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Impact of AAC Block Masonry Infill in RCC Multistoried Building against Seismic Forces

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ABSTRACT: **:**In the building construction, framed structures are frequently used due to ease of construction and rapid progress of work. Masonry infill panels have been widely used as interior and exterior partition walls for aesthetic reasons and functional needs.
The typical multi-storey construction in India comprises reinforced concrete RC frames with Autoclaved Aerated Concrete (AAC) block masonry infill.
In this study three cases of multistoried building i.e., a frame with infill walls and in-filled frame with central openings are considered for the analyzing the effect of infill walls on seismic performance
The infill walls are modeled using the equivalent strut approach. Structural analysis (for gravity and lateral loads) were performed. In this study linear finite element analysis has been performed using the package ETABS to predict the behavior of RC high rise frame with AAC block masonry infill.

KEYWORDS:AAC Block, Infills, Seismic force, Equivalent diagonal strut, ETABS, Seismic coefficient method, Response spectrum method.

I. INTRODUCTION

Brick masonry is most commonly used for building partitions for construction. The CO2 emission in the brick manufacturing process affects the green environment. Therefore, focus should be now more on seeking eco – friendly solutions for greener environment. Autoclaved Aerated Concrete (AAC) block, an eco – friendly material, gives a prospective solution to building construction. In this paper, attempt has been made to replace the red bricks with eco – friendly AAC blocks.

Autoclaved Aerated Concrete blocks are Lightweight, Load-bearing, High-insulating, Durable building product, which is produced in a wide range of sizes and strengths.AAC Blocksis lightweight and compare to the bricks, AAC blocks are three times lighter. Masonry walls are widely used as interior partitions and as exterior walls to form part of the building envelope in reinforced concrete frame structures.Where these walls are intended to be non-load bearing, they are not designed to contribute to the axial load-carrying or lateral load-resisting capacity of the structure.

The potential for interaction of infill walls and partitions with the structural frame has often been ignored to simply the design or because the lack of design information has made it difficult to assess the extent of composite action. In fact, an infill wall enhances considerably the strength and rigidity of the structure. It has been recognized that frames with infills have more strength and rigidity in comparison to the bared frames and their ignorance has become the cause of failure of many of the multi-storeyed buildings.

1.2 ADVANTAGES OF AAC BLOCKS:

- **Eco - friendly:** AAC helps to reduce at least 30% of environmental waste as compared to traditional concrete. There is a decrease of 50% of greenhouse gas emissions.
- **Lightweight:** It is 3-4 times lighter than traditional bricks and therefore, easier and cheaper to transport.
- **Energy Saver:** It has an excellent property that makes it an excellent insulator.
- **Great Acoustics:** AAC has excellent acoustic performance. It is able to be used as a very effective sound barrier.
- **Fire Resistant:** Just like the regular concrete, ACC is fire resistant. This material is completely inorganic and not combustible.
- **Low Maintenance:** AAC reduces the operating cost by 30% to 40%. It also reduces overall construction cost by 2.5%.
- **Faster Construction:** It reduces construction time by 20%. As these blocks are lighter, it makes construction easier and faster.

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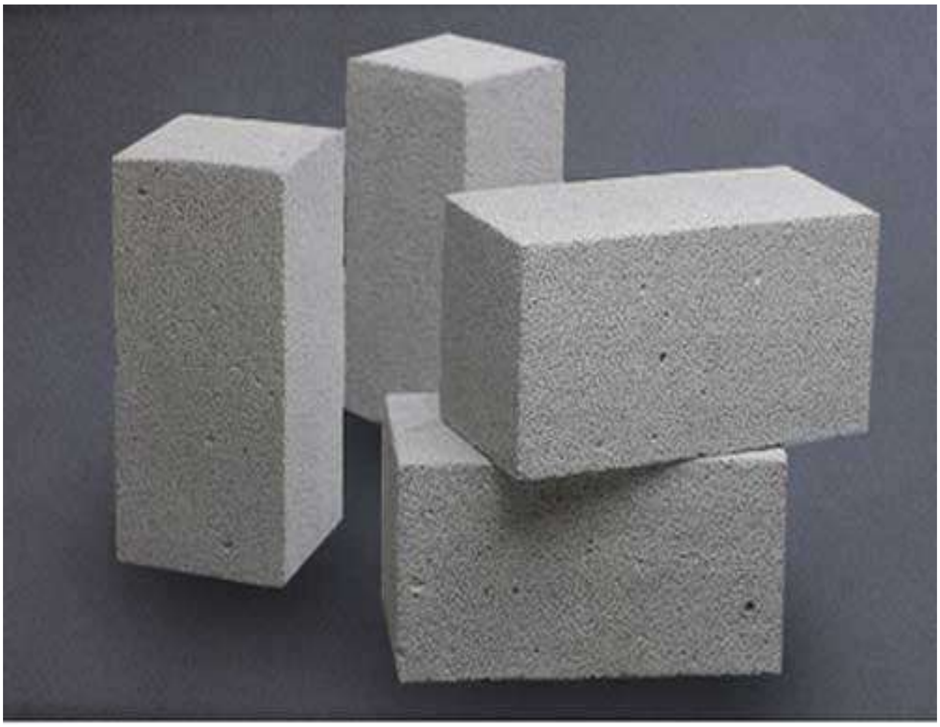

Fig.1.1 AAC blocks

Fig .1.2 Building constructed with AAC blocks

1.3 STRUCTURAL AND CONSTRUCTIONAL ASPECTS OF INFILLS:

The presence of masonry in-fills are the cause of

i. unequal distribution of lateral forces in the different frames of a building - over stressing of some frames .

ii. vertical irregularities in strength and stiffness - soft storey or weak storey as a result higher inter–storey drifts and higher Ductility demands of RC elements of the soft storey in comparison to remaining stories .

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iii. horizontal irregularities - significant amount of unexpected torsional forces since the centre of rigidity is moved towards the stiffer in-filled frames of increased stiffness and as a result Occurrence of very large displacements in the extreme bare Frames.
iv. Inducing the effect of short column or captive columns in In-filled frame - a captive column is full storey slender column whose clear height is reduced by its part-height contact with a relatively stiff masonry infill wall, which constraints its lateral deformation over the height of contact (CEB, 1996) resulting in premature brittle failure of columns and
v. failure of masonry infills - out-of-plane and in-plane failure results which become the cause of casualties.

A significant amount of research work has been carried out on the consideration of stiffening effect of infill panels and its constructional details. A clear decision has to be taken by the structural engineers , whether the infill walls will be made to participate in resisting the load or not. Depending upon its load resisting mechanism of infills the construction details will be followed as : ionly axial load - infill walls tight to the under side of the floorsystem– arching action is the dominant mechanism,
ii axial and lateral load – friction or mechanical anchorage along the top to transfer lateral load to the wall – connection must be able to transfer reaction,
iii only lateral load - wall built tight to the columns and a movement joint at the top of wall, and no axial and lateral movement joints along all the sides of walls and must be sufficiently thick to isolate the effects of inter- storey drift, floor deflection and different
movement - this type of wall is called partition wall.\

II. RESULTS AND DISCUSSIONS :

2.1 GENERAL:

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 are 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. It's observed that the results obtained for shear wall and steel braced model using linear static analysis is higher than the results obtained in linear dynamic analysis. Maximum storey displacement will usually occur at the top storey of building and the lateral displacement of building under seismic load using the equivalent Static and the response spectrum analyses is shown below.

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 for both shear wall and steel bracing systems. The storey drift of all models using equivalent static method and response spectrum method is shown in below.

DISPLACEMENT AND STOREY DRIFT FOR INFILL FRAME STRUCTURE

Table 5.1 Displacement for zone V(Infill Frame)

DISPLACEMENT – ZONE V (INFILL FRAME)

SL NO	ZONE	SEISMIC COEFFICIENT METHOD				RESPONSE SPECTRUM METHOD			
		Storey	X mm	Storey	Y mm	Storey	UX mm	Storey	Y mm
1	V	Storey9	6.568	Storey9	18.545	Storey9	5.272	Storey9	14.268
2	V	Storey8	6.076	Storey8	16.715	Storey8	4.954	Storey8	13.026
3	V	Storey7	5.552	Storey7	14.825	Storey7	4.615	Storey7	11.745
4	V	Storey6	5.006	Storey6	12.905	Storey6	4.259	Storey6	10.437
5	V	Storey5	4.458	Storey5	11.012	Storey5	3.891	Storey5	9.131
6	V	Storey4	3.928	Storey4	9.219	Storey4	3.524	Storey4	7.872
7	V	Storey3	3.435	Storey3	7.607	Storey3	3.166	Storey3	6.715
8	V	Storey2	3.001	Storey2	6.276	Storey2	2.833	Storey2	5.733
9	V	Storey1	2.541	Storey1	5.291	Storey1	2.443	Storey1	4.971

Table 5.2 Storey drift for zone V(Infill Frame)

STOREY DRIFT – ZONE V (INFILL FRAME)

SL NO	ZONE	SEISMIC COEFFICIENT METHOD				RESPONSE SPECTRUM METHOD			
		Storey	Drift (X)	Storey	Drift (Y)	Storey	Drift (X)	Storey	Drift (Y)
1	V	Storey9	0.000164	Storey9	0.00061	Storey9	0.000107	Storey9	0.00042
2	V	Storey8	0.000177	Storey8	0.000632	Storey8	0.000115	Storey8	0.000435
3	V	Storey7	0.000186	Storey7	0.00064	Storey7	0.000123	Storey7	0.000445
4	V	Storey6	0.000187	Storey6	0.000631	Storey6	0.000127	Storey6	0.000444
5	V	Storey5	0.000181	Storey5	0.000598	Storey5	0.000127	Storey5	0.000429
6	V	Storey4	0.000168	Storey4	0.000537	Storey4	0.000123	Storey4	0.000394
7	V	Storey3	0.000149	Storey3	0.000444	Storey3	0.000116	Storey3	0.000335
8	V	Storey2	0.000154	Storey2	0.000337	Storey2	0.00013	Storey2	0.000263
9	V	Storey1	0.001277	Storey1	0.002731	Storey1	0.001234	Storey1	0.002546

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5.5 DISPLACEMENT AND STOREY DRIFT FOR INFILL FRAME WITH OPENING STRUCTURE

Table 5.3 Displacement for zone V (Infill Frame with opening)

DISPLACEMENT – ZONE V (WITH OPENING)

SL NO	ZONE	SEISMIC COEFFICIENT METHOD				RESPONSE SPECTRUM METHOD			
		Storey	X mm	Storey	Y mm	Storey	UX mm	Storey	Y mm
1	V	Storey9	7.108	Storey9	18.831	Storey9	5.668	Storey9	14.405
2	V	Storey8	6.584	Storey8	16.959	Storey8	5.33	Storey8	13.139
3	V	Storey7	6.014	Storey7	15.017	Storey7	4.966	Storey7	11.827
4	V	Storey6	5.411	Storey6	13.04	Storey6	4.574	Storey6	10.484
5	V	Storey5	4.8	Storey5	11.087	Storey5	4.166	Storey5	9.141
6	V	Storey4	4.202	Storey4	9.236	Storey4	3.751	Storey4	7.845
7	V	Storey3	3.642	Storey3	7.574	Storey3	3.342	Storey3	6.655
8	V	Storey2	3.149	Storey2	6.205	Storey2	2.961	Storey2	5.645
9	V	Storey1	2.621	Storey1	5.196	Storey1	2.51	Storey1	4.862

Table 5.4 Storey drift zone V (Infill Frame with opening)

STOREY DRIFT – ZONE V (WITH OPENING)

SL NO	ZONE	SEISMIC COEFFICIENT METHOD				RESPONSE SPECTRUM METHOD			
		Storey	Drift (X)	Storey	Drift (Y)	Storey	Drift (X)	Storey	Drift (Y)
1	V	Storey9	0.000175	Storey9	0.000624	Storey9	0.000113	Storey9	0.000428
2	V	Storey8	0.000192	Storey8	0.000649	Storey8	0.000124	Storey8	0.000446
3	V	Storey7	0.000204	Storey7	0.00066	Storey7	0.000134	Storey7	0.000457
4	V	Storey6	0.000207	Storey6	0.000651	Storey6	0.00014	Storey6	0.000457
5	V	Storey5	0.000203	Storey5	0.000617	Storey5	0.000142	Storey5	0.000442
6	V	Storey4	0.00019	Storey4	0.000554	Storey4	0.000139	Storey4	0.000406
7	V	Storey3	0.000169	Storey3	0.000457	Storey3	0.000132	Storey3	0.000344
8	V	Storey2	0.000176	Storey2	0.000345	Storey2	0.00015	Storey2	0.000271
9	V	Storey1	0.001321	Storey1	0.002669	Storey1	0.00127	Storey1	0.002481

5.6 COMPARISON OF DISPLACEMENT, INCLUDING SEISMIC COEFFICIENT METHOD AND RESPONSE SPECTRUM METHOD

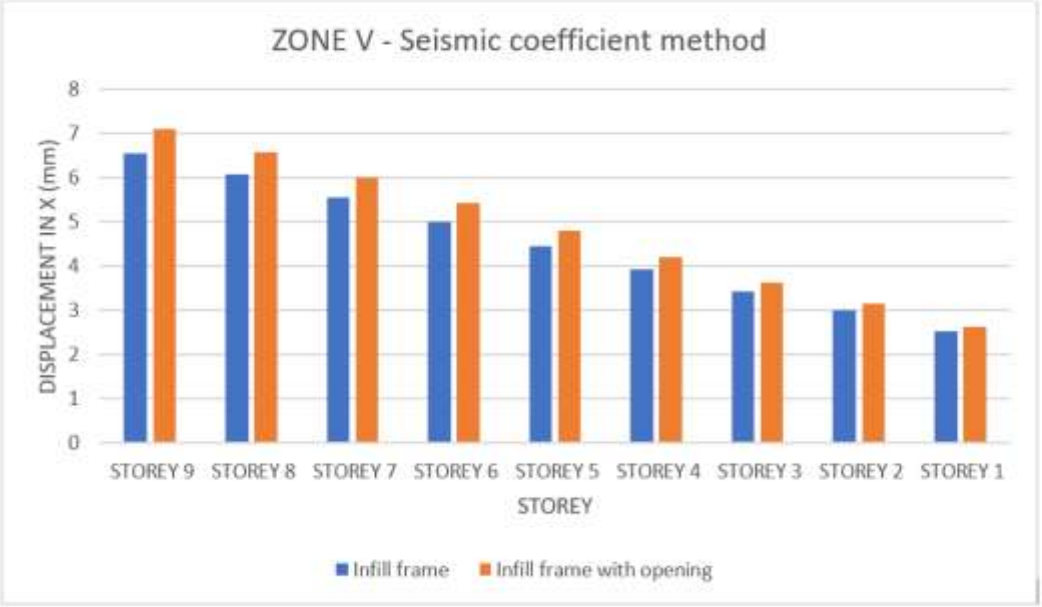

Fig .5.1 Comparison of displacement in zone V(X direction)

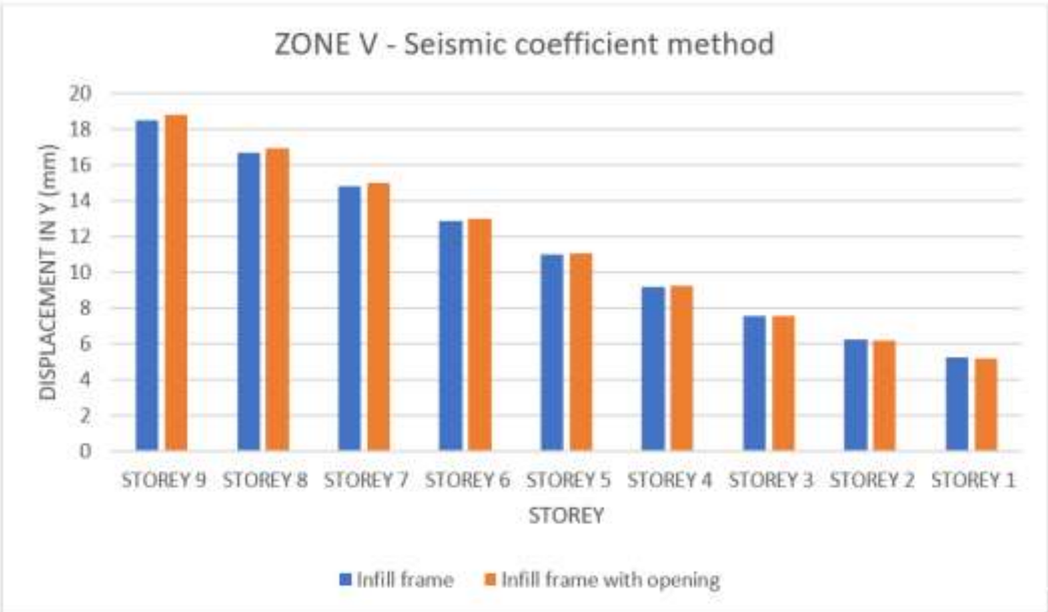

Fig .5.2 Comparison of displacement in zone V(Y direction)

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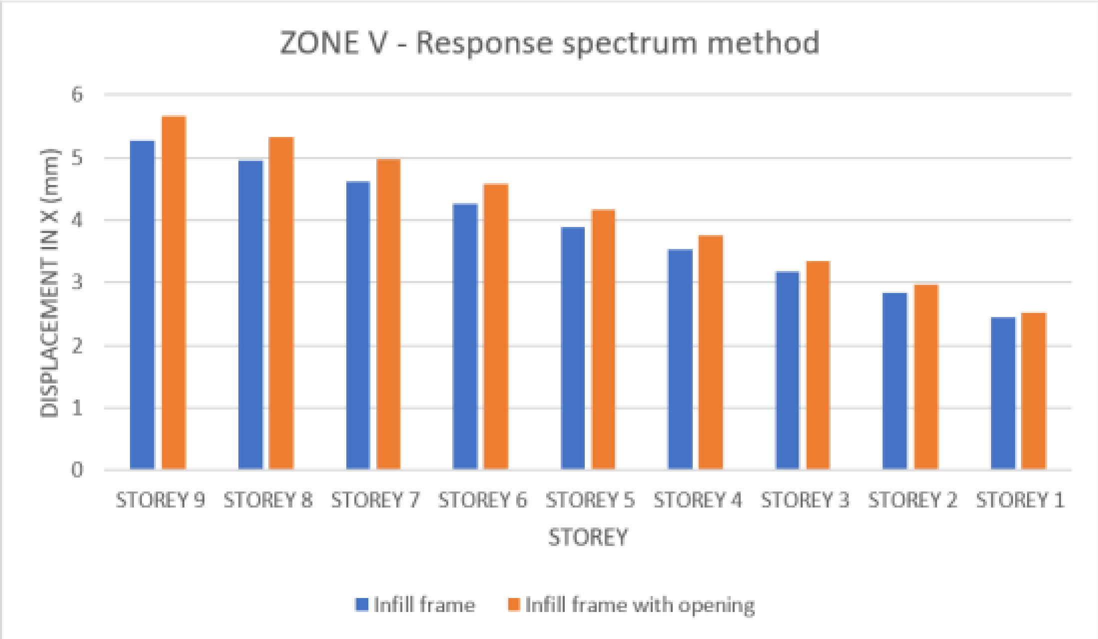

Fig .5.3 Comparison of displacement in zone V(X direction)

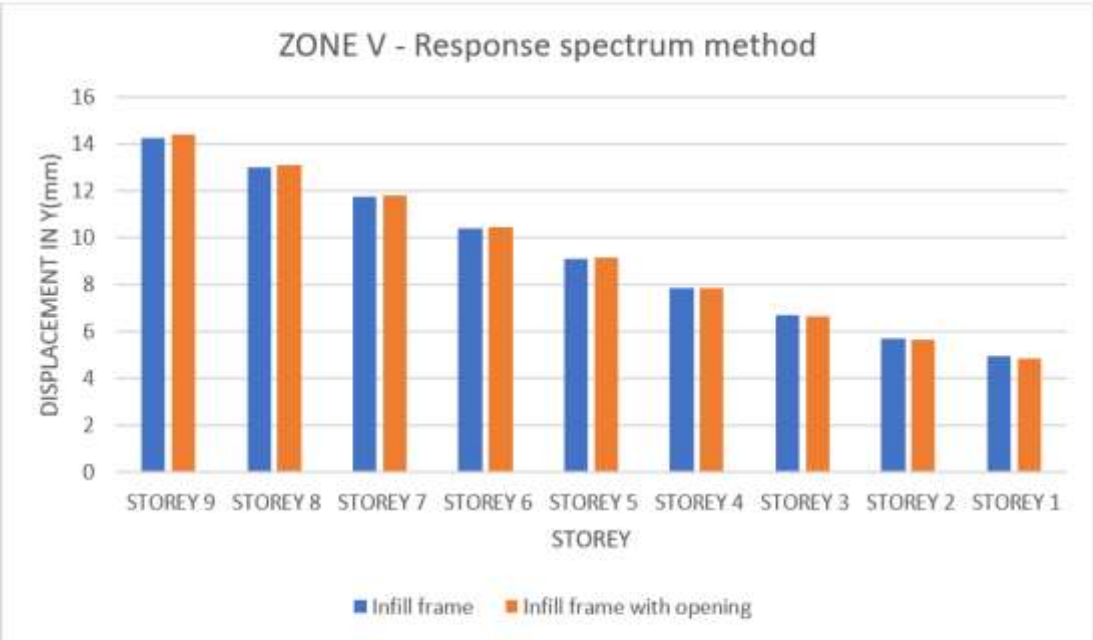

Fig .5.4 Comparison of displacement in zone V(Y direction)

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5.7 COMPARISON OF STOREY DRIFT, INCLUDING SEISMIC COEFFICIENT METHOD AND RESPONSE SPECTRUM METHOD.

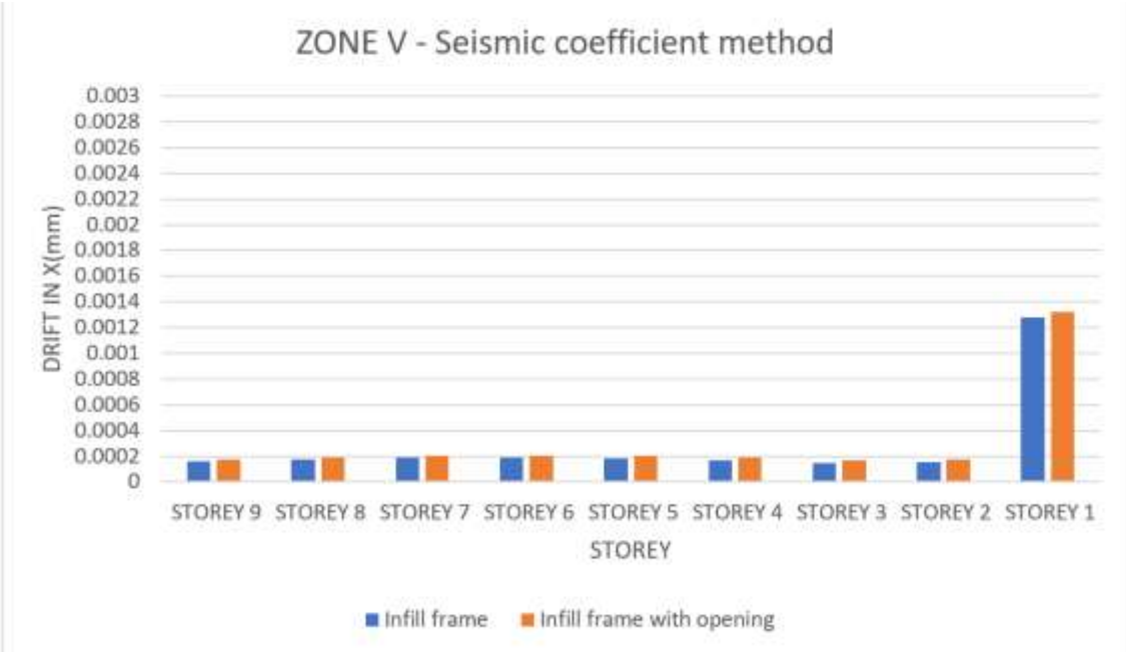

Fig .5.5 Comparison of storey drift in zone V (X direction)

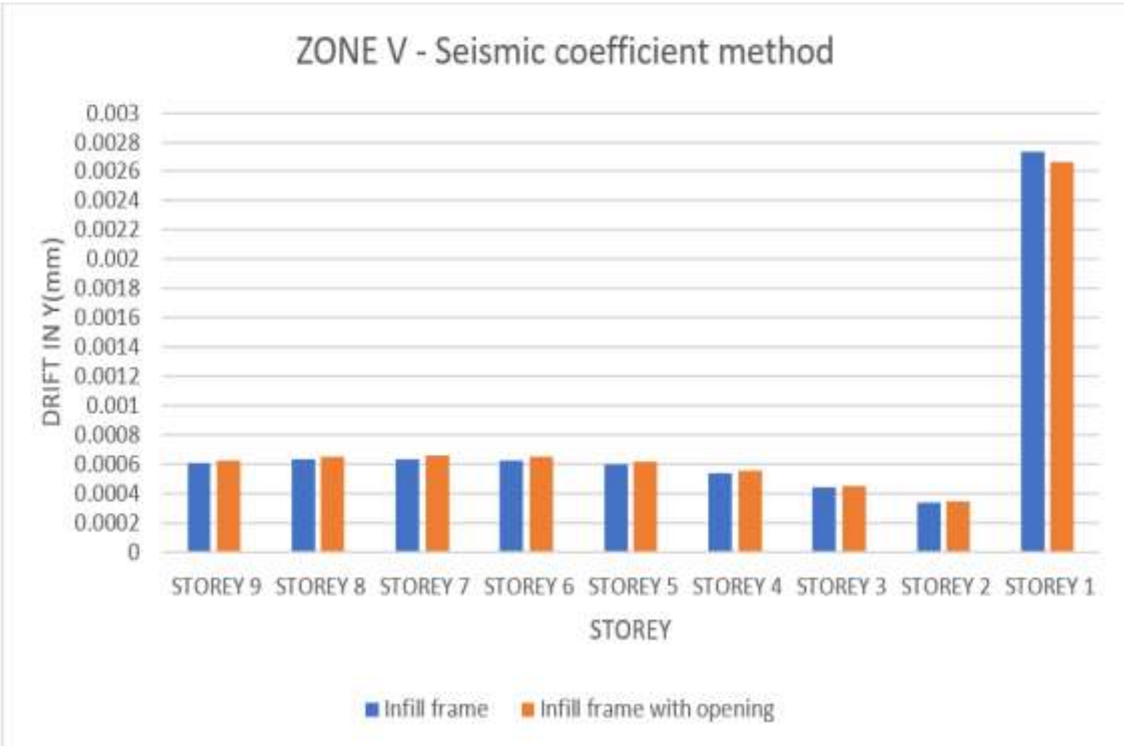

Fig .5.6 Comparison of storey drift in zone V (Y direction)

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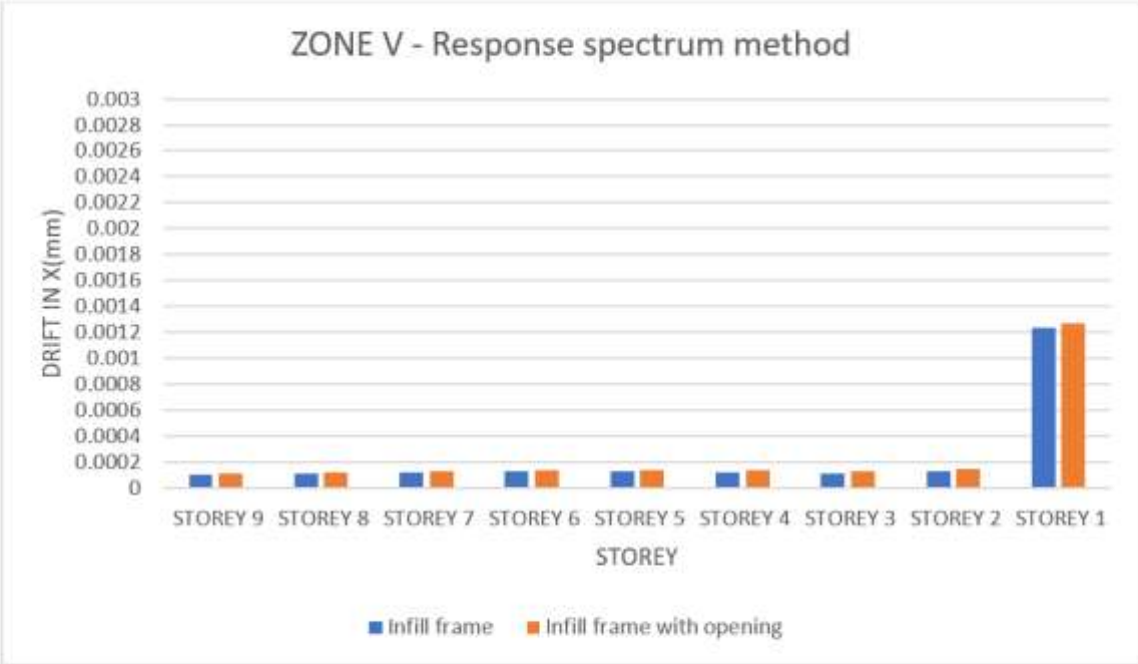

Fig .5.7 Comparison of storey drift in zone V (X direction)

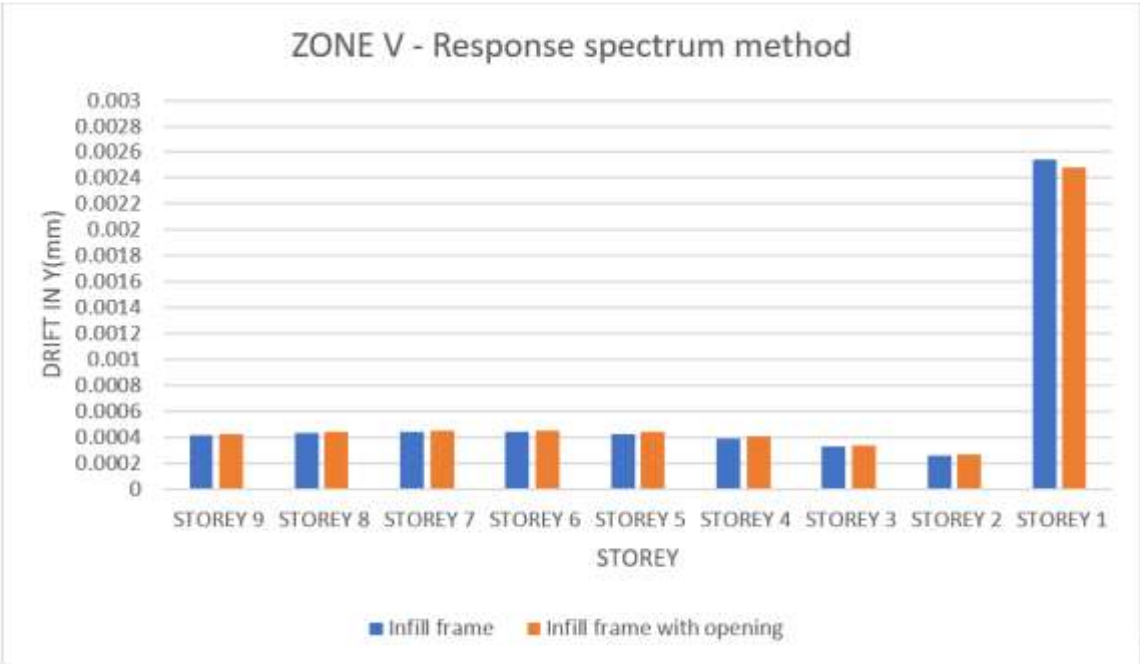

Fig .5.8 Comparison of storey drift in zone V (Y direction)

III. DISCUSSION:

FOR DISPLACEMENT GRAPH

- From the above graph we can conclude that displacement is higher in storey 9 for infill frame with opening.
- Displacement values for infill frames and infill frames with openings are almost equally varying.

FOR STOREY DRIFT GRAPH

- Storey drift will be higher in middle stories e.g. Storey 3 to storey 6 for infill frame frames with opening.
- Storey drift for the ground floor i.e. Storey 1 will be higher than the other floors for infill frames and infill frames with opening.

IV. CONCLUSION

I. The maximum storey displacement occurs in Zone V of in-filled frame with opening model using seismic coefficient method and response spectrum method in Y direction.

II. When compare to in-filled frame with opening in-filled frame without opening reducing the lateral displacement drastically.

III. 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.

IV. The lateral displacement of both 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.

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

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