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Effect of Soft Storey on Tall Building At Different Floor Levels

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ABSTRACT: Open first storey is a typical feature in the modern multi-storey constructions in urban India. Such features are highly undesirable in buildings built in seismically active areas; this has been verified in numerous experiences of strong shaking during the past earthquakes. Though multi-storeyed buildings with open ground floor are inherently vulnerable to collapse due to earthquake load, their construction is still widespread in the developing nations like India. Social and functional need to provide car parking space at ground level and for offices open storey's at different level of structure far out-weighs the warning against such buildings from engineering community. With ground soft storey for office space open floor is required on different levels of building. In this thesis we are concentrating on finding the best place for soft storey on tall building with using ETABS software

KEYWORDS: soft storey; tall building; deflection; storey drift; storey stiffness; ETABS

I. INTRODUCTION

Many urban multistory buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first stories. The upper stories have brick unfilled wall panels. The draft Indian seismic code classifies a soft storey as one whose lateral stiffness is less than 70% of the storey above [Draft IS: 1893, 2002]. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height. In buildings with soft first storey, the upper storey's being stiff undergone smaller inter-storey drifts. However, the inter-storey drift in the soft first storey is large. The strength demand on the columns in the first storey is also large, as the shear in the first storey is more. For the upper storey's, however, the forces in the columns are effectively reduced due to the presence of the Buildings with abrupt changes in storeystiffnesses have uneven lateral force distribution along the height, which is likely to locally induce stress concentration. This has adverse effect on the performance of buildings during ground shaking.

II. OBJECTIVE OF THE STUDY

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. However there is little work carried out by researcher related to finding vulnerability of RCC building with soft storey at different levels in multi-storey building. In this paper the seismic vulnerability of building is shown with an Example of G+24 building with soft storey at intermediate floor using linear static analysis. Analysis and design would be carried out on a RCC moment resisting framed tall building without Infill wall on different floors with the help of Software ETABS 2015. The main objectives of the study are,

- Study on effect of infill walls on building.
- Study the behaviour of reinforced concrete framed multi-storey buildings with soft storey at different levels.
- Study about the variation in the reinforcement by providing the soft storey in multi-storey buildings

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- Finding out the safety and minimum damage level of high rise buildings with soft storeys.

III. METHODOLOGY

The modelling is done with the software ETABS 2015. The details of building are shown below.

Table 1 Properties of the building selected for the study

Type of building	Symmetrical office building
Location of building	Calicut
Number of floors	G+24 floors
Height of the building	100m
Plan dimensions	30 X 18m
Typical storey height	4m

Table 2 Material properties of the building

Grade of concrete	M 30
Grade of steel	Fe 415
Density of concrete	25kN/m ³
Poisson's ratio for concrete	0.2
Density of brick wall	20kN/m ³
Poisson's ratio for brick wall	0.15

Table 3 Sectional properties of the building

Size of beams	Beam 1	300 X 300mm
	Beam 2	300 X 450mm
Size of columns	Column 1	300 X 300mm
	Column 2	450 X 750mm
Thickness of slab		150mm
Thickness of brick wall		230mm
Thickness of shear wall		200mm

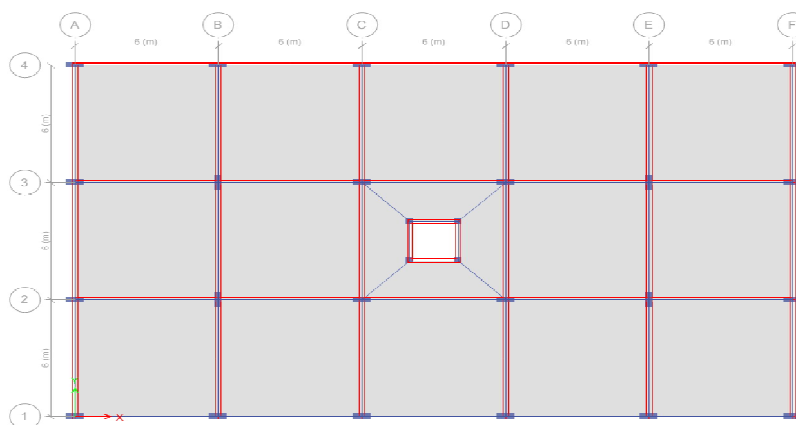


Fig. 1 Plan of the building

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Models Considered for the Study

Reinforced concrete building with

- Soft storey at Ground floor level
- Soft storey at 6th floor level
- Soft storey at 12th floor level
- Soft storey at 18th floor level
- Soft storey at 24th floor level

Assigned Loads on the Building

The dead loads, live loads, wind load and earth quake forces are assigned on the building as per Indian Standard codes.

Table 4 Load pattern of the building

Weight of floor finish	1kN/m ²
Imposed load intensity	5kN/m ² for typical floors 2kN/m ² for roof
Zone	III
Soil type	Medium
Response reduction factor	5
Importance factor	1
Damping of structure	5%
Basic wind speed	39m/sec

IV. RESULT AND DISCUSSION

Deflection

The fig. 2 represents the variation of deflection of storey in down ward direction of soft storey models with respect to floor level. In this graph, it is observed that for all models there is a sudden increment in deflection at soft storey floor level. The deflection value of ground soft storey building is more. There is a reduction in the deflection when the soft storey is at top order of the building. The deflection value is very less when soft storey is at top floor level.

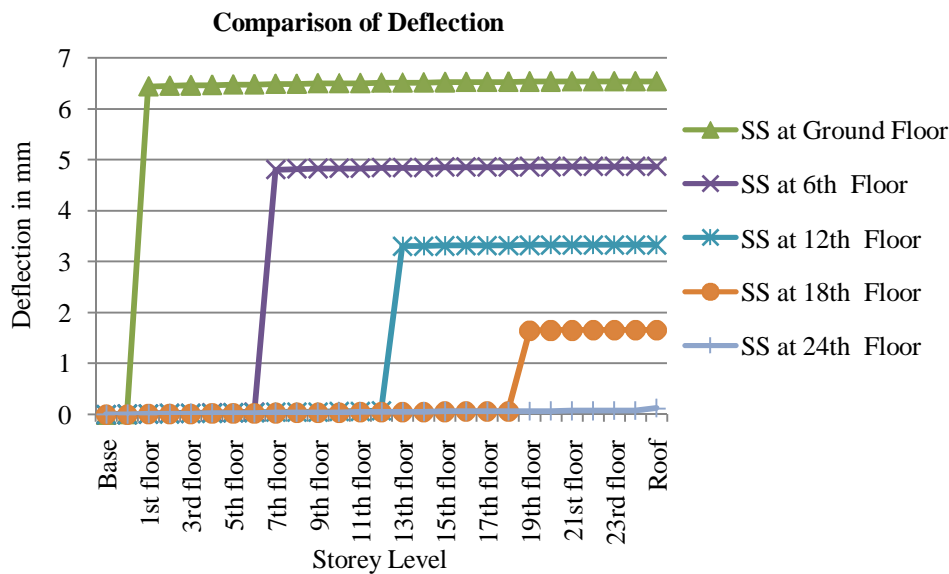


Fig. 2 Variation in deflection of storey soft storey building models at all storey levels

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Displacement

The fig. 3 represents the variation of displacement of storey in X- direction of soft storey models with respect to floor level. In this graph, it is observed that the displacement value of ground soft storey building is more. For all models there is a sudden increment in displacement at soft storey level. The displacement is varying linearly brick infilled storey. The displacement value is very less when soft storey is at top of the building.

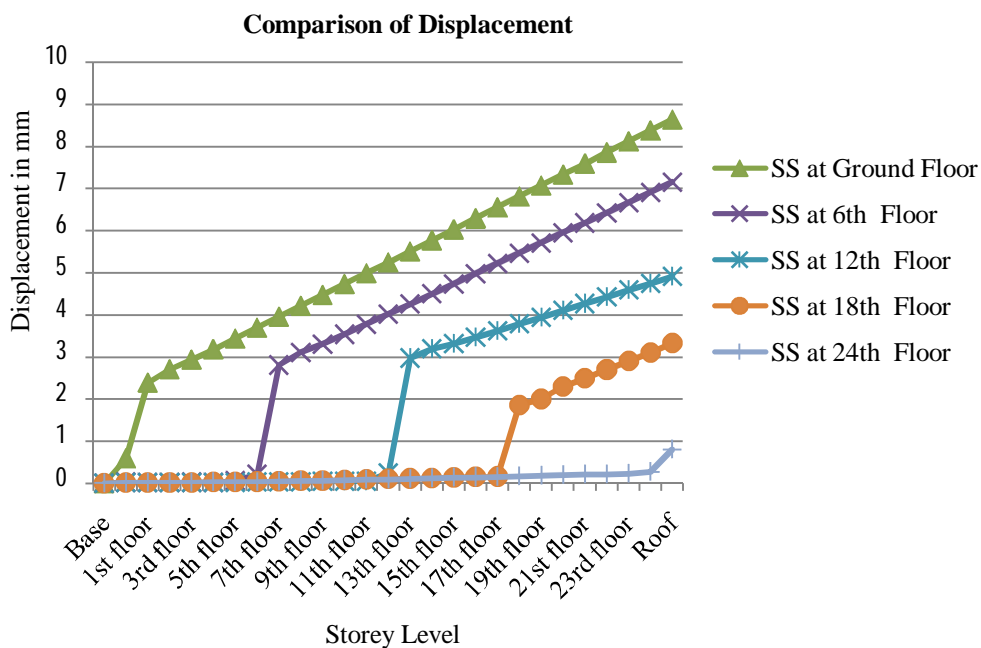


Fig. 3 Variation in displacement of storey of soft storey building models at all storey levels

Storey Drift

Story drift is the drift of one level of a multistory building relative to the level below. Lateral drift and inter-storey drift are commonly used damage parameter in structural analysis. In this study, lateral drift of the 3D building frame was analysed for earthquake load coming from long direction. Interstorey drift was also evaluated and tabulated which is given by

$$SD_i = \frac{V_{Ui} - V_{Ui-1}}{h_i}$$

Where, $V_{Ui} - V_{Ui-1}$ = Relative displacement between successive storey.
 h_i = Storey height.

The fig. 4 represents the variation of storey drift of soft storey models with respect to floor level. In this graph, it is observed that for all models there is a sudden increment in storey drift at soft storey level, it is due to absence of masonry infill the lateral load is more affect that floor. The storey drift value of soft storey at 18th floor of the building is more. The Storey drift value is very less when soft storey is at top of the building

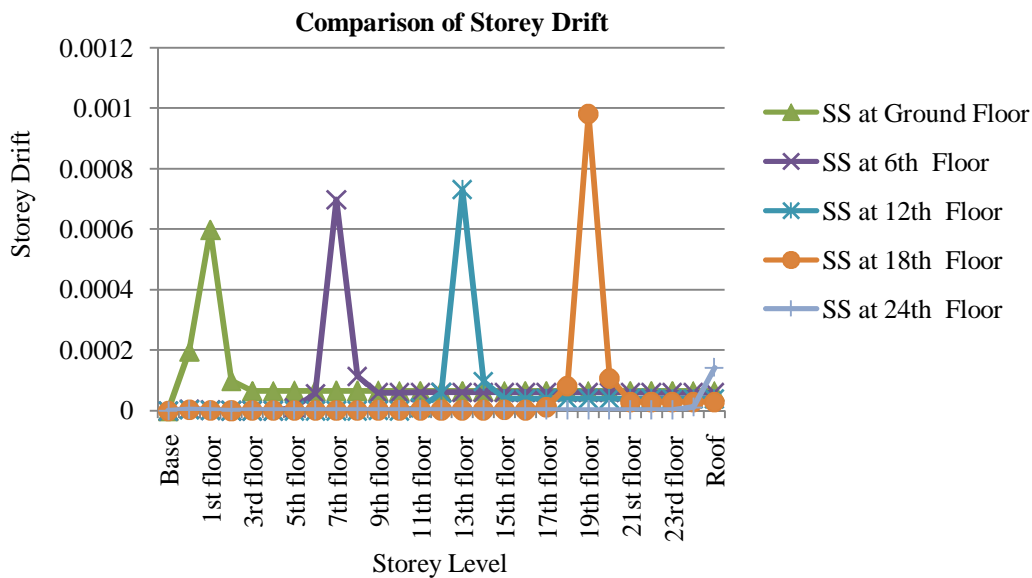


Fig. 4 Variation in storey drift of soft storey building models at all storey levels

Storey Stiffness

Stiffness is the rigidity of an object ie, the extent to which it resists deformation in response to an applied force. The fig. 5 represents the variation of storey stiffness of soft storey models with respect to floor level. In this graph, it is observed that the storey stiffness value of soft storey at 24th floor building is more. For all models there is a sudden drop in storey stiffness at soft storey level. The Storey stiffness value is very less when soft storey is at ground level.

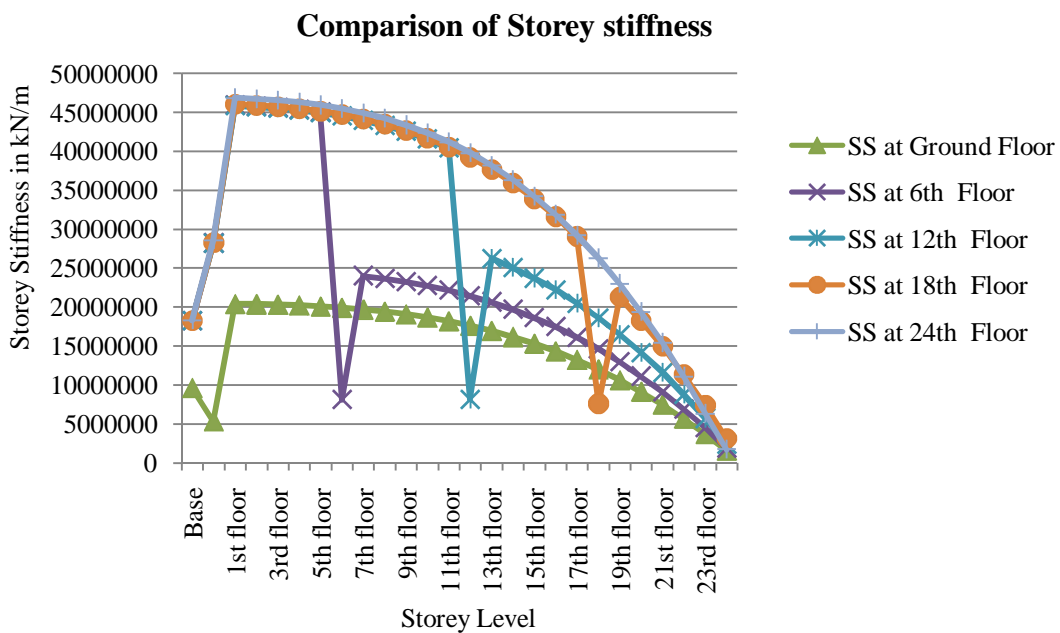


Fig. 5 Variation in stiffness of storey of soft storey building models at all storey levels

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V. CONCLUSION

Tall building of 24th storey is with soft storey at different floor levels are analysed for the load as per IS 456-2000, using finite element software package ETABS 2015. The building is located at Calicut, this location is seismic zone-III and basic wind pressure is 39m/s. These results may help to the future construction of soft storey buildings at Calicut. From this study it is clear that the effect of infill wall in the buildings.

From the result it is concluded that,

- The deflection of and displacement of storey are always maximum at soft storey level.
- There is a drop in the storey stiffness at soft storey level in all Models. From this more care is need design the columns in the soft storey.
- The infill walls increases the stability of the building.
- The results shows the soft storey column require more reinforcement.
- It is difficult to provide the more percentage of reinforcement in the intermediate storey columns. So the soft storey is suitable at bottom or top level of the building.
- The lower level soft storey columns require more percentage of reinforcement.
- It is advisable to provide soft storey at higher levels.

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