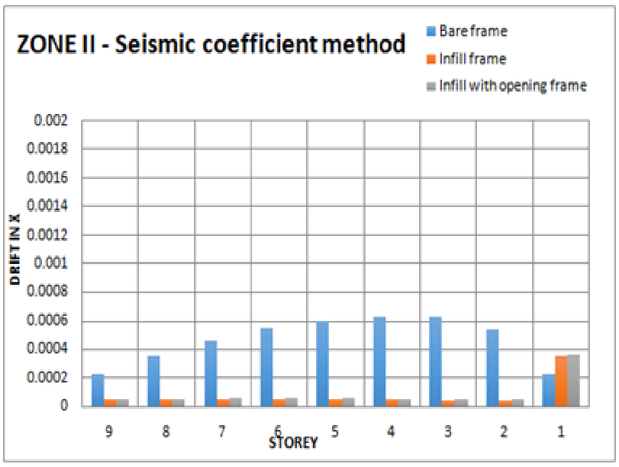
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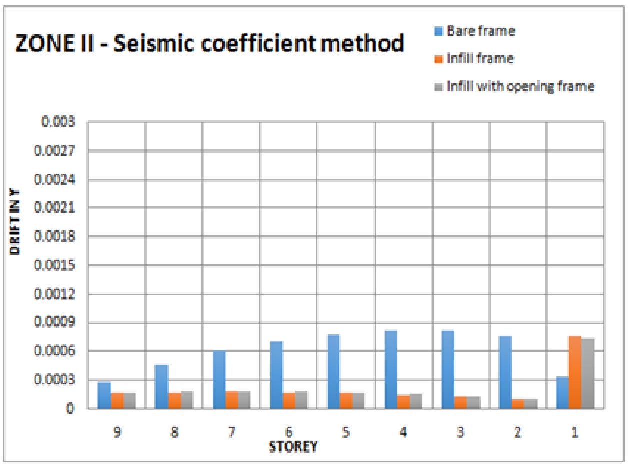
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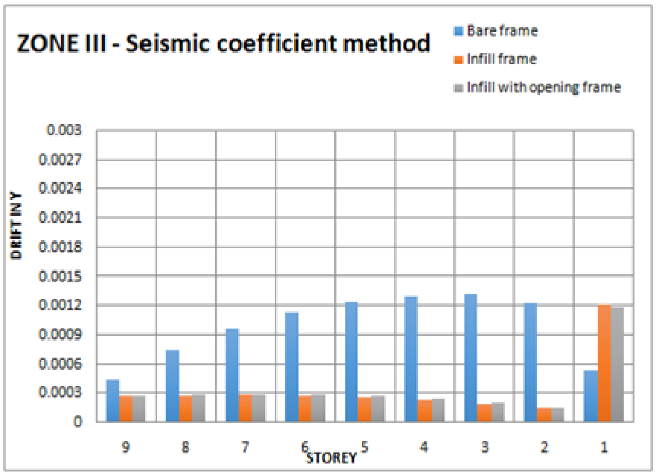
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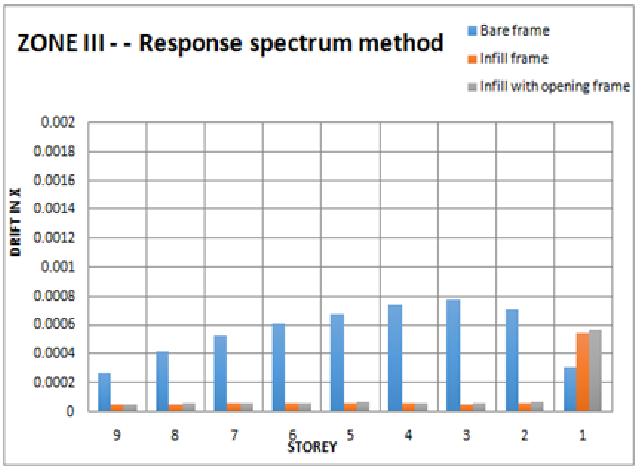
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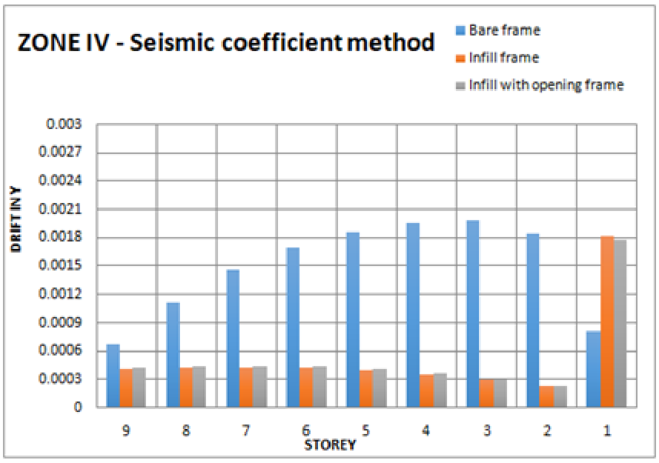
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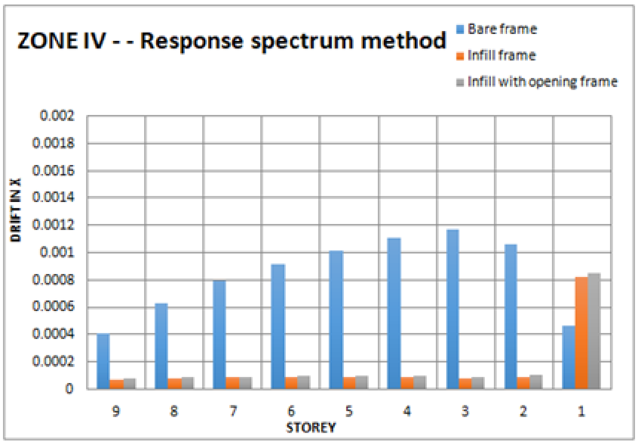
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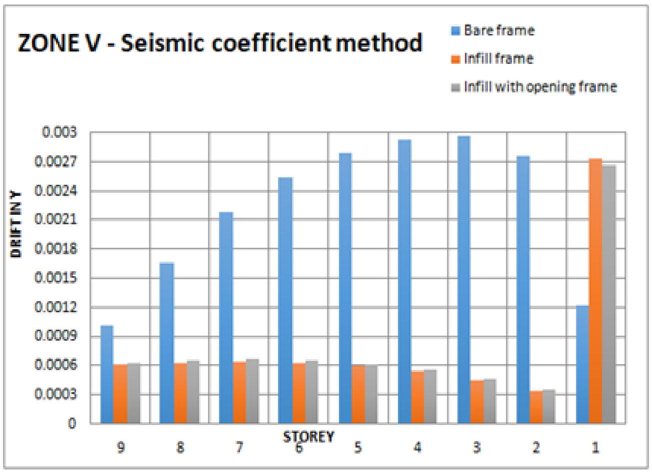
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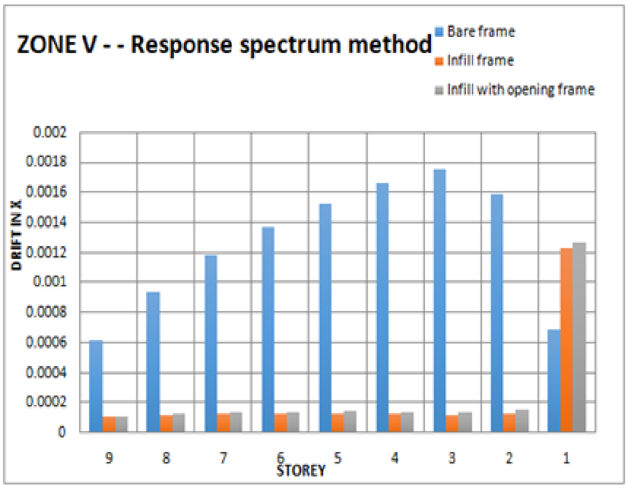
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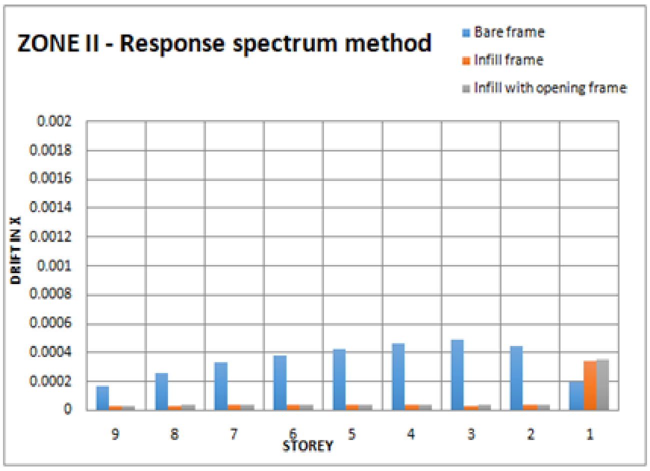
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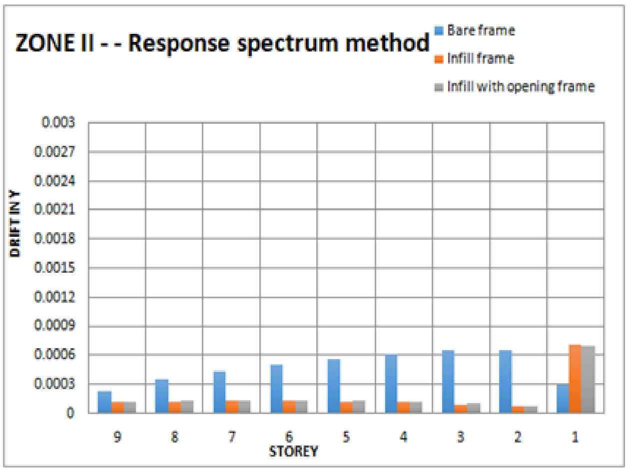
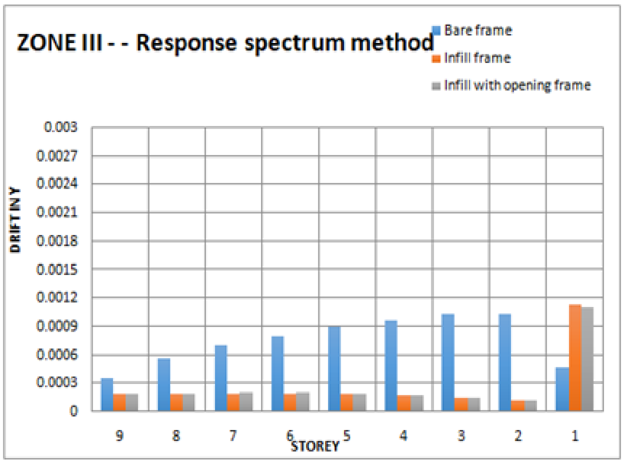
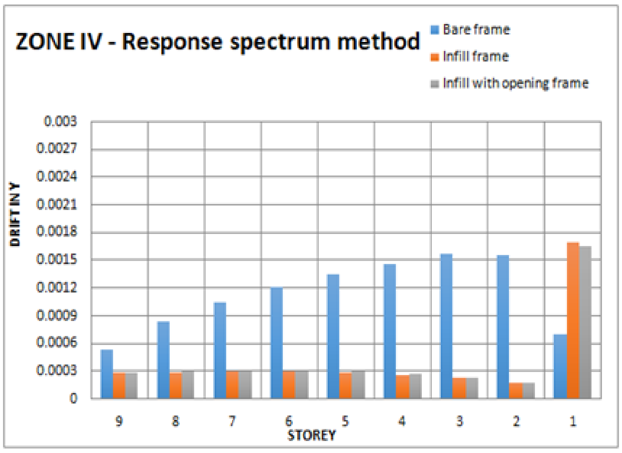
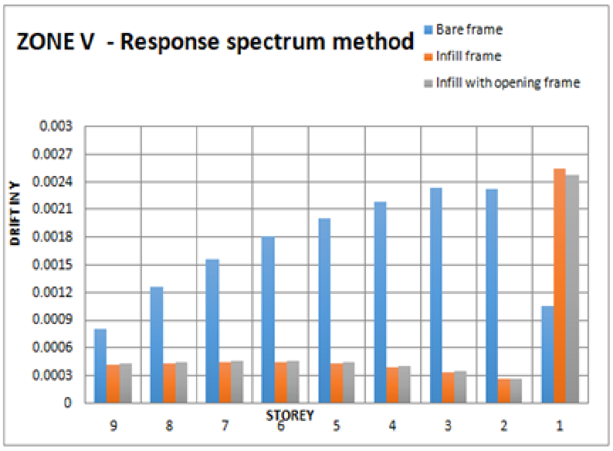
0.0002
0
9 8 7 6 5 4 3 2 1
STOREY


ZONE II - - Response spectrum method
Bare frame
Infill frame
Infill with opening frame
DRIFT IN Y
0.003
0.0027
0.0024
0.0021
0.0018
0.0015
0.0012
0.0009
0.0006
0.0003
0
9 8 7 6 5 4 3 2 1
STOREY







Conclusion

The maximum storey displacement occurs in Zone V of bare frame model using seismic co-efficient method in both X and Y directions. When compare to bare frame in-filled frame reducing the lateral displacement drastically in both with opening and without opening. The lateral displacement is gradually increasing when zone factor is increasing and it is minimum at plinth level and maximum at terrace level depending on stories.

The lateral displacement of both bare frames, in-filled frame without openings and in-filled frame with openings are found out for seismic co-efficient method and response spectrum method and when comparing the displacement value obtained from seismic co-efficient method are greater than response spectrum method.

Storey drift for bare frame is having minimum value at base when compare to in-filled frames, and it is maximum at intermediate stories and gradually reducing to the top stories. Thus, extra stiffness of column requires at middle stories compared to other stories in both seismic co-efficient method and response spectrum method.

References

1. Kashif Mahmud, Md. Rashadul Islam and Md. Al-Amin," Study the Reinforced Concrete Frame with Brick Masonry Infill due to Lateral Loads", International Journal of Civil & Environmental Engineering IJCEE – IJENS Vol. 10 No.04.
2. Amiya K. Samanta, "On Utilization of Seismic Resistance of Masonry Infills in Design of Low – Rise Mixed R C Buildings – A Case Study, ARPN Journal of Engineering and Applied Sciences.
3. Suyamburaja Arulselvan, K.Subramanian, E.B. Perumal and A.R. Santhakumar, "R C Infilled Frame – R C Plane Frame Interactions for Seismic Resistance". Journal of Applied Sciences 7 (7) : 942-950, 2007, ISSN 1812-5654.
4. Jaswant N. Arlekar, Sudhir K. Jain and C V R Murty, "Seismic Response of R C Frame Buildings with Soft First Storeys", Proceedings of the CBRI Golden Jubilee Conference of Natural Hazards in Urban Habitat, 1997, New Delhi.
5. D K Bell and B J Davidson, "Evaluation of Earthquake Risk Buildings with Masonry Infill Panels", NZSEE 2001 Conference.
6. Mehmet Baran and Tugce Sevil, "Analytical and Experimental Studies on Infilled R C Frames", International Journal of the Physical Sciences Vol.5(13), pp, 1981-1998, 18 October, 2010.
7. Santiago Pujol, Amadeo Benavent – Climent, Mario E Rodriguez and J Paul Smith-Pardo, "Masonry Infill Walls: An Effective Alternative for Seismic Strengthening of Low-Rise R C Building Structures", The 14th World Conference on Earthquake Engineering, October 12-17, 2008, Beijing, China.
8. B Binici and G Ozcebe, "Seismic Evaluation of Infilled R C Frames Strengthened with FRPS", Proceedings of the 8th U.S. National Conference on Earthquake Engineering April 18-22, 2006, San Francisco, California, USA.
9. F Demir and M Sivri, "Earthquake Response of Masonry Infilled Frames", October 14, 2002.