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Seismic Behaviour of Multistory Building with And Without Soft Story Effect Using Masonary Strut in ETABS Software

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Abstract— Many low-rise and medium-rise framed buildings have been constructed in the recent past, without proper attention paid in their design for wind or earthquake loads. This serious shortcoming in structural design and detailing has been exposed by failure that has occurred in the recent earthquakes in various parts of the country. Nowadays reinforced cement concrete frames are most common in building construction practices around the globe. The vertical gaps in reinforced cement concrete frames that are created by column & beam are generally filed by brick masonry. If these gaps are not filled by brick masonry, then the structure is known as a bare frame structure. Due to gaps, the bare frame has a very low resistance to lateral forces, which fail structure. Openings are provided in structure for doors, windows, etc. In this work, to provide stiffness to the structure, we provide an infill wall strut of 230 mm thick brick masonry & effective depth under compression calculated by equivalent diagonal strut method. Infill wall act as compression strut between column & beam & forces is transferred from one node to another. Such as a building in which the upper story has a brick-infill wall panel and an open ground story is called a stilt building and an open story is called a stilt floor or soft story. A soft story is also known as the weak story it is the story in which that has less substantial resistance than the above story or below. The G+6 storied residential building with different models is considered. In each case, we provide a bare frame and infill wall at different positions with different types of struts & then studied the behavior of the structure under seismic forces. Based on that, parametric studies on story displacement, story drift, time period shear force, and moments have been carried out using equivalent static analysis & response spectrum analysis to investigate the influence of this parameter on the behavior of buildings with soft story.

Keywords— Story Drift, Story Displacement, Time Period, Response Spectrum Analysis, Soft Store

I. INTRODUCTION

Earthquakes are the most destructive and life threatening phenomenon of all the times. Earthquakes are caused due to the large release of strain energy during a brittle rupture of rock. The force generated by seismic action of earthquake is different than other sorts of loads, such as, gravity and wind loads. It strikes the weakest location in the whole 3D building. The purpose of seismic resistant building is to provide comfort and safety which is done because of control on internal forces. Commonly, to protect structure damping has done i.e., to reduce the whole seismic energy by structural members which provides the capacity to resist against earthquake. An earthquake is the result of a rapid release of strain energy stored in the earth's crust that generates seismic waves. Structures are susceptible to earthquake ground motion and damage the structures. In order to take precaution for the damage of structures due to the ground motion, it is important to know the characteristics of the ground motion. The most important dynamic characteristics of earthquake are peak ground acceleration (PGA), frequency content, and duration. These characteristics play predominant rule in studying the behaviour of structures under the earthquake ground motion. Earthquakes produce almost instantaneous response leading to destruction of buildings and wind forces are also detrimental to structures if they are not designed for it. The effect of earthquake forces and wind forces goes on increasing with the height of the building and governing factor for design also depends on various factors from location of the building to the geometry of the building and also soil conditions. The key problem is to scale back the structural response by decreasing the dissipation of input energy due to earthquake.

A. Soft Story Behaviour

Construction of multi-storey building with open first story is common practice in India. This is unavoidable feature and is generally adopted for parking or reception lobbies. Such as building in which the upper story have brick infill wall panel and open ground story is called as stilt building and open story is called stilt floor or soft story. A soft story is also known as weak story it is the story in which that has less substantial resistance than above story or below. Stability of earth is usually disturbed due to internal forces and as a results of such disturbance, vibrations or jerks in crust takes place, which is understood as an earthquake. Earthquake produces low and high seismic waves which vibrate the base of structure in various manners and directions, so that lateral force is developed on structure. In such buildings, the stiffness of the lateral load resisting systems at those stories is quite but the stories above or below.

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Figure 1: Soft Story for Parking Floor

II. Objectives Of Study

The primary objectives of this plan can be shortening as follows:

1) To observe seismic analysis using equivalent static analysis method & dynamic analysis using response spectrum method in ETABS.
2) To study the different seismic parameters like story displacement, story drift, center of mass.
3) To find the optimum result of with and without infill wall having soft story effect in RC structure during earthquake.

III. Method Of Analysis used

A. Equivalent Static Analysis.

It is one among the methods for calculating the seismic loads. The high rise structures are not considered for the planning simple static method. In practical because it doesn't take into account all the factors that are the importance of the foundation condition. The equivalent static analysis is used to design only for the small structures. During this method only one mode is taken under consideration considered for each direction. The earthquake resistant designing for the low rise structures the equivalent static method is enough. Tall structures are needed quite two modes and mass weight of every story to design earthquake resistant loads. This is permitted in most codes of practice for normal, low-to medium-rise buildings.

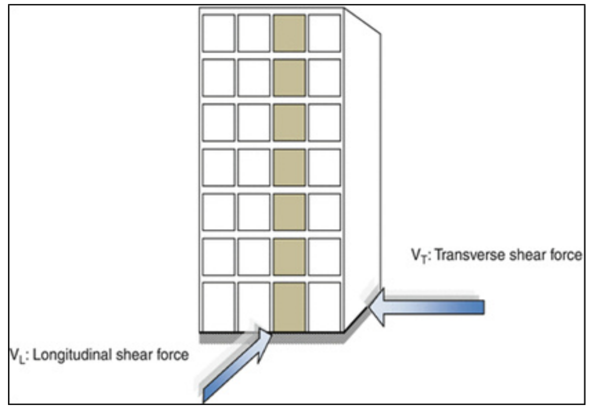


Figure 2: Base Shear along Longitudinal and Transverse Direction

B. Response Spectrum Method

The representation of the maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. The maximum response plotted against of un-damped natural period and for various damping values and can be expressed in terms of maximum absolute acceleration, maximum relative velocity or maximum relative displacement. For this purpose response spectrum case of study are performed consistent with IS 1893.

The response "design acceleration spectrum" which refers to the max acceleration called spectral acceleration coefficient Sa/g, as a function of the structure for a specified damping ratio for earthquake excitation at the base for a single degree freedom system. The revised IS 1893-2016 uses the dynamic analysis by response spectrum. During this method takes under consideration all the five important engineering properties of the structures.

1) The elemental natural period of vibration of the building.
2) The damping properties of the structure.
3) Sort of foundation provided for the building.
4) Importance factor of the building.
5) The ductility of the structure represented by response reduction factor.

C. Modelling and Analysis

In the present study, the buildings are modelled by using the software ETABS and different infill wall locations are used for improving seismic performance of the building. Walls are modelled by equivalent strut approach and wall load is uniformly distributed over beams. The diagonal length of strut is same as the brick wall diagonal length with the same thickness of strut as brick wall, only depth of strut is derived. Walls are considered to be pinned connected to the columns and beams. The Span Length in longitudinal direction is 15 m and in transverse direction 9 m .The c/c distance between floor to floor is 3m and soft story height is 3m. Different loads such as dead load, live load, roof live load, wall load, and earthquake load is applied on building at appropriate location as per codes used for Loading. This model are analyzed by using equivalent static analysis and response spectrum analysis. Design is completed firstly by Indian Codes (i.e. IS 456-2000, IS 1893-2016).

The multi-story building are modelled in five different configurations are as follows-

Model 1: Model with bare frame.
Model 2: Model with in-filled frame single strut approach from 1st story.
Model 3: Model with in-filled frame single strut approach with soft story effect.
Model 4: Model with in-filled frame double strut approach from 1st story.
Model 5: Model with in-filled frame double cross strut approached with soft story effect.

D. Building Prameters Considered in this Work

Structure	SRMF (R=5)
Floors	G + 6
Ground storey height	3 m
Typical storey height	3 m
Height of building	21 m
Length of building	15 m
Width of building	9 m
Tx	0.487 Sec
Ty	0.630 Sec
Damping	5%
Soil type	Medium (II)
Seismic zone	III
Importance factor	1.2
Live load	3 kN/m^2 (Typical Floor) 1.5 kN/m^2 (Terrace Floor)
Floor finish	1 kN/m^2
Wall load	External wall - 12.74 kN/m Internal wall - 6.371 kN/m Parapet wall - 4.6 kN/m
Size of beam	300 X 450, 300 X 600
Size of column	450 X 450
Size of strut	Width – 230 mm Height – 390 mm
Outer Wall	230 mm
Inner Wall	115 mm
Parapet (1m height)	230 mm

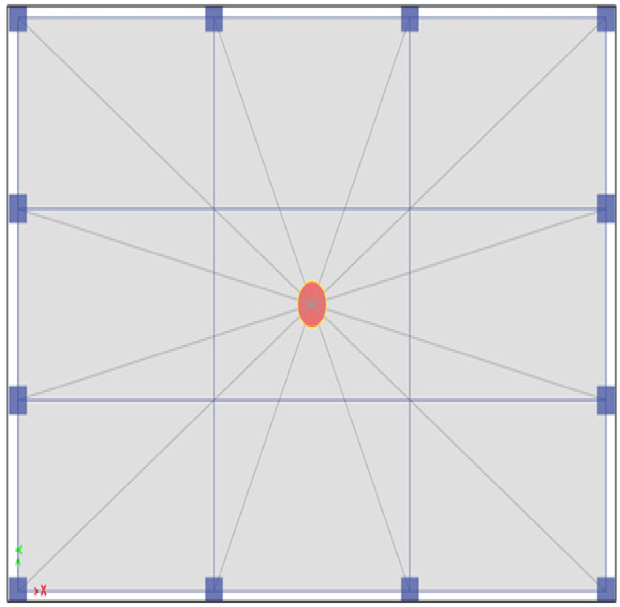
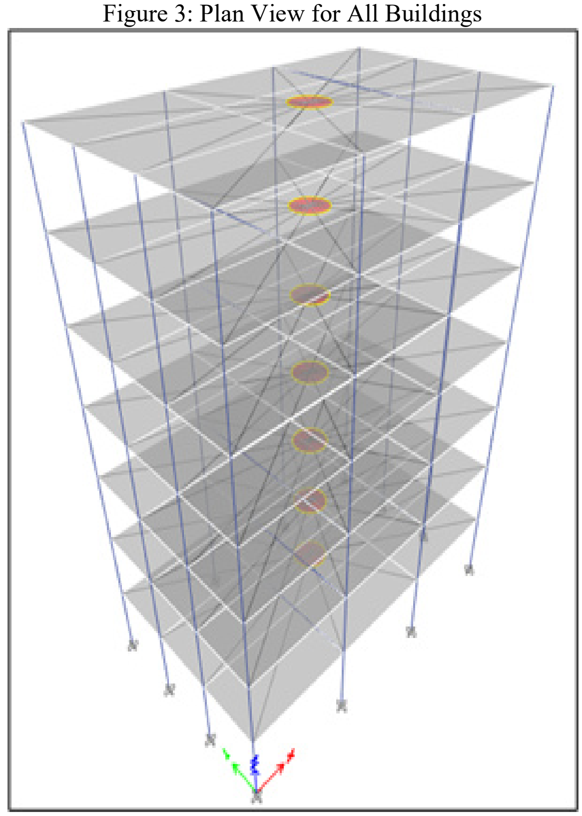
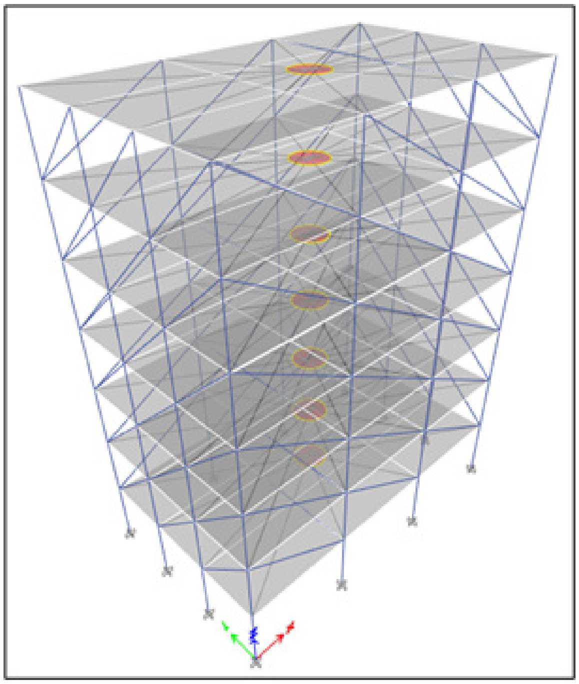


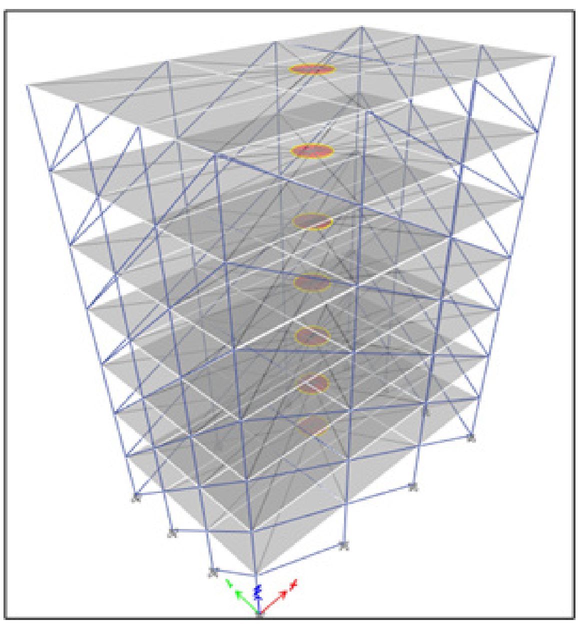
Figure 3: Plan View for All Buildings



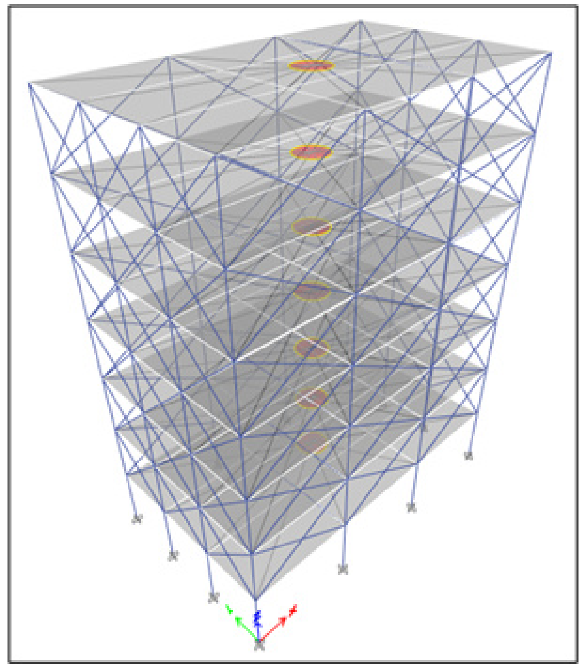
Figures 4: Shows Building With Bare Frame. (Model-1)



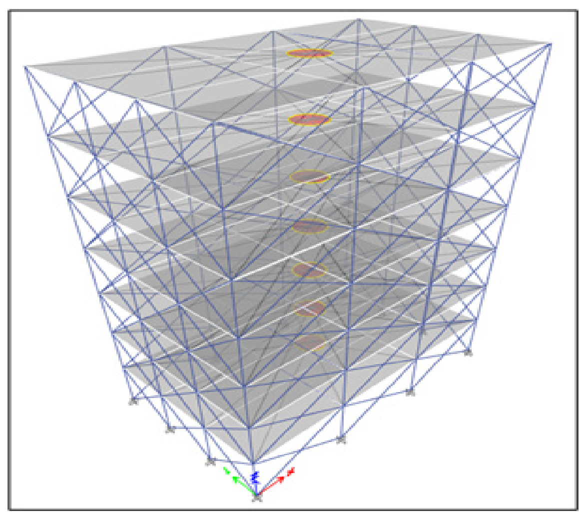
Figures 5: Shows In-Filled Frame Single Strut Approach from 1st Story (Model-2).



Figures 6: Shows In-Filled Frame Single Strut Approach from Soft Story Effect. (Model-3).



Figures 7: Shows In-Filled Frame Double Strut Approach from 1st Story. (Model-4).

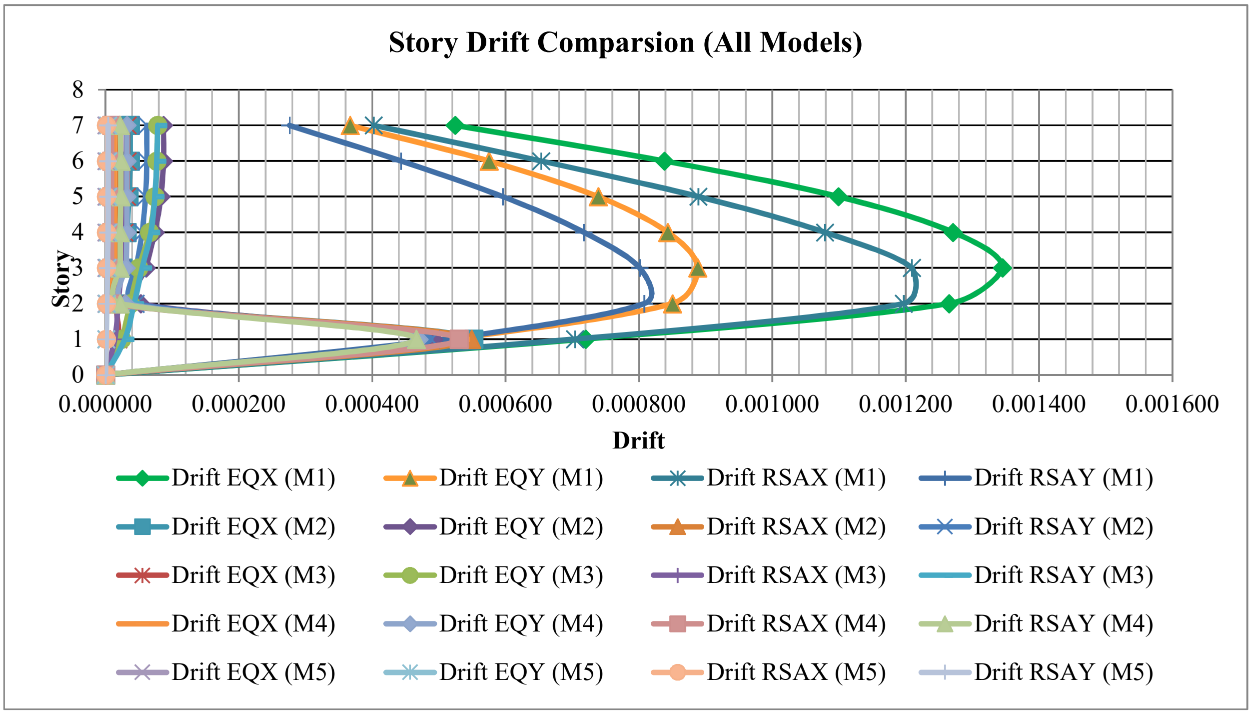


Figures 8: Shows In-Filled Frame Double Strut Approach from Soft Story Effect (Model-5)

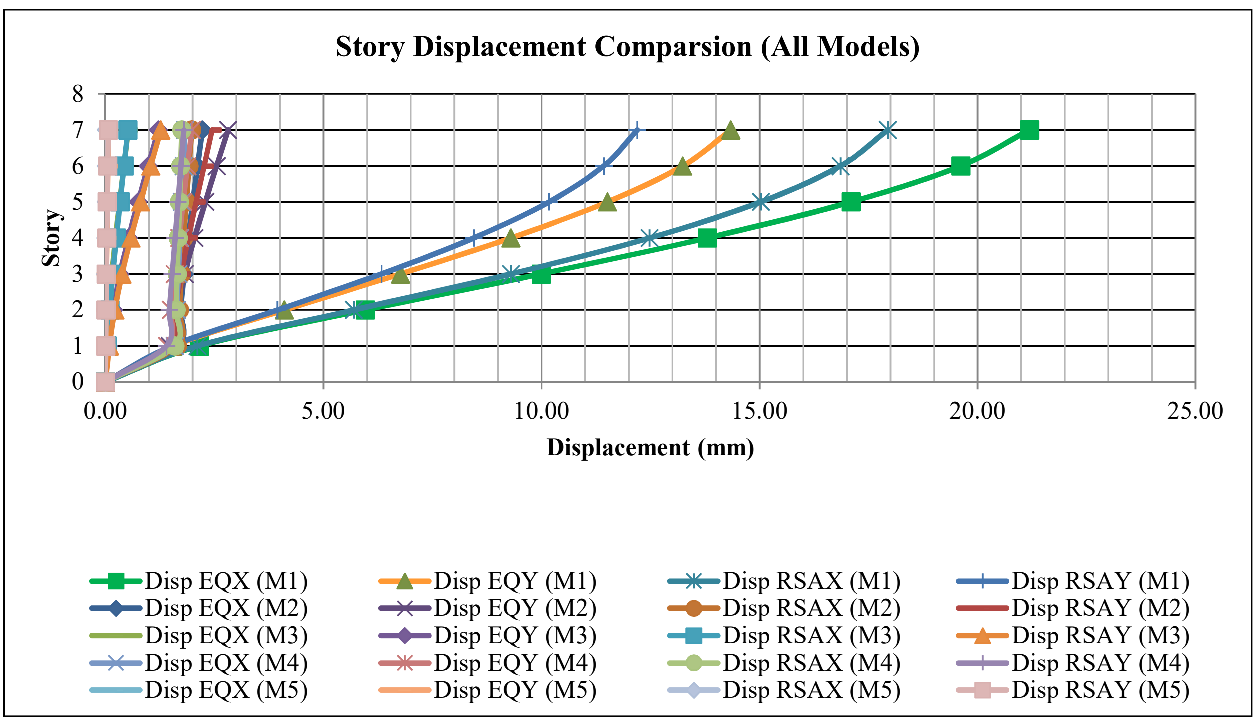
IV. RESULTS AND DISCUSSION

An attempt is made to find the vulnerability location of soft storey by considering the soft storey at the ground levels with and without using struts

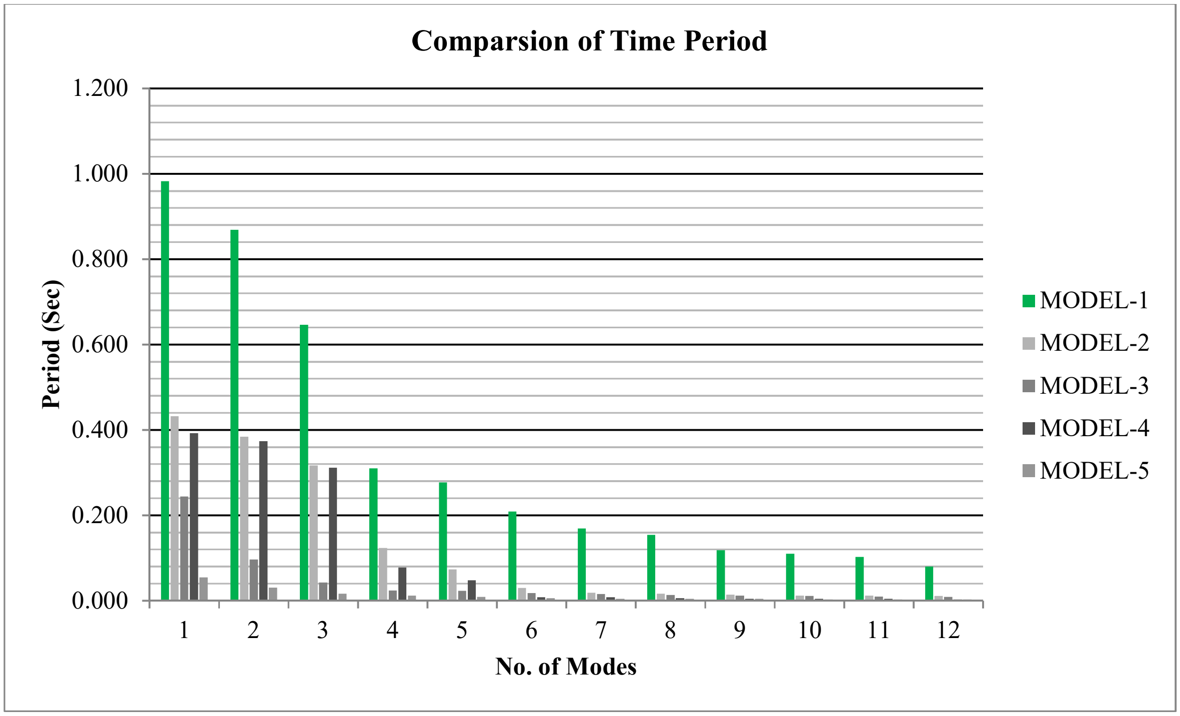
A. Results of Storey Drift



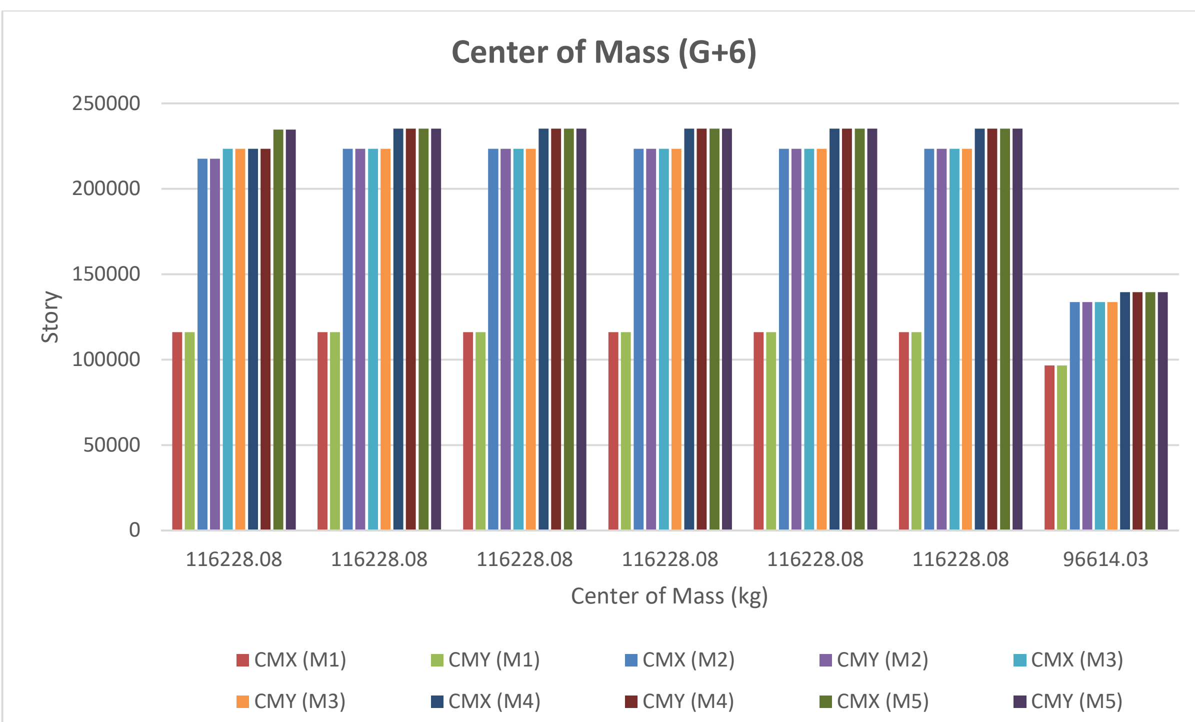
B. Results of Storey Displacement



C. Results for Time Period



D. Results for Center of Mass



V. Conclusion

In the present work attempt has been made to compare the seismic analyses of different buildings and following are the conclusions drawn.

- In case of an open first storey frame structure, the storey drift & displacement is very large than the increasing upper storeys, which may cause the collapse of structure during strong earthquake shaking. The necessary measures should take to improve capacities of the columns in the soft first storey.
- Drift and displacement of the structure are more in the case of bare frame. And these can be lowered by making the provision of strut at the level of soft storey.
- From the analysis it is seen that, deflection is more in case of bare frame as compare to that of infill frame, because presence of infill contributes to the stiffness of building. This effect is clear from comparison of all models with Model 1.
- Time duration of the structure is more in bare frame, whereas it reduces in case of strut frame. Fundamental time period decreases when the provisions of different types of strut are considered.
- Stiffness of the soft storey in case of bare frame is less than the upper storey. And it is seen that stiffness of the storey increases by providing the bracings at soft story level.
- Behaviour of square column is better than rectangular column, in terms of storey drift & story displacement. It is also observed that due to double strut used in building column force are reduced drastically.
- Moments & Shear forces in bare frame are always maximum as compare to infill wall & strut in all Models.
- It also concludes from the observation cross (X-type) strut is very effective in case of infill wall building as compare to other type used. It should be considered in soft story at some location in outer periphery to strengthen the column.

VI. Future Scope

- To observe the effect of soft storey in a building at different level with different shapes of shear wall throughout the height of the building and also the shear wall at the center of the building.
- Study the effect of soft storey at different level for structure having irregularity in plan.
- Study the effect of soft story and the floating column due to soft story.
- The structure can be analyzed in different soil type and seismic zone and also study in hilley terrain area.

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