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Behaviour of Partially Infilled Frames using Finite Element

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Abstract: ***This paper presents an explicit behaviour of Reinforced Concrete frame by considering the masonry infill wall material fully and partially in the structure. A two storey 2D frames of six different cases and 10 storey 3D building of four different cases with fully and partially assignment of infill masonry walls. Analysis was performed in E-TABS software for all the 10 cases by generating synthetic earthquake matched time history with response spectrum. The study was carried out the effect of infill wall on the behaviour of column. The results were discussed and maximum storey displacements were taken in to consideration to study the behavior of the structure. The Storey displacements for the ten cases were taken in to account and revealed that higher displacements were observed in the cases with the partial infill and effect on column due to the partial or absence of infill wall adjacent to the column.***

Keywords: ***Masonry Infill, Response Spectrum, Storey Displacements, Synthetic Earthquake, Time History***

I. INTRODUCTION

Reinforced concrete frames generally constructed with masonry infill wall. Masonry infill wall is the supported wall that closes the building perimeter constructed with three-dimensional frame. In general infill walls were not considered as load bearing during the analysis of the structure but the effect of infill has beneficial effects in the structure. A n excellent performance is of the buildings that designed by considering the infill. The infill walls are built integrally with frames but not considered as structural element where the entire lateral load is transferred by bare frame alone which is the common practice. In few cases the infills built integrally considered as structural element because the entire lateral stiffness is considered in the analysis used in the RC frame members and joints [1]. Short column and captive column effect are significant source of earthquake damage. Captive column effect is one of the most important failures evoked throughout earthquake attributable due to partial infill created adjacent to the column as shown in "Fig. 1" .The effective of lateral stiffness due to partial infill of masonry wall is carried out in the current research work for G+10 structure modeled in ETABS and the response of columns and its behavior was analyzed.

Fig. 1. Captive Column Failure

II. LITERATURE

In order to evaluate the storey displacements in a structure in depth literature review has been done on infill framed structures. The following conclusions revealed by the authors were discussed as follows:

In the current research authors has done experimental work on the performance of seismic reinforced concrete frame models and strengthened with glass-fiber-reinforced polymer infill laminates. Three specimens were casted and evaluated the efficiency of the glass fiber infill panels. The behaviour of GFRP infill laminates were incorporated in RC-frame structures and evaluated lateral displacements. The experimental test results revealed that both the strength and the initial lateral stiffness of an RC frame structure could be increased with the application of GFRP laminates [2].

A macro level method was considered for the seismic assessment of Infilled Frame Structures (IFS) between the frames and infill material. The interaction between frame and infill is modelled and analysed by using dynamic non liner analysis and also for infilled masonry infill walls [3].

Performance behaviour of normal infilled frames and their seismic analysis will vary complex results between the structural and non-structural members. The infill is considered as non-structural member and analysis was performed by using non liner static and dynamic analysis of 2D framed models with incorporating of fibers.

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The results revealed that more shear is generated adjacent to the columns accounting 60% of overall base shear. The collapse of structure also depends on infill type [4].

In this the author studied the interaction between the frame and masonry infill. Under the nonlinear dynamic analysis was carried out in the region Bucharest area. A bare frame and infilled frames with 3 & 6 storey buildings are modelled and analyzed. A strut model was incorporated in the frame with the codal provisions od Romanian and FEMA standards. The orientation of infill changes the dynamic characteristics of RC structure and reduce the damage [5].

In this research the author considered brick as infill material in RC framed G+5 structures. Five models were considered with varying percentage of 0% and 10% opening at the Centre of the wall. ESLM and RSM were used to analyse the structure. The results revealed that the stiffness decreases with increase in opening size of the infill cladding. The seismic performance is increased for infilled structure when compared to bare frame [6].

In this paper the author considered four storey structure and considered infill effect on it. Different cases were considered with and without openings, bare frame models. A diagonal strut member is used as infill wall in the frames and analysed in ETABS 2015. The strut member reduces the displacements in the structure which leads to limiting the drift as well decrease the time period for Infilled frame [7].

III. RESEARCH SIGNIFICANCE

From the literature review it is observed that partial work has been done in the area of masonry infill wall frames and the captive column effect. The current analysis tries to analyze the failure of column due to shear forces generated due to captive column effect. From the studies of recent earthquakes, it is found that the column adjoining infill with partial opening for ventilator or window undergoes a severe shear failure as indicated in the "Fig. 2".

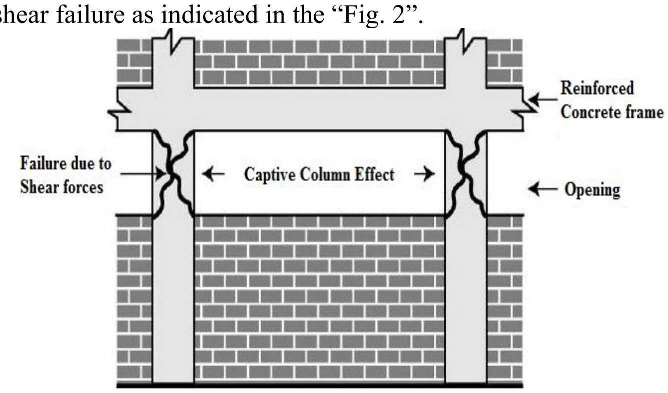

Fig. 2. Shear Failure

IV. MODELLING & ANALYSIS

Preliminary data for modelling the 2D frames of 6 cases and 3D buildings of 4 cases were assumed and modelled in E-TABS software as shown in Table- I.

Table- I: Preliminary Input Data

S. No	Parameter	Dimensions
1	Height of Building	35.5m
2	Storey Height	3m
3	Number of Stories	G+10
4	Building Dimension	42 X 30 m
5	Beam Size	0.23 X 0.35 m
6	Column Size	0.45 X 0.50 m
7	Grade of Concrete	M30
8	Grade of Steel	Fe415
9	Density of Concrete	25 kN/m^3
10	Density of Steel	7850 kg/m^3
11	Poisson's Ratio of Concrete	0.2
12	Modulus of Elasticity of Concrete	27.38 N/mm^2
13	Modulus of Elasticity of Steel	2.1x10^5 N/mm^2
14	Masonry Wall Thickness	0.23 m
15	Slab Thickness	0.15 m

The current analytical investigation is with varying height of infill wall and its effect on reinforced concrete frames modelled with six different cases and building models with four different cases are shown in Table- II.

Table- II: 2D Frame & 3DBuilding Cases

S. No	Frame/ Model No	Fig. No	Cases
1	Frame 1	3	No Infill Wall
2	Frame 2	4	Full Infill Wall
3	Frame 3	5	Full Infill Wall in Ground Storey
4	Frame 4	6	Full Infill Wall in 1st Storey
5	Frame 5	7	Full Infill Wall in 1st Storey & Partially Infill Wall in Ground Storey
6	Frame 6	8	Partially Infill Wall in Ground & 1st Storey
7	Model 1	9	No Infill Bare Frame
8	Model 2	10	Full Masonry Infill Wall
9	Model 3	11	Partially Masonry Infill in Base Storey
10	Model 4	12	Partially Infill Beside Columns in all Stories

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A. Modelling

All the 2D frames with six different cases and four 3D building models as per Table – I & II were modelled in E-Tabs software as shown from "Fig. 3" to "Fig. 12".

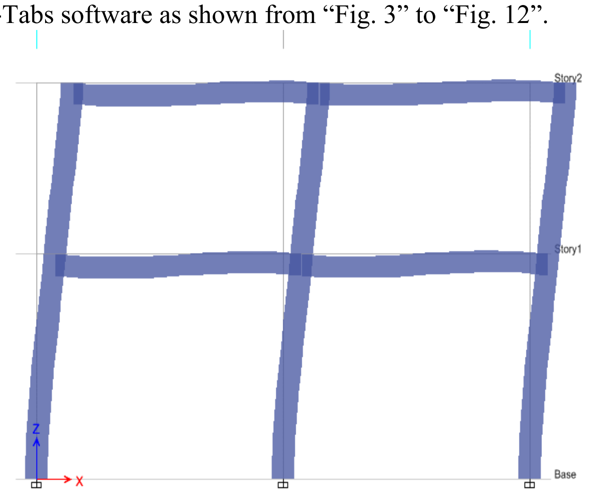

Fig. 3. No Infill Wall

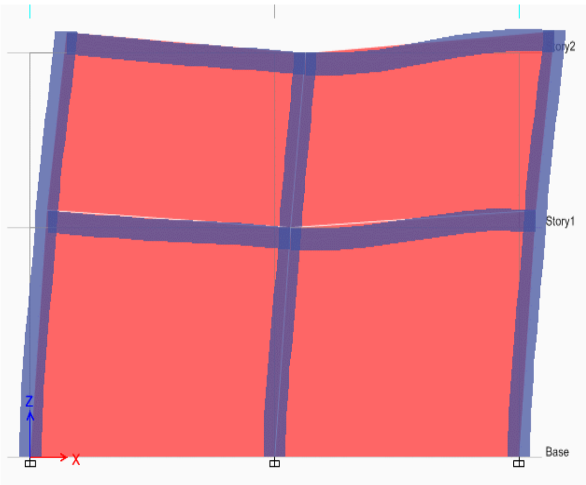

Fig. 4. Full Infill Wall

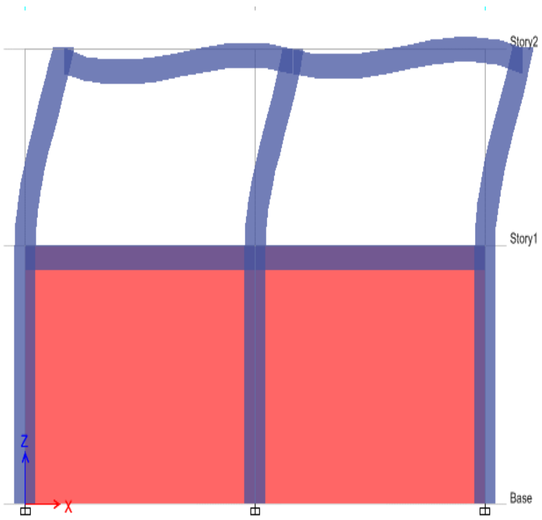

Fig. 5. Full Infill Wall in Ground Storey

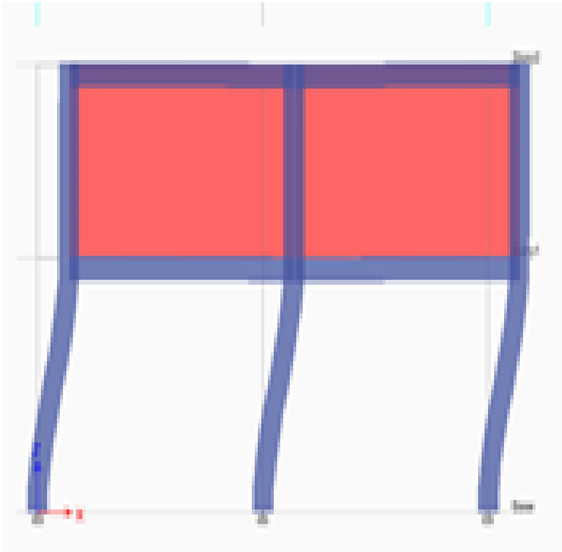

Fig. 6. Full Infill Wall in 1st Storey

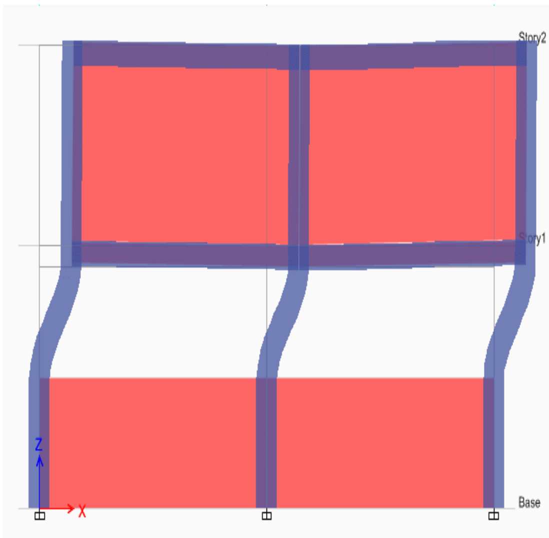

Fig. 7. Full Infill Wall in 1st Storey & Partially Infill Wall in Ground Storey

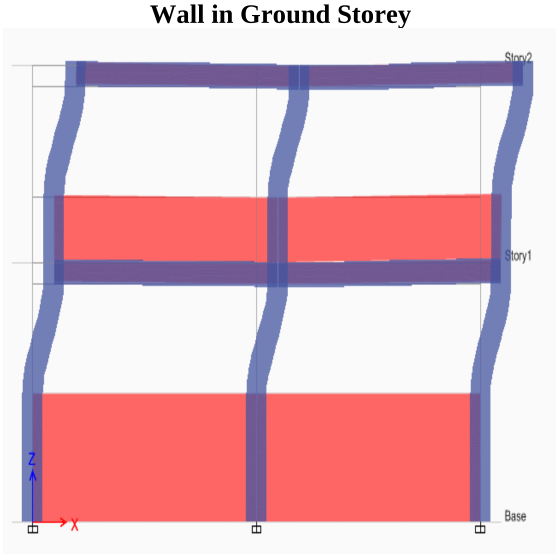

Fig. 8. Partially Infill Wall in Ground & 1st Storey

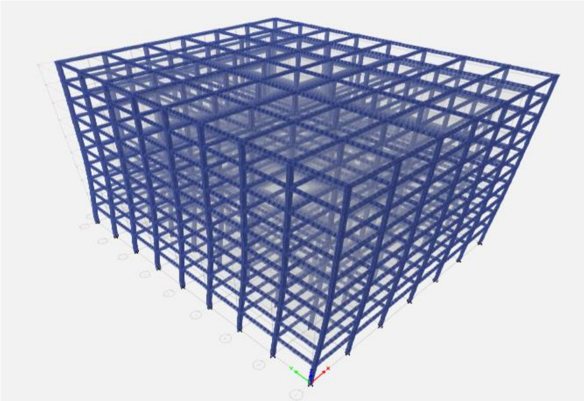

Fig. 9. No Infill Bare Frame

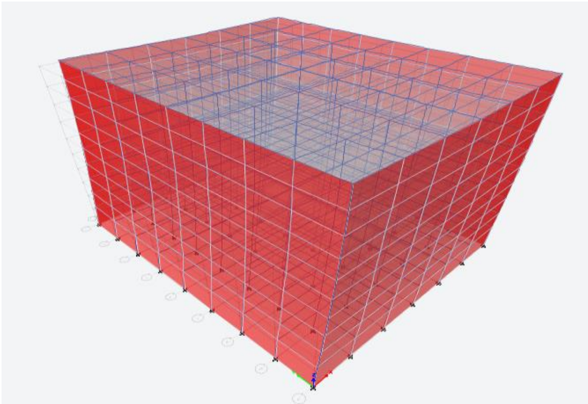

Fig. 10. Full Masonry Infill Wall

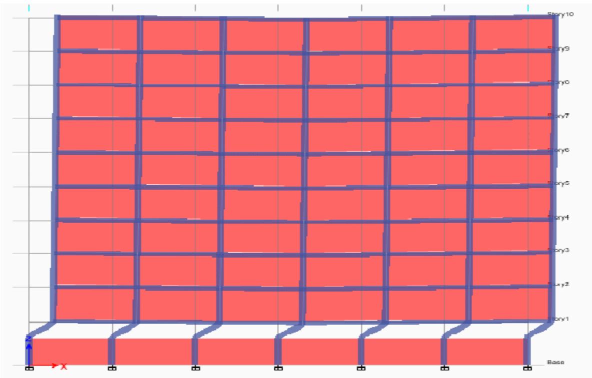

Fig. 11. Partially Masonry Infill in Base Store

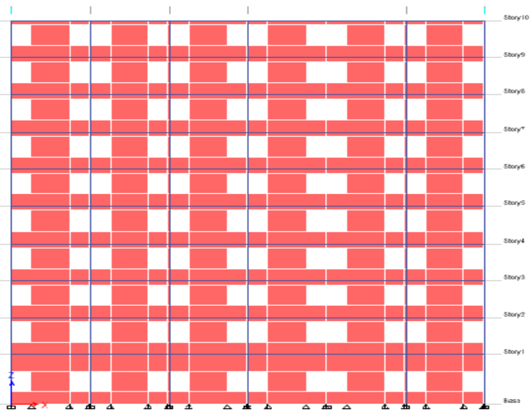

Fig. 12. Partially Infill Beside Columns in all Stories

B. Analysis

Analysis was performed according to loads as per IS codes for all the 2D frames of 6 cases and 3D building models of 4 cases and by considering the following load data shown in Table 4.3.

Table 4.3: - Building Load Details

S. No	Type of Load	Code
1	Dead load	IS 875 Part I – 1987
2	Live load	IS 875 Part II – 1987
3	Earthquake Load Eq – x	IS 1893 – 2002
4	Earthquake Load Eq – y	
5	Synthetic Earthquake	
6	External Cladding Load	IS 875 Part I – 1987
7	Internal Cladding Load	

V. RESULTS

The analysed reinforced concrete 2D frames and 3D buildings for all the cases were done and their maximum storey displacements for six different cases for frames and four different cases for buildings are shown from “Fig.13” to “Fig. 22”.

A. 2D Frame Displacements

Fig. 13. Maximum Storey Displacement for Frame 1 in Storey 2 is 470X10^{-3}mm

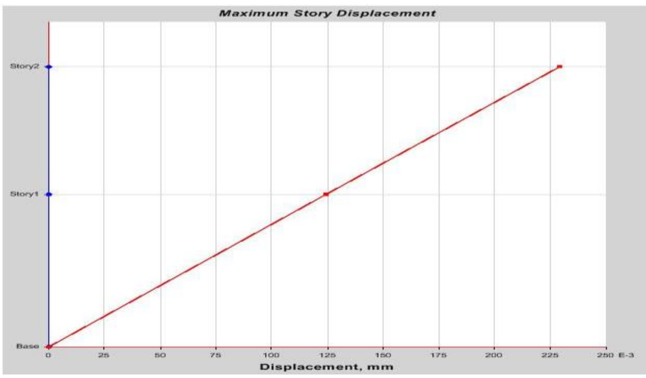

Fig. 14. Maximum Storey Displacement for Frame 2 in Storey 2 is 230X10^{-3}mm

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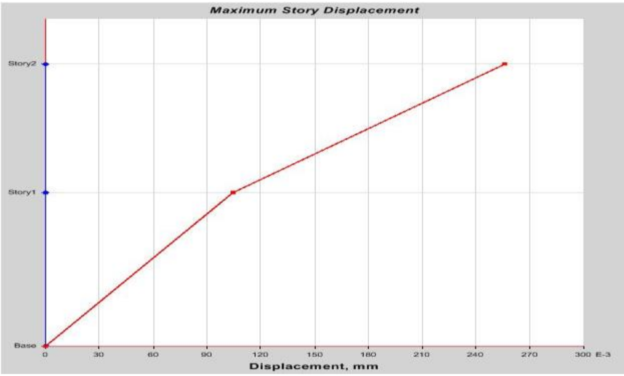

Fig. 15. Maximum Storey Displacement for Frame 3 in Storey 2 is 255X10^{-3}mm

Fig. 16. Maximum Storey Displacement for Frame 4 in Storey 2 is 405X10^{-3}mm

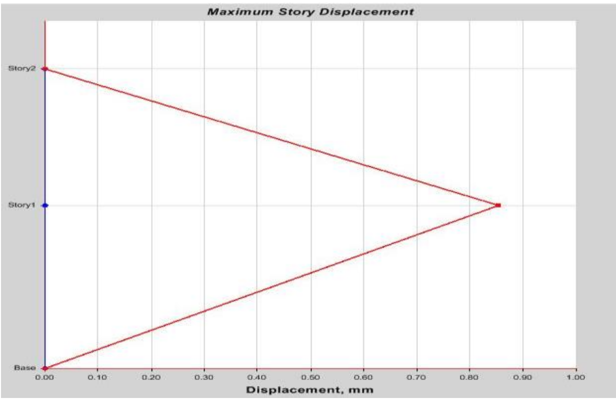

Fig. 17. Maximum Storey Displacement for Frame 5 in Storey 1 is 0.85mm

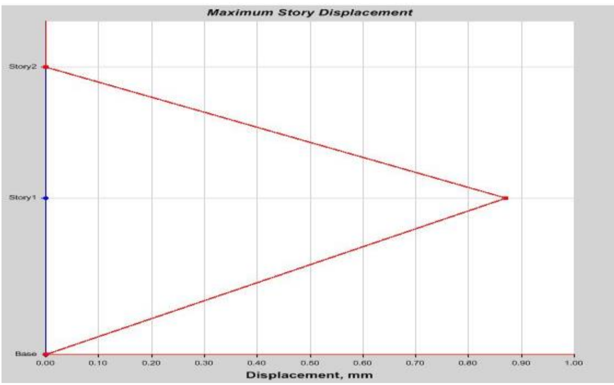

Fig. 18. Maximum Storey Displacement for Frame 6 in Storey 1 is 0.88mm

B. 3D Building Displacements

Fig. 19. Maximum Storey Displacement for Model 1 in 10th Storey is 325X10^{-3}mm

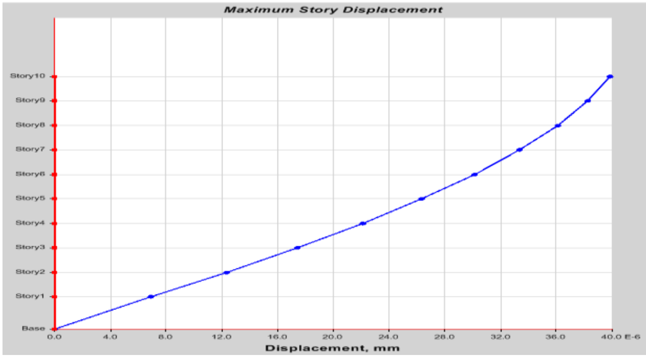

Fig. 20. Maximum Storey Displacement for Model 2 in 10th Storey is 40X10^{-6}mm

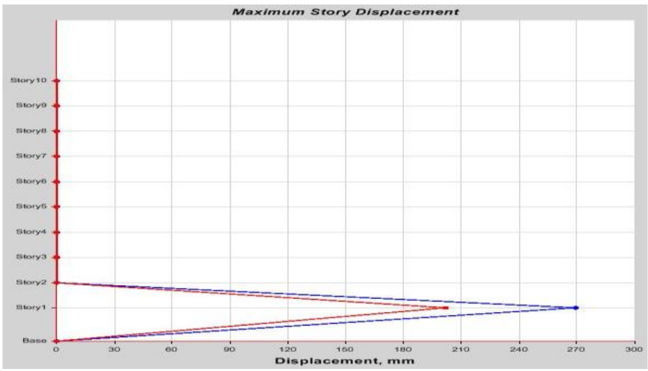

Fig. 21. Maximum Storey Displacement for Model 3 in Storey 1 is 270 mm

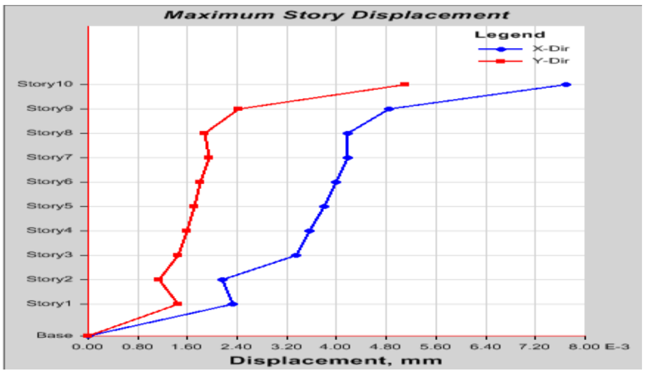

Fig. 22. Maximum Storey Displacement for Model 4 in Storey 10 is 7.8X10^{-3} mm (X -Direction)

VI. CONCLUSIONS

From the above results, it can be inferred that the structure is at risk of captive column impact because of partial infill created beside the column that generated vast shear force within the unsupported length of columns.

1. Reinforced concrete 2D frame with case 1 shows the storey displacement of 0.47mm in 2nd storey.
2. The storey displacement is dropped down to 0.23 with full infill masonry wall as shown in case 2, which provides the stiffness to the adjacent column members.
3. It shown an increase in storey displacement of 0.405 mm in the case 4 i.e., infilled in the 1st storey and no masonry infill in 2nd storey, due to less stiffness in the 1st storey.
4. In 2D frame with cases 5 & 6 the storey displacements were increased due to partial masonry infill in 1st and 2nd storey due to the effect of no infill adjacent to the column member.
5. The reinforced concrete 3D building in model 1 with no masonry infill shows the storey displacement of 0.325 is much higher than model 2 of 0.00004 mm with full infill structure.
6. The model 3 was analysed with partially masonry infill only in the bottom storey and full masonry infill in remaining stores shows higher storey displacement of 270mm in 1st storey.
7. In 3D building with model 4 i.e., partial masonry infill wall in all the floors revels the maximum storey displacement in 10th storey in x - direction is 0.0078mm.

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