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VULNERABILITY OF SOFT STOREY BUILDING IN VARIOUS SEISMIC ZONE

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Abstract—

Behavior of building under earthquake loading is complex in nature. It depends on mass, time period, stiffness and horizontal as well as vertical configuration of structure. In past it is observed that buildings having certain vertical configuration seemed to be more prone to damage in earthquake than others, irrespective of which construction material or structural systems had been used. Irregularities in vertical configuration (Soft storey) tend to create abrupt changes in strength or stiffness that may concentrate forces in an undesirable way. So, although the size of the overall force that building must withstand is determined by the Newton's second law of motion, the way in which this is distributed and concentrated, is determined by its vertical & horizontal configuration. However, shear wall placement and location play an important role in resisting the horizontal thrust due to earthquake and wind. Present study carried on eleven storied reinforced building located at various seismic zones and parameter are considered as base shear, stiffness, time period, storey displacement, drift. For evaluating the results ETABs analysis software is used.

Keywords – Earthquake, Mass , Time period, Stiffness, Vertical configeration, Soft Storey, Shear wall location, Seismic zones, Etabs.

1. INTRODUCTION

- **Soft Storey :-**

Generally, the building in which the ground storey consists of open space for parking is called as Stilt

building and the parking storey is called as stilt Floor or Soft-Storey. When sudden change of stiffness takes place along the building height, the storey of which the drastic reduction of stiffness is observed is called a soft storey.

As per IS 1893 - 2002 (part I)

A Soft Storey is one in 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.

During recent Gujarat earthquake it was observed that most of the buildings in the cities of Bhuj and Ahmedabad, which were badly affected and collapsed, were with stilt floor. In many cases of

collapsed buildings, it was found that only the stilt floor had collapsed, whereas the upper floors were intact or only slightly affected. The stilt floors in these buildings have performed as "Soft storey" i.e., the collapse mechanism caused by effect of stilt floor having much less stiffness as compared to upper floors.

Reinforced concrete (RC) frame buildings are becoming increasingly common in urban India. Many such buildings constructed in recent times have a special feature - the ground storey is left open for the purpose of parking (Figure 1), i.e., columns in the ground storey do not have any partition walls (of either masonry or RC) between them. Such buildings are often called open ground storey buildings or buildings on stilts.

Behaviour of building under earthquake loading is complex in nature. It depends on mass, time period, stiffness and horizontal as well as vertical configuration of structure. In past it is well observed that buildings having certain vertical configuration seemed to be more prone to damage in earthquake than others, irrespective of which construction material or structural systems had been used.

- **Measures to overcome effects of soft storey**

Vertical continuity of stiffness in a building should be main objective of designer while designing the structural system of soft storey. If this is not achieved, then attempts should be made to reduce the vertical discontinuity of stiffness up to an extent so that structure should not be considered as irregular building.

Various alternative arrangement can be made to solve soft storey phenomenon at ground floor by enhancing the stiffness of ground floor to such an extent that it does not fall under criteria of soft storey.

(1) To provide shear wall in building.
(2) To provide squat shear wall in soft storey region.
(3) To provide A/V type bracing in soft storey building.

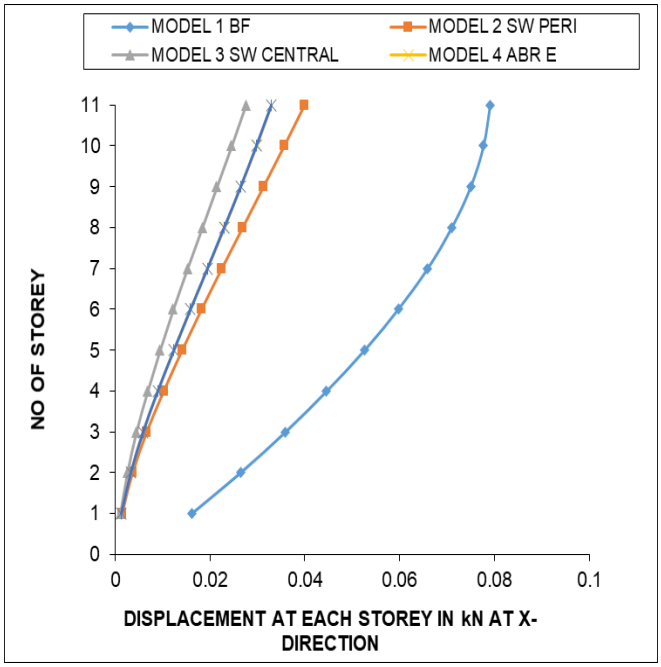
2. LITERATURE REVIEW

- A.G. Galimath (2015): presented a paper of "ANALYTICAL REVIEW OF SOFT STORY". (vol. 2; ISSUE 6 | SEPT 2015.) The author is state's that the R.C. Frame buildings with open bottom storey are known to perform poorly during in strong earthquake shaking thus, it is cleared at such buildings will exhibit poor performance during strong shaking. The hazardous features of Indian R. C. Frame buildings needs to be recognise immediately necessary measures taken to improve the performance of buildings.
- Shivani Pyasi, Nita Rajvaidya (2015) presented "Seismic Analysis of Unsymmetrical (G+10) Multi-storey at Varying Floors in Medium Soil. (Vol 2; ISSUE-7 | OCT 2015). The main objective of this paper is to investigate the effective building frame with soft storey at varying floors to withstand under diff. Seismic zones. In this work G+10 storey is considered with all four zones under five cases of varying soft storey positions with soil conditions is medium.
- Vipin v. Halde, Aditi H. Deshmukh (2015) presented Review On Behaviour of Soft Storey in Building. (Vol 2; ISSUE-7 | OCT 2015). He state's The behaviour of soft storey is different during a quake, the structural member undergoes damage and to provide member to withstand that additional forces due to soft storey heavy or bulky member need to be provided.
- Pankaj Agarwal, S.K. Thakkar and R. H. Dubey (Paper No. 424, volume 3rd, No. 3, Sep 2002): Presented paper of Seismic Performance of Reinforced Concrete Building During Bhuj Earthquake of Jan. 26, 2001.
- Dr. Sudhir K Jain: Explanatory Examples On Indian Seismic Code IS 1893(Part -1). (DOC. NO. IITK-GSDMA EQ-21, V-2.). He presents problem statements of earthquake design of buildings.

3. PROBLEM STATEMENT

In order to investigate the behaviour of the building structures several three dimensional analytical models are considered in this study. All models are subjected to lateral loads during seismicity in that region and analysed with response spectrum method of analysis using ETABS. Plan dimensions of building frames were 15.00m X 25.00 m. The inter-storey height of the structure is 3.5 m. The grade of concrete M25 and steel Fe 500 is used.

Frame dimension (Based on preliminary design) column size 350x650mm, beam size 230x450mm.Shear wall is modeled as quadrilateral shell elements uniform thickness 230mm meshing is done for shear walls in the 10x10 elements for the distribution of forces. Slab is modeled as plate element of thickness 200 mm (rigid diaphragm). Loads on the structure is self-weight of



frame (beam. columns, slabs), and live load of 3 kN/m^2 is considered for analysis of the frame.

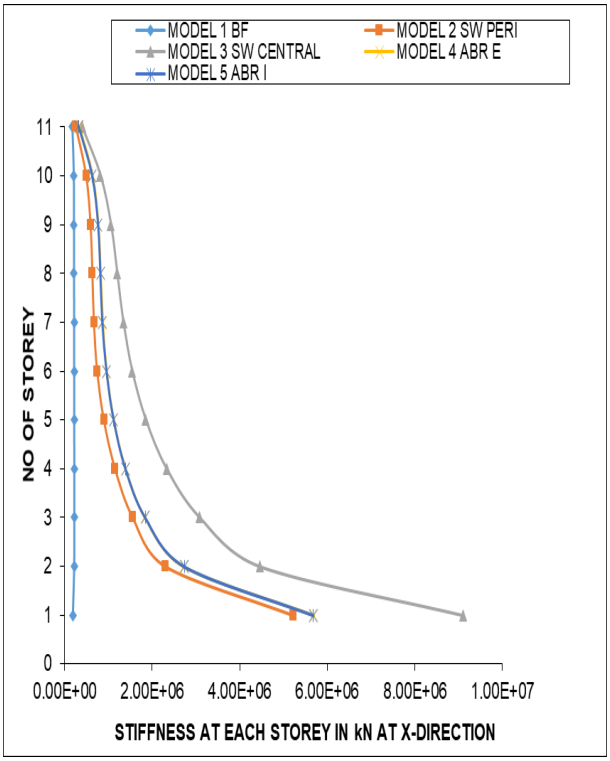
The structure is analysed for the seismic loads and load combinations as per the Indian standards, IS: 1893 (Part I)-2002, for seismic zone V, importance factor 1, soil type II, live load 3kN/m^2. Full dead load (self-weight) and 25% of live (Imposed) load constitute the seismic weight.

4. RESULTS AND DISCUSSION

From the graph it is observed that, when shear wall and Bracings added to bare frame model the displacement along X direction and Y direction , then the storey displacement is minimum in both directions

However, it has been observed that, the storey displacement is dependent upon the placement of shear wall and bracings, when shear walls and bracings are equally placed (i.e. 50-50%) in both directions, then the storey displacements are less and nearly same in X and Y directions.

If shear walls are placed very close to the C.G of the structure then the displacements are minimum and vice-



versa when shear walls are placed away from the C.G of the structure, then the displacements are observed maximum in both directions.

Table 4.5 Displacement along X-direction.

STOREY	M1	M2	M3	M4	M5
STORY11	0.0791	0.04	0.0275	0.033	0.033
STORY10	0.0777	0.0357	0.0245	0.0299	0.0298
STORY9	0.075	0.0313	0.0214	0.0265	0.0265
STORY8	0.071	0.0269	0.0183	0.0231	0.023
STORY7	0.0659	0.0225	0.0152	0.0195	0.0195
STORY6	0.0597	0.0182	0.0122	0.0159	0.0159
STORY5	0.0526	0.0141	0.0094	0.0124	0.0124
STORY4	0.0446	0.0102	0.0068	0.009	0.009
STORY3	0.0359	0.0066	0.0044	0.0059	0.0059
STORY2	0.0264	0.0036	0.0025	0.0033	0.0033
STORY1	0.0161	0.0014	0.001	0.0013	0.0013

From the above graph it is observed that, when shear wall and Bracings added to bare frame model the displacement along X direction and Y direction, then the Storey displacement is minimum in both directions However, it has been observed that, the storey displacement is dependent upon the placement of shear wall and bracings, when shear walls and bracings are equally placed (i.e. 50-50%) in both directions, then the storey displacements are less and nearly same in X and Y directions.

If shear walls are placed very close to the C.G of the structure then the displacements are minimum and vice-versa when shear walls are placed away from the C.G of the structure, then the displacements are observed maximum in both directions.

5. CONCLUSION

5.1 General

The present work is carried out with objective of evaluating the seismic behavior of various buildings having rectangular shape in plan and G+10 storey building considered for all cases. The seismic behaviour of these various cases has been assessed in the form of seismic parameters such as storey shear, displacement, drift, base shear, stiffness and natural period etc.

5.2 Scope for Future Studies

The torsion behaviour is very critical in the inelastic range of the materials generally under severe seismic loading. Structure undergoes yielding; the response of the structure also plays an important role in earthquake resistant design of structures. Inelastic seismic analysis procedures like, static pushover analysis and inelastic time history analysis can be performed to understand the actual behaviour and collapse mechanism of the structure.

- Shear walls for high rise buildings are very much effective as they minimize deflections, torsion and bending moment which are more in such buildings. Therefore, shear walls for 11-storey and above buildings can be studied in detail.

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