# Seismic Analysis of a Structure with Soft Storey and Floating Column

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**Abstract:** In Urban area, multi storey buildings or commercial building are constructed by providing floating columns at ground floor as we need ample of open space or parking area in the lower floor. On the other hand, A typical soft story building is an apartment building of three or more stories located over a ground level with large openings, such as a parking garage or series of retail businesses with large windows. The study on behavior of structure having soft story and floating column is to be analyzed. Study tends to see if such kind of structure performs well in earthquake prone zones or not. An investigation is performed on analytical model of a multistorey building recognizing the presence of a floating column and soft storey using the software ETABS. To study the effect of earthquake on this kind of buildings, Equivalent static analysis and Response spectrum analysis have been considered. The parameters like storey drift, storey shear, buliding torsion, storey moment have been studied in detail.

**Key Words: — *Soft Storey, Floating Column, Equivalent Static Analysis Method, Response Spectrum Analysis Method, ETABS.***

## I. INTRODUCTION

The shortage of space is a growing issue nowadays due to increase in population for this there is a need of having column free space. The main reason floating column came into existence is to keep the ground storey open and is a peculiar part of modern multi storey buildings in India. On the other hand, A soft story building is a multi-story building in which one or more floors have windows, wide doors, large unobstructed commercial spaces, or other openings in places where a shear wall would normally be required for stability as a matter of earthquake engineering design. Both this feature adds structural load on the building which may lead to structural failure especially in the earthquake prone areas. Open ground storeys are poor systems because of the strength discontinuity along the height of column in building. If columns are weak, they'll show severe damage which may lead to building collapse which is very dangerous and at times fatal to mankind.

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*Floating Column:* The columns whose junior end does not entend to ground and and handovers the above loading on a beam as a point load, such type of column are called as Floating Columns. Floating columns arises in use to bid extra open space for assembly hall of parking purpose. The floating column building does not generate any problem under only vertical loading condition but it rises susceptibility in lateral loading (earthquake loading) condition, due to vertical discontinuity. During the earthquake the lateral forces established in higher storey have to be transmitted by the proposed cantilever beams due to this the overturning forces are established over the column of the ground floor. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path. The beams in turn transfer the load to other columns below it. In such columns the loads were considered as a point load. A column is supposed to be a vertical member beginning from foundation level and shifting the load to the ground. The term floating column is also a vertical component which (due to architectural design/ site situation) at its lower level (termination Level) rests on a beam which is a horizontal member. The beams in turn assign the load to other columns below it.

*Soft Storey:* A soft story building is a multi-story building in which one or more floors have windows, wide doors, large unobstructed commercial spaces, or other openings in places where a shear wall would normally be required for stability as a matter of earthquake engineering design. A typical soft story building is an apartment building of three or more stories located over a ground level with large openings, such as a parking garage or series of retail businesses with large windows. It is the one which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys above. An open ground storey building has both columns and masonry infill walls in the upper stories but only columns in the ground storey. It is the most common type of vertical irregularity occurs in building which is left open for the purpose of parking, i.e., columns in the ground storey do not have any partition walls (of either masonry or RC) between them. The soft storey has lesser strength and stiffness as compared to upper stories, which are stiffened by masonry infill walls. This increases the flexibility of first storey which results in extreme deflections and it leads to concentration of forces at the second storey connections and large plastic deformation.

## II. METHODOLOGY

### *2.1 Method of Analysis:*

*2.1.1 Response Spectrum Analysis:*

Response spectrum analysis is also known as linear dynamic statistical analysis method. This analysis generally done with the help of IS code for seismic analysis. The IS code used for this study is IS 1893:2002 (Part 1). The values of seismic zone factor, soil type is taken from the tables which are from this IS 1893:2002 (Part 1) code. The damping ratio is generally taken as 5% for this analysis is shown in the figure 1 below. The response spectrum Graph for medium soil condition is shown in the below graph. The graph is plotted between the Time period and Spectral acceleration coefficient (Sa/g).

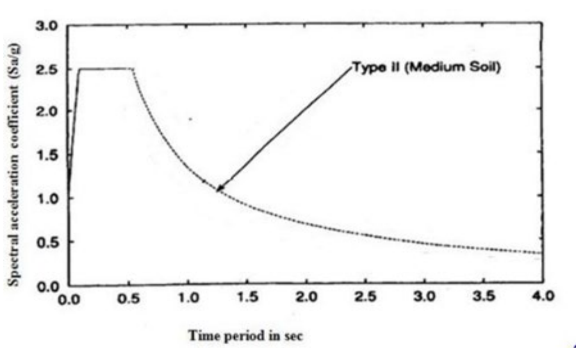


Fig.1. Response spectrum for medium soil type for 5% damping

In this we need to discover the size of powers finished for instance X, Y and Z and after that see the repercussions for the structure. Mix techniques combine the going with:

- Absolute - crest esteems are included
- Square foundation of the total of the squares (SRSS).
- Complete quadratic blend (CQC) - a strategy that is a change on SRSS for firmly divided modes.

The output from the Response spectrum analysis is purely different from the linear dynamic analysis using the ground motions, in case of structure or building is irregular or high rise building this analysis of response is not accurate as we compared with other analysis and other method of analysis is needed, which is nonlinear static analysis or dynamic analysis.

### *2.2 Equivalent Static Analysis***:**

This technique indicates a bunch of forces working on a construction to recreate the impact of earthquake ground movement, which is ordinarily determined by a seismic design reaction range. It is expected that the construction responds in its essential way. The building should be low-ascent and not contort impressively as the earth changes for this to be valid. Given the characteristic recurrence of the construction, the reaction is perused from a design reaction range (either determined or characterized by the building code). Many building guidelines improve the helpfulness of this idea by adding parts to represent higher buildings with certain higher modes, just as unobtrusive levels of curving. Numerous codes utilize alteration factors that bring down the design pressing factors to represent impacts because of "yielding" of the construction (for example power decrease factors).

### *2.3 Building Specification and Modelling of Building*

In the present study, analysis of G+ 11 stories building in Zone V seismic zones is carried out in ETABS.

*2.3.1 Basic parameters considered for the analysis are:*

| | |
|---|---|
| Utility of Buildings | Residential Building |
| No of Storey | 12 Stories (G+11 Building) |
| Grade of concrete | M40 |
| Grade of Reinforcing steel | HYSD Fe500 |
| | |

| | |
|---|---|
| Type of construction | RCC framed structure |
| Dimensions of beam | 230mmX500mm, 230mmX400mm |
| Dimensions of column | 500mmX500mm, 400mmX400mm |
| Thickness of slab | 120mm |
| Height of bottom storey | 4m |
| Height of remaining storey | 3m |
| Building height | 34m |
| Live load | 5 KN/m2 |
| Dead Load | 2 KN/m2 |
| Density of concrete | 24 KN/m3 |
| Loads considered in Buildings | Dead load, live load, floor load, earthquake load, wind load |
| Seismic Zones | Zone V |
| Site Type | II |
| Importance factor | 1.5 |
| Response reduction factor | 5 |
| Damping ratio | 5% |
| Structure class | B |
| Basic wind speed | 44 m/s |
| Method of analysis | Response spectrum analysis, Equivalent static analysis |
| Wind design code | IS 875: 1987 (Part 3) |
| RCC design code | IS 456: 2000 |
| Steel design code | IS 800: 2007 |
| Earthquake design code | IS 1893: 2002 (Part 1) |

### *2.4 Building models in ETABS Software:*

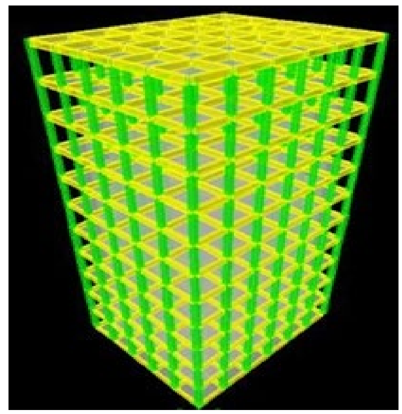

Fig.2. Floating Column

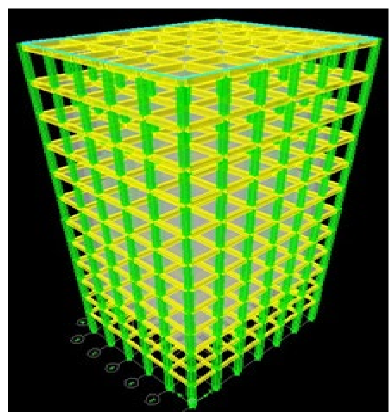

Fig.3. Soft Storey

Figure 2 and Figure 3 shows the modelling of the building using the ETabs software with floating column and soft storey respectively.

## III. Results And Conclusion

### *3.1 For Response Spectrum Analysis*

*3.1.1. Storey drift:*

Comparison of drift values *i.e X values* against storey number in *X* direction shows similar results for both except after second storey in case of soft storey building. (Figure 4).

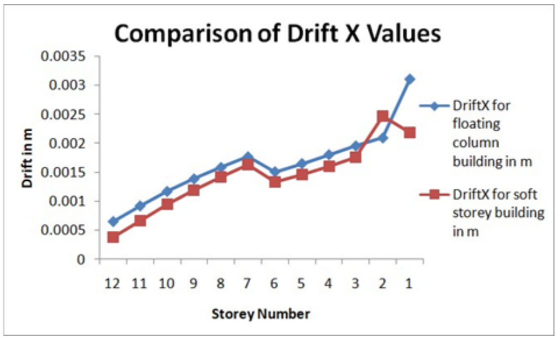


Fig.4. Comparison of storey drift in X direction

Comparison of drift values *i.e Y values* against storey number in *Y* direction shows similar results as shown in *X* direction. (Figure 5)

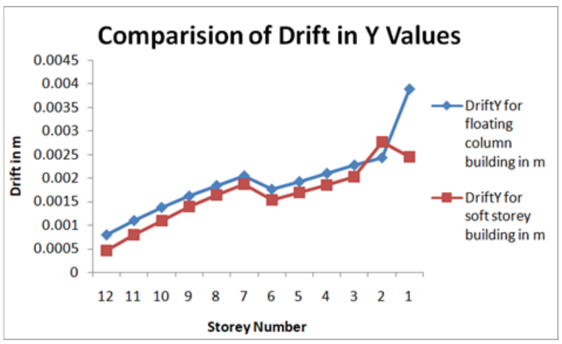


Fig.5. Comparison of storey drift in Y direction

*3.1.2. Storey Shear:*

Comparison of Shear values against storey number in *X* direction shows shear values for soft storey building being higher than that for floating column building. (Figure 6).

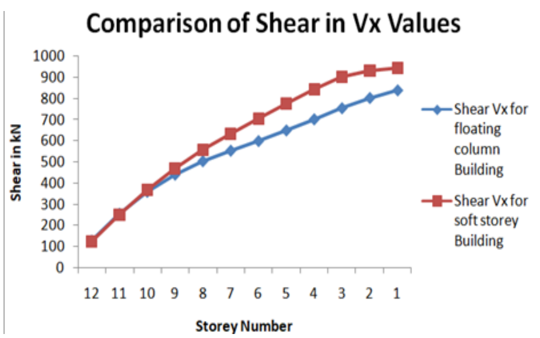


Fig.6. Comparison of shear Vx

Comparison of Shear values against storey number in *Y* direction similar results as in *X* direction. (Figure 7).

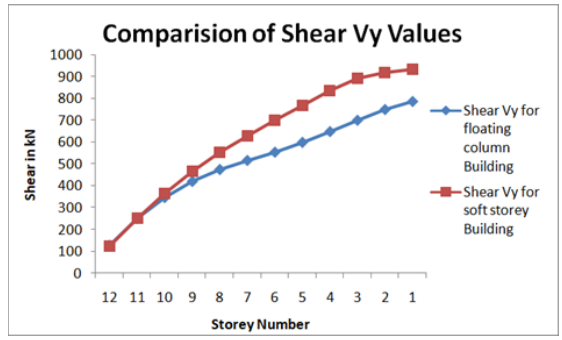


Fig.7. Comparison of shear Vy

*3.1.3. Building Torsion:*

Building torsion values shows almost same type of result in both the case of building as shown. (Figure 8).

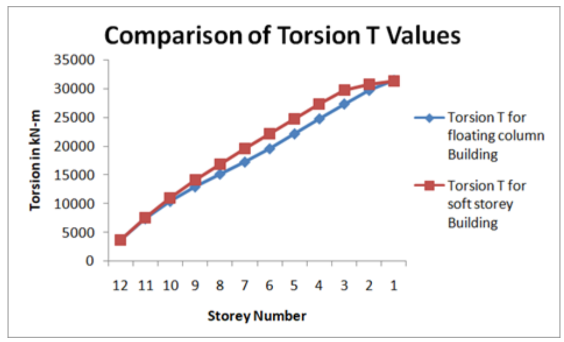


Fig.8. Comparison of Torsion

*3.1.4. Storey moment:*

Storey moment in *X* direction shows increase in its value for soft storey building due to the presence of big opening being induced for the wide space. (Figure 9)

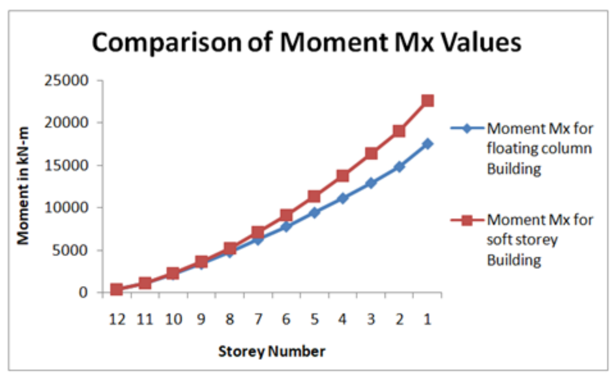


Fig.9. Comparison of moment Mx

It shows somewhat same results in the *Y* Direction as well. (Figure 10)

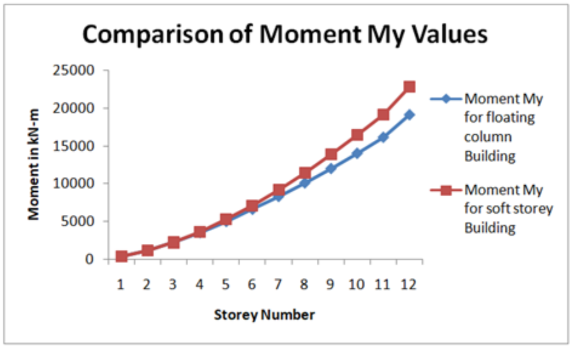


Fig.10. Comparison of moment My

*3.1.5 Time period:*

Time period values decreases from bottom to top storey and its values shows same results while at the top storey for both types of building. (Figure 11).

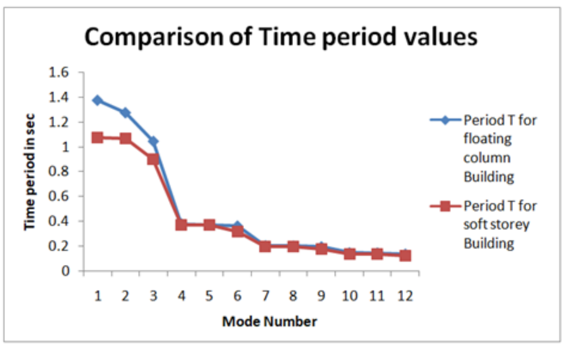


Fig.11. Comparison of Time period

## *3.2 For Equivalent Static Analysis:*

*3.2.1 Storey drift:*

Comparison of drift values for both the types of building is shown for *X* Direction. (Figure 12).

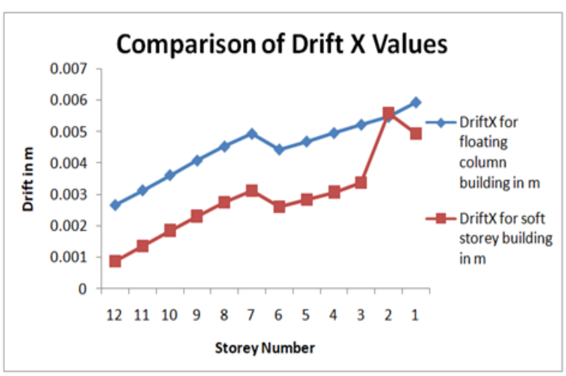


Fig.12. Comparison of storey drift in X direction

Comparison of drift values for both the types of building is shown for *Y* Direction. (Figure 13).

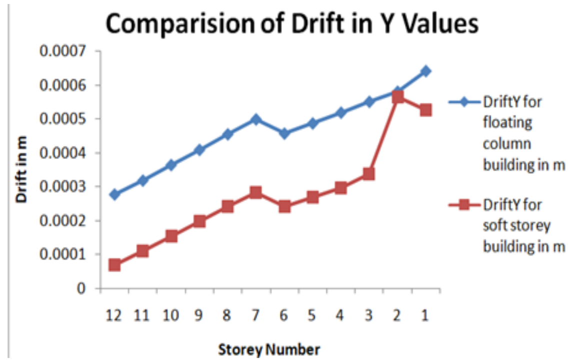


Fig.13. Comparison of storey drift in Y direction

*3.2.2 Storey Shear:*

Comparison of shear values for both the types of building is shown for *X* Direction. (Figure 14).

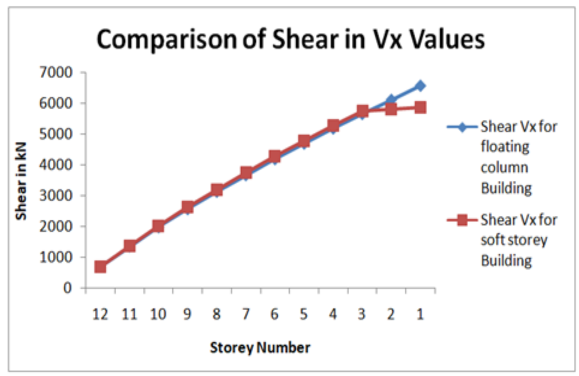


Fig.14. Comparison of shear Vx

Comparison of shear values for both the types of building is shown for *Y* Direction. (Figure 15)

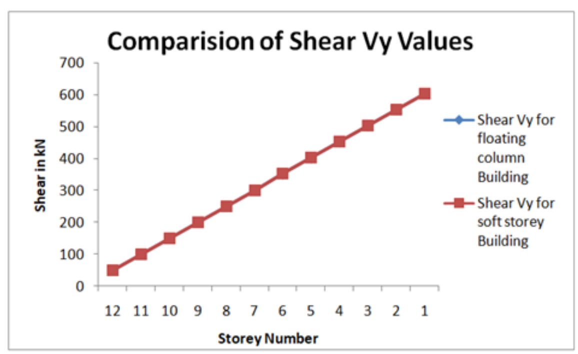


Fig.15. Comparison of shear Vy

*3.2.3. Building Torsion:*

Building torsional values are same for both case except at second and first storey it tends to decrease in soft storey building. (Figure 16).

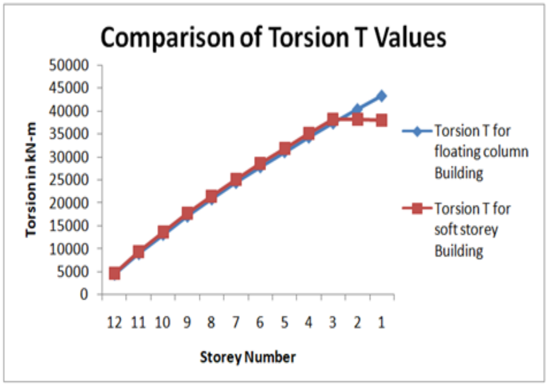


Fig.16. Comparison of Building Torsion

*3.2.4 Storey moment:*

It shows almost same results for both type in *X* direction. (Figure 17).

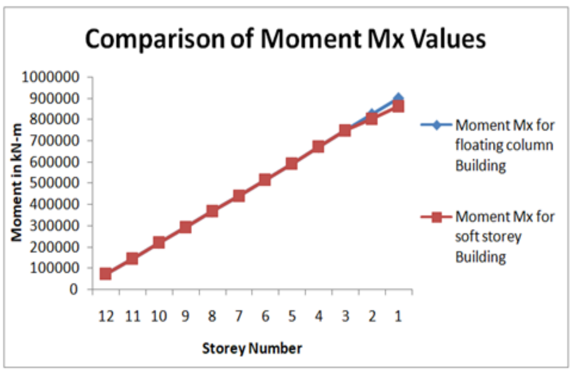


Fig.17. Comparison of moment Mx

It shows same results as shown for the *X* direction in *Y* direction as well. (Figure 18).

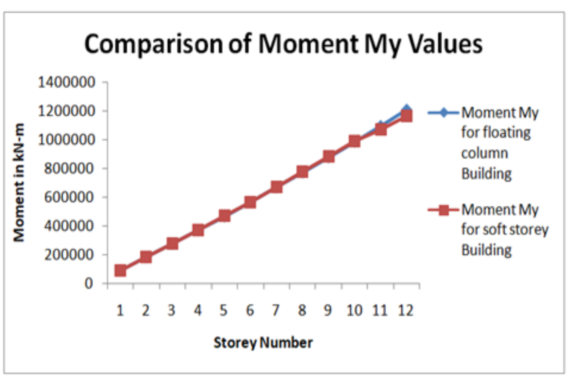


Fig.18. Comparison of moment My

*3.2.5. Time period:*

It shows same results in both the types of analysis. (Figure 19).

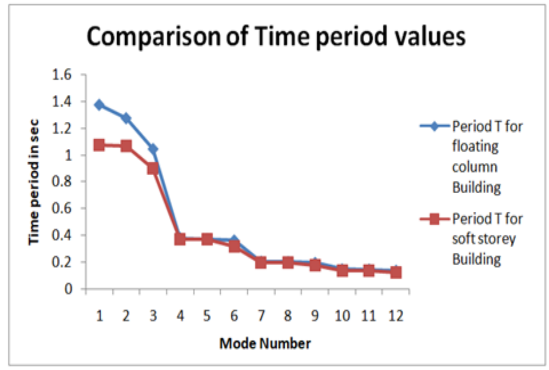


Fig.19. Comparison of Time period

## IV. Conclusion

Following conclusions have been made on the basis of analysis and results:

1. Floating column structures perform ineffectively during earthquakes.
2. It is notable that RC outline structures with open first stories perform seriously during critical earthquake shaking. For structures with delicate ground levels, the float and strength need in the primary level columns are incredibly high. It is hard to supply such capacities in the main floor columns. Thus, it is obvious that such designs will work ineffectively during a huge earthquake. This perilous part of Indian RC outline buildings should be identified right once, and the necessary advances done to improve the building's exhibition.
3. The storey drift in X direction and Y direction has higher in floating column than soft storey structure in both RSA and ESA case.
4. The shear, bending, Torsion values has higher values for soft storey building than floating column building in case of RSA and it has almost same vales for both buildings in ESA analysis.
5. The time period values are decreases from node 1 to node 12 in both buildings

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