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"Dynamic analysis of high rise building with soft storey."

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Abstract - *Using analysis tools, the impact of soft storeys in high rise structures was examined in the current research project. It has been done to analyze high rise buildings for specific dimensions. At various levels, soft storeys were offered, and the effects of those soft storeys were examined using dynamic analysis.*

Key Words: **soft storey, high rise building, dynamic analysis.**

1.INTRODUCTION

One level of a building is referred to as a "soft-story" if it is much more flexible or weaker in its ability to resist lateral loads than the stories above it, the floors below it, or the foundation itself. Today, soft stories are used in multi-story buildings to accommodate parking, which is a necessary element. Along with parking, the ground floor is maintained open for societal and practical requirements such a shop, reception area, spacious meeting room, and banking hall. The frequency of offering these functionalities has been rising daily. Even though multistory structures with soft storey floors are prone to collapsing after an earthquake, their construction is nonetheless common. Recent earthquakes that caused severe structural damage to some modern structures highlight the need of preventing abrupt changes in lateral stiffness and strength. While soft story damage and collapse are most frequently seen in buildings, they may also occur in other kinds of structures. These types of structures performed poorly during previous earthquakes, and the damages were similarly significant. During an earthquake, this open-air level is susceptible to collapsing. Stiffness and irregularity in a structure are brought on by soft storey in a building. Due to this, the constructions experience uneven storey drift, plastic hinge creation, and ultimately collapse. The functional and social necessity to provide office space in open stories at different levels of the tower, as well as parking spaces, vastly outweighs the technical community's caution against such structures.

Soft floors are offered at various levels and on several storeys to satisfy the demands of offering various types of structures at once in high-rise buildings. As a result, when providing this type of construction at a storey above the ground level, that storey is referred to as a soft story. Studying the structure's behavior while adding more soft storeys is also crucial. Studying the seismic performance of high-rise buildings is crucial since it entails analyzing the structure's architecture in the event of an earthquake and doing seismic analysis to gauge displacement and story drift.

In the current study, we have taken into account more than one floor as a soft storey as well as the intermediate storey. Models are developed based on several soft story locations. All models undergo dynamic analysis with the use of ETABS 18, and the outcomes for storey drift, displacements, time history, and base shear are compared.

AIM & OBJECTIVE

This study aims to analyse the behavior of soft storey in high rise structures with dynamic analysis.

This proposed paper is focused on

1. To analyse the behavior of structure with soft storey in high rise building.

2. To work out the comparison of high-rise buildings with soft storeys using static and dynamic analysis.

3. To find out the location of soft storey in high rise building using dynamic analysis.

4. To prepare the dimensionless charts of proposed work for considered cases.

2. LITERATURE REVIEW

Amin, M. R., P. Hasan, and B. K. M. A. Islam. (2011) [1] had investigated the impact of soft storey for a reinforced concrete, multi-story building structure. As recommended in FEMA-273, similar diagonal struts were supplied in their work in place of brickwork to create an infill impression. For each model, the soft story level was changed from the ground floor to the top floor, and an analogous static analysis was performed. According to this study, the inter-storey drift ratio increased below the mid-story level, reaching its greatest value where the soft storey was situated. For varying building heights, the rate of rise in drift ratio increases linearly from the bottom to the top level for any given floor (maintained soft). From their research, they came to the conclusion that the placement of the soft storey shifts downhill from mid-story as the building height grows.

F. Hejazi, S. Jilani, J. Noorzaei, C. Y. Chieng, M. S. Jaafar, A. A. Abang Ali (2011) [2] investigated adding bracing in various configurations to the structure to lessen the impact of soft stories on a building's seismic response. It was discovered that a key influence in the displacement of soft story buildings during earthquakes is the location and numbering of the bracing. A building's strength was deemed to be extremely weak and susceptible to failure after an earthquake if it lacked any lateral load resisting elements, such as bracing or shear walls. It was demonstrated that the application of bracing significantly decreased the impact of soft stories on structural response to seismic excitation.

Devendra Dohare, Dr. Savita Maru (2014) [3] were made to investigate the seismic response of soft story buildings with various arrangements under static and dynamic earthquake stress. According to calculations, base shear in RC-framed buildings with brick masonry infill on the upper floors and soft ground floors that are subjected to earthquake loading can be more than twice what is predicted by the equivalent earthquake force method with or without infill or even by the response spectrum method when there is no infill in the analysis model.

Sultan, Mohammed Rizwan, and D. Gouse Peera (2015) [4] studied, a 15-story skyscraper in four completely distinct shapes—a rectangle, an L, an H, and a C—is utilized as a comparison. In this work, comparative dynamic analysis has been examined for each of the four situations to assess the structure's deformation. Buildings with significant irregularities have been shown to deform more than those with smaller irregularities, especially in strong seismic zones, and the storey overturning moment varies inversely with storey height. Compared to structures with irregular shapes, regular buildings have the largest storey base shear.

Smita, Gupta, Dr M Helen Santhi (2015) [5] had concentrated on the comparison of a soft-storey building's time history with and without a lead rubber isolator. The soft-storey building with and without isolator is evaluated using Elcentro seismic data and the dynamic features were compared since the base isolation is a strategy created to avoid or reduce damage to buildings during an earthquake. The reduction in the basic time period, base shear, and base moment showed that employing lead rubber isolators under the base of buildings might lessen the damage to buildings caused by earthquakes.

Mohd Jamaluddin, Danish (2017) [6] A fifteen story building's 3D analytical model was constructed. Eleven distinct building types, each with 15 stories. All significant elements that affect the strength, stiffness, mass, and deformability of the structure are included in the building's analytical model. In an effort to better understand how buildings with an open ground floor and an intermediary soft level with floating columns operate in seismically active places. By using the equivalent static analysis (ESA) and response spectrum analysis (RSA) methods, the fundamental time period, base shear, storey displacement, and storey drift were determined for all models and compared. This study demonstrated that the inclusion of floating columns in the upper storeys reduces storey drift due to an increase in stiffness. It was found that adding any kind of shear wall reduced storey movement by 50%. Providing a service storey in a tall structure of smaller height was safe since the effect of soft story was lessened at intermediate locations of a building. It was determined that giving floating column was helpful on the higher floor since its impact was reduced when it was provided at the upper storey level.

B. Lalitha, P. Polu Raju et al (2017) [7] For a G+9 multistory structure, the Pushover analysis was performed in order to examine the impact of soft storey at various floor levels. When subjected to seismic stress, the behavior of RC-framed buildings with soft storeys has been studied in terms of hinge formation patterns, total lateral drift, storey shear, overturning moment, and time period for the structure under consideration. Infill walls had a considerable impact on the frame's rigidity and lateral resistance. To prevent the creation of soft storeys, infills should not be distributed unevenly. The maximum lateral drift value reduces as the soft storey moves to higher levels. To lessen the impact of soft-story in the event of unforeseen circumstances, soft storey should be installed in higher floor levels above middle floor heights. They have determined that the story's maximum lateral drift values should be restricted, and the column's stiffness should be enhanced.

Zahir, Dr. Vivek Garg et al (2017)[8] were worked onG+9 6-bay by 3-bay RC building frame situated inseismic zone V as per IS: 1893(part 1)-2002. It was analysed with and without infill masonry wall. Static and response spectrum analysis were carried out on bare and infill frame models. The results obtained from the analysis for infill frame are compared in terms of story shear, floor displacement, story drift, time period and vertical support reaction with bare frame. The results obtained from the analysis indicates that storyshear increases for infill frame models compare to bare frame model by equivalent static method and response spectrum method. According to the analogous static method's results for floor displacement and story drift, infill frames have much less displacement and drift than bare frames. By using the response spectrum approach, the time required for the infill frame is significantly reduced as compared to the bare frame. In comparison to the static technique, the vertical support reaction for the infill frame was found to be more responsive.

3. Methodology

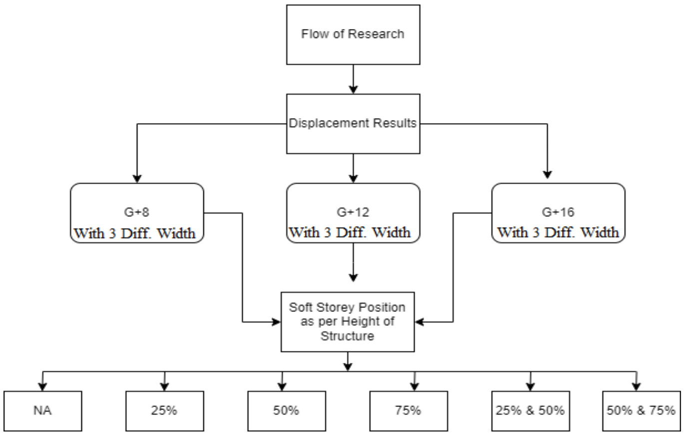


Fig. no 1: Flow of Research

In this point, the flow of Research has been given. structure which are considers shows in following table

Table no. 1: Structural Parameters Considered for thisresearch

Base Width Consideredin m	25.54
	29.37
	33.2
Height of structure	G+8
	G+12
	G+16
Size of column	300 X 650
Size of beam	300 X 500
Grade of concrete	M30
Analysis type Consideration	Static Analysis
	Dynamic Analysis

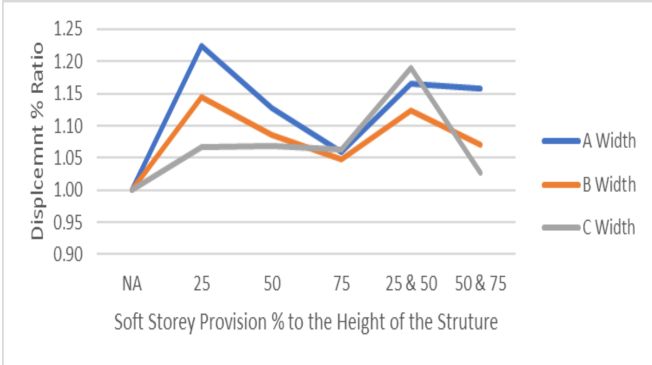
4. Results and discussion

As discussed in previous section various cases are tabulated as given in flow of research, based-on result compile displacement ratio are obtained considering building frame without soft story as reference case

The graphical representation of various casesconsidered are as follows with Static and dynamic analysis

4.1 Effect of soft storey position on Displacement with same height and varying width of the structure for Static analysis:

Following plots shows variation of Displacement % against % height position of soft storey for static analysis.



Graph no 1. Variation of displacement % against %height position of soft storey for static analysis of G+8 frame

Observations

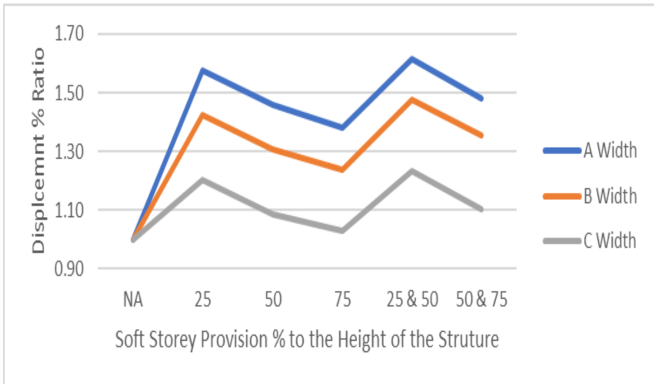
From plot 1 variation following observations are noted

1.Displacement are increasing from lower height percentage location of soft story as compared to frame without soft story.

2.Position changes from lower to upper position (indicated by percentage height) displacement are reduced compare to the soft story position at lower height.

3.It is also noted that displacement are not much differ for two different position of soft story height.

4.Displacement are partially same in case of all width for pre define position height of soft story.



Graph no 2. Variation of displacement % against %height position of soft storey for static analysis of G+12 frame

Observations

From plot 2 variation following observations are noted

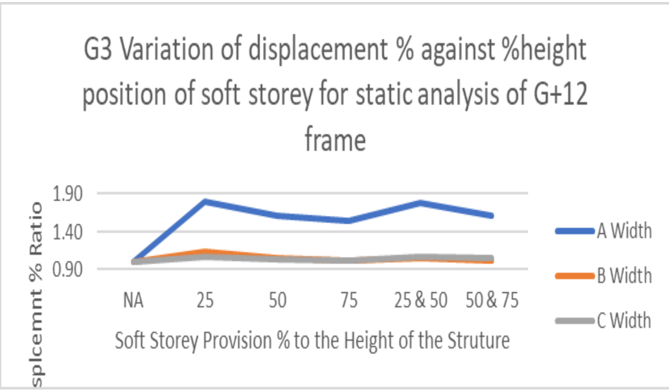
1. Displacement are increasing from lower height percentage location of soft story as compared to frame without soft story.

2.Position changes from lower to upper position (indicated by percentage height) displacement are reduced compare to the soft story position at lower height.

3.It is also noted that displacement are not much differ for two different position of soft story height as compared to lower position of soft story height.

4.Displacement are partially same manner in case of all width for pre define position height of soft story.

5.Displacement get reduced with increase in base width of the building.



Graph no 3. Variation of displacement % against %height position of soft storey for static analysis of G+12 frame

Observations

From Plot 3 variation following observations are noted

1. Displacement are increasing from lower height percentage location of soft story as compared to frame without soft story.

2.Position changes from lower to upper position (indicated by percentage height) displacement are reduced compare to the soft story position at lower height.

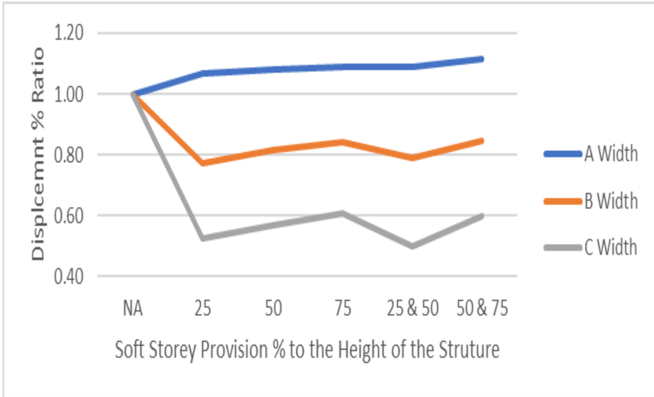
3.It is also noted that displacement are not much differ from 2 different position of soft story height as compared to lower position of soft story height.

4.In case of width consideration type A width shows higher displacement as compared to type B & C width.

5.displacement in type B & C width is seems practically same as compared to no soft story structure

4.2 Effect of soft storey position on Displacement with same height and varying width for Dynamic analysis:

Following plots shows variation of Displacement % against % height position of soft storey for Dynamic analysis



Graph no. 4 Variation of displacement % against %height position of soft storey for dynamic analysis of G+8 frame

From Plot 4 variation following observations are noted

according to variation of displacement ratio, for percentage height position of soft story with dynamic analysis, for g + 8 height of frame are as follows

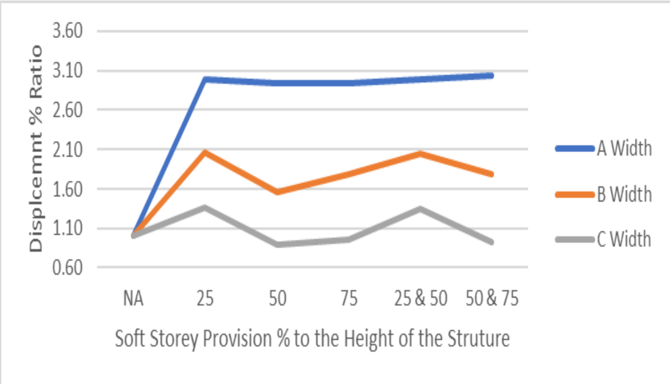
1.Maximum displacement obtained is 10% of displacement of frame without soft story

2.Displacement for lower soft story position with remains partially same for different position of soft story considered including multiple level.

3.For medium width as percentage height position increases marginal displacement reduces in dynamic analysis up to 20% compared to frame without soft story.

4.For higher width the reduction on displacement continuous up to 50% compare to frame without software.

5.The multiple levels of story combinations of 25% and 50% height position shows the better performance compared to other combination.



Graph no. 5 Variation of displacement % against %height position of soft storey for dynamic analysis of G+12 frame

From Plot 5 variation following observations are noted

according to variation of displacement ratio, for percentage height position of soft story with dynamic analysis, for g + 12 height of frame are as follows

1. G5 shows that displacement are varying according to the width of building frame, in dynamic analysis

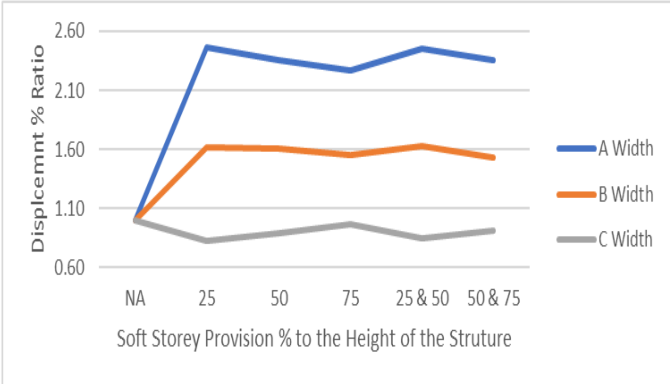
2. Maximum displacement obtained is get twice of displacement of frame without soft story

3. Displacement for lower soft story position with remains partially same for different position of soft story considered including multiple level in width type A.

4. For medium width as percentage height position increases marginal displacement reduces in dynamic analysis up to 10% compared to frame without soft story.

5. C width shows for higher width the reduction on displacement continuous up to 10% compare to frame without software.

6. Higher width with 50% and 75% height soft storey position shows the better performance compared to other combination.



Graph no. 6 Variation of displacement % against %height position of soft storey for dynamic analysis of G+16 frame

From Plot 6 variation following observations are noted

according to variation of displacement ratio, for percentage height position of soft story with dynamic analysis, for g + 16 height of frame are as follows

1.Maximum displacement obtained is 160% of displacement of frame without soft story

2.Displacement for lower soft story position with remains partially same for different position of soft story considered including multiple level in width type B.

3.For medium width as percentage height position increases marginal displacement reduces in dynamic analysis up to 10% compared to frame without soft story.

4.C width shows for higher width the reduction on displacement continuous up to 10% compare to frame without software.

5.The multiple levels of story combinations of 50% and 25%+50% height position shows the better performance compared to other combination.

4.3 Effect of soft storey position on Displacement with same width and varying height for Static analysis:

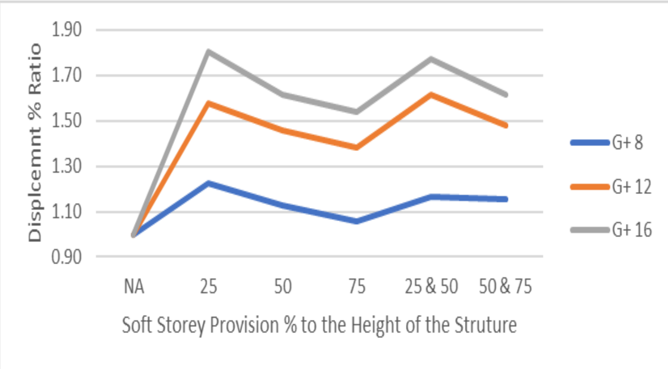
Plot 7, 8 & 9 shows the Variation of Displacement with same width and varying height for Static analysis. Following observations has been noted:

1.For lower with there is a lower displacement.

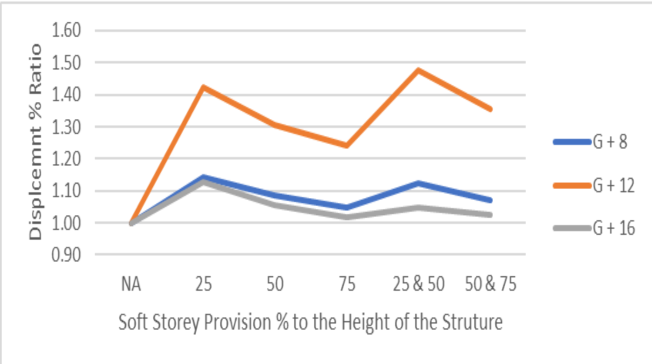
2.Lower position of soft story gives higher displacement in particular case.

3.For higher width and lower height when soft stories located at 75 percentage of height the displacement is nearly same as medium width with lower height.

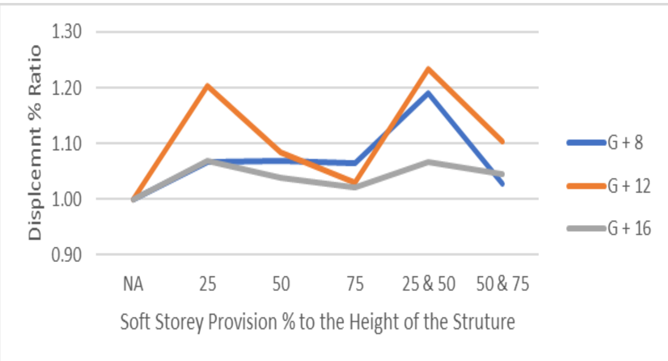
4.When soft story position is at 75% of height for higher width, as height increases the displacement induced will be nearly same.



Graph no. 7 Variation of Displacement % against % height position for Static Analysis with A type width frame



Graph no. 8 Variation of Displacement % against % height position for Static Analysis with B type width frame



Graph no. 9 Variation of Displacement % against % height position for Static Analysis with C type width frame

4.4 Effect of soft storey position on Displacement with same width and varying height for Dynamic analysis:

Plot 10, 11 & 12 shows the Variation of Displacement with same width and varying height for Dynamic analysis. Following observations has been noted:

1. For the structure with lower with and lower height the displacement seems to be equal

2. Displacements are maximum for all type of width medium height of the structure.

3. Displacements are increasing from lower height percentage location of soft story at compared to the frame without soft story for -

a. Lower width and all considered height of the structure.

b. Medium width and medium height of the structure.

c. Medium Width and Higher height of the structure

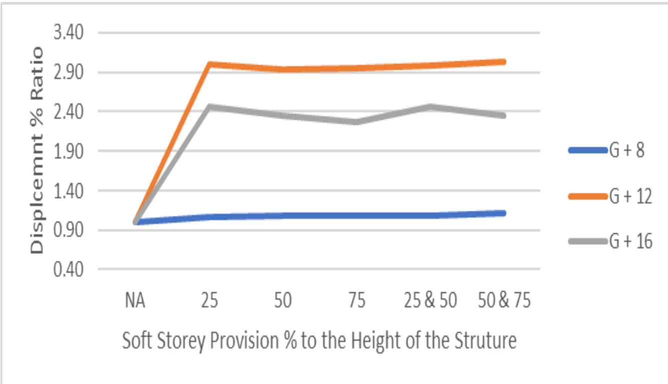
d. Higher with medium height of the structure.

4. Displacements are decreasing from lower height percentage location of story at compared to frame without story for-

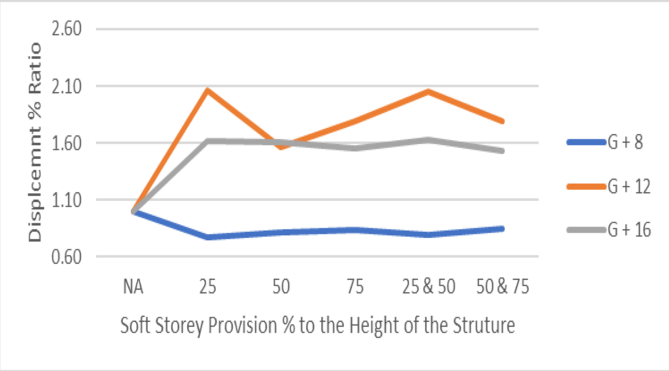
a. Medium width and lower height of the structure

b. Higher width and lower height of the structure

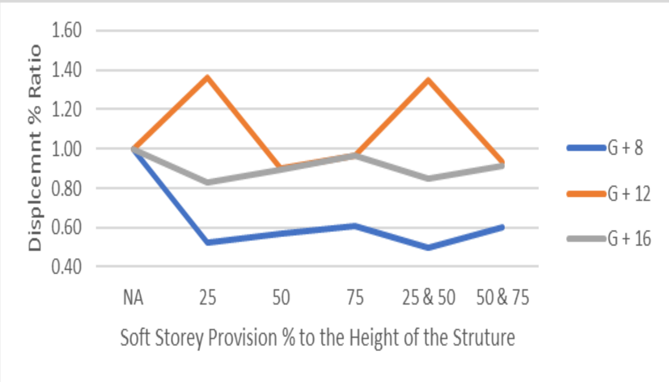
c. Higher Width and Higher height of the structure



Graph no. 10 Variation of Displacement % against % height position for Dynamic Analysis with A type width frame



Graph no. 11 Variation of Displacement % against % height position for Dynamic Analysis with B type width frame



Graph no. 12 Variation of Displacement % against % height position for Dynamic Analysis with C type width frame

5 CONCLUSIONS

Effect of soft story position on displacement

1. Maximum displacement of story reaches to 80% higher than the story without short story in static analysis and increase in maximum displacement is almost double as compared to structure without soft story

2. For position of South story at 25% height maximum displacement is observe in static and dynamic analysis.

3. 15 to 75 % reduction in maximum displacement areobserve with increase in up to 30% weight for higherheight reduction is on higher side in static

4. In dynamic analysis reduction in displacement are observed to be more than 1.6 times with increase in width up to 30%

5. In dynamic analysis it is also observed that lower height and higher weight given lowest displacement. Instatic 3% Rise is observed and dynamics 50% reduction is observed in displacement compared to structure without short story.

6. Two position of soft storing considered in the set of observation gives higher displacement compared to single position. Particularly combination with middle percentage height and higher percentage height perform better than lower percentage height and Middle percentage height.

7. Reduction in displacement are observe 2.4 in static and dynamic analysis due to combination with middleand higher height position of soft story as compared tolower and middle position of South story.

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