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# Minimization of Effect of Soft Storey during Earthquake by Providing Semi Soft Storey

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**Abstract -** *Most of reinforced concrete (R.C.) structures are fail due to soft storey mechanism. The present work focused on an behaviour of soft storey and semi soft storey. We had seen that in previous earthquakes severe structural damage suffered by many multi-storey buildings exemplify the importance of avoiding sudden changes in lateral stiffness and ductility. In this study I try to investigate performance of a building (G+4) with soft storey along with semi soft storey is analysed in order to reduce soft storey effect on seismic response of building. The linear response spectrum analysis was carried out and the results obtained from models were compared in terms of storey displacement, storey drift, storey shear, time period and best alternative for construction in earthquake-prone area has selected.*

***Key Words***: **Soft storey, Shear wall, Storey drift, Storey displacement, Storey shear, Time period, Time historey analysis, Response spectrum analysis, ETAB.**

## 1. INTRODUCTION

A soft storey known as weak storey is defined as a storey in a building that has substantially less resistance or stiffness or inadequate ductility to resist stresses induced due to earthquake. Soft storey buildings are characterized by having a storey which is provided without brick wall or shear wall in between two columns and beams. Many multistorey buildings in India have open first storey. This is primarily being adopted to accommodate parking or reception lobbies in the first stories. For to take this advantage this feature is unavoidable. In soft storey building upper stories have brick unfilled wall panels. The Indian seismic code classifies lateral stiffness of soft storey is less than 70% of the storey above [IS: 1893, 2016]. Whereas during an earthquake the total seismic base shear as experienced by a building is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height. Due to the presence of infill walls in the entire upper storey except for the ground storey makes the upper storey much stiffer than the open ground storey. Thus, the upper storey moves almost together as a single block and most of the horizontal displacement of the building occurs in the soft ground storey itself. In other words, this type of buildings sways back and forth like inverted pendulum during earthquake shaking, and hence the columns in the ground storey columns and beams are heavily stressed. Therefore, it is required that the ground storey columns must have sufficient strength and adequate ductility. Due to various needs. A soft storey is also unavoidable and thus it becomes important to study the performance of a soft storey building.

Know a day we had seen that solution for soft storey peoples provide shear wall, but it is highly uneconomical so that shear walls are not preferred in regular everyone.

## 2. REVIEW OF LITERATURE

*Misam. A and Mangulkar Madhuri N. (2012) discussed about severe structural damage suffered by several modern buildings during recent earthquakes illustrates the importance of avoiding sudden changes in lateral stiffness and strength. The lower level containing the concrete columns behaved as a soft storey in that the columns were unable to provide adequate shear resistance during the earthquake. Usually the most economical way to eliminate such failure in a building is by adding shear wall to soft stories. In this paper occurring of soft storey at the lower level of high-rise buildings subjected to earthquake has been studied. Also has been tried to investigate on adding of shear wall in various arrangements to the structure. Four different models were prepared in this paper & they are as follows:*

*Model 1: The structure without lateral load resistance system is called model-I.*

*Model 2: The model-I (Soft storey at bottom) is modified into this model with adding the shear wall.*

*Model 3: This model is also a shear wall-frame building. The shear wall is added at the corners bays of the building.*

*Model 4: This model is also a shear wall-frame building. The shear wall is added at the two center bay of building. In this model, the soft storey at the lowest floor has been added the shear wall in center bay too.*

*Mohamed Riyas N.K, Dr. Raneesh K.Y and Marshiyth K.P (2016) studied the seismic vulnerability of building with an Example of G+24 building with soft storey at intermediate floor using linear static analysis. Analysis and design were carried out on an RCC moment resisting framed tall building without Infill wall on different floors with the help of Software ETABS 2015 and concluded that deflection and displacement are always maximum at soft storey level. Models considered for the study are as follows:*

*Model 1: Soft storey at ground floor level*

*Model 2: Semi Soft storey at ground floor level*

*Model 3: Soft storey at 12th floor level*

*Model 4: Soft storey at 18th floor level*

*Model 5: Soft storey at 24th floor level*

*Ranjit V. Surve, Prof. D.S. Jagtop and Y.P. Pawar (2015) investigated on finding the best place for soft storey in high rise building with ground level and also focused on natural time period of multistoried structure. He concluded that shifting of the soft storey to higher level results in reduction of number of hinges and if soft storey is provided at ground level, the base shear was found to be maximum.*

## 3. PROBLEM STATEMENT OF STUDY

In present work, in order to determine dynamic response of Soft Storey and Semi Soft Storey at different floor levels in seismic zone III will be modeled and analyzed in ETABS software. Dynamic response spectrum analysis will be performed on the structure. In present work one conventional (G+4) RC frame with soft storey (Building-1) building model and one same (G+4) RC frame with semi soft storey (Model-1) building model are considered in order to reduce soft storey effect on seismic response of building.

A. Models of building

Model-1: Soft storey at ground floor.

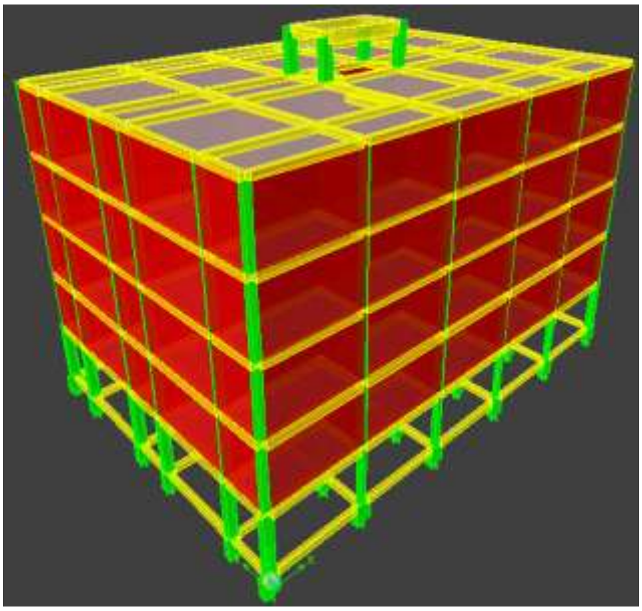


Fig. 1: Multi storey building with soft storey (Model 1)

Model-2: Semi Soft storey at ground floor. Means providing break masonary on every alternate opening.

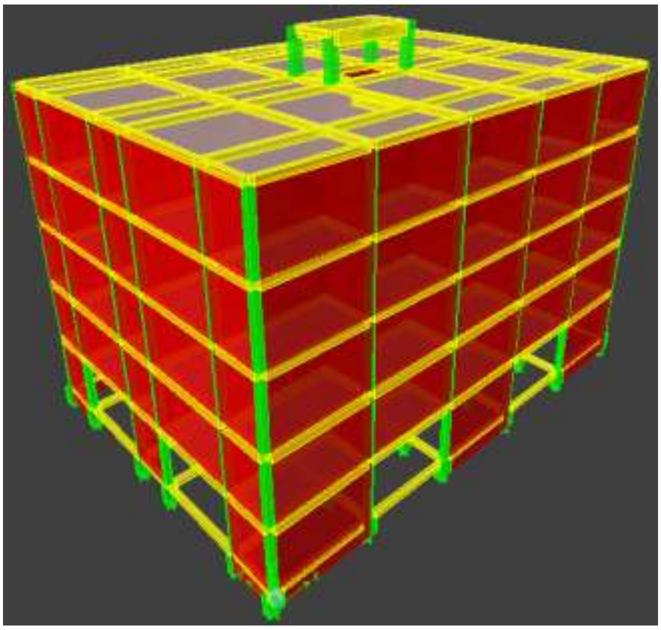


Fig. 2: Multi storey building with semi soft storey (Model 1)

B. Design data of building

| Data for building | Dimension |
|---|---|
| No. of storey | 5 (G+4) |
| Plan dimension | 24.5 m X 17 m |
| Storey height | 3.2 m |
| Slab thickness | |
| S1 | 0.12 M |
| S2 (Waist Slab) | 0.15 M |
| Column size | |
| C1 | 0.23 X 0.3 M |
| C2 | 0.23 X 0.45 M |
| C3 | 0.23 X 0.6 M |
| Beam size | |
| B1 | 0.23 X 0.3 M |
| B2 | 0.23 X 0.4 M |
| B3 | 0.23 X 0.5 M |
| Wall Thickness | 230 mm |
| Live load+ Floor finish | 3 kN/m2 |
| Grade of concrete | M 30 |
| Grade of steel | Fe 415 |
| Earthquake data | Zone-II Type II medium soil, Importance factor-1. |

## 4. RESULTS AND DISCUSSION

Dynamic analysis for RC Frame building with soft storey is done by using response spectrum analysis for earthquake zone III as per Indian standard code. Loads are calculated and distributed as per the code IS: 875 (part-1 to 3) 2015. The effect of location of soft storey at different height of building is evaluated. There is significant change in seismic parameters like storey displacement, storey drift, storey shear and time period and is noticed and discussed below:

**Storey displacement:**

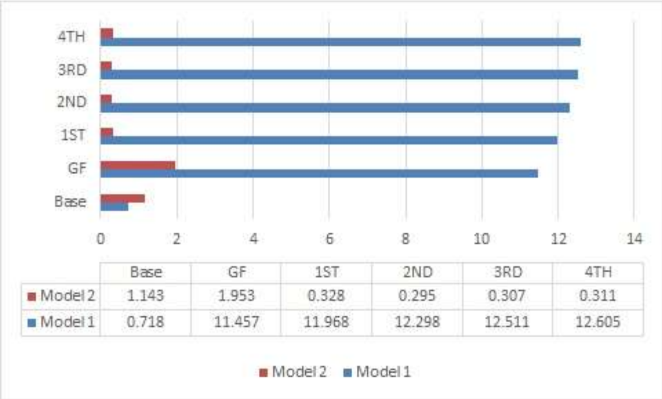



**Fig. 3**: Storey Displacement in X-direction


**Fig. 4**: Storey Displacement in Y-direction

Here we can see that displacement of model 1 building is greater at all the levels on both the directions. The displacement value of model 1 is about 87.77% and 36% higher compared to model 2 in X & Y direction respectively.

**Storey drift:**


**Fig. 5**: Storey Drift in X-direction


**Fig. 6**: Storey Drift in Y-direction

From fig. no. it is observe that storey drift on model no. 2 in X- direction is negligible as compaire to model no. 1. And from fig. no. storey drift it ground floor of model 1 is 49.23% greater than model 2. But from first floor storey drift value of model 2 is about 48.72% higher compared to model 1 in Y-direction.

**Storey shear:**

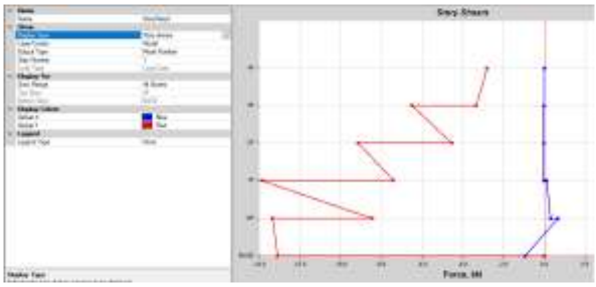


**Fig. 7 :** Storey Shear of Model 1 in X & Y direction

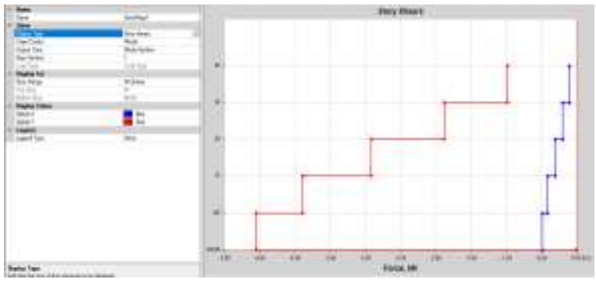
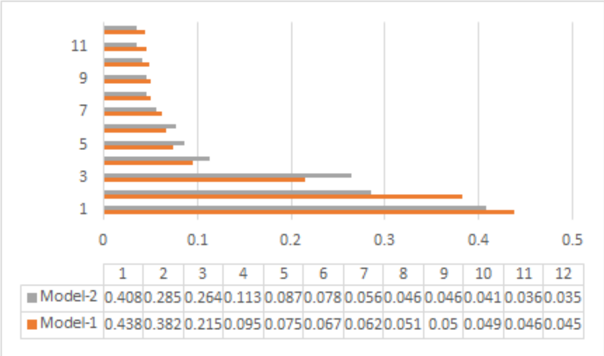


**Fig. 8:** Storey Shear of Model 2 in X & Y direction

From the above charts (model 1 to 4) it was observed that maximum storey shear is very uneven in model 1, where in model 2 near about symmetrically decreases. The storey shear value of model 1 is about 67% & 10% higher compared to model 1 in Y & X direction

**Time period:**




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Model-2 | 0.408 | 0.285 | 0.264 | 0.113 | 0.087 | 0.078 | 0.056 | 0.046 | 0.046 | 0.041 | 0.036 | 0.035 |
| Model-1 | 0.438 | 0.382 | 0.215 | 0.095 | 0.075 | 0.067 | 0.062 | 0.051 | 0.05 | 0.049 | 0.046 | 0.045 |

**Fig. 9:** Time Period of Model 1 & 2

Here it is observed that time period of model 1 in second in mode 1,2,7,8,9,10,11 and 12 is 8% greater than model 2. In mode 3,4,5 and 6 value of time period in model 2 is 18 % greater than model 1.

## 5. CONCLUSIONS

Storey displacement of model 1 (soft storey) was found to be maximum compare to model 2 (semi soft storey) in both X & Y direction.

i. Storey drift of model 2 was found to be negligible compare to model 1 in X direction and in Y direction it nearabout 50% than model 1 at ground.
ii. As the level of the soft storey increase the value of displacement decrease.
iii. As the level of the soft storey decrease the value of drift increase.
iv. As the level of soft storey decreases the value of time period increases.
v. The storey shear is maximum at ground level and keeps on decreasing towards the top storey of the structure.
vi. Providing semi soft storey is the most economical method of reducing the effect of soft storey.
vii. Therefore, it is advisable to provide semi soft storey in terms of soft storey to reduce the earthquake effect without reducing the advantages of soft storey.

## 6. ACKNOWLEDGEMENT

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