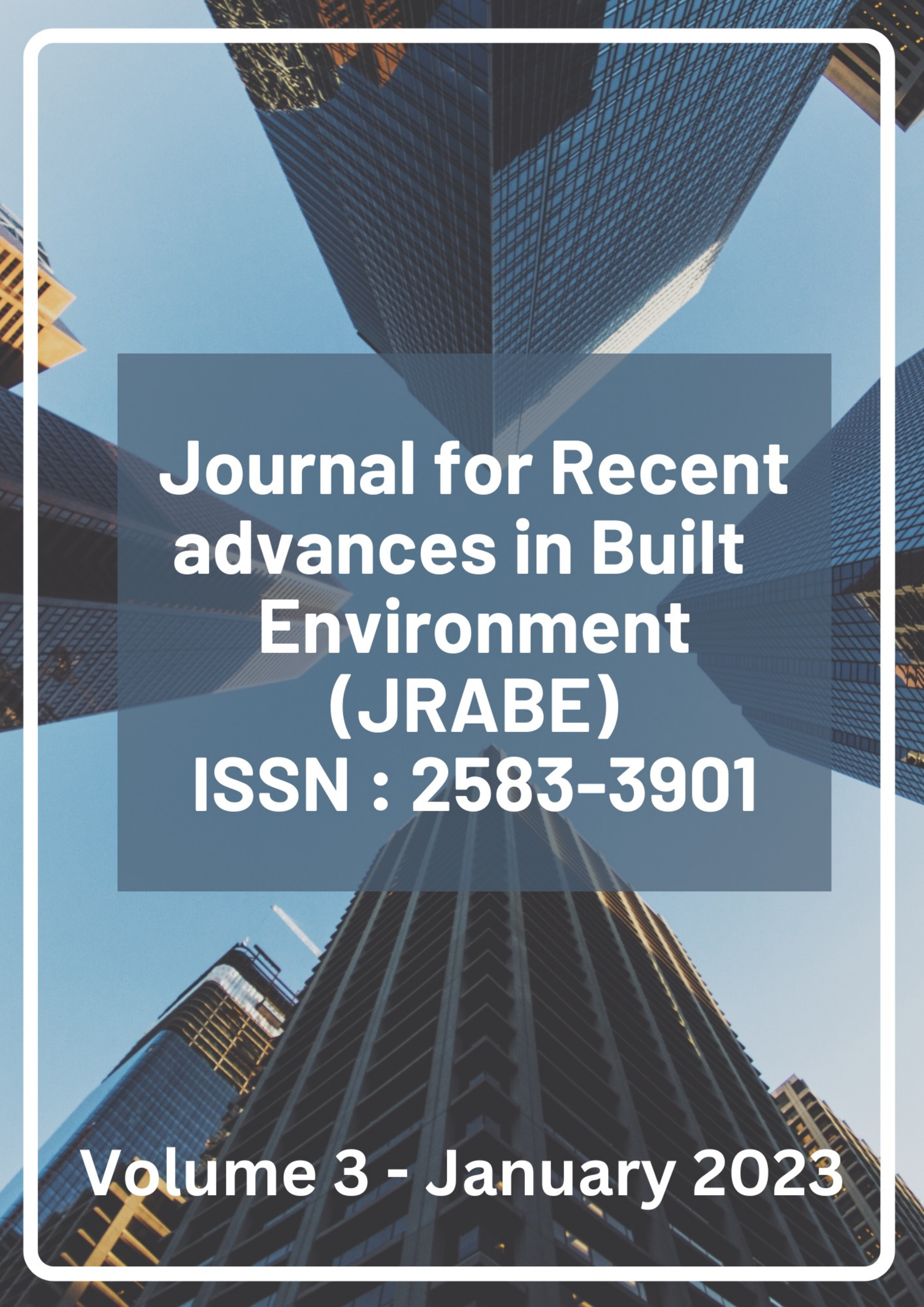

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SEISMIC ANALYSIS OF MULTI STORED BUILDING WITH SHEAR WALLS AT DIFFERENT LOCATION

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Abstract

In multi-story buildings, shear walls are employed as a horizontal load-resisting element. In residential construction, they serve as vertical walls that often take the form of a box and support the building's horizontal axis. These walls are made to be structural walls that are incorporated into structures to resist lateral stresses brought on by wind, earthquakes, and other factors. They also have a high degree of stiffness and strength to do so. A shear wall has a major axis that is stiffer than its other axis. It is regarded as having a basic structure that offers rather stiff resistance to forces acting in its plane from the vertical and horizontal directions. A shear wall experiences axial, shear, torsional, and flexural strains, under the combined loading, leading to a complex internal stress distribution. Loads are transferred vertically to the foundation from the building in this manner.

In this paper the effectiveness of shear wall is checked by changing the location. Two cases are considered such as bare frame and in-filled frame with and without shear walls. Ten different models are considered for each of the cases. The structural elements for multi-story buildings with G+9 are designed for seismic zone V with soft soil and are analyzed as per the code IS 1893:2016 by using E-TABS. The different models will be modelled and analyzed using equivalent static and response spectrum methods for earthquake loads by providing the shear walls at different locations with mass irregularities.

The various parameters, such as lateral displacements, storey drift, and base shear, are determined. The results are checked to see if they are within the permissible limits. Infill frames with shear walls at the core and re-entrant corners outperform all other models in lateral displacement and story drift; the results were found to be twice as good as other models in lateral displacement and story drift. Models 1 and 6 have longer times periods due to the lack of shear walls. The base shear of the first five models is higher compared to other models due to the symmetry of their structures. .

1.0 Introduction:

Earthquakes vary in intensity and magnitude from place to place, causing minor to severe damage to structures and life. Shear walls take both flexural and lateral forces, to overcome this phenomenon. Shear walls serve a good purpose in high-rise buildings because they reduce steel consumption and provide more carpet area than the column system.

2.0 Literature review:

Five models of twelve storeys are considered in zone III by changing the locations of the shear wall.

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Model one was a bare frame, and the remaining four models had shear walls in different positions. The models were analysed by the linear static method. Parameters like storey drift, storey shear, and displacement were compared and calculated by using ETABS. It was concluded that it was more effective to provide shear walls to resist lateral forces. (1)

Work is also carried out to determine the shear wall position in multi-story buildings based on both elastic and elasto-plastic behaviour. A 15-story building, which was located in seismic zone IV, was considered. STAAD Pro and SAP 2000 software are both used to conduct elastic and elasto-plastic analyses. Shear force, bending moment, storey drift, and shear wall location were estimated in both the cases. It was concluded that shear walls may added in the shorter direction between the sixth and seventh frames or the first and twelfth frames. (2)

In order to determine the best location for the shear wall in a multi-story building, five models of 25-story buildings in seismic zone V were taken into consideration. One model had a bare frame, and the others had shear wall models in various locations. The models were analyzed using linear static and linear dynamic methods, considering building's central concrete core wall using ETABS. The various variables such as displacement, storey shear, and storey drift were analyzed. The study concludes that Model 5 performs better than the other models. (3)

RC-framed buildings with six, twelve, twenty-four, and thirty-six stories at different positions were taken into account. Eight models were analyzed. Model 1 is infilled framed structure but with no shear walls, while the other models had shear walls. To determine the parameters such as time period, lateral displacement, damping, and base shear by using ETABS, the seismic performance evaluation was carried out using the response spectrum , elastic analysis, as well as nonlinear static pushover, or in-elastic analysis. It was determined that model 7 and 8 exhibited improved lateral stiffness. (4)

A six-story structure in seismic Zone IV was examined using various shear wall forms and positions. In order to calculate characteristics like axial force and moments in the Y and Z directions, four models were considered, with one being a bare frame and the other three being shear walls of the same length at various locations. STADD-pro analytic software was used to complete the analysis. It was determined that the presence of a shear wall in a different position had an impact on the axial stress on the column. (5)

3.0 Modelling

A regular building with a 10 (G+9) number of stories is considered for the purpose of studying the seismic behavior of high rise buildings by providing shear walls at different locations. The description and plan of the buildings is shown below.

Building Description

Table 1

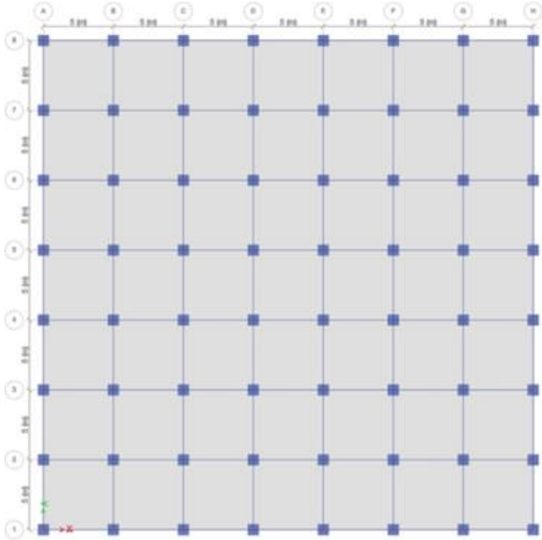
Model Description

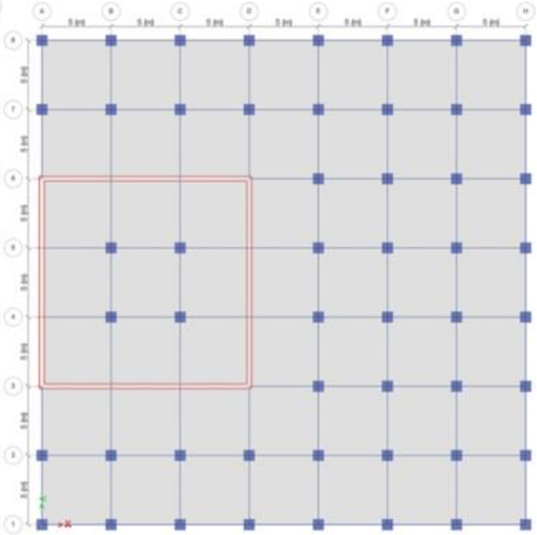
Parameters	
Seismic Zone	V
Seismic Zone Factor (Z)	0.36
Response Reduction Factor(R)	5
Height of the building	30 m
Storey to storey Height	3 m
Thickness of Shear Wall	0.35 m
Thickness of Infill Wall	0.2 m
Thickness of Slab	0.225 m
Column Size	0.8 X 0.8 m
Beam Size	0.6 X 0.6 m
Live Load	4 kN/m^2
Floor Finish	1.7 kN/m^2
Unit weight of Reinforced Concrete and masonry	25 kN/m^3 20 kN/m^3
Poisson's Ratio of concrete and Masonry Infill (u)	0.2 and 0.2
Damping	5%
Material Properties	M40Grade of Concrete (f_{ck})
Material Properties	Fe500i Grade of Steel (f_y)

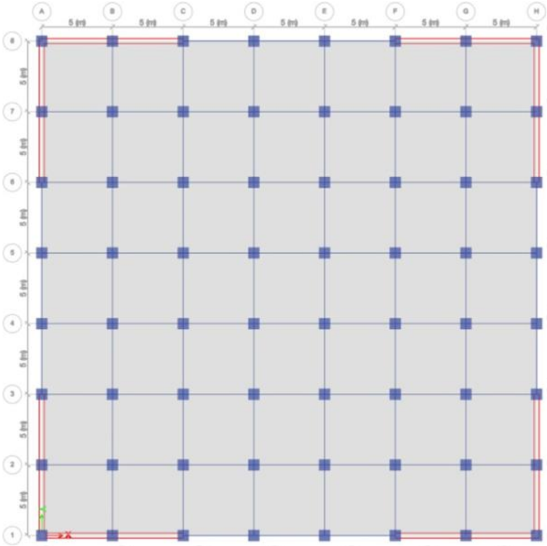
3.1 Plan of Models

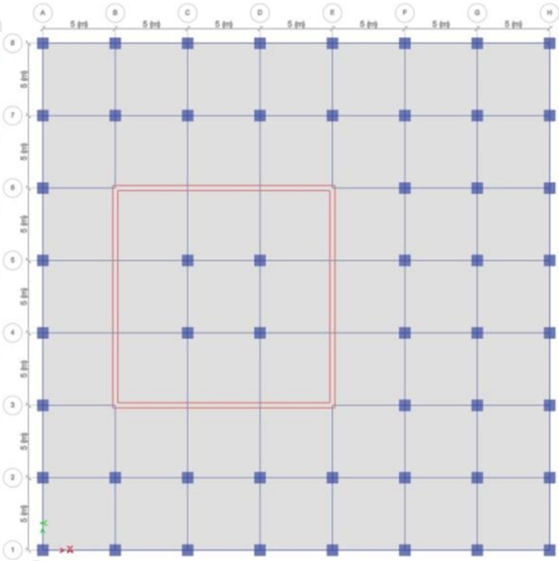
The figures shown below from fig 1 to 10 show the eight models considered for this study. Figure 1 is the model with no shear walls whereas Fig 2 to Fig 10 shows models with shear walls.

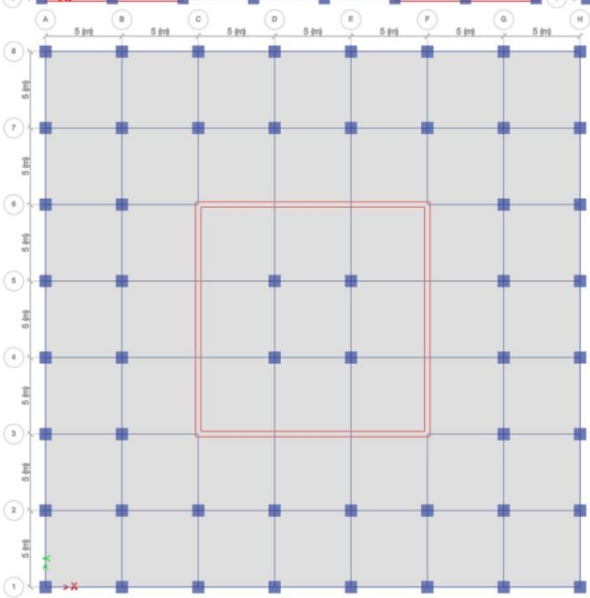
Fig 11 and 12 show the grid and 3D view of the model in Etabs

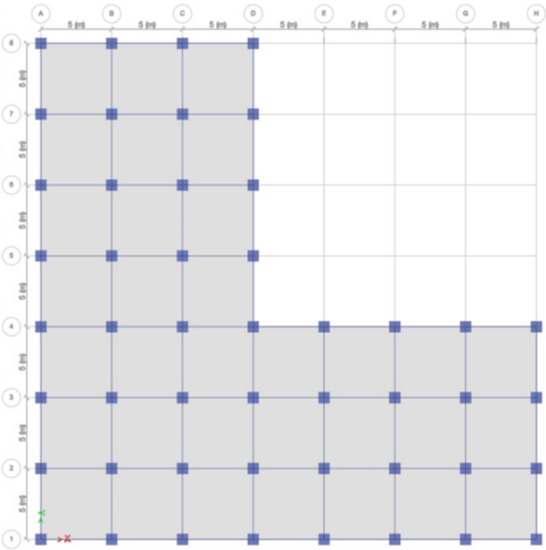












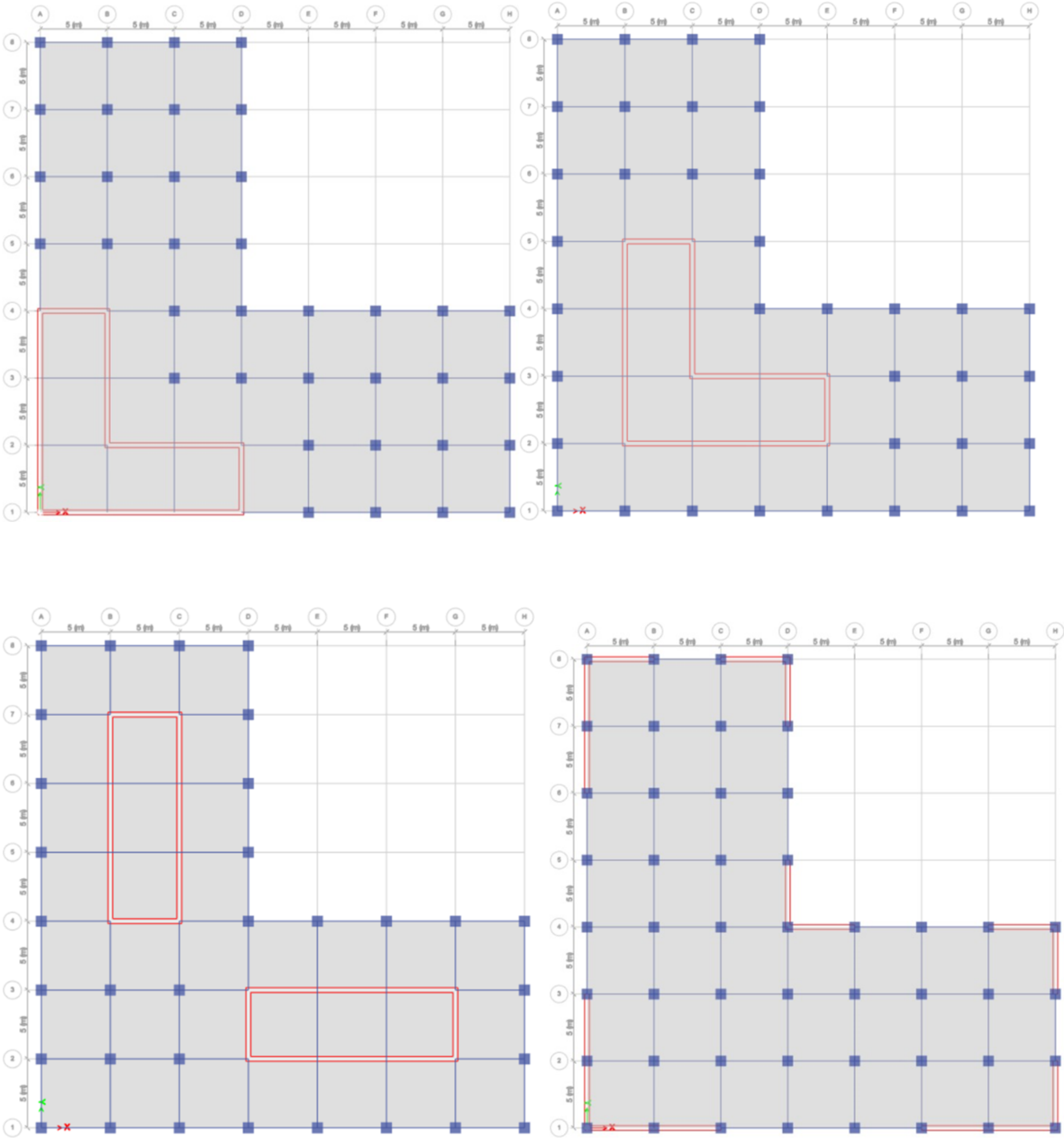


Figure 1 to 10 Models with shear walls are various locations

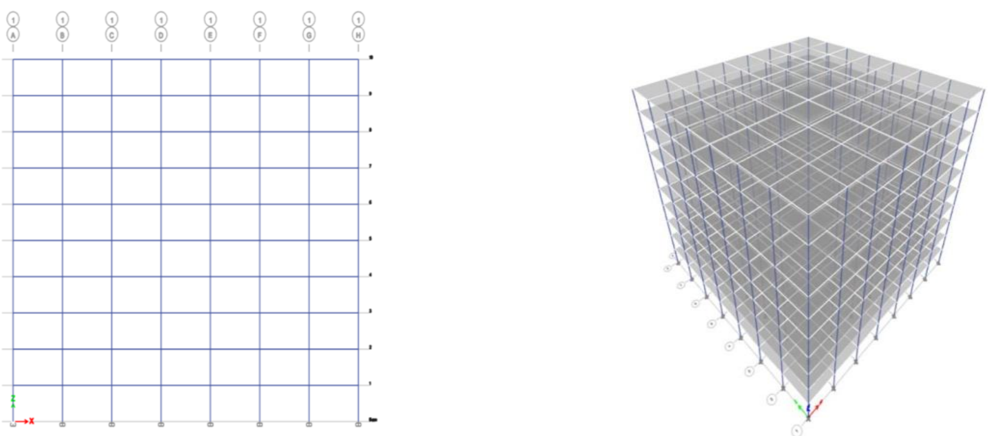


Fig 11 and fig 12 grid and 3D model

4.0 RESULTS AND DISCUSSIONS

4.1 Time period

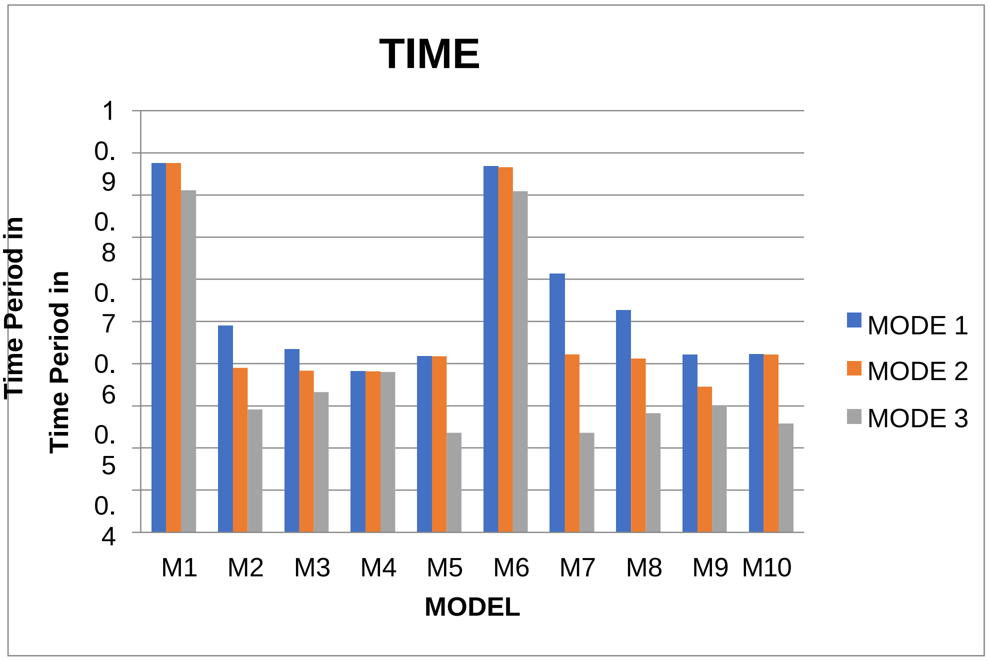


Figure 13 Time Period of Bare Frame Model

Figure 13 shows the time period for the bare frame model. Model-1 and Model -6 have more time period compared to shear wall models for all three different modes, this is because the base shear is less in Model-1 and Model-6 compared to other models. This shows that the bare fame models without shear walls are more susceptible to seismic action than the models with shear walls. This also indicates that the base shear of the model increases with the decrease in time period.

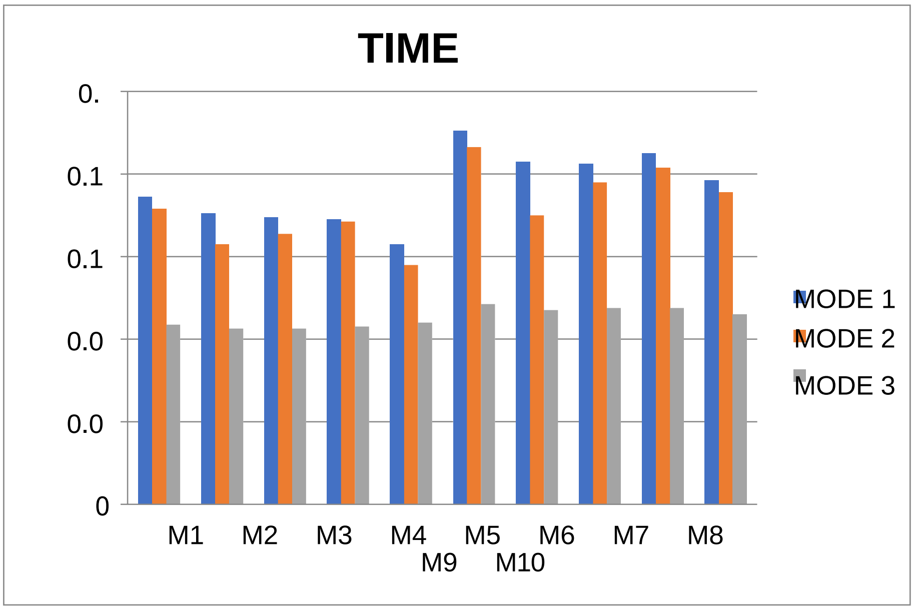


Figure 14 Time Period of Infill Frame Model

Figure 14 shows the time period for the Infill Frame Models. Model- 6 has more time period compared to other models, this is due un-symmetry of the structure and absence of shear wall.

4.2 Base shear

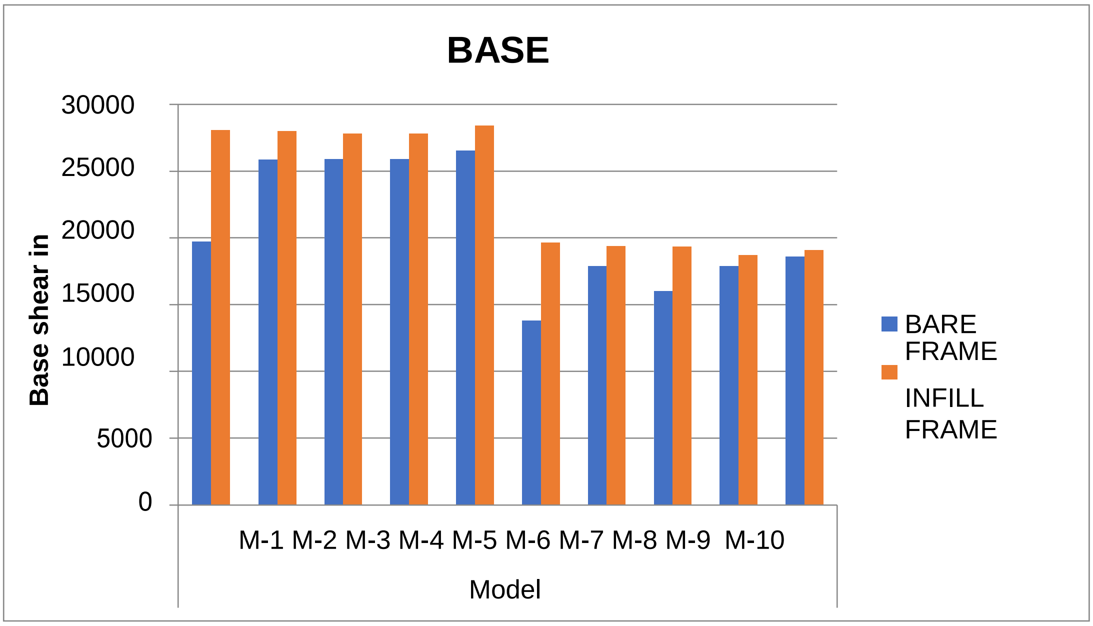


Figure 15 Base Shear of Bare Frame and Infill Frame

Figure 15 shows the base shear for different models with a bare frame and an infill frame. The first five models show higher base shear with higher structural stability as compared to the other models; this is due to symmetrical structures. When comparing base shear between an infill and bare frame, the infill frame has a higher base shear.

4.3 Lateral displacement

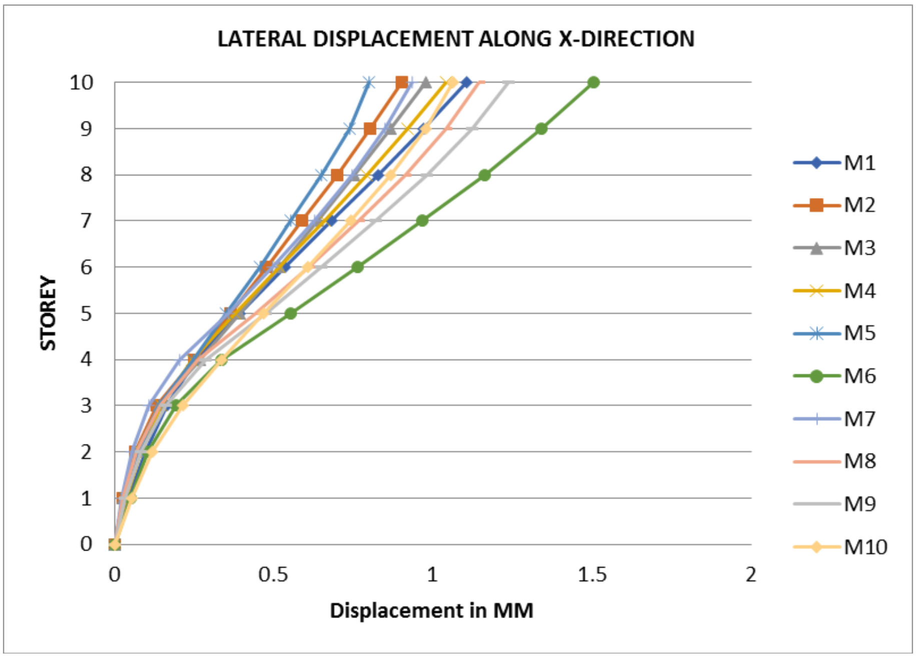


Figure 16 Lateral Displacement of Bare Frame

It is observed in figure 16 that the lateral displacement is more in Model-1 and Model-6 .This is mainly due to less rigidity in the bare frame model. As the base shear of the structure decreases, displacement increases. The strength and stiffness of the structure are increased by providing the shear wall in the building.

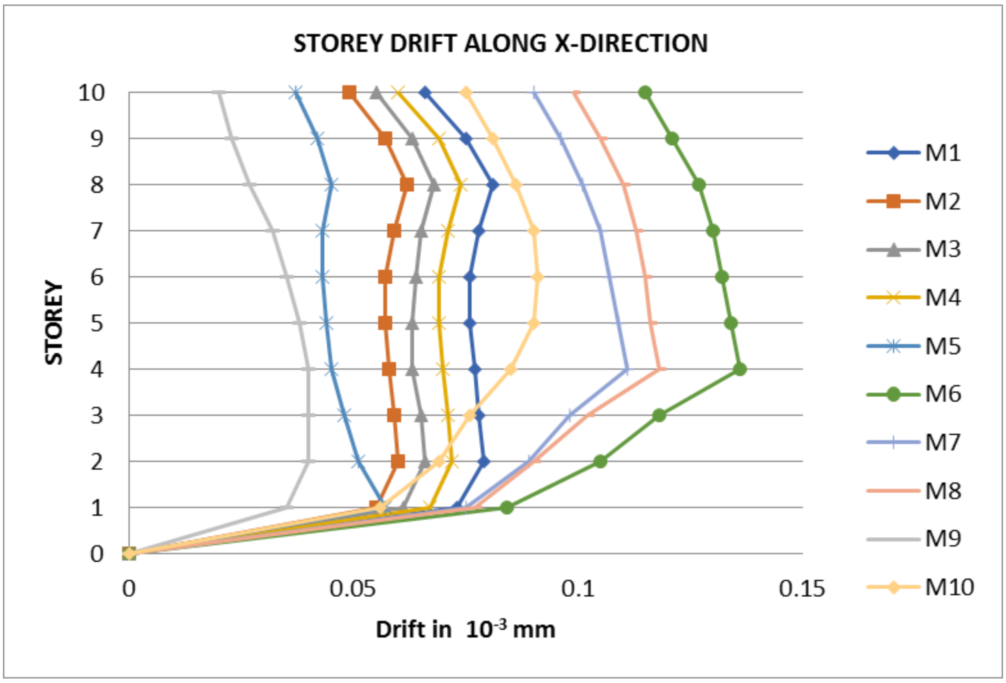


Figure 17 Lateral Displacement of Infill Frame

Figure 17 shows the lateral displacement for the infill frame models. It is observed that the lateral displacement in the Model-1 is less when compared to the Model-6; this is because the center of rigidity and centre of mass nearly co-inside in the Model-1.

4.4 Storey drift

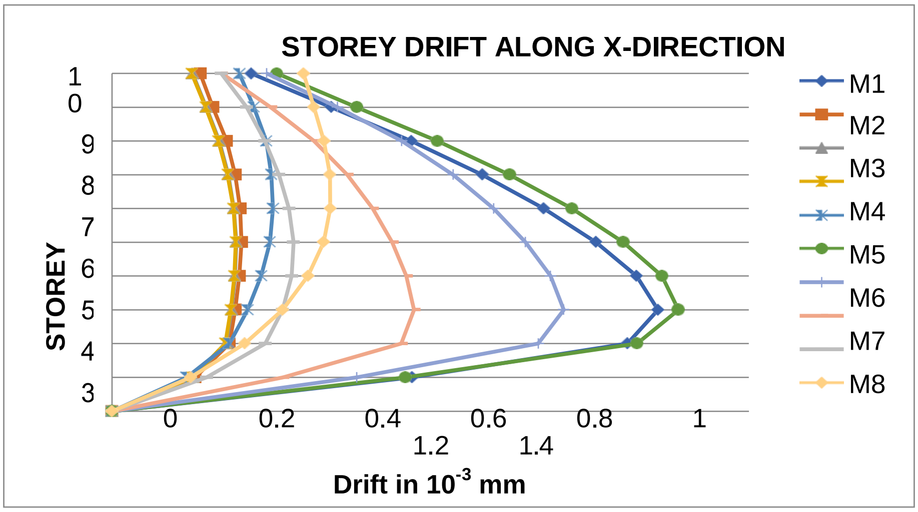


Figure 18 Storey Drift of Bare Frame

Figure 18 shows the storey drift plot for bare-frame models. Model-1 and Model-6 shows the maximum storey drift, this is due to absence of shear wall. It is also observed that the storey drift decreases by providing the shear wall. It is also seen that when the shear wall is provided at the core of the symmetrical structure (where the centre of mass and rigidity co-inside), the storey drift is less for the structure.

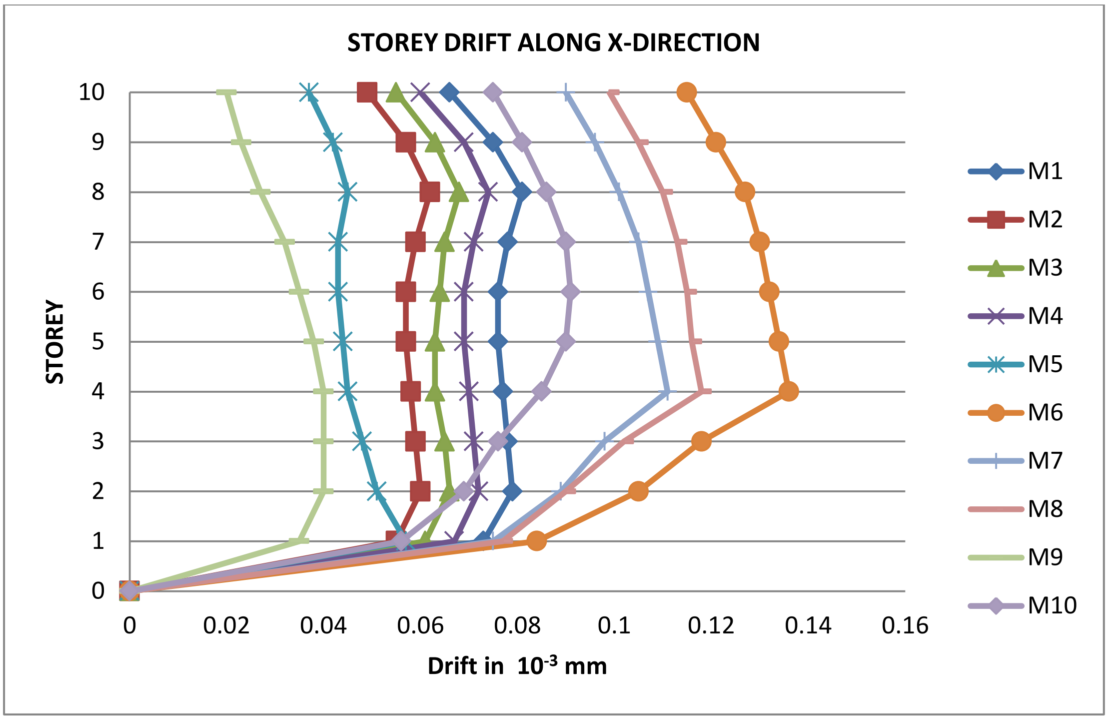


Figure 19 Storey Drift of Infill Frame

Figure 19 shows story drifts for infill frames. The storey drift is maximum in Model-6 and Model-1 has minimum drift this is due to the fact that the rigidity and mass centres nearly coincide.

4.5 Storey shear

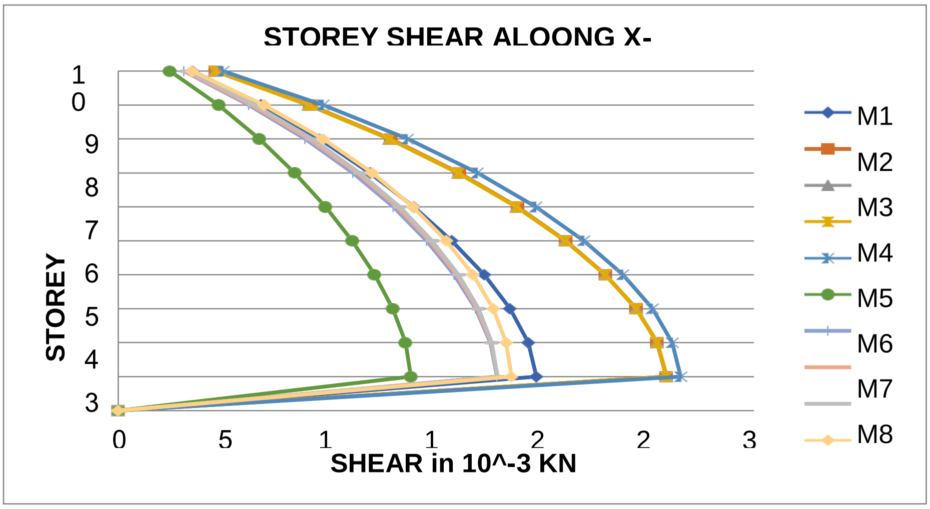


Figure 20 Storey shear of Bare Frame

Figure 20 shows that the Model-6 has less storey shear and the Model-5 has higher storey shear when compared to other models; this is due to the Model-5 has high stability and stiffness.

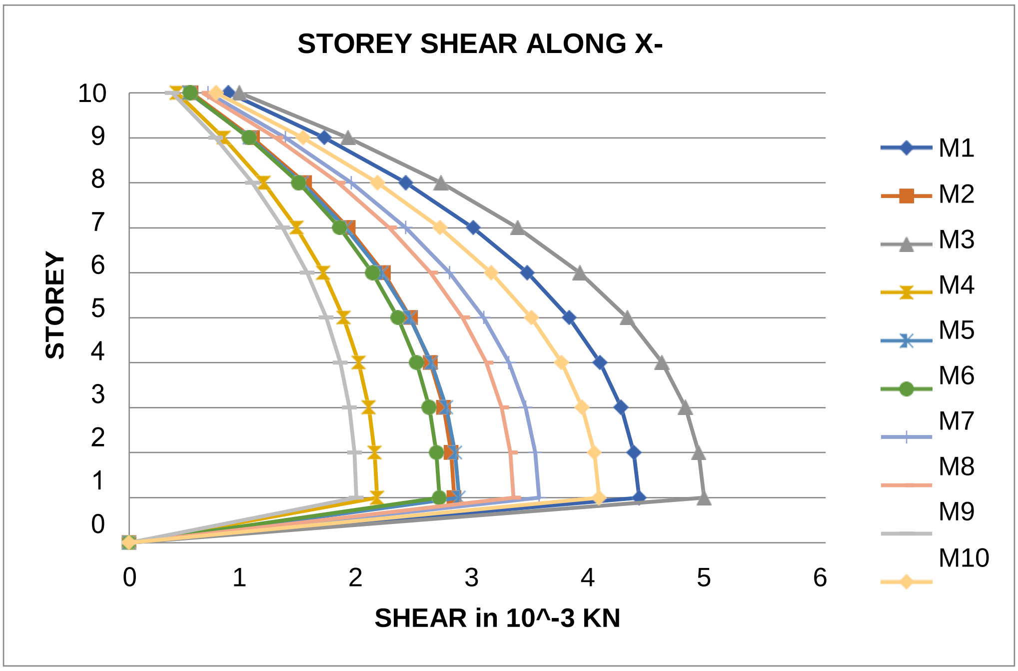


Figure 21 Storey shear of Infill Frame

The storey shear for an infill frame is shown in Figure 21; Model -9 has less storey shear. Because of the masonry structure's action, Model-3 has higher storey shear than all other models.

4.6 Storey stiffness

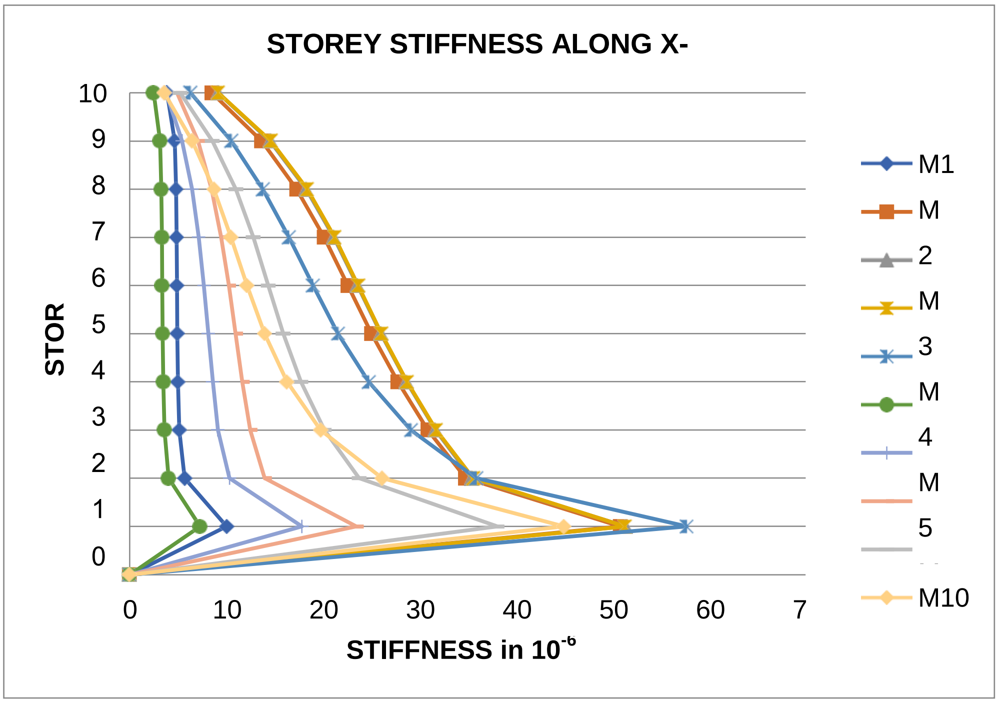


Figure 22 storey stiffness of Bare Frame

Figure 22 shows the storey stiffness is maximum by providing a shear wall at the core for Model-2, Model-3, and Model-5 at the re-entrant corners.

5.0 **Conclusions:**

1. The time period for both bare frame and infill frame models were analyzed, and it was found that Model-1 has the maximum and Model-4 has the minimum time period.
2. The base shear found to be maximum from Model-1 to Model-5 for both bare frame as well as infill models; this is due to symmetrical shape which results in higher stability of the structure.
3. Model 6 has maximum lateral displacement and story drift in both bare frame and infill models.
4. Model-6 of the bare frame and Model-9 of the infill frame show less storey shear.
5. The storey stiffness of the infill frame is more than 4 times that of the bare frame; this is due to the strut action of the masonry wall, which retards the movements of the storey.
6. Storey drift for all models is within the permissible limits as per IS 1893 (Part 1): 2016, i.e., 0.004*h, where h is the story height.
7. From the work carried out, it is evident that the provision of shear walls and infills increases the performance of the building, i.e., the base shear will be more reducing the lateral displacement, story drift, and lateral stiffness.

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