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SESIMIC EVALUATION OF UNSYMMETRICAL MULTI-STOREY BUILDINGS WITH AND WITHOUT FLOATING COLUMNS BY STAAD PRO

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ABSTRACT

In present scenario, multi-storey buildings in urban area are required to have column free space due to shortage of space, population and also for aesthetic and functional requirements. For this purpose buildings are provided with floating columns at one or more storey. These floating columns are highly disadvantageous in a building built in seismically active areas. The earthquake forces that are developed at different floor levels in a building need to be carried down along the height to the ground by the shortest path. Deviation or discontinuity in this load transfer path results in poor performance of the building. The object of present work is to study the behaviour of unsymmetrical multi-storey building with and without floating columns under seismic forces. For this purpose P+3 storey and P+20 storey building are considered and analyzed for seismic zone III and seismic zone V and for soil Type I, Type II and Type III by using software STAAD Pro. Present work provides the good information on the parameters base shear and storey drift in the multi-storey building.

Keywords: Floating Column, Seismic Analysis, Storey Drift, Base Shear, unsymmetrical building.

I. INTRODUCTION

Many multi-storied buildings in India have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking, reception lobbies and hotel lounge in the first or second storey. For the free movement of vehicle or persons the larger column free space is necessary. Such features are highly undesirable in building built in seismically active areas. The behaviour of a building during earthquake depends critically on its overall shape, size and geometry. The earthquake forces developed at different floor levels in a building need to be brought down along the height to the ground by the shortest path; any deviation or discontinuity in this load transfer path results in poor performance of the building

1.1 Floating Column

The floating column is a vertical element which ends (due to architectural design/ site situation) at its lower level (termination Level) rests on a beam which is a flexural member. The beams in turn transfer the load to other columns below it. It is also defined as a column which ends at its lower level on a beam and does not reach to the foundation level. A structure with floating column can be categorized as vertically irregular as it causes irregular distributions of mass, strength and stiffness along the building height. In every building the load transfer takes place from horizontal members (beams & slabs) to vertical members (walls and columns) which transfer the load to foundation level. So there should be a clear load path available for the load to reach the foundation level. Absence of column at any level changes the load path and transfers the floating column load through horizontal beams below it, also known as transfer girders. This altered path will cause large vertical earthquake forces under horizontal earthquake ground motion due to overturning effect.

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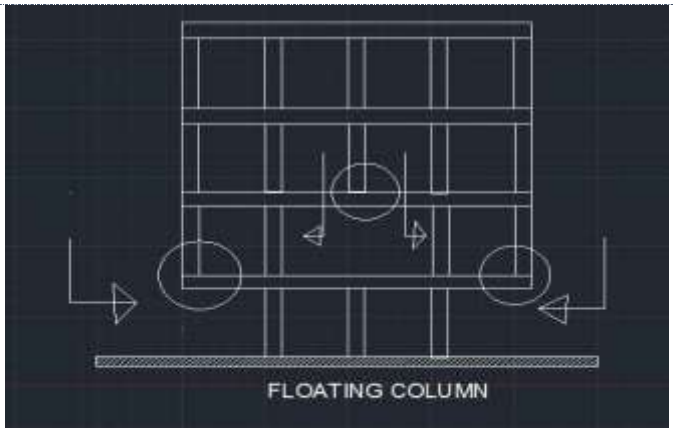

Fig. 1: Building having floating column

II. LITERATURE REVIEW

Research on the behaviour of the floating column with different models is described below:

SARIKA YADAV et. al. [2016], discussed the behaviour of multi-storey buildings having floating columns under seismic forces and observes the effect of shear wall in the same building using software STAAD Pro. The work provides a good source of information on the parameters lateral displacement and storey drift in the multi-storey buildings having floating columns with and without shear wall.

On the basis of analysis and results following conclusions have been made:

1. The storey drift and displacement is more for floating column buildings.
2. By providing shear wall drift and displacement values reduces as compared to without shear wall models for all the zones.
3. In zone IV and V displacement values crosses the maximum permissible limits in case of without shear wall but it becomes safe in case of building models with shear wall.

ISHA ROHILLA et. al. [2015], discussed the critical position of floating column in vertically irregular buildings for G+5 and G+7 RC buildings for zone II and zone V on Type - II soil. The effect of size of beams and columns carrying the load of floating column has been assessed. On the basis of analysis and results following conclusions have been made:

1. Floating columns should be avoided in high rise building in zone 5 because of its poor performance.
2. Increasing dimensions of beams and columns of only one floor does not decreases storey displacement and storey drift in upper floors so dimensions should be increased in two consecutive floors for better performance of building.

KAVYA N et. al. [2015], Compare the seismic behaviour of the RC multi-storey buildings with and without floating column. To determine seismic behaviour of the buildings the seismic parameters such as lateral displacement, base shear, fundamental time period and inter storey drift are studied. On the basis of analysis following conclusions are drawn:

1. The natural time periods obtained from the empirical expressions do not agree with the analytical natural periods.
2. There is more increase in the lateral displacement, base shear and inter storey drift for the floating column buildings compared with the regular building.

SARITA SINGLA et. al. [2015], Studied and analyse the seismic response of multi-storeyed RC framed buildings with and without floating columns. Different cases of the building are studied by varying the location of floating columns floor wise and within the floor. The structural response of the building models with respect to Fundamental time period, Spectral acceleration, Base shear, Storey drift and Storey displacements is investigated.

Following are some of the conclusions which are drawn on the basis of this study.

1. It was observed that in building with floating columns there is an increase in fundamental time period in both X-direction(about 5-8%) as well as Z-direction(about 3-7%) as compared to building without floating columns due to decrease in stiffness of structure.

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2. By introduction of floating columns in a building base shear and spectral acceleration decreases due to increase of natural period of vibration of structure. Thus, it has this technical and functional advantage over conventional construction.

A.P. MUNDADA et. al. [2014], comparative study of seismic analysis of multi-storied building with and without floating columns is done. For this purpose 3 cases are taken in case 1 no floating column is introduced, in case 2 floating column are introduced, in case 3 struts are provided below the floating column.
Following are some of the conclusions which are drawn on the basis of this study.

1. The probability of failure of building having floating column is more than building without floating column. But it can be reduce by introducing inclined compressive member i.e. struts below floating column
2. Due to the provisions of struts in the building with floating columns, the deflection is greatly reduced.
3. Provision of floating column is advantageous in increasing FSI of the building but is a risky factor and increases the vulnerability of the building

KEERTHIGOWDA B. S et. al. [2014], examined the adverse effect of the floating columns in building. The RC building with floating column after providing lateral bracing is analyzed. A comparative study of the results obtained is carried out for three models. The various models such as bare frame without floating columns, bare frame with floating columns and bare frame with floating column after providing bracings have been analyzed. The building with floating columns after providing bracings showed improved seismic performance. Through the parametric study of storey drift, storey shear, time period and displacement, it was found that the multi-storey buildings with floating columns performed poorly under seismic excitation. Thus to improve seismic performance of the multi-storey RC building, lateral bracings were provided. The bracings improved seismic performance of multi-storey building up to 10% to 30%.

PRERNA NAUTIYAL et. al. [2014], investigated the effect of a floating column under earthquake excitation for various soil conditions and as there is no provision or magnification factor specified in I.S. Code, hence the determination of such factors for safe and economical design of a building having floating column is done. From the study it is concluded that the base shear demands for medium soil are found higher than that of the hard soil in both cases (i.e. G+3 and G+ 6 models). As the height of the building increases, variation in base shear from medium to hard soil condition decreases. For different soil conditions (medium to hard) the max moments vary from 22- 26% for four storied building model and 16-26% for six storied building model. It can further been concluded that as the height of the building increases the variation of max. moments gets reduced for different soil conditions.

SRIKANTH.M.K et. al. [2014], studied the importance of presence of the floating column in the analysis of building and also, along with floating column some complexities were considered for ten storey building at different alternative location and for lower and higher zones. Alternate measures, involving stiffness balance of that storey where floating column is provided and the storey above, are proposed to reduce the irregularity introduced by the floating columns. The high rise building is analyzed for earthquake force by considering two type of structural system. Frame with only floating column and floating column with complexities for reinforced concrete building. The entire work consists of four models and these models were analysed for lower (II) and higher (V) seismic zones for medium soil condition. Based on the study the conclusions are as follows:

1. The displacement of the building increases from lower zones to higher zones, because the magnitude of intensity will be more for higher zones, similarly for drift, because it is correlated with the displacement.
2. Storey shear will be more for lower floors, then the higher floors due to the reduction in weight when we go from bottom to top floors. And with this if we reduce the stiffness of upper floors automatically there will be a reduction in weight on those floors so in the top floors the storey shear will be less compared to bottom stories.
3. Whether the floating columns on ground floor or in eight floors the displacement values increases when a floating column is provided in edge and middle than the outer face of the frame.

III. PROBLEM FORMULATION AND ANALYSIS

The object of the present work is to compare the behaviour of multi-storey buildings with and without floating columns. For this purpose P+20 storey and P+3 storey building are considered. For both the multi storey buildings different floating column positioning are taken in account. Multi-storey buildings are analyzed for seismic zone III and V on soil type I, II and III i.e., hard soil, medium soil, soft soil respectively. For this purpose 2 types of model namely 1 and 2 are modelled and analyzed further.

MODEL 1: building without floating column
MODEL 2: building with floating column
For Model 2 two different cases are considered
Case 1: Floating column at first floor
Case 2: Floating column at second floor
Now both the cases are studied by changing the positioning of floating column only for P+20 storeys.
Case (A): centre most columns in exterior frame are floating column
Case (B): Alternate columns in exterior frame along the two long edges except the corner ones are floating column

For evaluating the seismic response of a building and obtaining the information of seismic parameters like base shear and storey drift both the buildings are analyzed by software STAAD Pro.

Present work gives the good source of information about base shear and storey drift in multi-storey building. Plan for both the buildings are shown in fig.2.

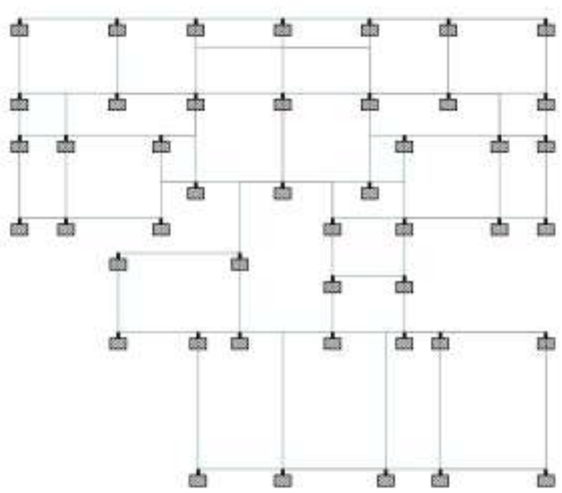

Fig. 2(a): Plan of Model P+20 storey building

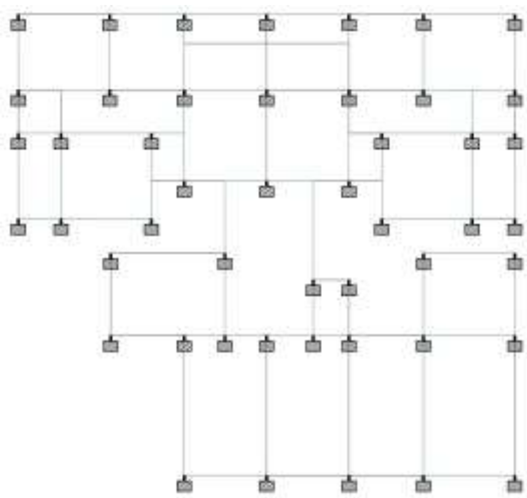

Fig. 2(b): plan for P+3 storey building

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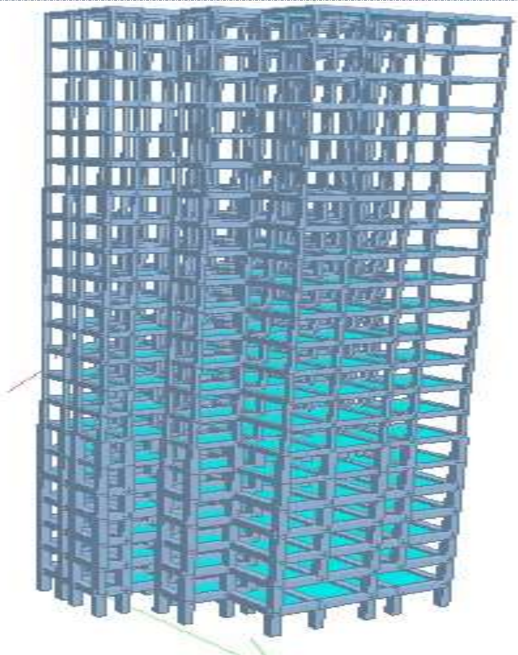


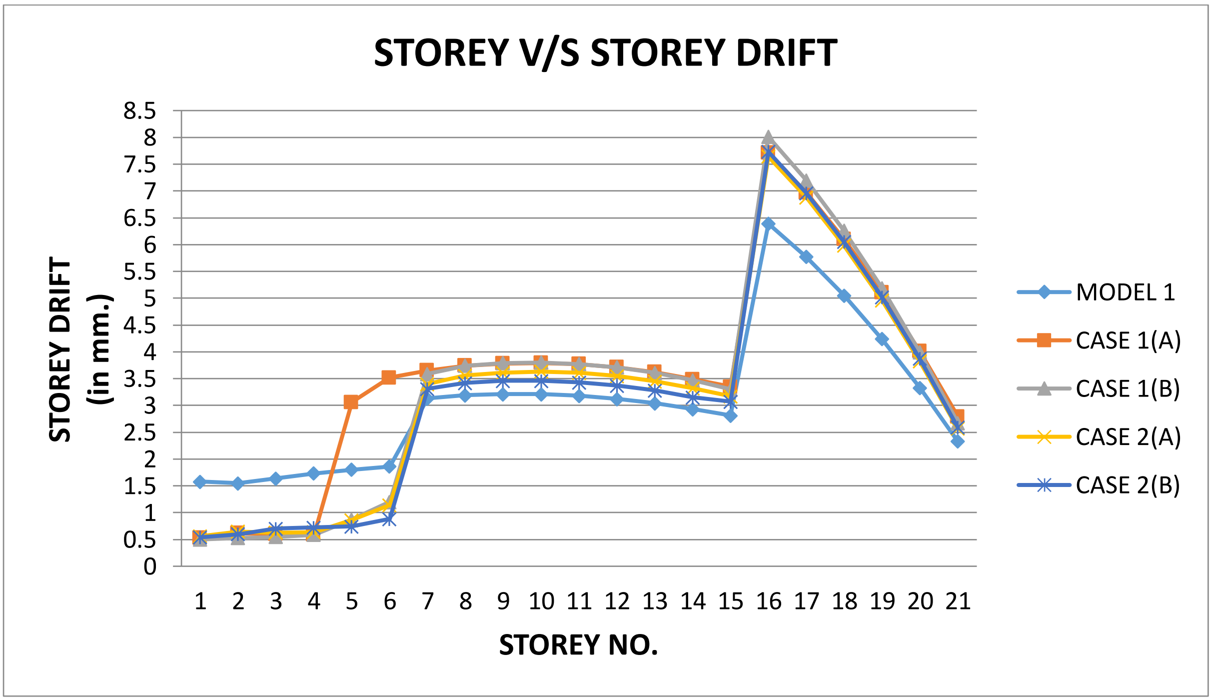
Fig. 3: Isometric rendered view of building having floating column at first floor (P+20 storey building)

IV. RESULT AND DISCUSSION

The results are compared in graphical form for both the models and all the cases.

1. Storey drift

Graphs for P+20 storey building



Storey drift in P+20 storey building, Zone 5, Soil Type – 1 (hard soil)

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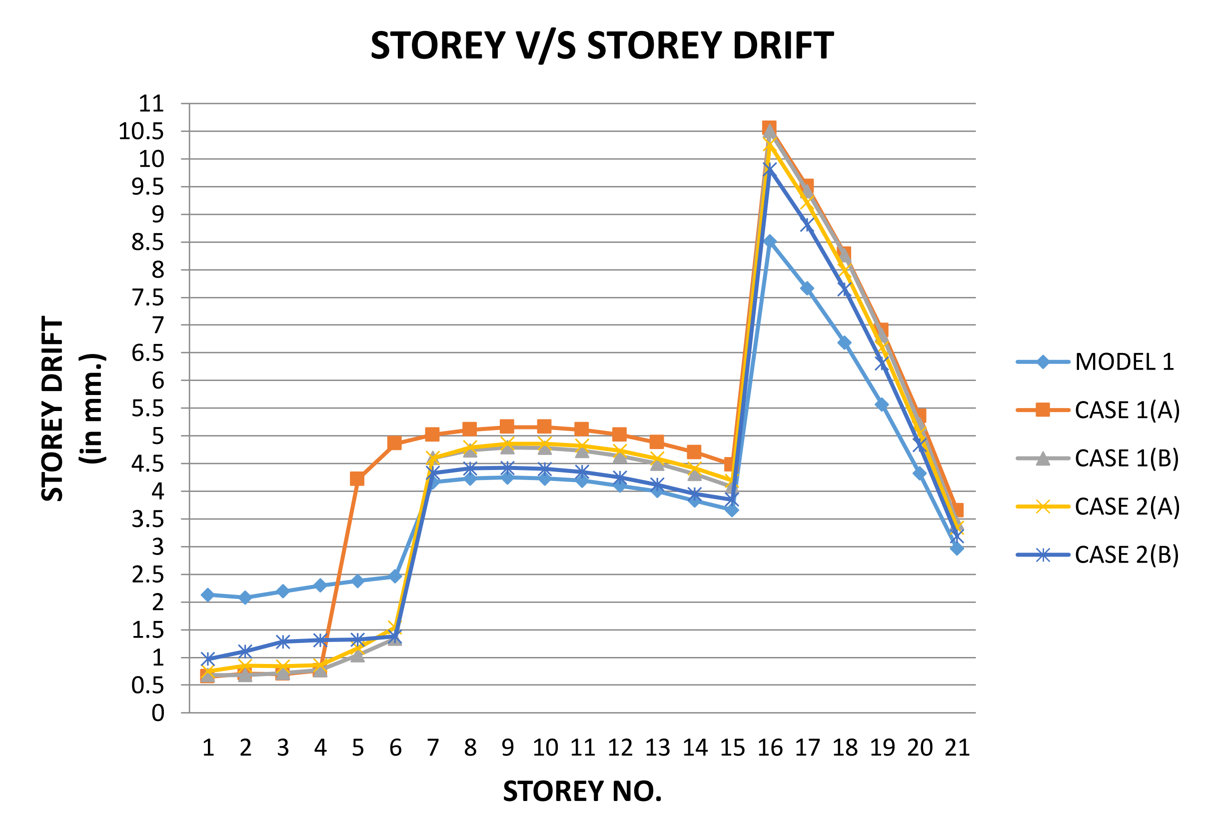

Storey drift in P+20 storey building, Zone 5, Soil Type – 2 (Medium soil)

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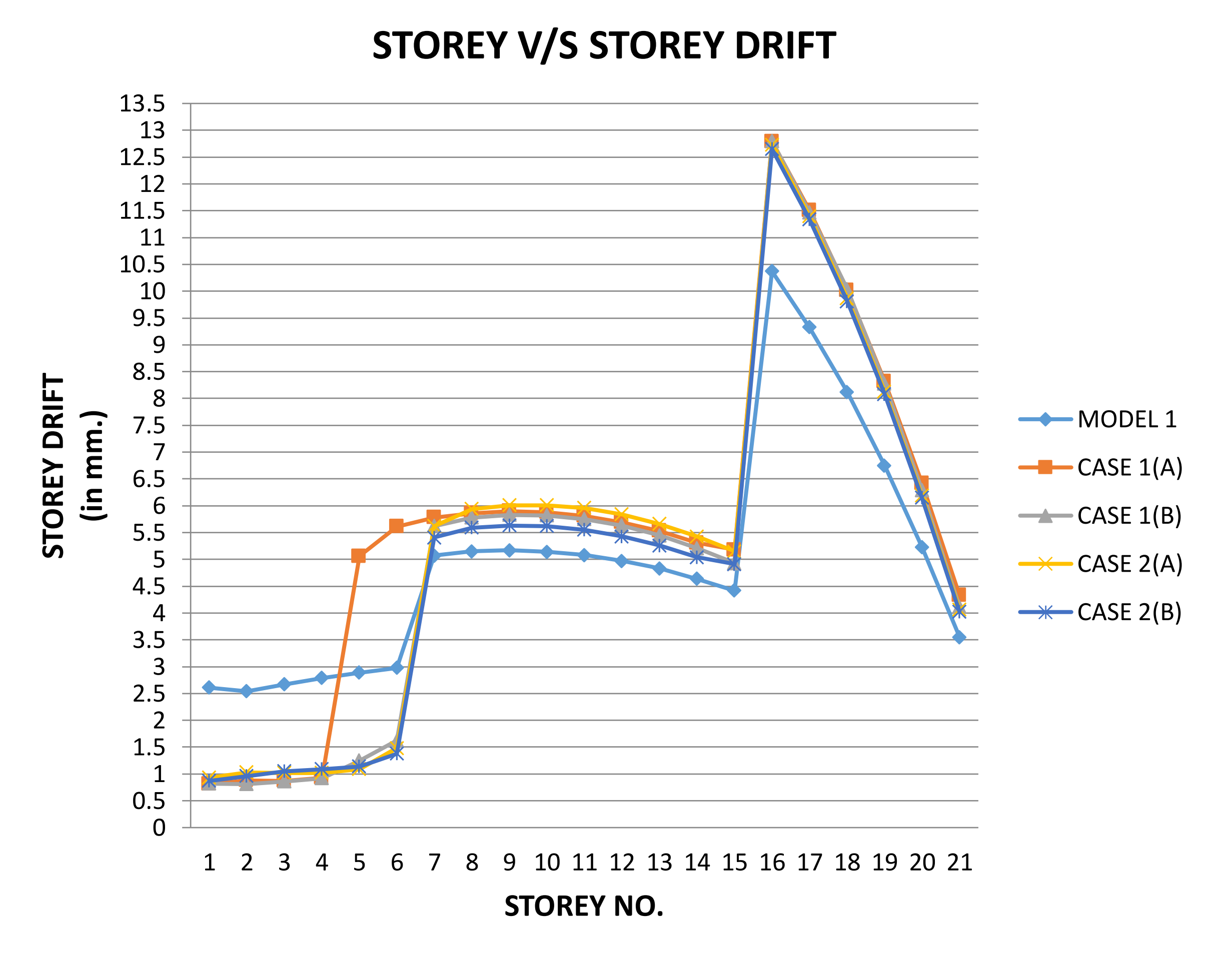

Storey drift in P+20 storey building, Zone 5, Soil Type – 3 (Soft soil)

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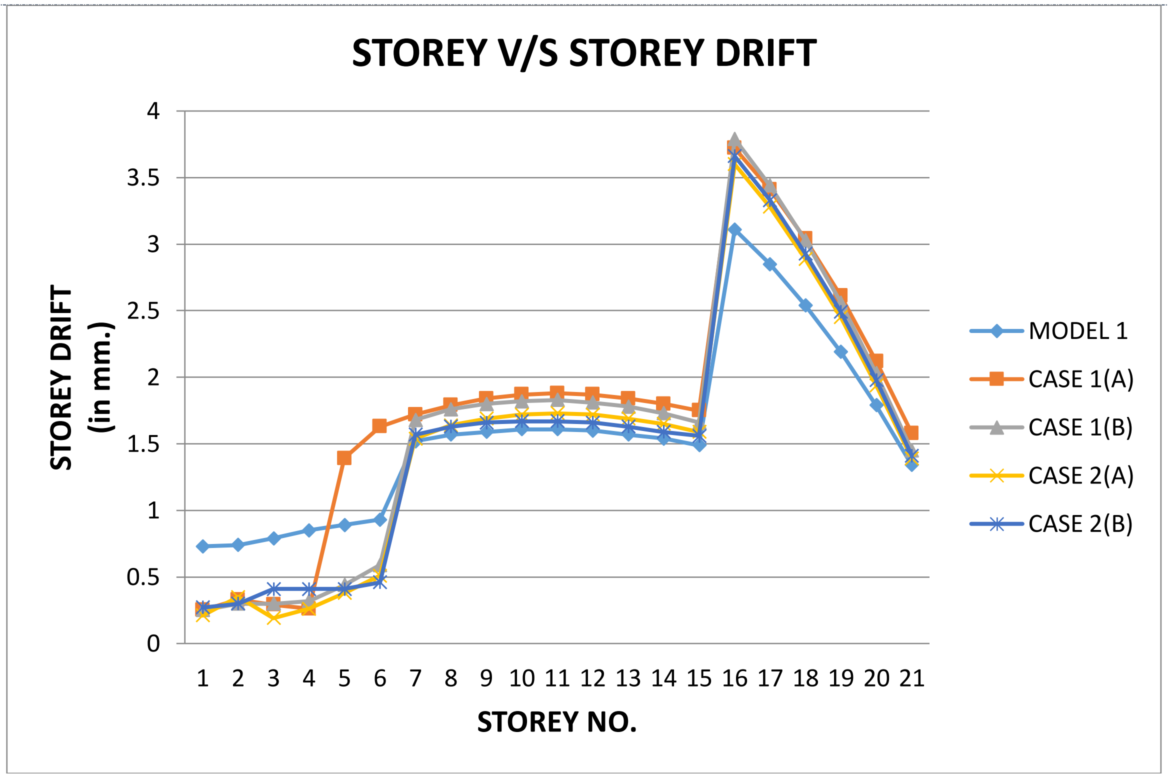
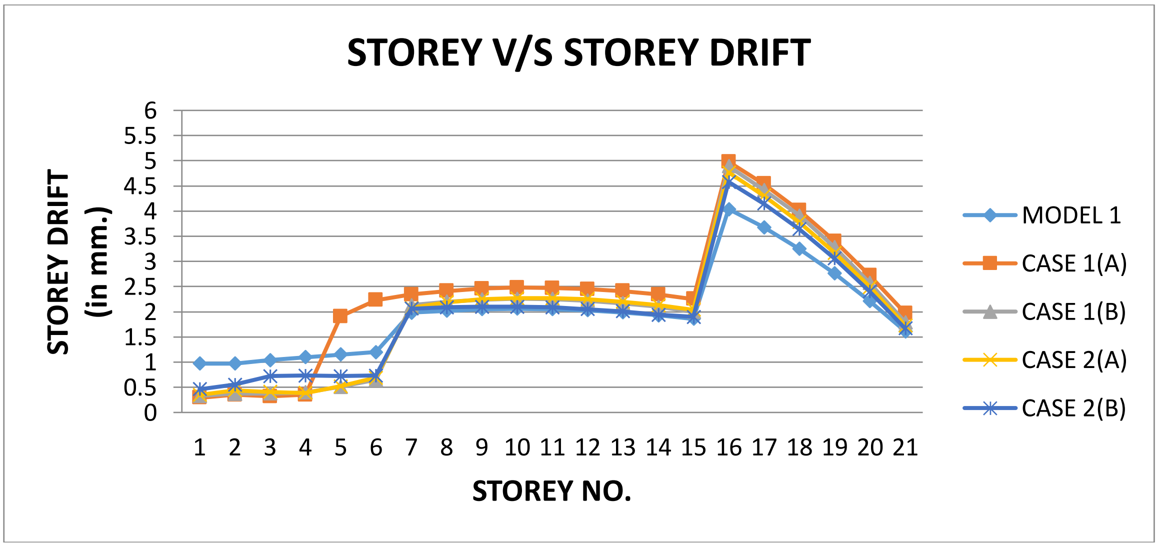


Storey drift in P+20 storey building, Zone 3, Soil Type – 1 (hard soil)



Storey drift in P+20 storey building, Zone 3, Soil Type – 2 (Medium soil)

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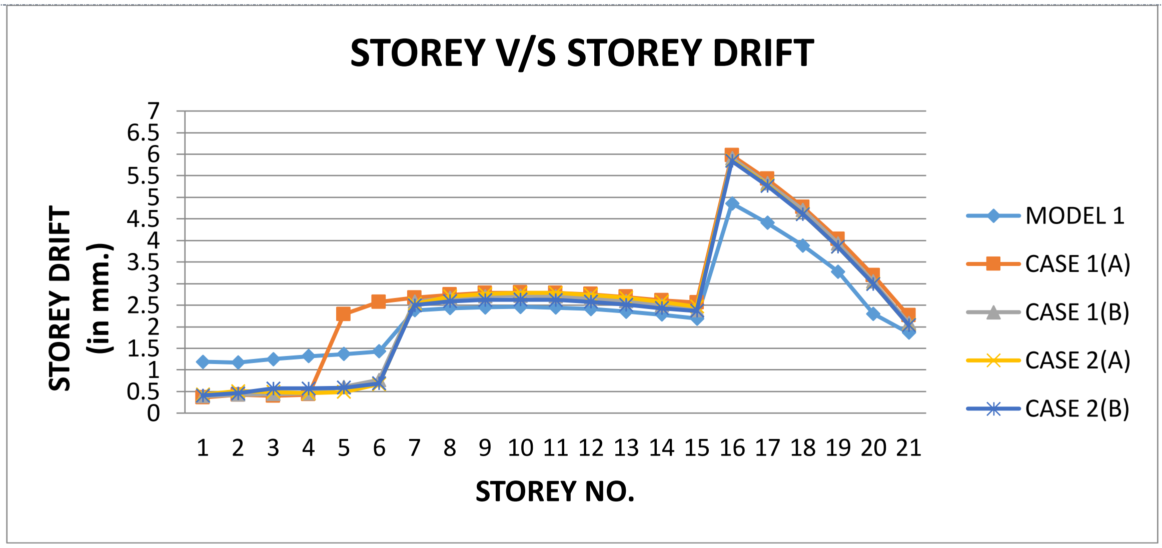
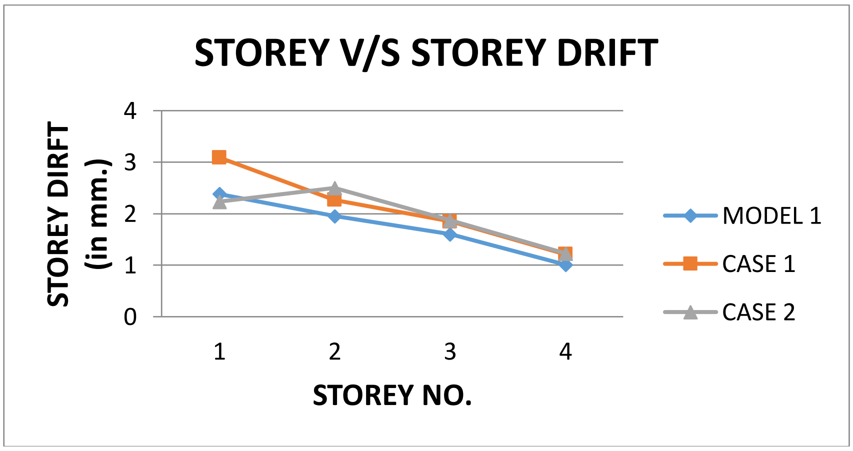


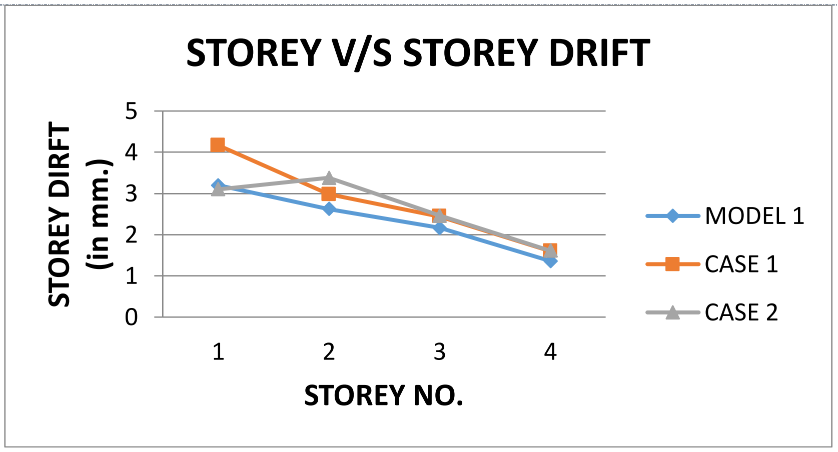
Storey drift in P+20 storey building, Zone 3, Soil Type – 3 (Soft soil)

It is clear from the above graphs that building constructed in soft soil is more vulnerable. It has high storey drift values. It is observed that storey drift sudden increase between 6th and 7th storey and between 15th and 16th storey it is highest at 16th storey and then reduces above that storey. The values are very more in seismic zone V than seismic zone III.

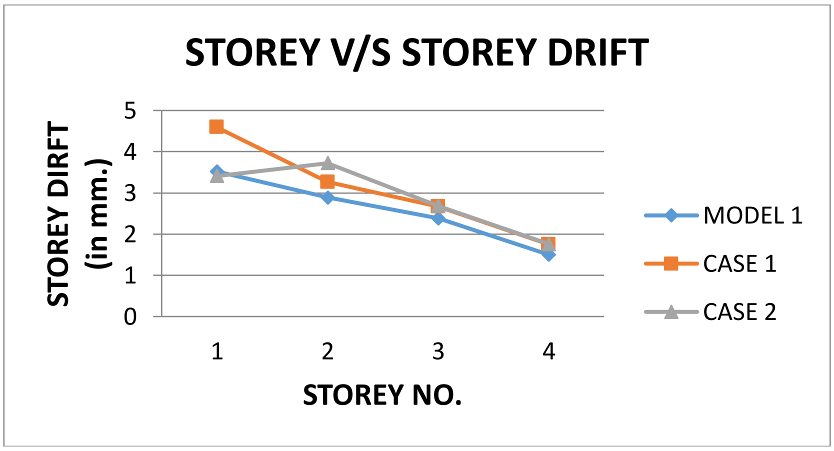
Graphs for P+3 storey building



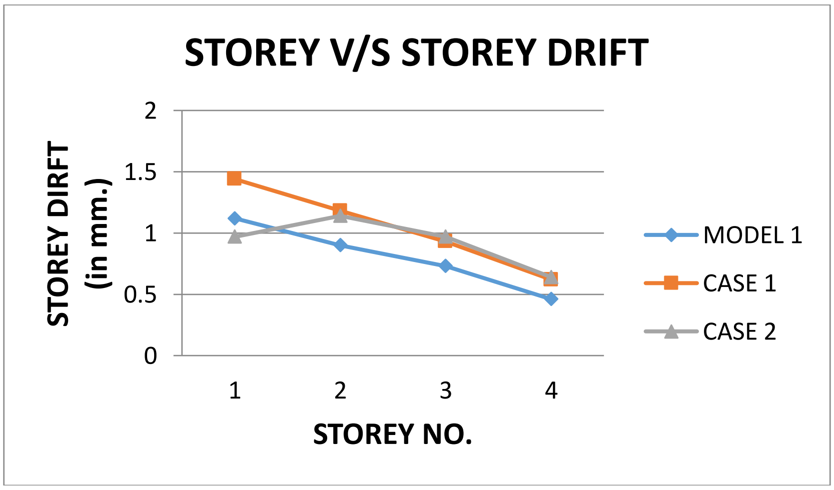
Storey drift in P+3 storey building, Zone 5, Soil Type – 1 (hard soil)



Storey drift in P+3 storey building, Zone 5, Soil Type – 2 (Medium soil)



Storey drift in P+3 storey building, Zone 5, Soil Type – 3 (Soft soil)



Storey drift in P+3 storey building, Zone 3, Soil Type – 1 (hard soil)

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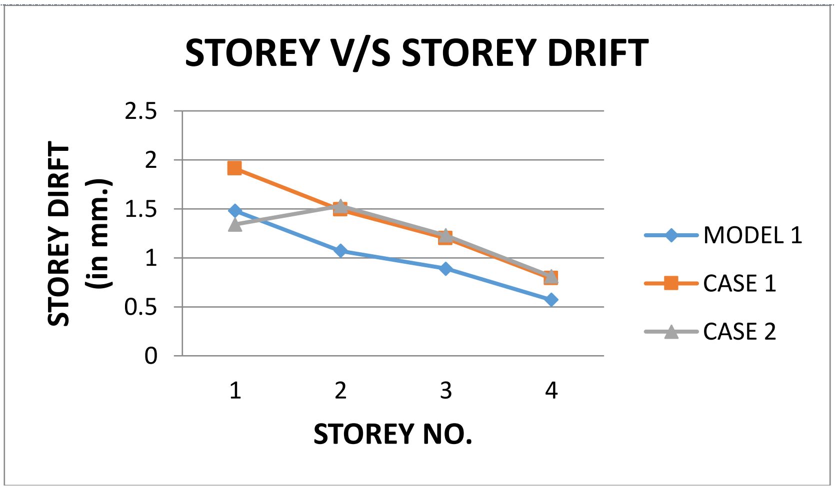
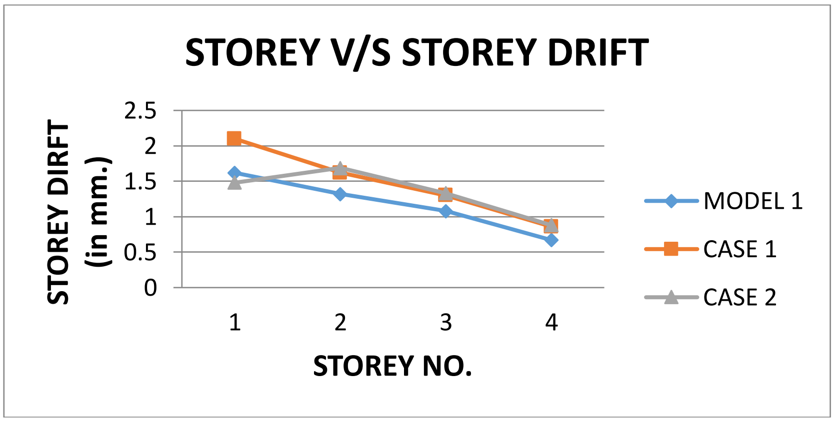


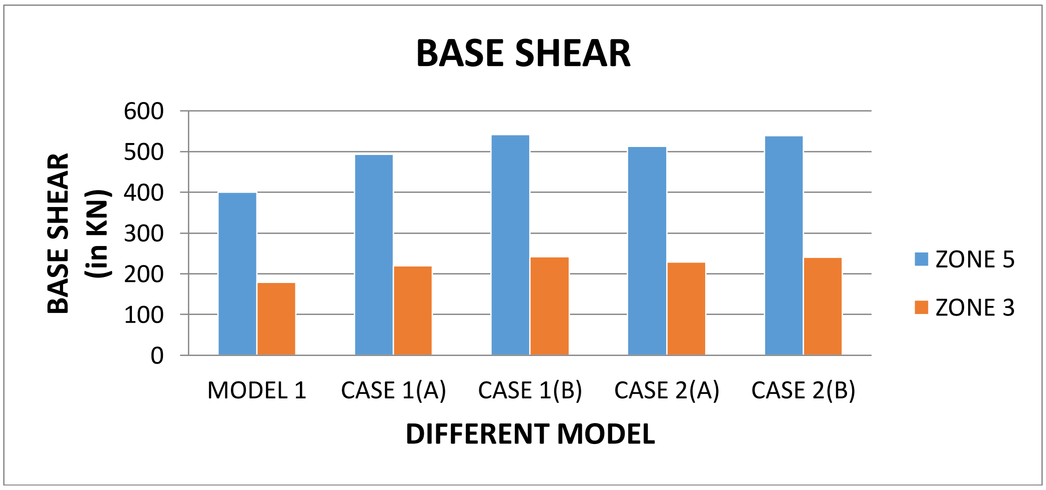
Storey drift in P+3 storey building, Zone 3, Soil Type – 2 (Medium soil)



Storey drift in P+3 storey building, Zone 3, Soil Type – 3 (Soft soil)

It is clear from the above graphs that building constructed in soft soil is more vulnerable. It has high storey drift values. It is observed that storey drift is more at ground floor and then values get reduced. The values are more in seismic zone V than seismic zone III.

2. Base Shear



Base shear in P+20 storey building for different seismic zone, Soil Type – 1 (hard soil)

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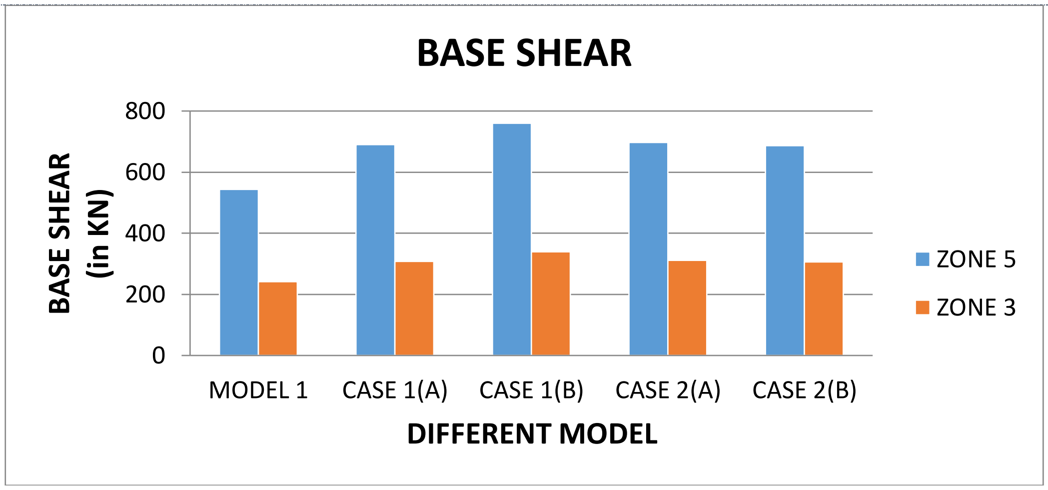
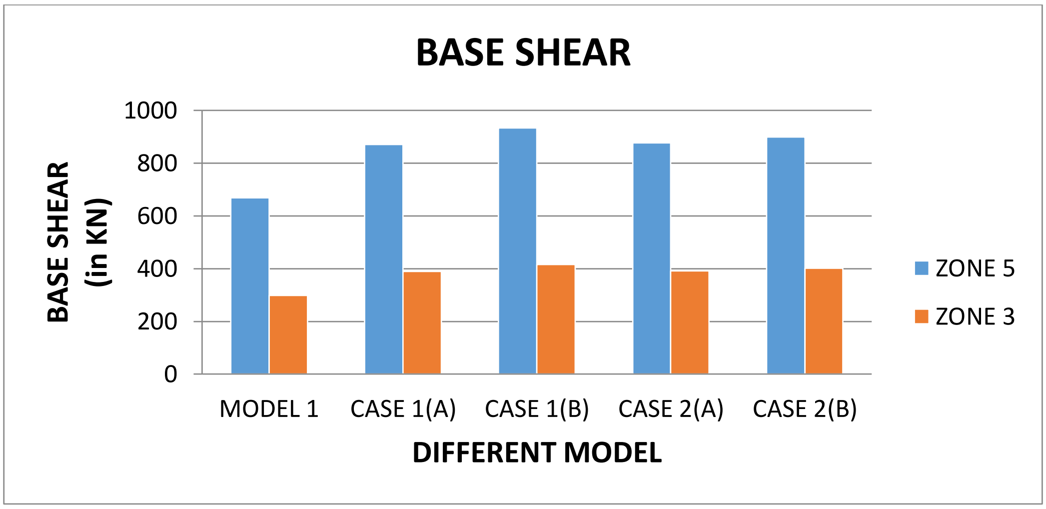
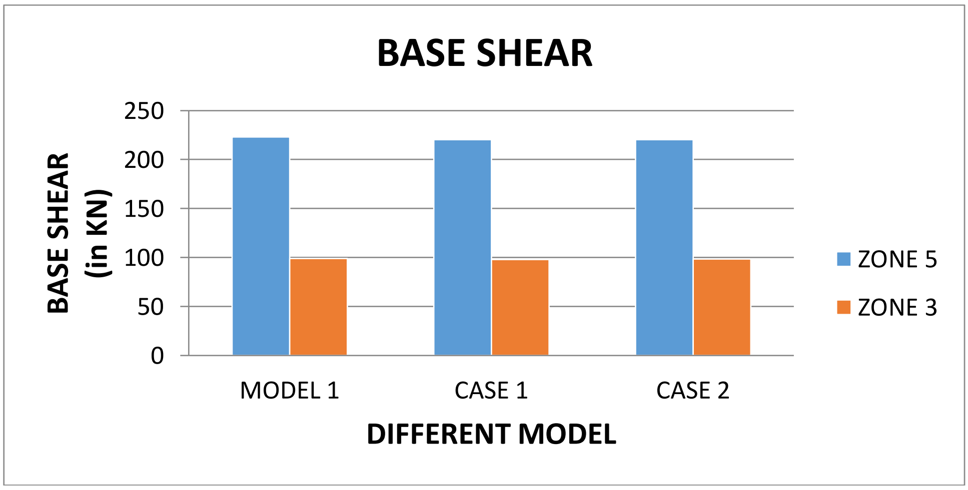


Base shear in P+20 storey building for different seismic zone, Soil Type – 2 (medium soil)



Base shear in P+20 storey building for different seismic zone, Soil Type – 3 (soft soil)



Base shear in P+3 storey building for different seismic zone, Soil Type – 1 (hard soil)

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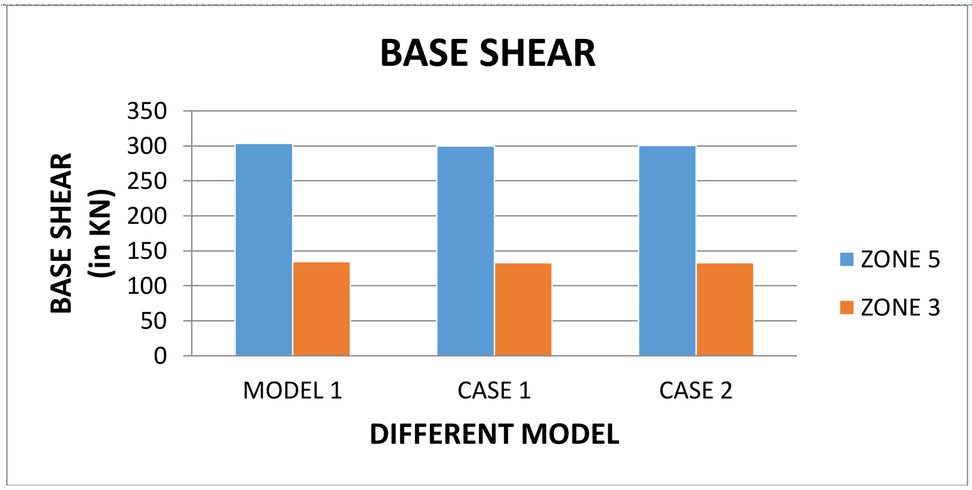
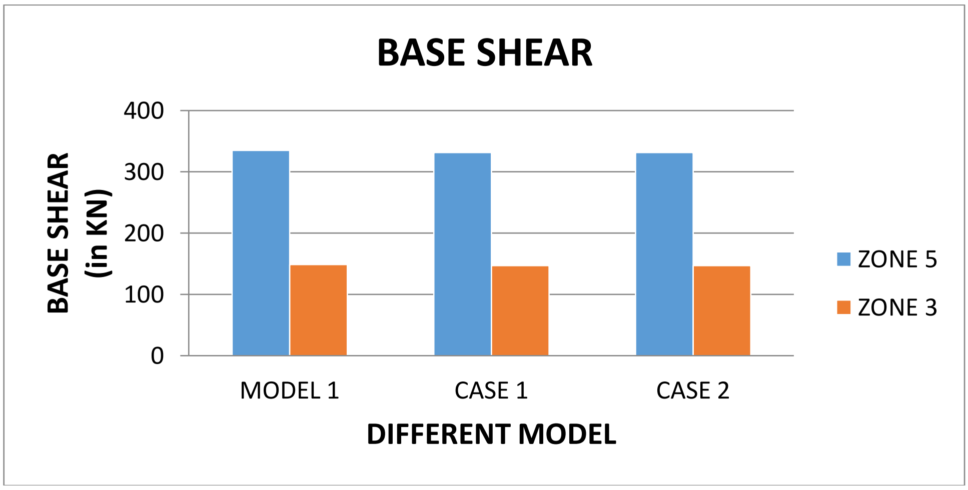


Base shear in P+3 storey building for different seismic zone, Soil Type – 2 (medium soil)



Base shear in P+20 storey building for different seismic zone, Soil Type – 3 (soft soil)

It can be observed from above graphs that base shear is very low for seismic zone III than seismic zone V for all the cases. And the highest base shear value is in soft soil.

V. CONCLUSION

On the basis of the study following conclusion can be drawn:

1. It was observed that there is an increase in storey drift in building having floating column.
2. It was observed that the values of storey drift are more for soft soil than that of medium soil and hard soil in all the cases.
3. The highest storey drift is experienced at 16th storey in P+20 storey building and at 1st storey in P+3 storey building when floating columns are provided at first floor and second floor.
4. Base shear is more for case 1(B), i.e. (Alternate columns in exterior frame along the two long edges except the corner ones are floating column at first floor) than other cases in P+20 storey building.
5. Values of base shear and storey drift are much more in seismic zone V than seismic zone III.

Hence it is observed that providing floating column in a high rise building in Seismic Zone V is very vulnerable. Construction of high rise building on soil type III (soft soil) is so much hazardous because as it can observed from the graphs that for all the cases the storey drift and base shear both the parameters show maximum values in soft soil

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REFERENCES

[1] Sarika Yadav, Raksha Parolkar "Seismic behaviour of multi-storey buildings having floating columns" IJCSER, vol. 4, issue 1, pp. 87-94, 2016
[2] Isha Rohilla, S.M. Gupta, Babita Saini, "Seismic response of multistory irregular building with floating column" IEEE Trans. Power System, vol. 19, no. 1, pp. 356–365, 2015.
[3] Kavya N., Dr. K. Manjunatha, Sachin P. Dyavappanavar, "Seismic evaluation of multistory RC building with and without floating columns" IEEE Trans. Power System, vol. 19, no. 1, pp. 356–365, 2015.
[4] Sarita Singla, Ashfi Rahman, "Effect of floating columns on seismic response of multi-storied RC framed buildings" IEEE Trans. Power System, vol. 19, no. 1, pp. 356–365, 2015.
[5] A.P. Mundada, S.G. Sawdatkar, "Comparative seismic analysis of multistory building with and without floating column" IEEE Trans. Power System, vol. 19, no. 1, pp. 356–365, 2014.
[6] Keerthigowda B.S., Syed Tajoddeen, "Seismic analysis of multistory building with floating column" IEEE Trans. Power System, vol. 19, no. 1, pp. 356–365, 2014.
[7] Prerna Nautiyal, Saleem Akhtar, Geeta Batham, "Seismic response evaluation of RC frame building with floating column considering different soil conditions" IEEE Trans. Power System, vol. 19, no. 1, pp. 356–365, 2014.
[8] Srikanth M.K., Yogeendra R. Holebagilu, "Seismic response of complex buildings with floating columns for zone II and zone V" IEEE Trans. Power System, vol. 19, no. 1, pp. 356–365, 2014.

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