SEISMIC ANALYSIS OF UNSYMMETRICAL (G+10) MULTI-STOREY RC BUILDING WITH TWO SOFT STOREY AT VARYING FLOORS IN MEDIUM SOIL

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Abstract-*The behaviour of soft storey building in earthquake is very crucial because soft storey building is more flexible. Usually, the soft storey exists at the ground level, but it could be at any other level too. Since the presence of a soft storey which has less rigidity than other storeys and if this fact was not taken into consideration it causes the construction to be affected by the earthquake, because the columns in this part are forced by the earthquake more than the ones in the other parts of the building. The main objective of this work is to investigate the effective building frame with soft storey at varying floors to withstand under different seismic zones. In this work G+10 storey is considered with all 4 zones under 5 cases of varying soft storey positions with soil condition is medium in this way there are 20 problems are analysed. The results are considered under bending moment, shear force, storey displacement and axial force.*

Keywords- Soft storey, building frame, floors, seismic forces, Story displacement, shear force etc

Introduction- A building which is said to be soft storey is one which more than one floor having windows, bays, spacious area, high floor or other openings in area where a bracing, equivalent diagonal struts and shear wall would normally be required for providing stability as a matter of earthquake engineering design. A normal soft storey structure is an multi-storey building of 3 or more stories located over a ground level with large floor height, such as a parking, garage or series of commercial areas with large windows. Generally, OGS (open ground storey) buildings are called soft storey structure, even though their ground storey may be soft and weak. The soft storey buildings are designed as framed structures with or without consider to structural action of masonry infill walls.

Bhola M. Sontakke et. al. (2015) explains soft storey is one of the main reasons for building damage during an earthquake and has been mentioned in all investigation report. Soft storey due to increase storey height is well known subject. Change in amount infill walls between stories also results in soft story. These are usually not considered as a part of load bearing system. This study investigates the soft storey behaviour due to increase in storey height, lack of infills at ground floor storey and existence of both these cases by means of nonlinear static and dynamic response history analysis for midrise reinforced concrete building displacement increases, unwanted risk and sudden collapse. Soft storey behaviour due to change in storey height and or infills amount is evaluated in view of the displacement capacities, drift demand and structural behaviour.

Devendra Dohare et. al. (2014) explains soft storey is a common feature in the modern multi-storey constructions in our country. Though multi-storeyed buildings with soft storey floor are naturally at risk to collapse due to earthquake, but their construction is still widespread in the our country. Social aspect is that it provide car parking space and for offices soft stories at different level of structure far out-weighs the warning against such buildings from engineering community. With increases in civil engineering software, analysis work has been made easy and it reduced the time and tedious complex problems in analysis and design. Here in this work research has been made to study the seismic performance of soft storey building with various arrangement in soft storey building when subjected to static and dynamic seismic loading. It is observed that, providing infill improves resistant behaviour of the structure when compared to soft storey provided

Gaurav Joshi et. al. (2013) studies soft stories in a high rise building play an important role on the its seismic behaviour. At the soft storey level, there is a instability in the rigidity of the building due to short of infill walls or due to difference in floor height. In this study, seismic analyses of soft storey building frames have been carried out considering three building plans, fifteen soft storey cases and twenty load combinations. Soft stories have been created by varying the floor heights and effect of infill is ignored. So total forty five frames are analysed. Structure analysis and design software has been used for analysis purpose. Results are collected in terms of various parameter like maximum moment, maximum storey displacements, maximum shear force, maximum axial force and maximum drift, which are critically analysed.

Md Rihan Maaze et. al. (2013) analysed most of the reinforced concrete (RC) buildings are not designed to counter major or moderate seismic forces. Thus these buildings are vulnerable during the occurrence of an seismic forces. In present study bare frame and soft storey are modelled considering special and ordinary moment resisting frame (SMRF & OMRF) for medium soil profile under zone III. The masonry infill panels were modelled as equivalent diagonal strut 7 and 10 storey buildings are considered to represent medium and high rise buildings using SAP 2000 V15 software. The performance of building frames were compared with bare frame, in terms of ductility, safety, and stiffness ,this shows in high seismicity region the ductile detailing must be adopted to avoid the vulnerability of building for tremor loads.

Nikhil Agrawal et. al. (2013) present masonry infilled RC frames including soft storey buildings used in various multi structures in our country. In the present study, masonry infilled reinforced concrete (RC) frames including soft storey of with and without opening. This opening is express in terms of various percentages here, in this paper, symmetrical institutional building (G+5) located in seismic zone-III is considered by modelling of initial frame. This analysis is to be carried out on the models such as bare frame, strut frame, strut frame with 15% centre &corner opening, which is performed by using structure analysis and design software from which different parameters are computed.

Ari Wibowo, et. al (2010) observed that precast soft storey system had increases displacement in the structure for lower seismic zones, but the performance was considered marginal for higher seismic zones.

Geometry and modelling- In the present scenario, because of the wide range of geometry possible, the accumulated understanding is still limited, thus there is a need of an attempt to investigate the behavior of soft storey in building frame which will be used as general guidelines for the performance study of soft storey subjected to earthquake loading. For this study, building models of a 11 storey (G+10) are considered. The plan dimensions is 12m × 12 m and a floor height of 3 m each in all the floors and foundation depth is taken as 2.0 m.

Type of structure	Residential building (G+10)
Plan dimensions	12 m X 12 m
Soft storey height	4.5 m
Floor height	3 m
Foundation depth	2 m
Bay width in longitudinal direction	3m, 4m and 5m respectively
Bay width in transverse direction	3m, 4m and 5m respectively
Size of beams	250 mm X 450 mm
Size of columns	450 mm X 450 mm
Thickness of slab	150mm
Thickness of walls	250 mm
Seismic zone	II, III,IV and V
Soil condition	Medium
Density of brick masonry	20 kN/m^3

Table 1: Details of Structure

Following are the different cases

CASE 1 : Bare frame without soft storey
CASE 2 : Soft storey considered at 1st and 7th storey
CASE 3 : Soft storey considered at 2nd and 8th storey
CASE 4 : Soft storey considered at 3rd and 9th storey
CASE 5 : Soft storey considered at 4th and 10th storey

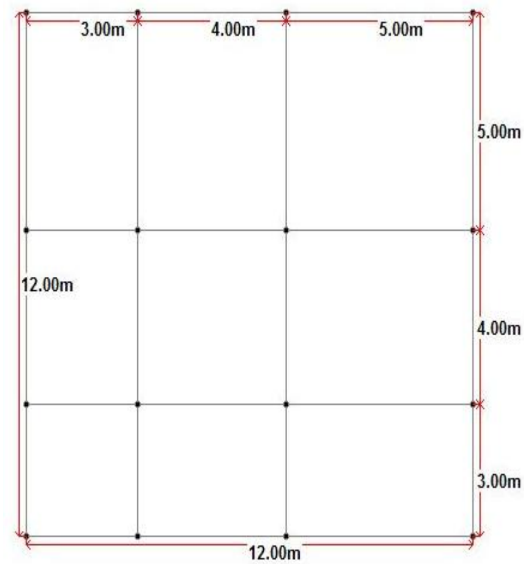

Figure 1: Plan of proposed problem

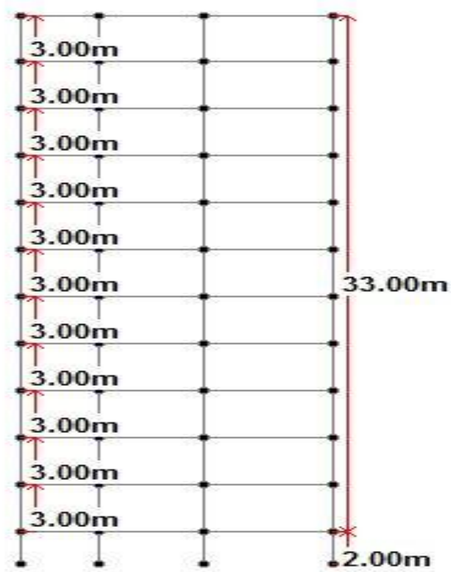

Figure 2: Elevation of proposed problem

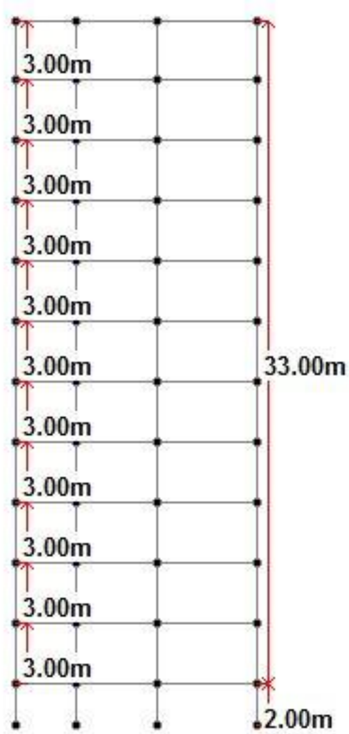

Figure 3: Front view of Case 1

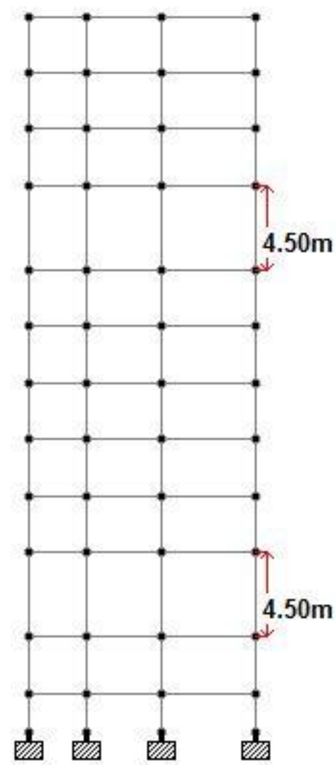

Figure 4: Front view of Case 2

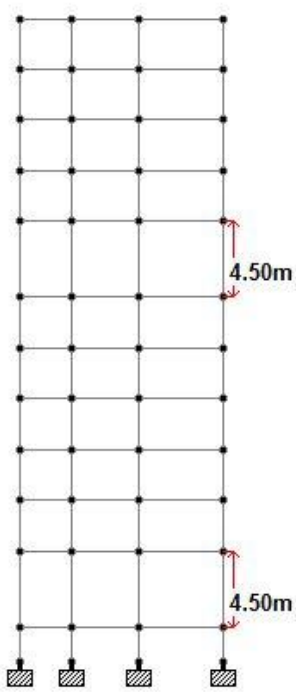

Figure 5: Front view of Case 3

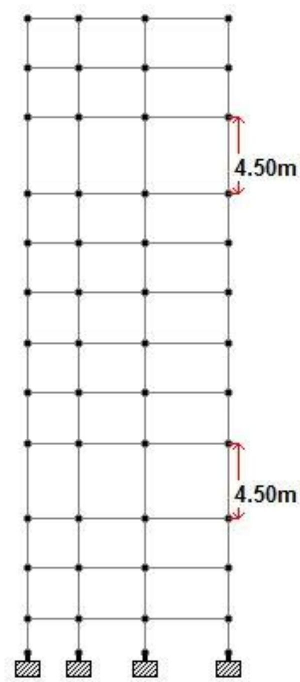

Figure 6: Front view of Case 4

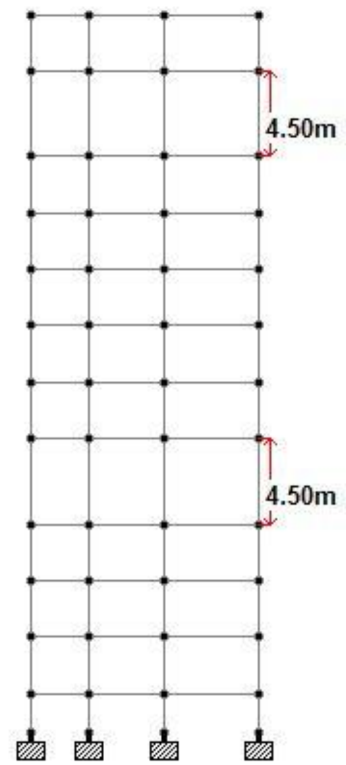

Figure 7: Front view of Case 5

RESULT AND DISCUSSION:-

1) Displacement:-

TABLE 2: Maximum displacement in different cases

Max peak story displacement in X Direction				
Model Type	Zone-II	Zone-III	Zone-IV	Zone-V
Case 1	94.787	147.242	217.181	322.089
Case 2	124.191	193.421	285.729	424.189
Case 3	95.036	146.818	215.861	319.426
Case 4	122.929	191.469	282.856	419.935
Case 5	120.718	187.942	277.575	412.025

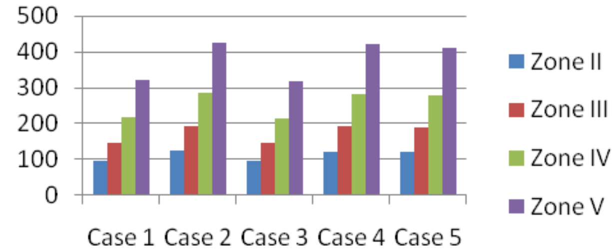

Figure.8: Maximum displacement in different cases

2) Beam Forces

2.1) Maximum Bending Moment

TABLE 3: Bending Moment (kNm) in beam

Bending Moment in beam				
Model Type	Zone-II	Zone-III	Zone-IV	Zone-V
Case 1	225.06	293.07	397.08	575.64
Case 2	258.32	334.86	486.18	714.54
Case 3	219.23	278.01	378.17	547.46
Case 4	258.41	346.43	498.31	729.68
Case 5	264.30	351.95	488.72	710.61

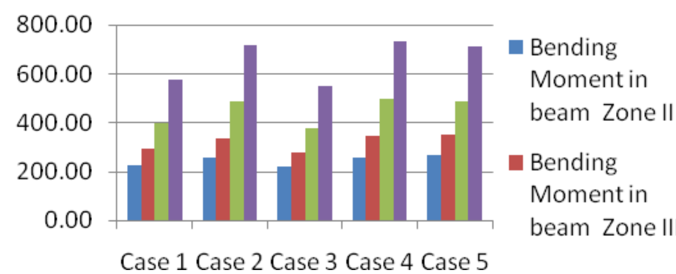

Figure 9: Bending moment (kNm) in beam

2.2) Shear Force

TABLE 4: Shear Force (kN) in beam

Shear force in beam				
Model Type	Zone-II	Zone-III	Zone-IV	Zone-V
Case 1	155.06	156.26	288.50	402.87
Case 2	179.67	264.88	341.67	484.33
Case 3	164.62	207.16	277.79	383.74
Case 4	190.04	262.33	358.72	503.32
Case 5	189.39	259.41	352.77	492.81

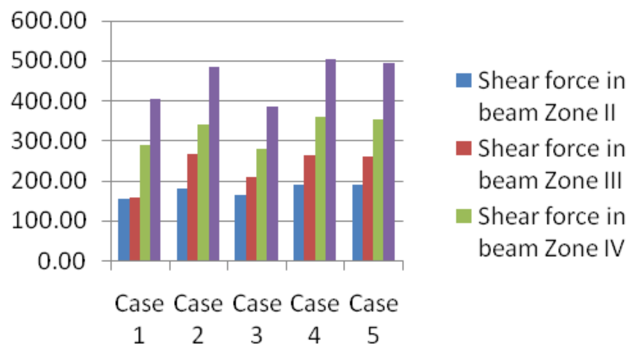

Figure 10: Shear Force (kN) in beam

3) Column Forces

3.1) Axial Force

TABLE 5: Axial Force (kN) in columns

Axial force in columns				
Model Type	Zone-II	Zone-III	Zone-IV	Zone-V
Case 1	4968.734	4968.734	4968.734	5082.086
Case 2	5082.399	5082.399	5082.399	5499.485
Case 3	5091.947	5091.947	5091.947	5091.947
Case 4	4368.982	4436.268	4591.732	5520.779
Case 5	5106.192	5106.192	5106.192	5508.989

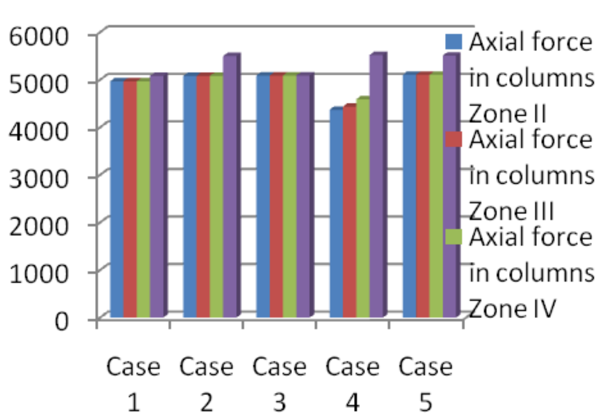

Figure 11: Axial Force (kN) in columns

4) Story Displacement

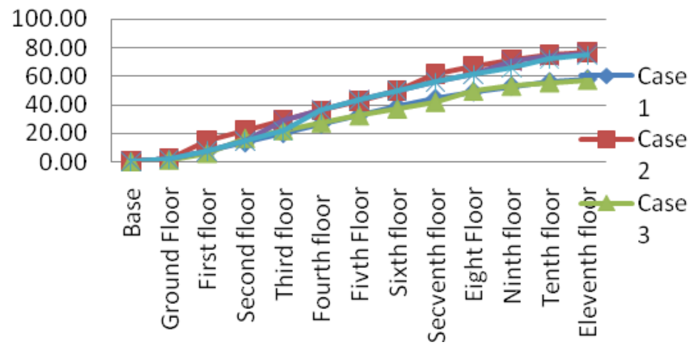

Figure 12: Storey displacement (mm) in zone-II of X direction

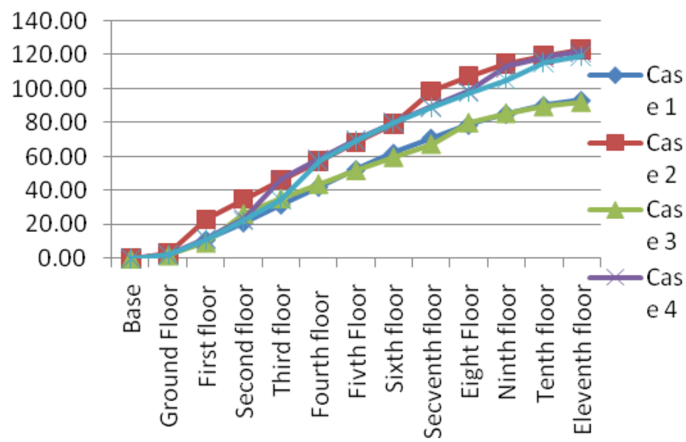

Figure 13: Storey displacement (mm) in zone-III of X direction

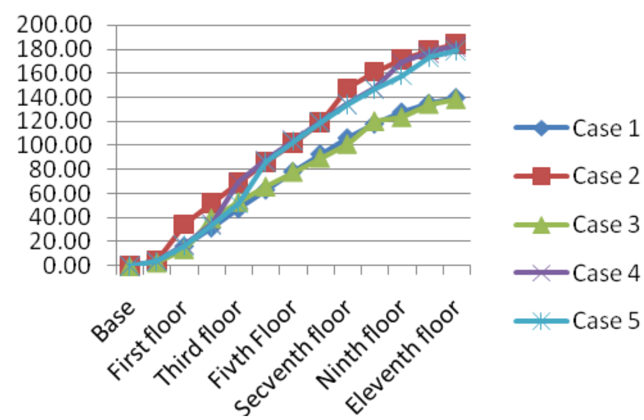

Fig. 14: Storey displacement (mm) in zone-IV of X direction

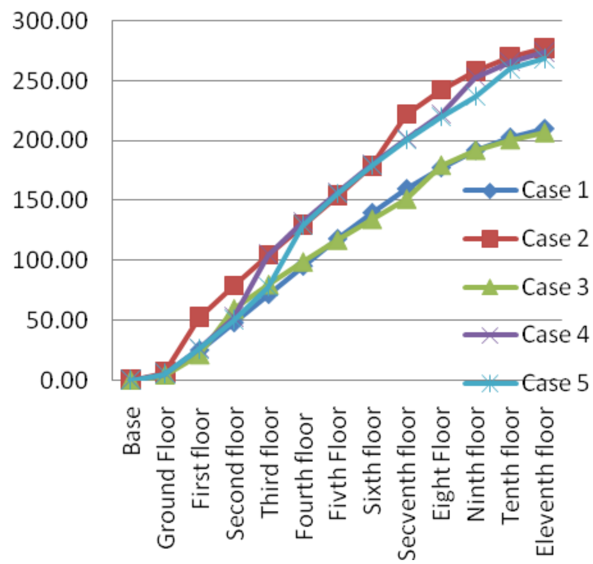

Figure 15: Storey displacement (mm) in zone-V of X direction

Conclusion-

The conclusion of the above listed results and graphs are as follows-

Displacement- It can be seen that minimum displacement is seen in case-3 (Soft storey at 2nd and 8th storey) and maximum is seen in case-2 (Soft storey at 1st and 7th storey) means case-2 is critical case in displacement and it should be avoided. So percent increased in displacement from minimum to maximum is 346.35%

Bending moment- In bending moment it can be seen that minimum bending moment is seen in case-3 (Soft storey at 2nd and 8th storey) and maximum is seen in case-4 (Soft storey at 3rd and 9th storey) means case-4 is critical and uneconomical because as a moment increases reinforcement is also increases. So percent increased in bending moment from minimum to maximum is 232.84%

Shear force- In shear force it is observed that minimum is in case-1 (Bare frame without soft storey) and maximum is in case-4 (Soft storey at 3rd and 9th storey) means case-4 is critical and uneconomical because as a shear force increase shear reinforcement is also increases. So percent increased in shear force from minimum to maximum is 224.60%

Axial force- In axial force it is seen that minimum is seen in case-4 (Soft storey at 3rd and 9th storey) and maximum is seen in case-5 (Soft storey at 4th and 10th storey) means case-5 is critical in axial forces in column. So percent increased in axial force from minimum to maximum is 26.36%

Storey displacement- In storey displacement it is seen that minimum is seen in zone-II, ground floor, case-3 (Soft storey at 2nd and 8th storey) and maximum is seen in zone-V, top floor, case-2 (Soft storey at 1st and 7th storey) means soft storey at top should be avoided.

From above listed results and graphs here it is observed that the soft storey in RCC framed structure is avoided but if that is necessary then it should be provided on ground storey of the structure and not at top of the structure. And from above study is seen that case-3 (Soft storey at 2nd and 8th storey) is best and it can be proffered. If there is utmost requirement of the structure to provide soft stories in the bottom/ ground story of the structure then that would be provided with some suitable lateral force resisting techniques like shear wall, bracing and RC diagonal struts etc.

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