[*Joshi * et al., 5(7): July, 2018*] ISSN: 2349-5197
Impact Factor: 3.765

INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

A REVIEW: SESIMIC ANALYSIS OF MULTISTOREY BUILDING HAVING FLOATING COLUMNS

Amit Joshi[1] & Murtaza Safdari[2]
[1&2]Department of Civil Engineering, Alpine Institute of Technology, Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal (M.P.), India

DOI: 10.5281/zenodo.1314109

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

Abstract
In recent times, 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 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 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 zone III and zone V and for soil Type I, Type II and Type III by using software STAAD Pro. Present work gives good source of information on parameters like storey drift and base shear.

Introduction
Today many multi-storeyed buildings have floating columns as an unavoidable feature. This is being adopted- a) to provide more space in ground floor for accommodation of parking or ground lobbies b) for architectural beauty c) to increase floor space index.

For the purpose of parking and all, usually the ground storey is kept free without any constructions, except the columns which transfer the building weight to the ground. For a hotel or commercial building, where the lower floors contain banquet halls, conference rooms, lobbies, show rooms or parking areas, large interrupted space required for the movement of people or vehicles. For this purpose floating column concept come into existence.

1.1 Floating Column
The floating column is a vertical element which at its lower level rests on a beam which is a horizontal member. Floating column rest on beams and do not go all the way to the foundation, the beams in turn transfer the load to other columns below it. Buildings having floating column have discontinuities in the load transfer path and this discontinuity can cause failure of building. When floating column is to be necessarily provided special care should be given to the transfer girders and column below the floating column. These beams and column should have sufficient strength to receive the load from floating column and convey it to foundation level.

INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

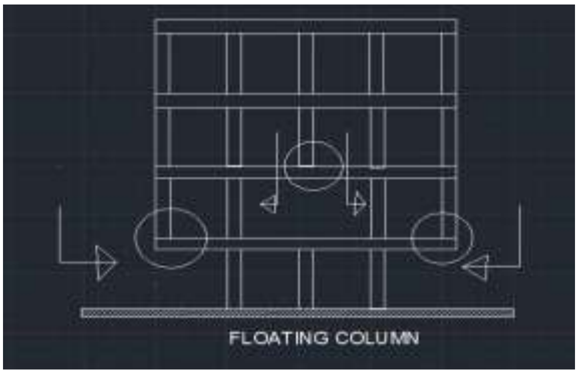


Fig. 1: Building having floating column

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. For this purpose three cases of multi-storey buildings are considered having 8 storey, 12 storey and 16 storey. All the three cases are analyzed for zone III, zone IV and zone V by 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. Drift and displacement values are less for lower zones and it goes on increases for higher zones because the magnitude of intensity will be the more for higher zones.
2. By providing shear wall drift and displacement values reduces as compared to without shear wall models for all the zones. As drift values are safe within maximum permissible limits in without shear wall models so there is no necessity of providing shear walls from drift view point.
3. In zone V buildings are not safe for both without and with shear wall. Hence it is advised to increase size of column to reduce the displacement values.

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 parameters used for study are storey drift, storey displacement and storey shear using ETAB software. 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. Storey displacement and storey drift increases due to presence of floating column.
3. Storey shear decreases in presence of floating column because of reduction mass of column in structure.
4. 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. The analysis is carried out for G+3 storey building situated at zone IV, using ETAB software. 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. And it can also be concluded from the analysis that the natural time period depends on the building configuration.

2. There is more increase in the lateral displacement and inter storey drift for the floating column buildings compared with the regular building. Both parameters increases along the height of the building
3. As the columns are removed the mass and stiffness gets increased hence the drift and base shear also increases. Therefore, the base shear is more for the floating column buildings compared to the conventional buildings.

SARITA SINGLA et. al. [2015], Studied and analyze the seismic response of multi-storeyed RC framed buildings with and without floating columns. G+6 multi-storied building, with special moment resisting frame was selected for study which is located in Zone IV on Type II soil. 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.
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.
3. Buildings with floating columns in ground floor are more vulnerable during earthquake. It was also observed that deflections increase marginally in that storey where floating columns are located.
4. Due to discontinuity of stiffness, the flexibility increases and strength decreases resulting in high displacements in structure having floating column.

A.P. MUNDADA et. al. [2014], studied the architectural drawing and the framing drawing of the building having floating columns. Existing residential building of G+ 7 has been selected for the project work. The load distribution on the floating columns and the various effects due to it is also been studied in the paper. 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 probabilities of failure of without floating column are less as compared to with floating column and the probabilities of failure with floating column is more than floating column with inclined compressive member i.e. struts.
2. Due to the provisions of struts in the building with floating columns, the deflection is greatly reduced. This is because struts provide stability to the columns balancing the moments.
3. Column shear values are increasing or decreasing significantly depending upon position and orientation of floating column.
4. 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. Models of the frame are developed for multi-storey RC buildings with and without floating columns to carry out comparative study of structural parameters such as natural period, base shear, and horizontal displacement under seismic excitation. 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 using ETABS 9.7.1. 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 considerably as different parameters such as storey drift, storey shear, time period and displacement improved upto 10% to 30%.

PRATYUSH MALAVIYA et. al. [2014], studied the effect of floating columns on the cost analysis of a structure designed on STAAD Pro V8i. For this purpose a 2 storied regular structure is considered. Modelling, analysis, estimation and design of the structure is done separately on the software. Analysis is performed on the zone II, zone III, zone IV and zone V. It is concluded that in the framed structure with no floating columns the nodal displacements is minimum with uniform distribution of stresses at all beams and columns. As a result it is most economical.

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. For the analysis purpose two models have been considered.

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 has been found that max. variation in values of max. moments comes at the ground floor (26%) for both the cases whereas the min. variation comes at the top floor (22% for case 1 and 16% for case 2). It can further been concluded that as the height of the building increases the variation of max. moments gets reduced for different soil conditions.

SABARI S et. al. [2014], studied the behaviour of multi-storey buildings with and without floating columns under earthquake excitations. RC Frames of different stiffness on floor wise and height of building are considered. The time history analysis of these RC Frames has been done by subjecting the whole system to BHUJ earthquake ground motion, using FEM Package SAP2000. A comparative study is carried out both for 2D and 3D RC frame structures with and without floating columns. A study is carried out to find variation in time period and structural response for various parameters like floor displacement, base shear, shear force, bending moment and torsion for the beams and axial force for all the models. The compatible time history and Bhuj earthquake data has been considered. It is concluded that by increasing the column size the maximum displacement and inter storey drift values are reducing.

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.

Modelling and analysis

The buildings considered for the work are P+20 storey and P+3 storey R.C. framed symmetrical building. Both the buildings are analyzed in seismic zone III and seismic zone V for soil type I, II and III i.e., hard soil, medium soil, soft soil respectively. Complete analysis is done for seismic response of buildings and to analyze the parameters storey drift and base shear using STAAD Pro. Plan of building is shown in fig.2

For both multi-storey building 2 models are modelled as follows
MODEL 1: Building without floating column
MODEL 2: Building with floating column
For model 2 two cases are taken for analyzing
CASE 1: Floating column at first floor
CASE 2: Floating column at second floor
Further for both the cases (1 and 2) two cases are also given only for P+20 storey building
CASE A: Alternate column including corner column along long edge in exterior frame are floating columns
CASE B: alternate column excluding corner columns along short edge in exterior frame are short columns

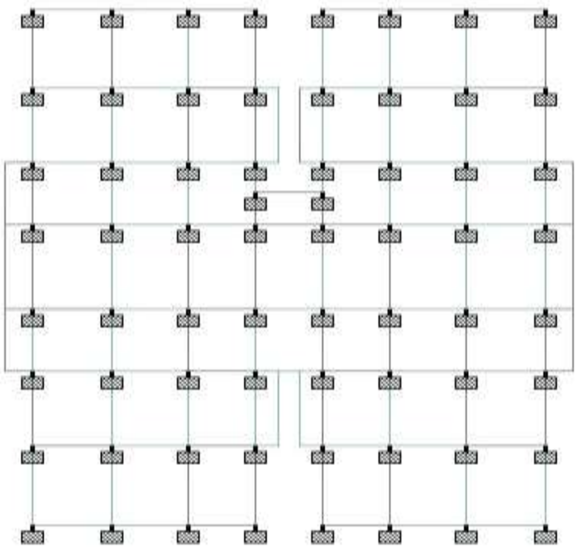


Fig. 2(a): plan for P+20 storey building

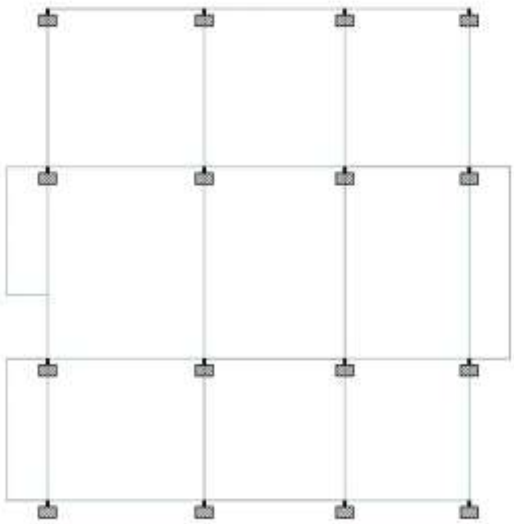


Fig. 2(b): plan for P+3 storey building

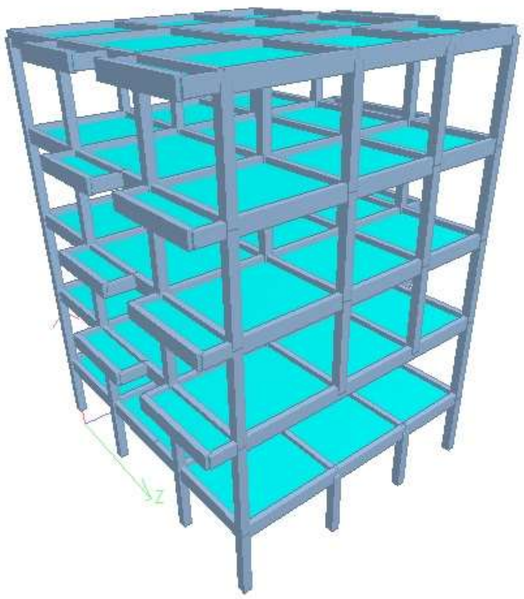


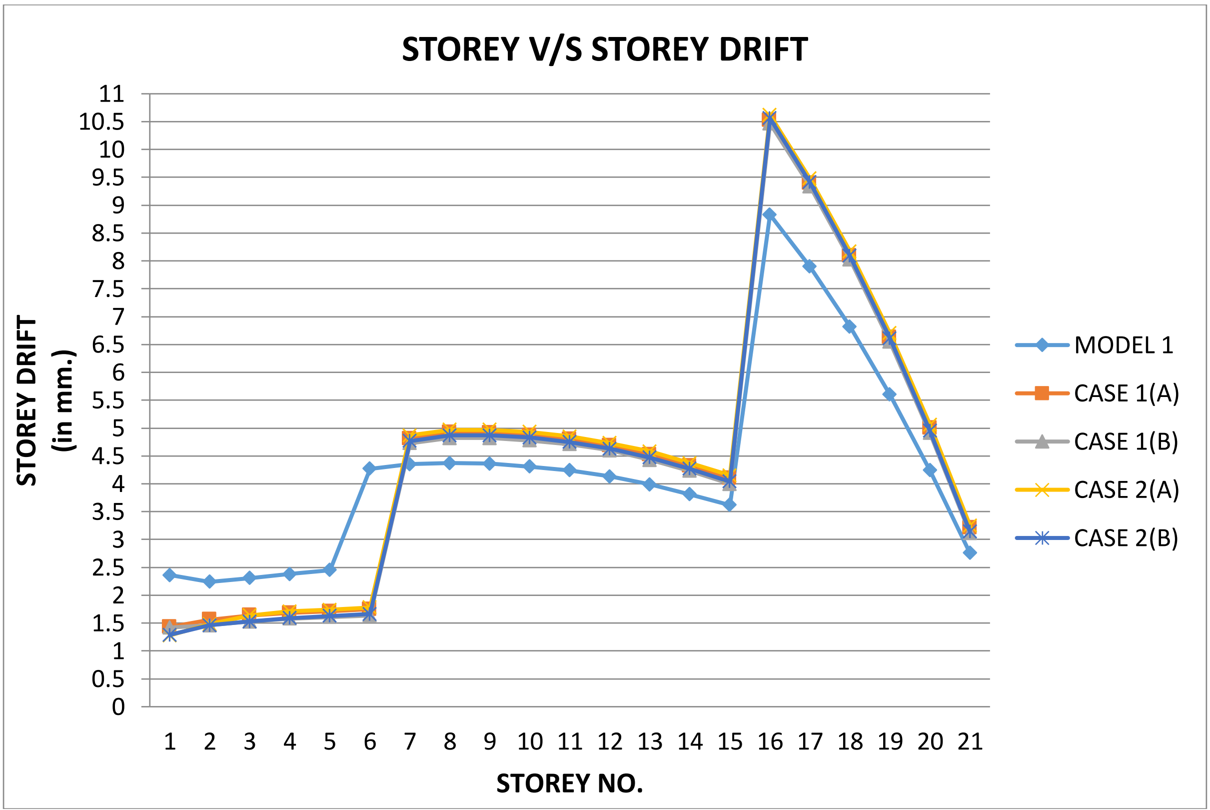
Fig. 3: Rendered isometric view of P+3 storey building having floating column at first floor

INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

Result and discusion

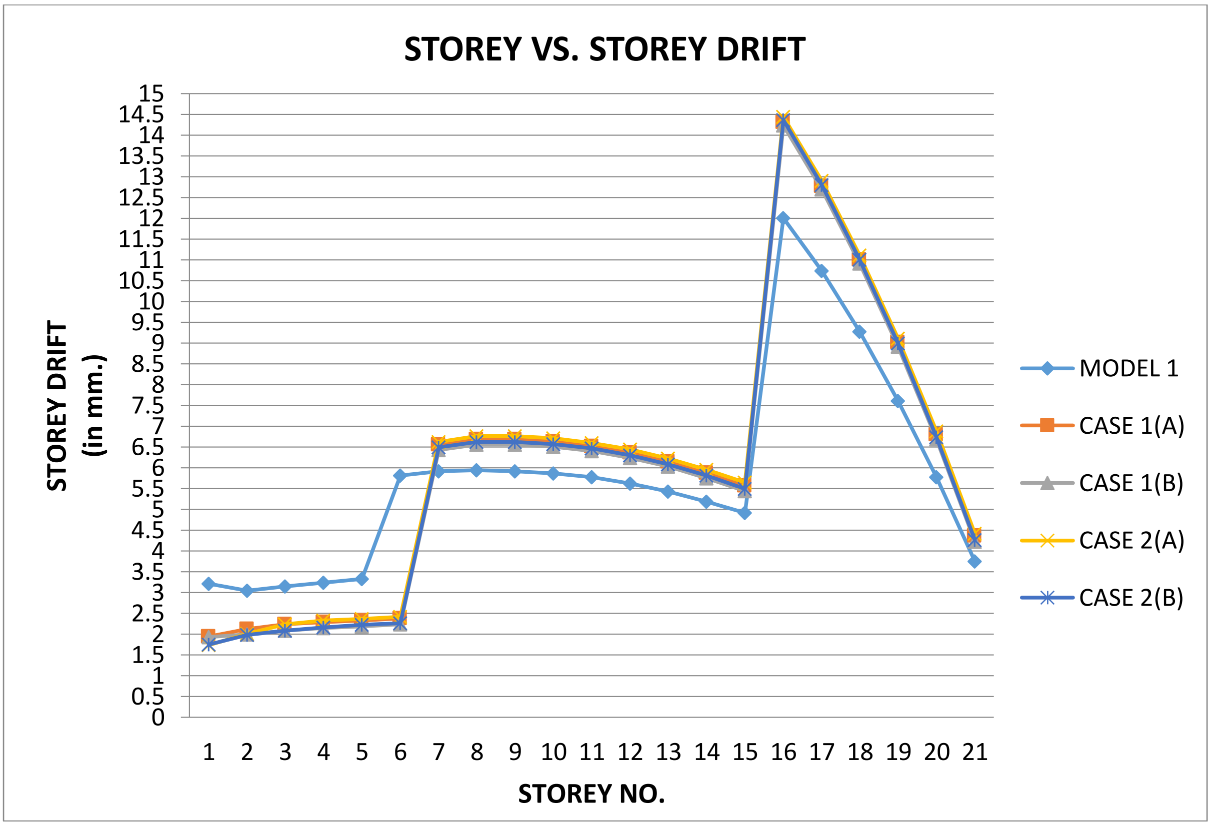
The study is done for evaluating the seismic parameters like storey drift and base shear. All the results for these parameters are represented in the form of graphs.

1. Storey drift



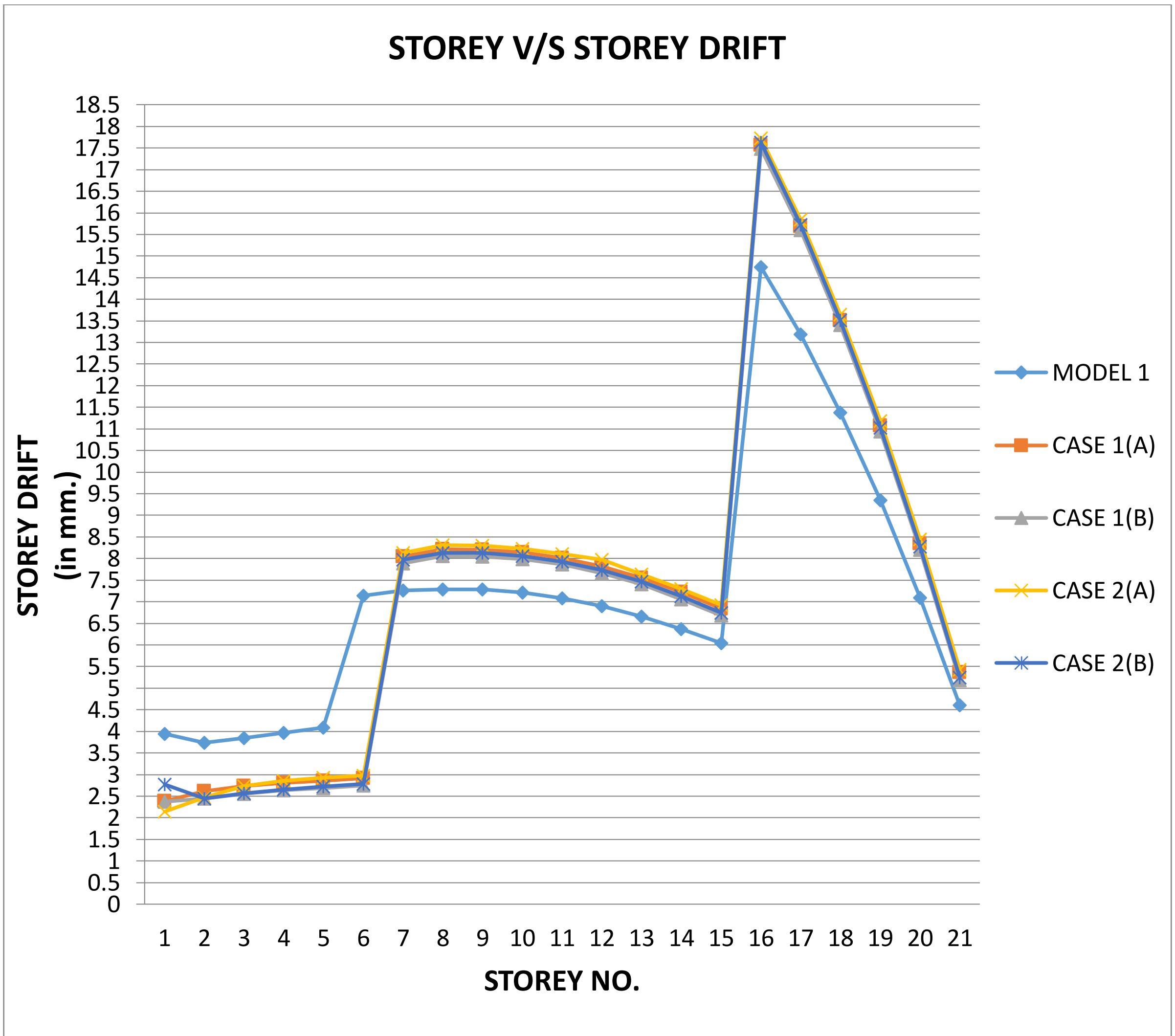
Storey drift in P+20 storey building, Zone 5, Soil Type – 1 (hard soil)

INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

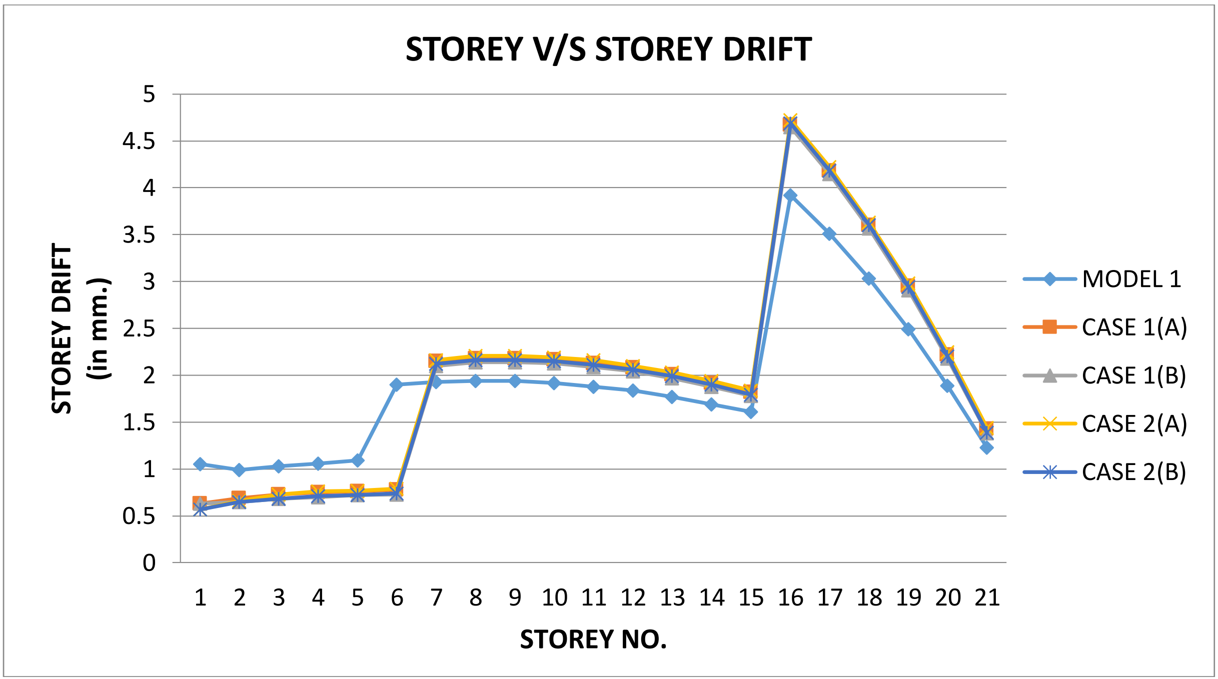


Storey drift in P+20 storey building, Zone 5, Soil Type – 2 (Medium soil)

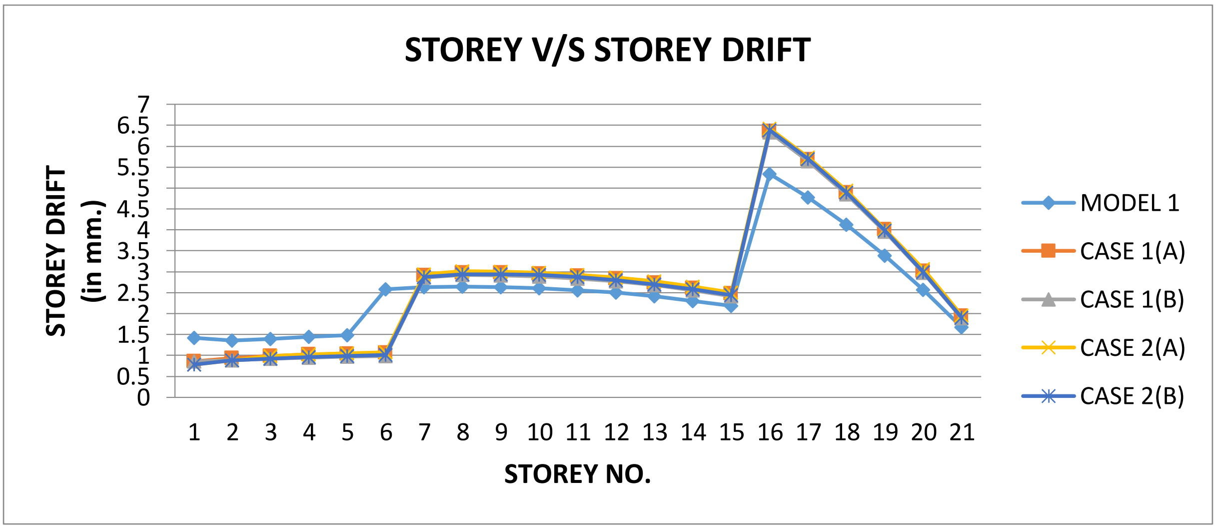
INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT



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

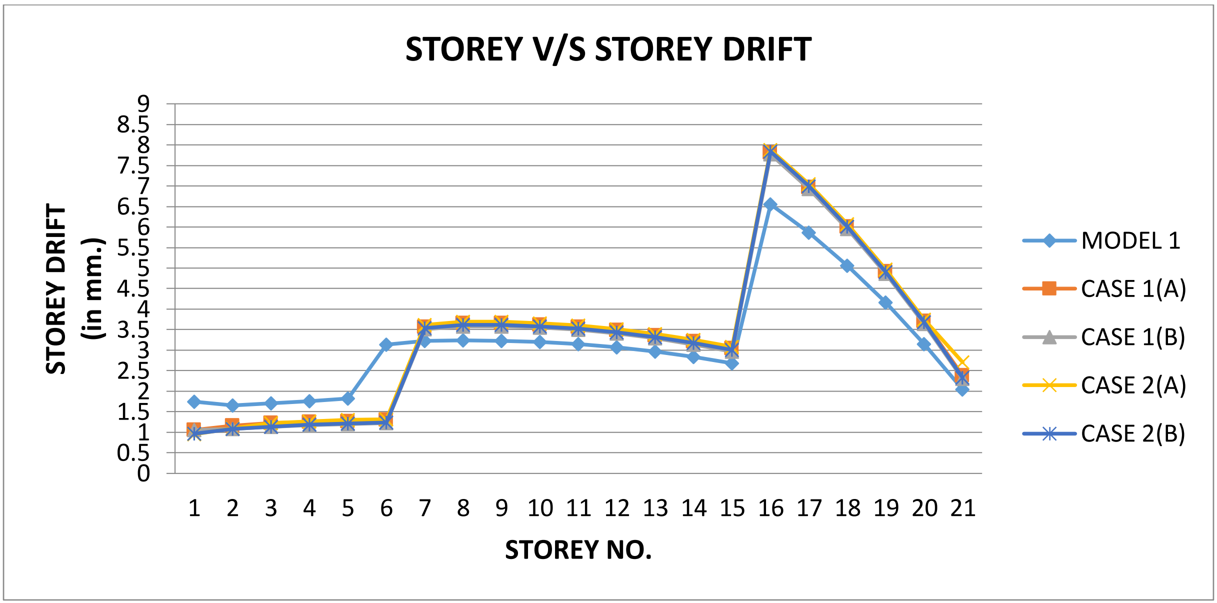


Storey drift in P+20 storey building, Zone 3, Soil Type – 1 (hard soil)

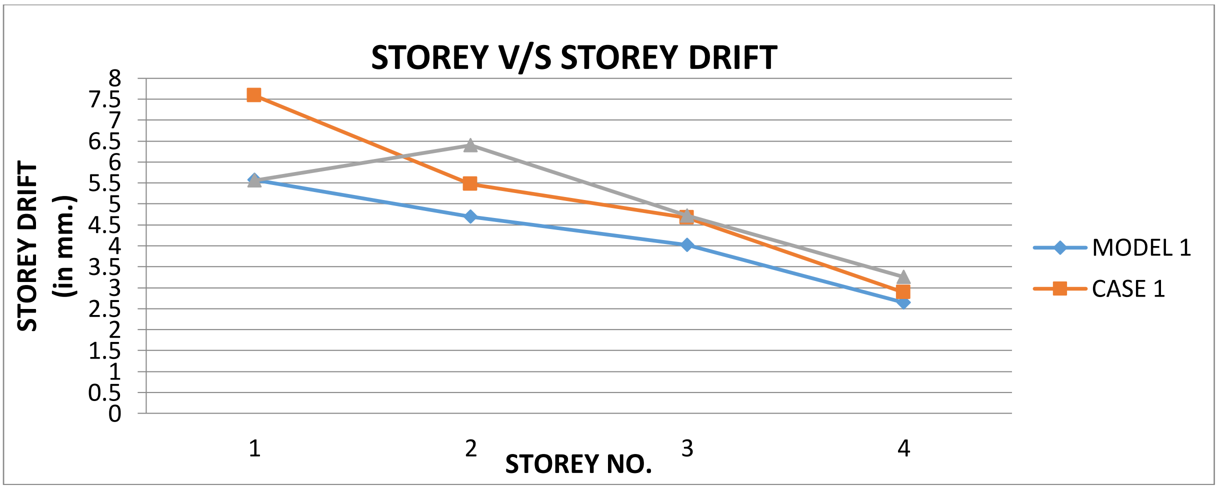


Storey drift in P+20 storey building, Zone 3, Soil Type – 2 (Medium soil)

INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

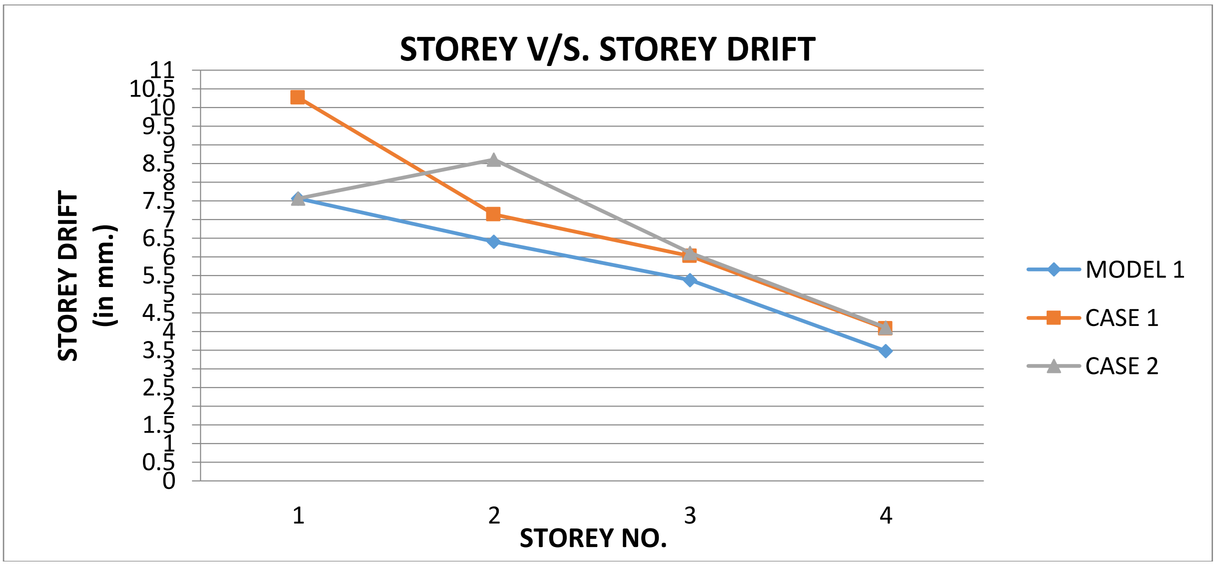


Storey drift in P+20 storey building, Zone 3, Soil Type – 3 (Soft soil)

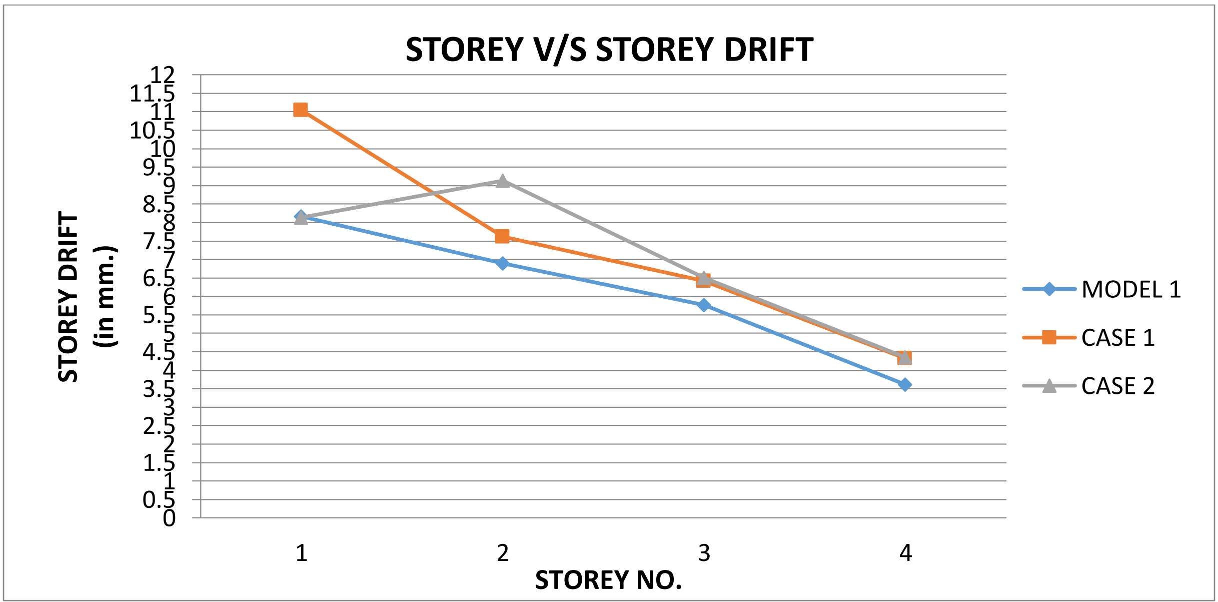


Storey drift in P+3 storey building, Zone 5, Soil Type – 1 (hard soil)

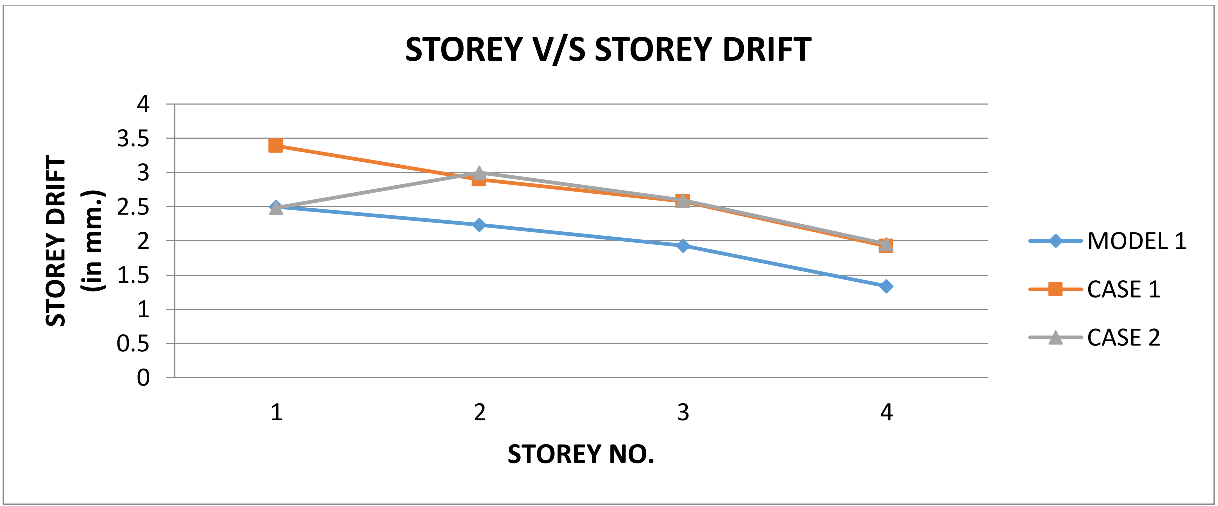
INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT



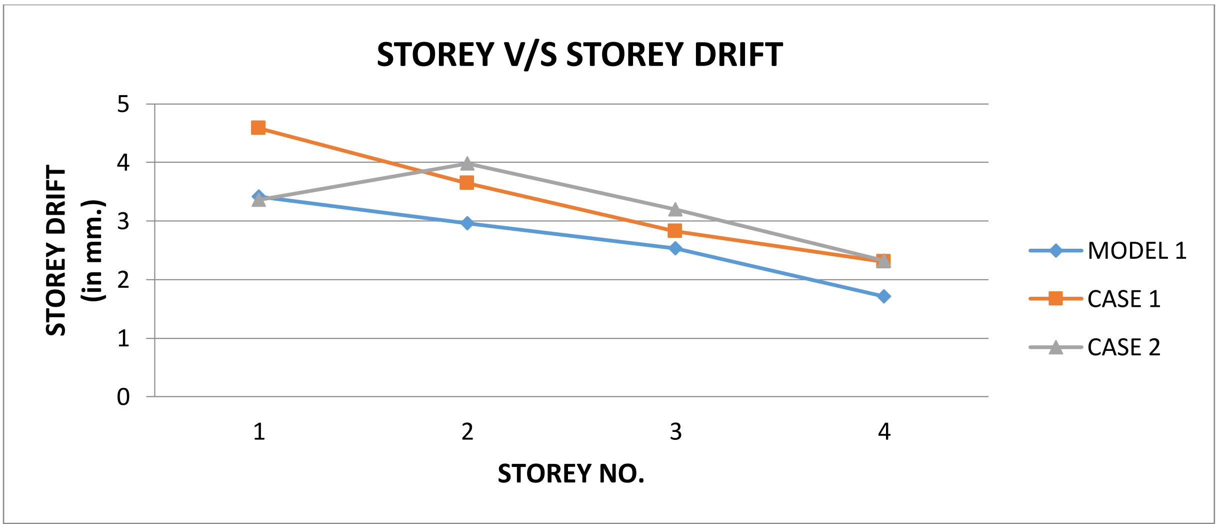
Storey drift in P+3 storey building, Zone 5, Soil Type – 2 (Medium soil)



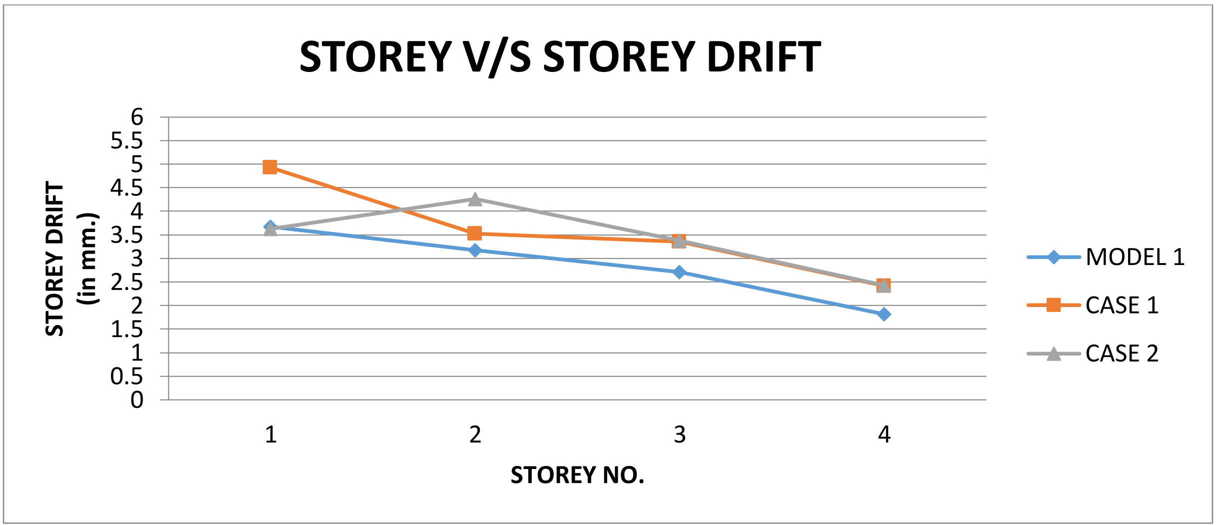
Storey drift in P+3 storey building, Zone 5, Soil Type – 3 (Soft soil)



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

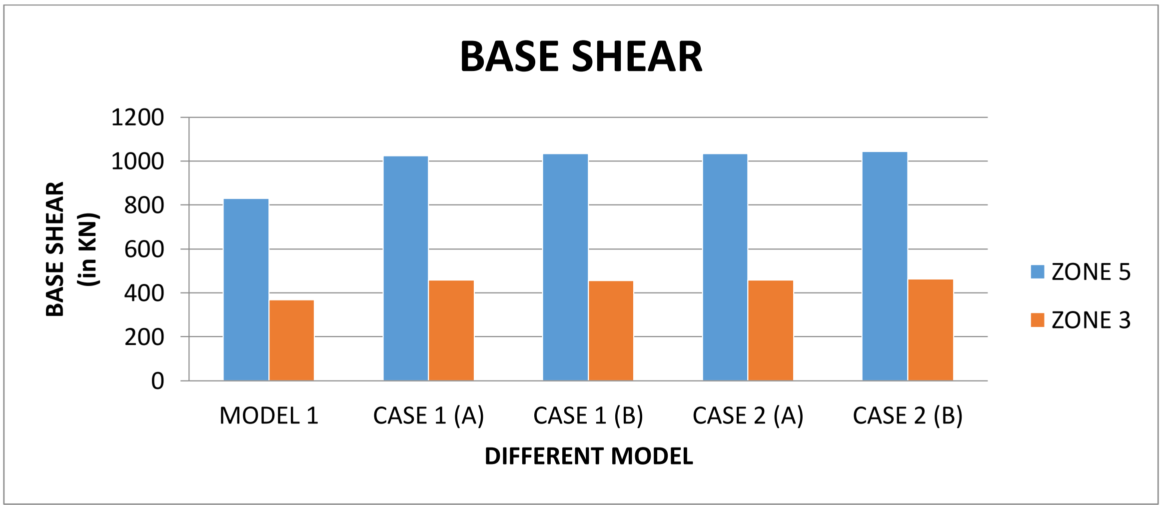


Storey drift in P+3 storey building, Zone 3, Soil Type – 2 (Medium soil)

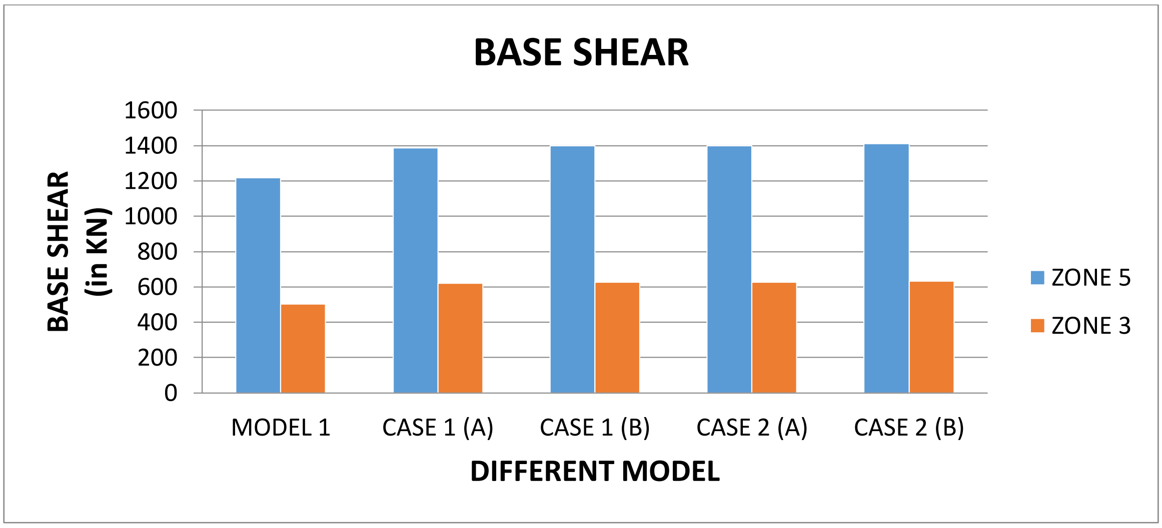


Storey drift in P+3 storey building, Zone 3, Soil Type – 3 (Soft soil)

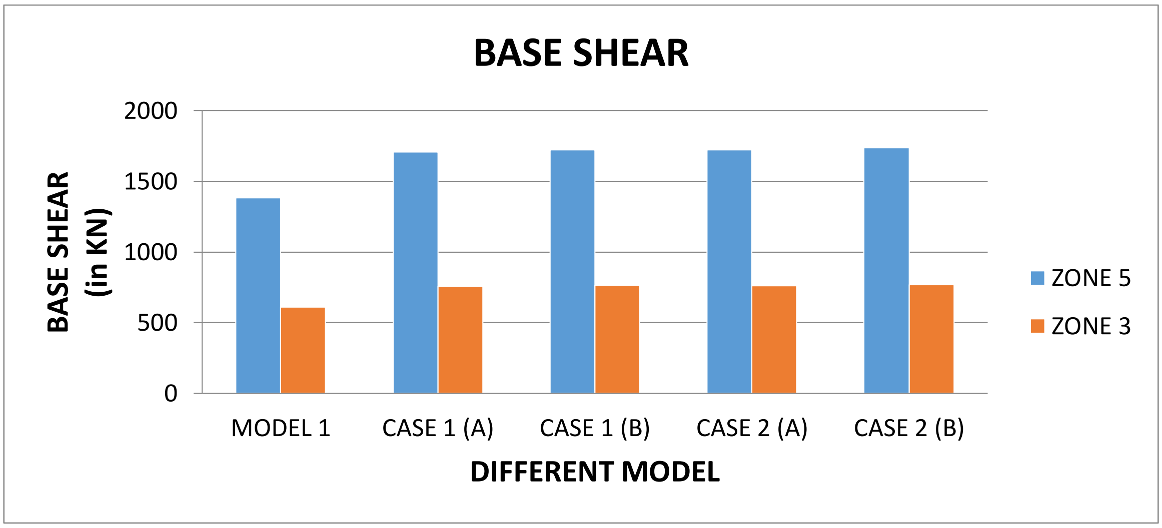
2. Base shear



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

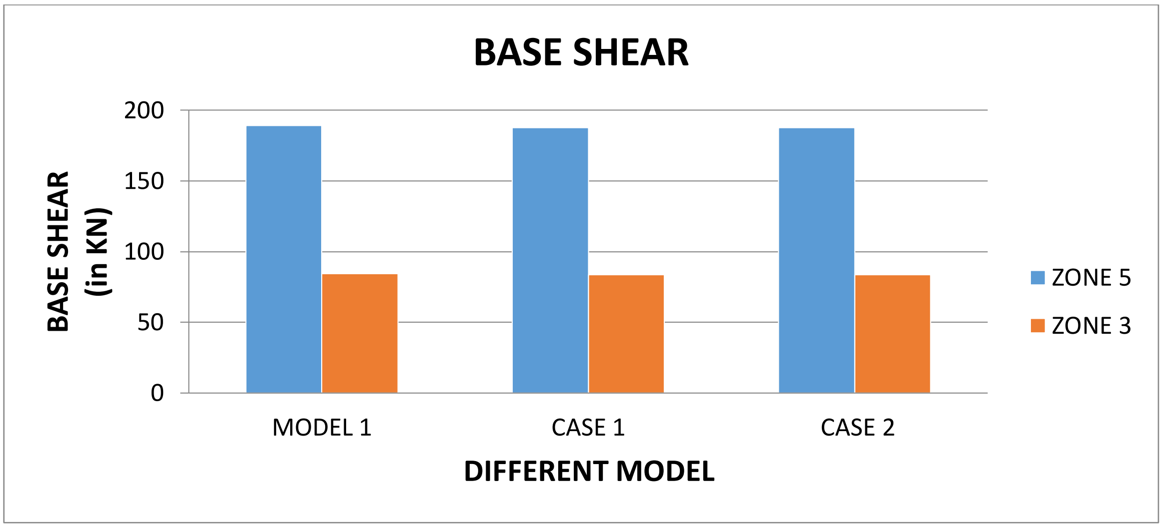


Base shear in P+20 storey building for different seismic zone, Soil Type – 2 (medium soil)

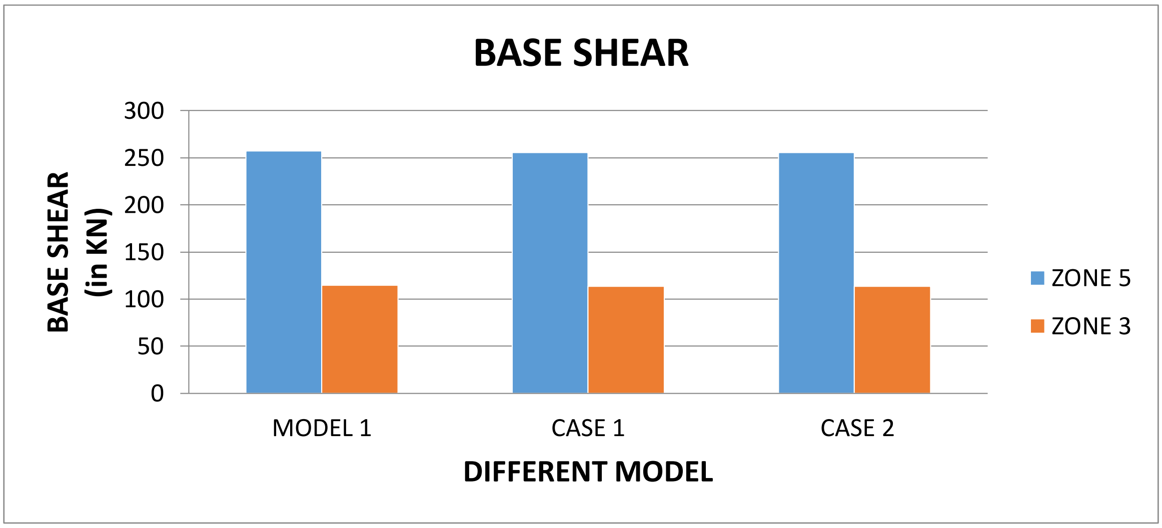


Base shear in P+20 storey building for different seismic zone, Soil Type – 3 (soft soil)

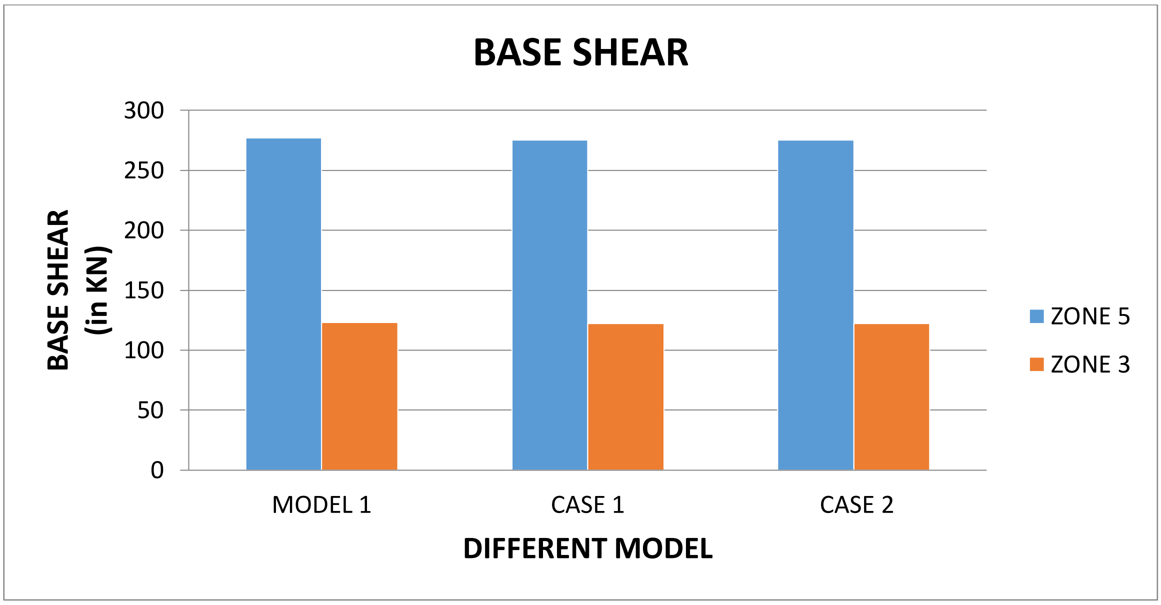
[Joshi * et al., 5(7): July, 2018] ISSN: 2349-5197
Impact Factor: 3.765
INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT



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



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



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

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 buildings having floating columns.
2. It was observed that the storey drift and base shear is more in soft soil than 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. In P+3 storey building storey drift is more when floating column are provided at first floor.
5. Base shear is more in building having floating column than building without floating column for P+20 storey building.
6. Base shear is almost same in P+3 storey building with and without floating columns.
7. Base shear in building having floating column is almost same for all the cases in P+20 storey building.
8. Values of base shear and storey drift are much more in seismic zone V than seismic zone III.

Hence it can be concluded 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.

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] Pratyush Malaviya, Saurav, "Comparative study of effect of floating columns on the cost analysis of a structure designed on Staad Pro v8i" IEEE Trans. Power System, vol. 19, no. 1, pp. 356–365, 2014.
[8] 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.
[9] Sabari S, Praveen J.V., "Seismic analysis of multistory building with floating column" IEEE Trans. Power System, vol. 19, no. 1, pp. 356–365, 2014.
[10] 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.