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Effect of Soft Storey on Multi-storey Building.

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ABSTRACT

In the present work study is carried out for the behaviour of G+10 storied R.C buildings with Rectangular shaped plan of soft storey at different levels. Floor height provided as 3.4m and also properties are defined for the irregular R.C building modelled in STAAD. Pro V8i software. Here twelve models are created in which soft storey is provided at ground, fifth and eleventh storey in all four seismic zones. From result it is found that location of Soft storey effects seismic behaviour of building in every zone from low to high seismicity. As the location of soft storey goes upper it gives more stable structure compared to soft storey at ground level. Soft storey at top level of structure is more stable than soft storey at middle part of structure. Soft storey at top level gives lower values of displacement in all seismic zones. Soft storey at upper floor level gives lowest values of Axial forces and bending moment in low and moderate seismic zone, while gives a slightly higher values of moments in severe and very severe seismic zones compared to soft storey located at middle floor level.

Keywords: Soft Storey, Multi-Storey, Staad-Prov8i, Storey Drift, Lateral Load, Shear Force, Storey Displacement, G+10, Seismic Zones.

1. INTRODUCTION

1.1 General

Many buildings structure having parking or commercial areas in their first stories, suffered major structural damages and collapsed in the recent earthquakes. Large open areas with less infill and exterior walls and higher floor levels at the ground level result in soft stories and hence damage. In such buildings, the stiffness of the lateral load resisting systems at those stories is quite less than the stories above or below. During an earthquake, if abnormal inter-story drifts between adjacent stories occur, the lateral forces cannot be well distributed along the height of the structure. This situation causes the lateral forces to concentrate on the storey (or stories) having large displacement(s). In addition, if the local ductility demands are not met in the design of such a building structure for that storey and the inter-storey drifts are not limited, a local failure mechanism or, even worse, a storey failure mechanism, which may lead to the collapse of the system, may be formed due to the high level of load deformation (P-Δ). If the P-Δ impact is considered to be the primary purpose for the dynamic fall apart of building structures throughout earthquakes, as it should be determined lateral displacements calculated inside the elastic design process can also offer very critical information approximately the structural behaviour of the device codes outline smooth storey irregularity by stiffness contrast of adjoining floors, displacement primarily based criteria for such irregularity determination is greater green, distribution concepts optimum solution where size, cost, effectiveness every aspect counts.

A simple understanding of soft storey is sudden change of lateral storey stiffness within the structure. An irregularity in vertical configuration tends to create sudden changes in strength or stiffness that may concentrate earthquake forces or other forces in an undesirable way. These can be very difficult to deal with even in a modern structure 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 the configuration of building in horizontal and vertical direction. The overall forces are concentrated at one or few points of the buildings such as a particular set of beams, columns, or walls. These few members may fail and, by chain reaction, bring down the whole building. The most serious condition of vertical irregularity is that of the soft storey. Such design creates a major stress concentration at that location of discontinuity of lateral storey stiffness and, in Extreme circumstance may lead to collapse unless adequate Design is provided at such locations.

1.2 Types of Irregularities

1) Plan Irregularity of the building: this type of irregularity is concerned with the cover area of the building. L-shape, Plus-shape, U-Shape, O-shape is the most common irregular structures plan wise. The building is said to be irregular if the two adjacent sides are not orthogonal to each other.

2) Vertical irregularity of the building: Stiffness irregularity, mass irregularity, vertical geometric irregularity etc comes under vertical irregularity of the building. This is more common than plan irregularity.

1.3 Location of soft storey

In the multi storey building the soft storey can be formed at any level to serve various purposes and to fulfil required function necessity, due to various needs a soft storey is also unavoidable and thus it becomes very important to study the performance of a soft storey building and study its effect. Generally in a structure the weak or soft storey is provided at the ground storey level but open storey can be provided at any other floor level.

1.4 Aim of Work

In this thesis we are concentrating on finding the best place for soft storey in Multi-storey Residential Building Using Staad Pro.

1.5 Objectives of Work

1. Focus on the behaviour of RC frame buildings with, soft storey at lower location, second soft storey at middle location, and third soft storey at upper location in seismic zones II, III, IV, and zone V.
2. To study the effect of storey drifts, lateral displacement and base shear in the seismic zones II, III, IV and zone V with soft storey at different levels of buildings.
3. To check the applicability of the multiplication factor of 2.5 as given in the Indian Standard IS 1893:2002 soft storey at different levels of building in zones II, III, IV& zone V.
4. To analyze the RC frame for dynamic analysis in relation to the storey drift and lateral displacements, base shear using software Staad Pro.
5. To promote safety without too much changing the constructional practice of reinforced concrete structures

1.6 Nomenclature

Model Description	Label
Soft Storey at ground floor in Zone-II	S1
Soft Storey at fifth floor in Zone-II	S2
Soft Storey at eleventh floor in Zone-II	S3
Soft Storey at ground floor in Zone-III	S4
Soft Storey at fifth floor in Zone-III	S5
Soft Storey at eleventh floor in Zone-III	S6
Soft Storey at ground floor in Zone-IV	S7
Soft Storey at fifth floor in Zone-IV	S8
Soft Storey at eleventh floor in Zone-IV	S9
Soft Storey at ground floor in Zone-V	S10
Soft Storey at fifth floor in Zone-V	S11
Soft Storey at eleventh floor in Zone-V	S12

1.7 Material Content

Material	Concrete	Steel
Grade	M 40	Fe 500
Mass Density	2549.3	7849
Unit Weight	25	76.97
Modulus of Elasticity	25,000,000	20,000,000
Poisson's Ratio	0.15	0.3

1.8 Building Parameters

Parameter	Value
Live load	3 KN/m2
Live load at upper soft storey's	5 KN/m2
Density of concrete	25 KN/m3
Thickness of slab	125 mm
Depth of beam	380 mm
Width of beam	230 mm
Dimension of column	300 x 450 mm
Thickness of outside wall	230 mm
Thickness of Parapet wall (1m)	100 mm
Height of floor	3.40 m

Earthquake zone	II/III/IV/V
Damping ratio	5%
Type of soil	II
Type of structure	Special moment resisting frame
Response reduction factor	5
Importance factor	1.5
Roof treatment	1 KN/m2
Floor finishing	1 KN/m2
Number of Storey's	11 (G+10)
Depth of Foundation	1.50 m

1.9 Plan

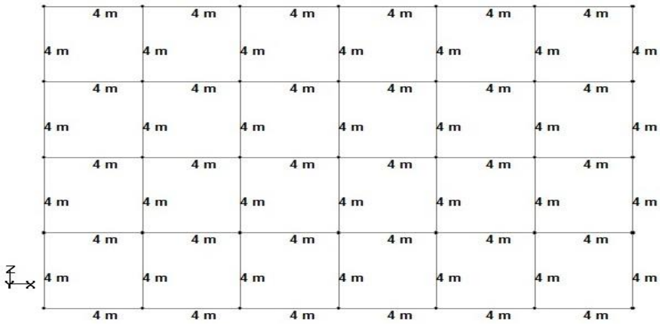

Fig. 1 : Plan

2. RESULTS

2.1 Graphical result comparison For Axial forces, Max Moment and displacement for soft storey at same levels in different seismic zones in structure.

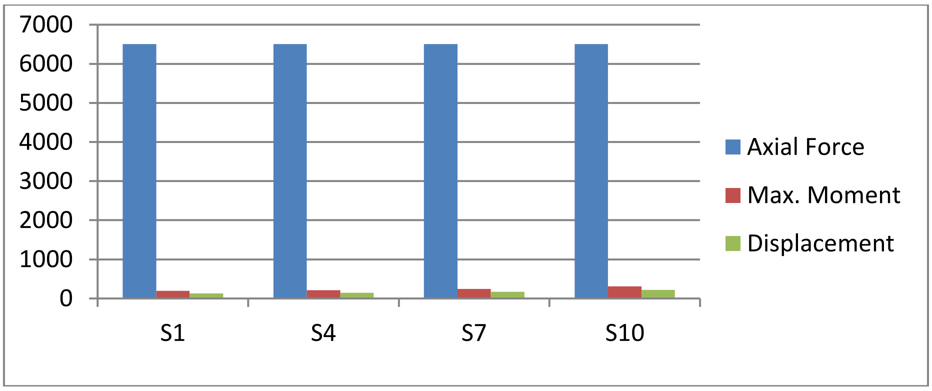

Chart 2.1.1 : Comparison of Axial forces, Max. Moment, Max. Displacement for model S1,S4,S7,S10

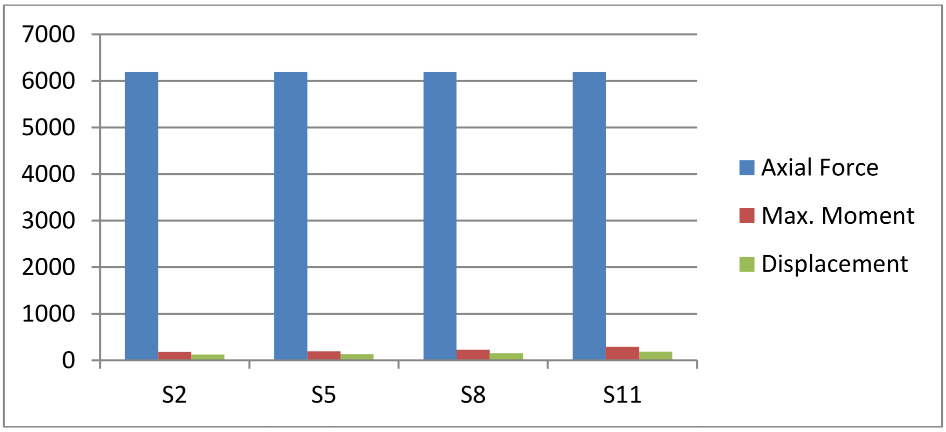

Chart 2.1.2 Comparison of Axial forces, Max. Moment, Max. Displacement for model S2, S5, S8, S11

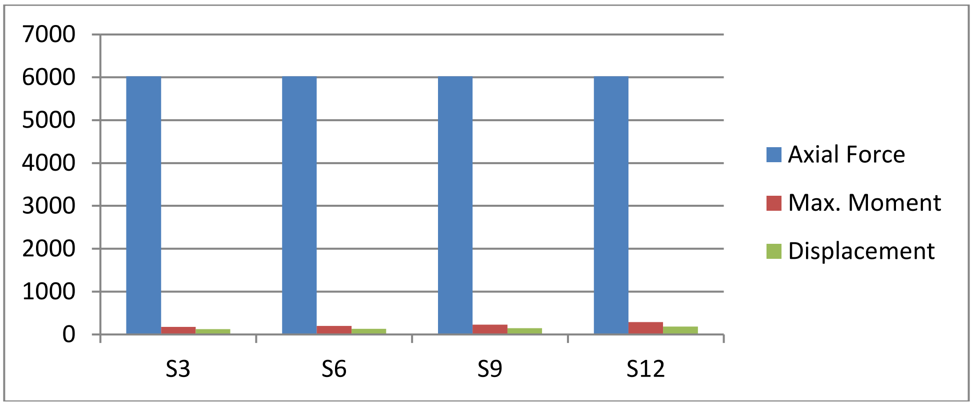

Chart 2.1.3 : Comparison of Axial forces, Max. Moment, Max. Displacement for model S3, S6, S9, S12

2.2 Comparison of base shear distribution of soft storey at same level in different seismic zones

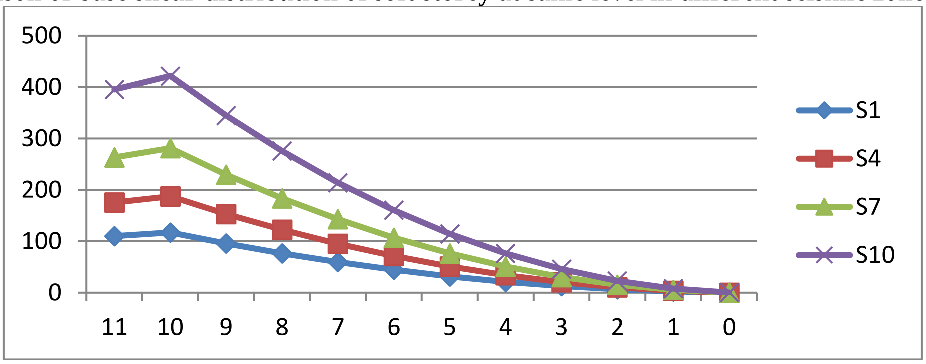

Chart 2.2.1 : Comparison of Storey shear distribution for model S1, S4, S7, S10

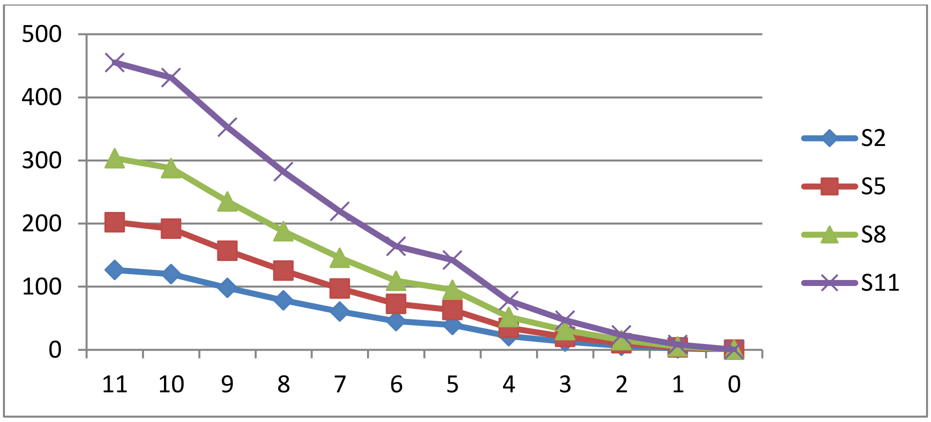

Chart 2.2.2 : Comparison of Storey shear distribution for model S2, S5, S8, S11

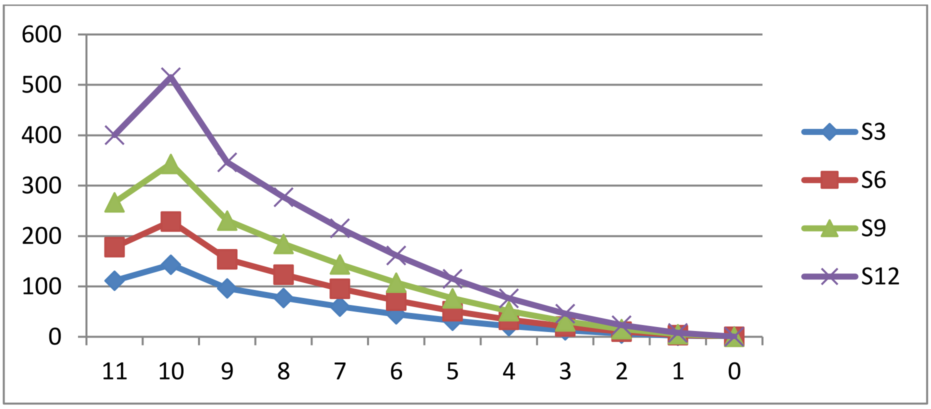

Chart 2.2.3 : Comparison of Storey shear distribution for model S3, S6, S9, S12

2.3 Comparison for Storey Drift of soft storey at same location and different seismic zone.

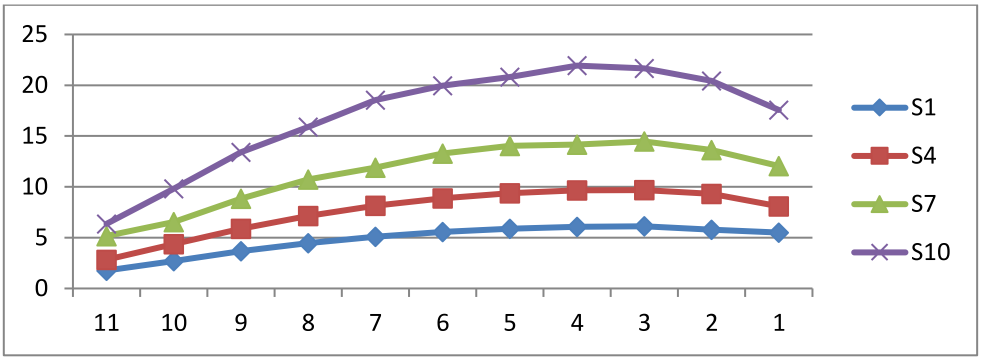

Chart 2.3.1 : Storey displacement Comparison for model S1, S4, S7, S10

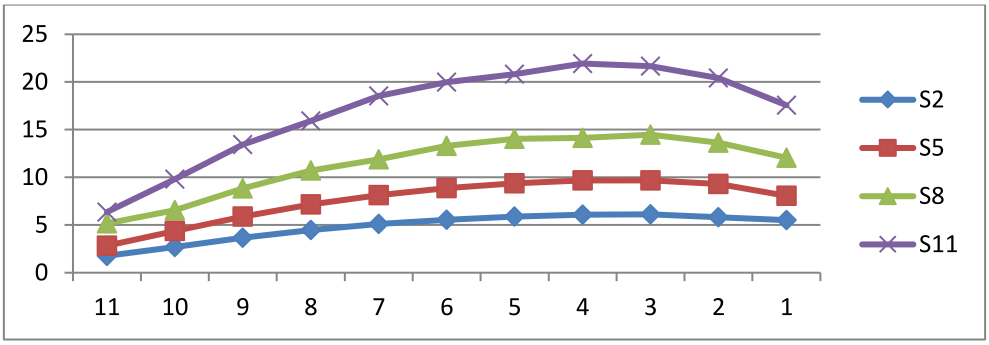

Chart 2.3.2 : Storey displacement Comparison for model S2, S5, S8, S11

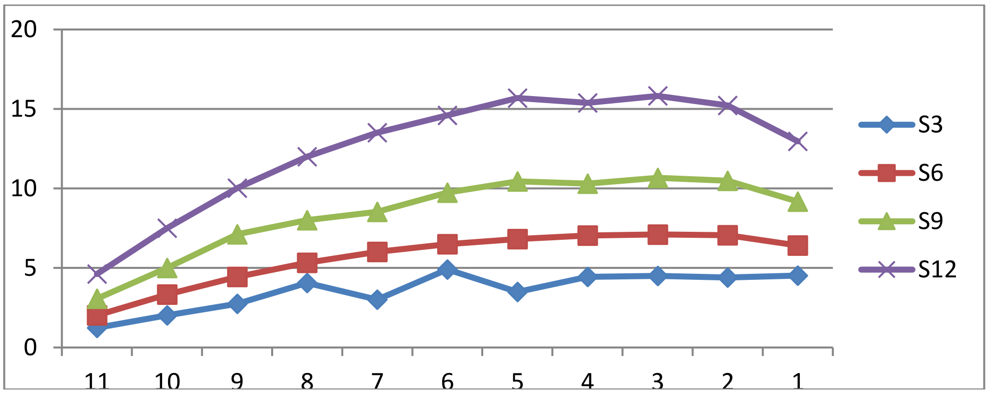

Chart 2.3.3 : Storey displacement Comparison for model S3, S6, S9, S12

2.4 Reinforcement Comparison

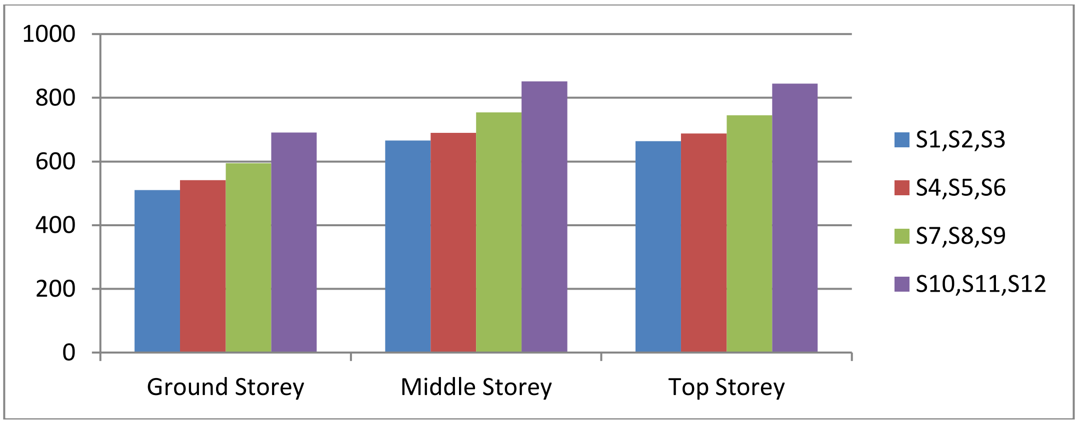

Chart 2.4.1 : Reinforcement Comparison for all models

3. DISCUSSION

1. It is examined in detail from the chart 2.2.1 to 2.2.3 that, the storey shear increases with the increase in the level of soft storey which will eventually increase the reinforcement in the structure.
2. Based on the chart 2.1.1 to 2.1.3 it is extensively discussed that, the maximum bending moment decreases with increase in the height of soft storey eliminating the possibility of toppling over of the structure.
3. It was noteworthy that, the displacement recorded is reduced with the decreased in maximum bending moment.
4. It is recorded that, the maximum bending moment reduces with increase in the zone from lower to higher.
5. It can be highlighted from chart 2.3.1 to 2.3.3 that with the increase in zone in ascending order, the storey drift falls off.
6. Chart 2.4.1 of the reinforcement comparison emphasizes that the reinforcement requirement in middle storey is maximum as compared to the ground storey and top storey.

4. CONCLUSION

Based on various model analysis and their result comparison following conclusions were drawn

1. Storey shear increases as the level of soft storey changes from lower to higher.
2. Bending moment in the structure decreases as the soft storey moves from lower location to higher location.
3. The displacement in the structure decreases with the variation in the zone in increasing order of the structure with the decrease in the bending moments.
4. Storey drift decreases as the location of soft storey in the structure changes from bottom upwards.
5. Storey drift increases with the change in location of structure with respect to the change in zone from lower to higher.
6. The stability of structure is more at the top than the soft storey at the middle of the structure.
7. The reinforcement requirement for soft storey at middle of the structure is maximum as compared to the soft storey at ground floor and top floor.

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