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SEISMIC ANALYSIS OF MULTI-STOREY RC BUILDING WITH SOFT STOREY AT DIFFERENT LEVELS WITH AND WITHOUT SHEAR WALL

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ABSTRACT:

The Presence of Open storeys with less or no infill walls and large height in multi storey buildings is in common practice for providing parking lots, reception lobbies, hotels, etc. However such practice is unsafe for the structures present in seismic area. These open storeys with less stiffness are called Soft Storeys. Past earthquakes in the country and around the world have shown that soft story irregularity pose a serious threat to the stability and safety of the building

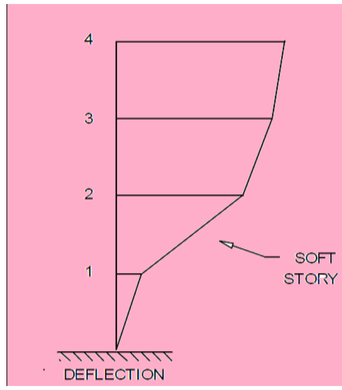
In the present Research various models of nine storey building (G+8) have been taken into consideration to study the effect of earthquake forces on the structure with soft story at different levels. The analysis of the structures is done by using response spectrum analysis using STAAD Pro v8i software. The nonlinear behaviour of the building is analysed and the height wise distribution of storey shear, displacement and storey drift has been studied and compared with buildings having soft story at different levels. Effect of Shear Wall is also analysed by comparing the results by providing shear wall at different positions and comparing the results with the structure without shear wall. It has been found that soft storey is much critical at intermediate floors in comparison to soft storey at ground floor and top floor. Also storey displacements and drift increases suddenly at the level of soft storey along the height of the structure. Hence, for the design of structure with soft storeys, special attention is needed.

Keywords: *Soft Storey irregularity, Response Spectrum Analysis, Storey Drift, Storey Displacement, Shear Wall*

INTRODUCTION

The term ***earthquake*** can be used to describe any kind of seismic event which may be either natural or initiated by humans, which generates seismic waves. Earthquakes are caused commonly by rupture of geological faults; but they can also be triggered by other events like volcanic activity, mine blasts, landslides and nuclear tests. An abrupt release of energy in the Earth's crust which creates seismic waves results in what is called an earthquake, which is also known as a tremor, a quake or a temblor. The frequency, type and magnitude of earthquakes experienced over a period of time define the seismicity (seismic activity) of that area.

Vertical irregularities in buildings are very common feature in urban area, large number of vertical irregular buildings exist in modern urban infrastructures. In most of situations, buildings become vertically irregular at the planning stage itself due to some architectural and functional reasons. This type of buildings shows more vulnerability in the past earthquakes. Open ground storey buildings are also called "open first storey buildings" or "pilotis". Due to the scarcity of land, the ground storey is kept open for parking purpose and no infill walls are provided in ground storey but the storeys above it are provided with infill walls. This type of building shows comparatively a higher tendency to collapse during earthquake because of the soft storey effect. Large lateral displacements get induced at the first floor level of such buildings yielding large curvatures in the ground storey columns. But due to increasing demand and urbanization, intermediate storeys are also provided as open storeys or with large heights for the purpose of banquet halls, conference rooms, theatres, etc. which reduces the stiffness of these stories creating the soft storey irregularity in intermediate storeys also.



MODELLING & MATERIAL SPECIFICATIONS:

STAADPro software is used for the analysis and seismic design of building frames. STAAD stands for Structural analysis and design program. This software is capable to analyze 2-D and 3-D building frames subjected to seismic loads and it can perform response spectrum method to obtain the required results. Software can also be design the building frames as per IS 13920 code.

There are various type of models are analyzed with different cases. The model is eight storey building with plan size 25x25m^2.

Table 1: Material Specifications

Name	E kN/mm2	Poisson's Ratio	Density kg/m3	Alpha /°C
STEEL	205.000	300E-3	7833.413	12E-6
ALUMINUM	68.948	330E-3	2712.631	23E-6
BRICK	14.000	220E-3	1937.461	3.1E-6
CONCRETE	21.718	170E-3	2402.615	10E-6

$E_c = 5000 \sqrt{f_{ck}}$ N/mm^2 = $5000 \sqrt{f_{ck}}$ MN/m^2

Steel

HYSD reinforcement of grade fe415 confirming to IS: 1786 is used throughout

THE DESIGN PARAMETERS ARE FOLLOWS:

Live load: 3.5kN/m^2 at typical floor
: 1.75kN/m^2 on terrace
Zone: II
Earthquake load:As per IS-1893(Part1) -2002
Type of soil: Type II, Medium soil condition as per IS: 1893
Building height: 28.8m (Regular Building)
Building height: 29.3m (Building with soft storey)
Storey height: 3.2 m (3.7m for soft storey)
Column size: 0.6 x 0.4 m^2
Main Beam size: 0.5 x 0.3 m^2
Thickness of Slab: 0.15m
Thickness of wall: 0.23 m
Thickness of Shear wall: 0.23 m
Damping in structure:5%
Importance Factor: 1.0

Type of structure	SMRF (Multi-storey rigid jointed plane frame)	Size of Columns	400mm x 600mm
Seismic zone	Zone II	Wall Thickness	230 mm
Number of stories	Nine (G + 8)	Live Loads	Live load-3.5KN/m², Terrace- 1.75KN/m²
Floor Height	3.2 m (3.5 m for soft storey)	Material	M-30 Grade concrete, Fe-415 Steel
Type of soil	Medium Type - II	Damping in structure	5%
Size of Beam	300mm x 500mm	Importance Factor	1.0

CASES CONSIDERED IN MODELLING:

Following 13 cases are considered for the analysis purpose.

Model 1: Regular 9 storey building with usual storeys.
Model 2: 9 storey building with soft storey at ground floor.
Model 3: 9 storey building with soft storey at third floor.
Model 4: 9 storey building with soft storey at sixth floor.
Model 5: 9 storey building with soft storey at eighth floor.
Model 6: 9 storey building with soft storey at ground floor with shear walls at corners.
Model 7: 9 storey building with soft storey at ground floor with shear walls at centre.
Model 8: 9 storey building with soft storey at third floor with shear walls at corners.
Model 9: 9 storey building with soft storey at third floor with shear walls at centre.
Model 10: 9 storey building with soft storey at sixth floor with shear walls at corners.
Model 11: 9 storey building with soft storey at sixth floor with shear walls at centre.
Model 12: 9 storey building with soft storey at eighth floor with shear walls at corners.
Model 13: 9 storey building with soft storey at eighth floor with shear walls at centre.

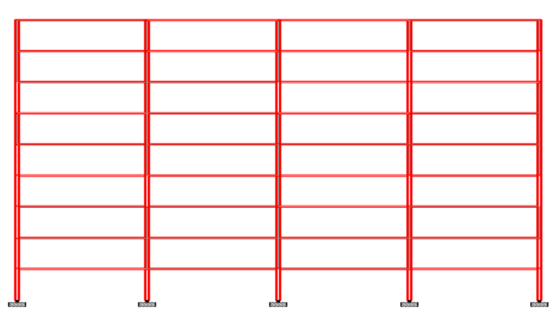


Figure 2: Elevation View

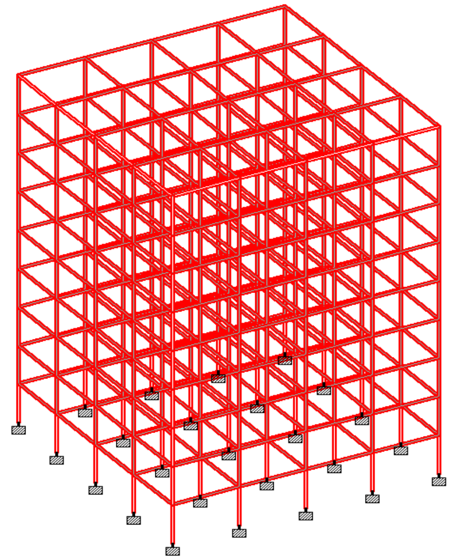


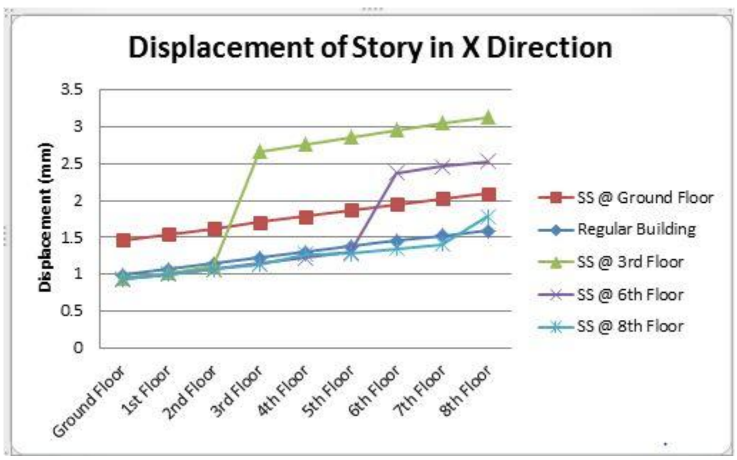
Figure 3: Isometric View

RESULTS & DISCUSSION

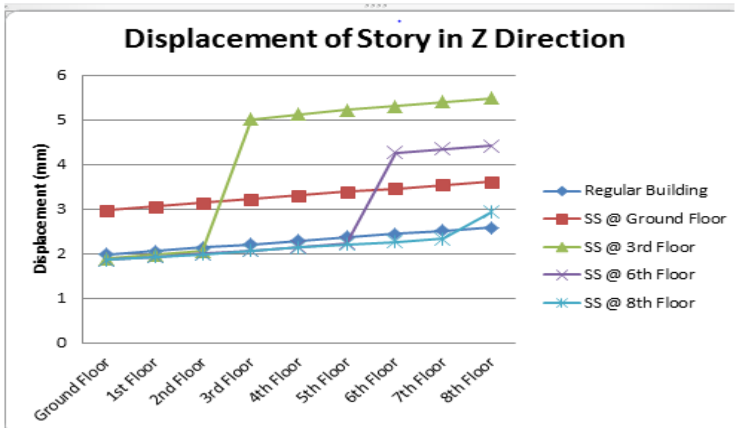
This chapter deals with the result and analysis of the models. The analysis is done on STAAD Pro V8i software. All the models are analysed and results obtained after the analysis is presented here. The aim of the study is to analyse the effect of soft storey in buildings at different levels and the effect of retrofitting the building with shear wall using response spectrum analysis and study the behaviour change and compare them with regular buildings. All the significant details regarding the analysis are discussed in this chapter.

This chapter gives the analysis results and comparison of models with soft storeys at different levels with regular buildings without shear wall. The results obtained after providing the shear wall at two different positions is also compared and the best position is suggested. This comparison is done in various parameters such as, Peak Story Shear, Story Displacement, Story Drift, Time Period, Max. Shear Force and Bending Moments in elements.

1 Displacement in structure in x direction

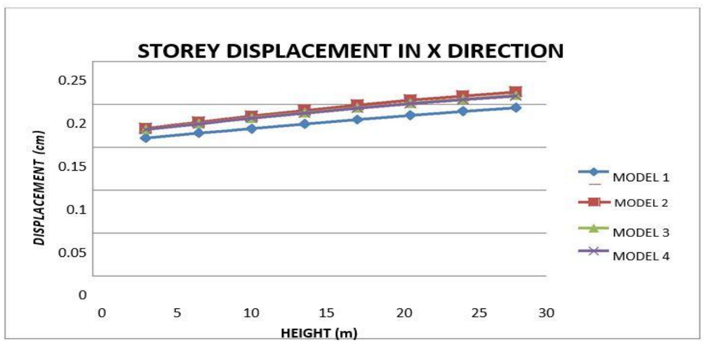


Graph .1 Displacement in structure in x direction

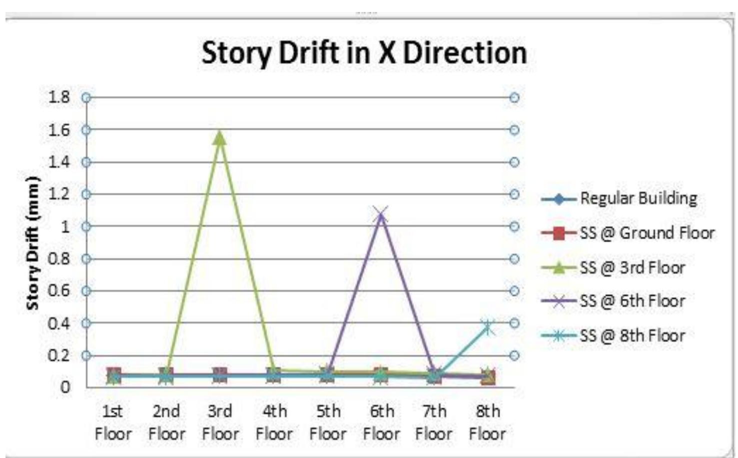


Displacement in storey structure in z direction

STOREY DISPLACEMENT –

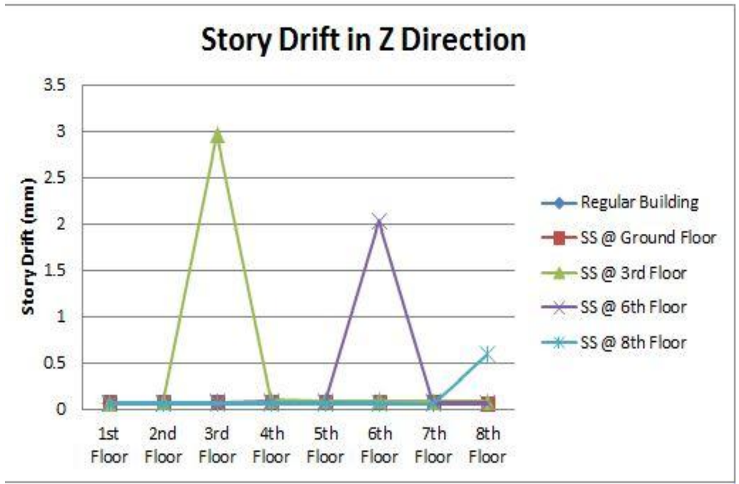


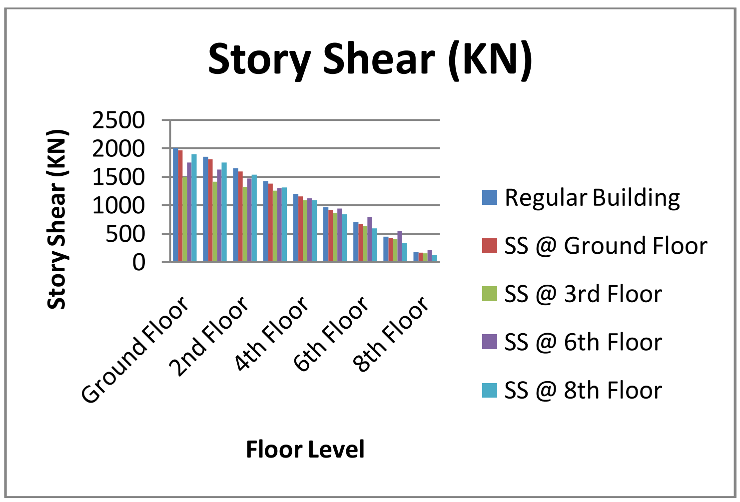
Displacement in 8 storey structure in x direction

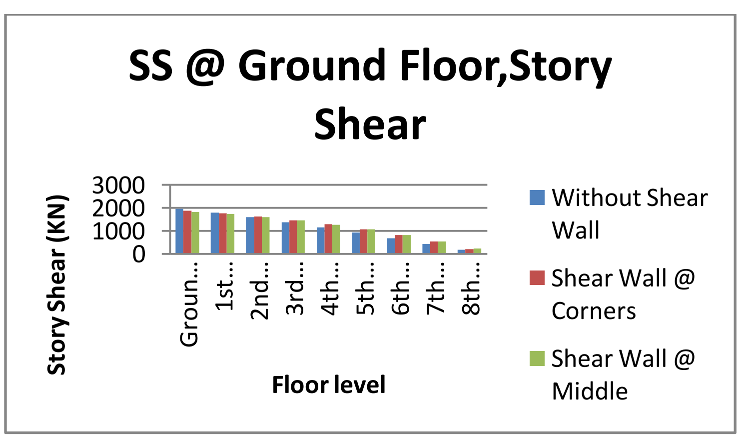


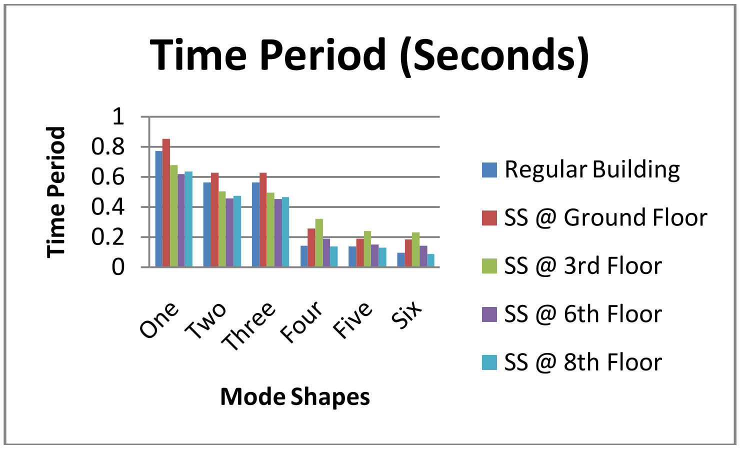
Storey drift in structure in x direction

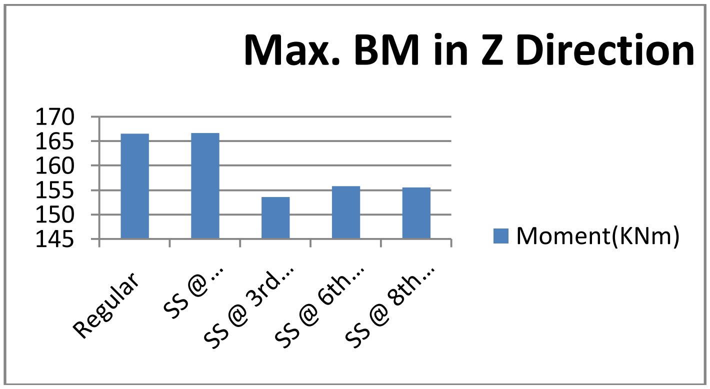
STOREY DRIFT–











CONCLUSIONS

Many research papers are available to understand the behaviour of soft storey when provided at ground level but very few papers are available when soft storey is provided at upper level..

1. The seismic performance of the soft storey building was very poor, when compared with the normal RC Structure.
2. The displacement and drift of storey are always maximum at soft storey level and a sudden increase in their value is observed at that level.
3. As the level of the soft storey increases the value of displacement decreases.
4. As the level of the soft storey decreases the value of drift increases.
5. As the level of soft storey decreases the value of time period increases.
6. The storey shear started decreasing with increase in level of soft storey at intermediate floors and then again starts increasing with further increase in level of soft storey up to top floor.
7. Soft storey at intermediate levels are more critical and prone to failure during earthquake, hence requires special attention.
8. Columns of Soft storey generally requires more reinforcement which is impossible to provide at intermediate levels, hence it is advisable to provide soft storey either at ground floor or top floor.
9. It is clearly observed that failure of structure starts at the level of soft storey hence the soft storey at higher levels is much safer than that at the lower levels.
10. The shear wall make the structure safe by enhancing stiffness, ductility and reducing lateral and vertical drift of the storey at joints, which is due to direct reduction of displacement of member along the propagation of seismic force.
11. Sudden decrease in displacement, drift and internal forces was observed after the provision of shear walls.

12. The value of internal forces i.e. bending moment and axial force was maximum for soft storey at ground floors than that at intermediate floors.
13. The results obtained for both the positions of shear walls are almost same and hence it is advisable to provide shear wall at each corner considering the aesthetic appearance of building.

FUTURE SCOPE OF WORK

1. The structure can be analyzed in different seismic zones and with different types of soils.
2. The effect of bracing or damper can also be analyzed on the structure.
3. Soil structure interaction can also be performed and analyzed on the structure.
4. Non linear pushover analysis and Time History analysis of RC building with soft storey can be performed using ETABS, SAP-2000.

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