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SEISMIC ANALYSIS OF G+12 WITH AND WITHOUT FLOATING COLUMNS WITH ETABS

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Abstract: A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. The term floating column is also a vertical element which ends (due to architectural design/ site situation) at its lower level (termination Level) rests on a beam which is a horizontal member. The beams in turn transfer the load to other columns below it. Such columns where the load was considered as point load. Theoretically such structures can be analyzed and designed. In recent times, multi-storey buildings in urban cities are required to have column free space due to shortage of space, population and also for aesthetic and functional requirements. For these 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 behaviour of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. In the present study multistoried building with floating column is analyzed by ETABS. Here G+12 structure is analyzed with and without floating columns by using response spectrum method and time history method under earthquake load in zone II and compared with parameters like lateral loads, storey displacements, storey drifts, storey shears, storey stiffness and base shears. From the results it is observed that the storey displacements, storey drifts and storey shears are more for a building without floating columns when compared with a building with floating columns.

Keywords *-floating column, multi-storey buildings, earthquake forces, ETABS.*

1. INTRODUCTION

Many urban multi-storey buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height.

The behaviour of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. 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. Buildings with vertical setbacks (like the hotel buildings with a few storey wider than the rest) cause a sudden jump in earthquake forces at the level of discontinuity. Buildings that have fewer columns or walls in a particular storey or with unusually tall storey tend to damage or collapse which is initiated in that storey. Many buildings with an open ground storey intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path.

A. What is floating Column?

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. The term floating column is also a vertical element which (due to architectural design/ site situation) at its lower level (termination Level) rests on a beam which is a horizontal member. The beams in turn transfer the load to other columns below it.

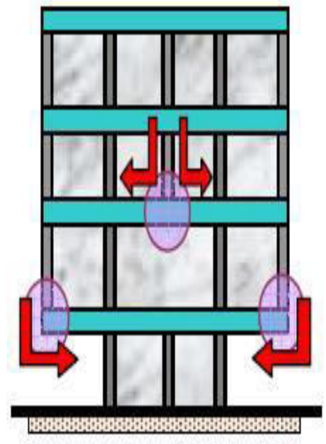

Figure.1: Hanging or floating columns

There are many projects in which floating columns are adopted, especially above the ground floor, where transfer girders are employed, so that more open space is available in the ground floor. These open spaces may be required for assembly hall or parking purpose. The transfer girders have to be designed and detailed properly, especially in earth quake zones. The column is a concentrated load on the beam which supports it. As far as analysis is concerned, the column is often assumed pinned at the base and is therefore taken as a point load on the transfer beam. STAAD Pro, ETABS and SAP2000 can be used to do the analysis of this type of structure. Floating columns are competent enough to carry gravity loading but transfer girder must be of adequate dimensions (Stiffness) with very minimal deflection.

Looking ahead, of course, one will continue to make buildings interesting rather than monotonous. However, this need not be done at the cost of poor behaviour and earthquake safety of buildings. Architectural features that are detrimental to earthquake response of buildings should be avoided. If not, they must be minimized. When irregular features are included in buildings, a

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considerably higher level of engineering effort is required in the structural design and yet the building may not be as good as one with simple architectural features.

Hence, the structures already made with these kinds of discontinuous members are endangered in seismic regions. But those structures cannot be demolished, rather study can be done to strengthen the structure or some remedial features can be suggested. The columns of the first storey can be made stronger, the stiffness of these columns can be increased by retrofitting or these may be provided with bracing to decrease the lateral deformation.

2. OBJECTIVE

The objective of the present work is to study the behaviour of g+12 buildings with and without floating columns under earthquake excitations. Finite element method is used to solve the dynamic governing equation. Response spectrum analysis and time history analysis is carried out for the multi-story buildings under different earthquake loading of varying frequency content. The base of the building frame is assumed to be fixed.

3. MODELLING AND ANALYSIS

The building structures with and without floating columns is analyzed using response spectrum method and time history method in ETABS 2016.

A. Building Data

1	Details of the building	
i	Structure	OMRF
ii	Number of stories	G+12
iii	Type of building	Regular and Symmetrical in plan
iv	Plan area	8.5 m x 8.5 m
v	Height of the building	36 m
vi	Storey height- Bottom story Typical story	3.0 m 3.0 m
vi	Support	Fixed
vi ii	Seismic zones	II
2	Material properties	
i	Grade of concrete	M30
ii	Grade of steel	Fe415
iii	Density of reinforced concrete	25 kN/m^3
iv	Young's modulus of M30 concrete, E_c	27386127.87 kN/m^2
v	Young's modulus steel, E_s	2 x $10^8 kN/m^2$
3	Type of Loads & their intensities	
i	Floor finish	1.5 kN/m^2
ii	Live load on floors	3 kN/m^2

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iii	wall load on beams		3.9 kN/m^2
iv	Parapet wall load		1 kN/ m^2
4	Seismic Properties		
i	Zones		
		II	0.10
ii	Importance factor (I)		1
iii	Response reduction factor (R)		5%
iv	Soil type		II
v	Damping ratio		0.05
vi	Time history function		Elcentro

Table.1 Description of the Building data

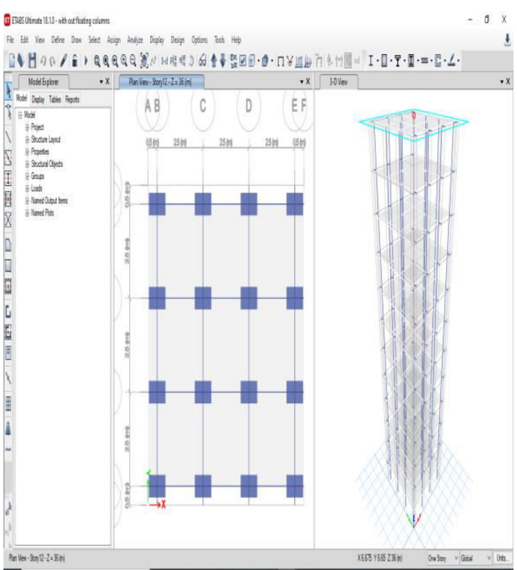

Figure.2: Model of G+12 building without floating columns

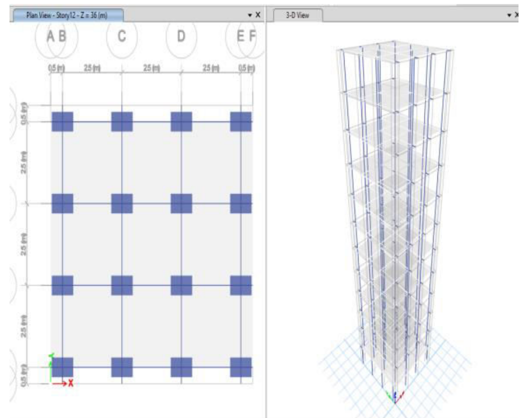

Figure.3: Model of G+12 building with floating columns

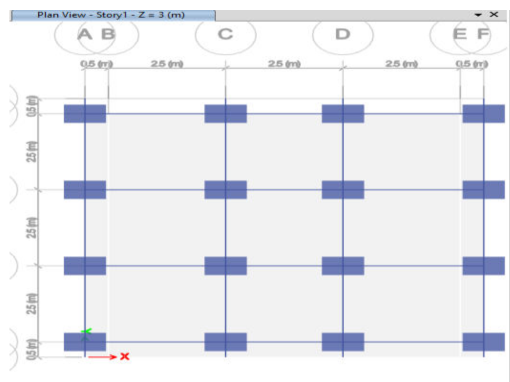

Figure.4: Plan of story 1 of the building with floating columns

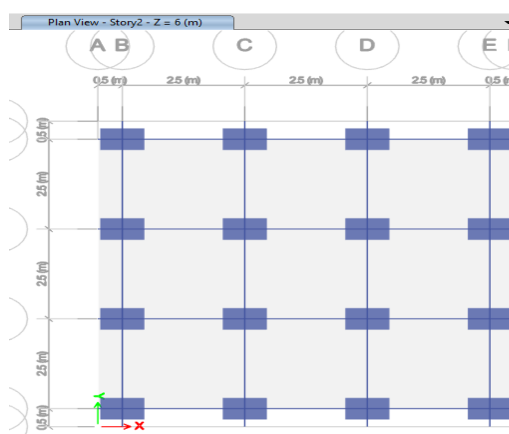

Figure.5: Plan of story 2 of the building with floating columns

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From the figures 3, 4 and 5 it is clear that the floating columns are provided in story 1 and the remaining storeys column placement is same as the normal building.

4. RESULTS & DISCUSSIONS

A. Results of Building without floating columns

a. Lateral Loads

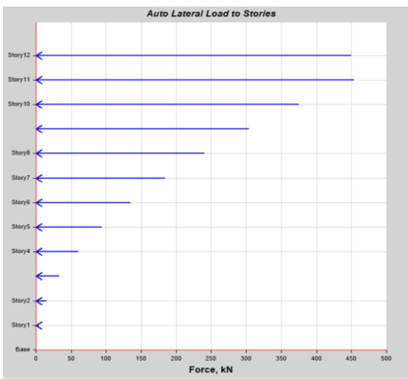

Figure.6: Lateral loads on stories in X-direction for a building without floating columns

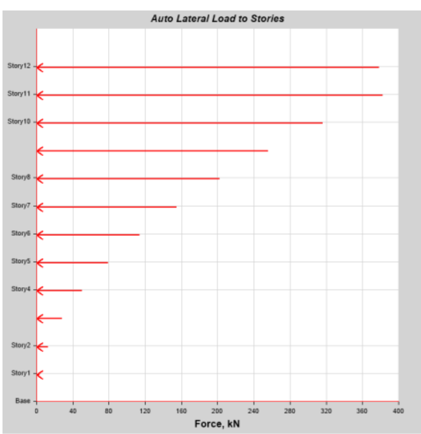

Figure.7: Lateral loads on stories in Y-direction for a building without floating columns

The lateral loads on a building with floating columns are 45% less than the building without floating columns.

b. Story Displacements

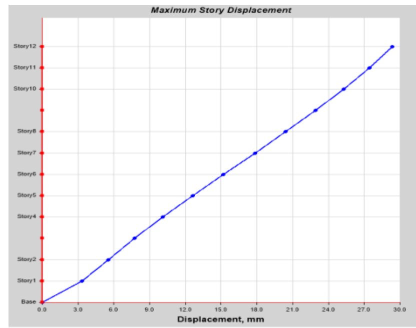

Figure.8: Storey displacements of a building without floating columns for EQ X

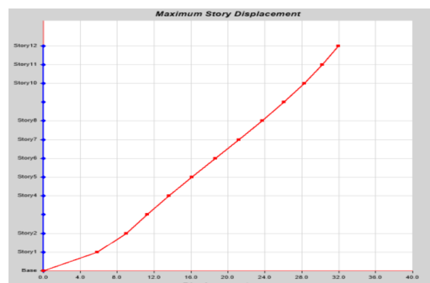

Figure.9: Storey displacements of a building without floating columns for EQ Y

The storey displacements of a building without floating columns are 50% more than the building with floating columns.

c. Story Drifts

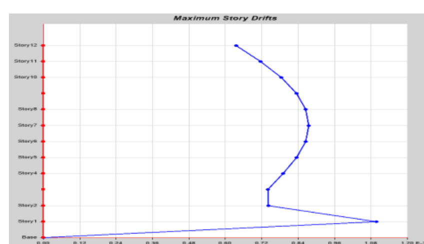

Figure.10: Storey drifts of a building without floating columns for EQ X

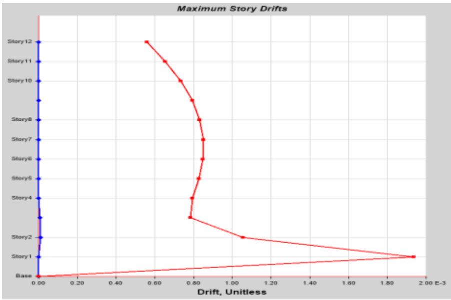

Figure.11: Storey drifts of a building without floating columns for EQ Y

d. Story Shears

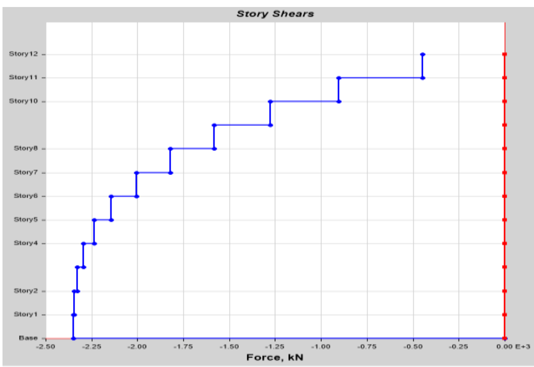

Figure.12: Storey shears of a building without floating columns for EQ X

The storey shears of a building with floating columns in X-direction are increasing with respect to Y-direction. The storey shears of a building with floating columns are 48% less than the building without floating columns.

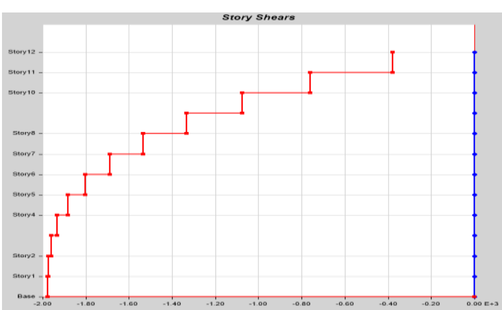

Figure.13: Storey shears of a building without floating columns for EQ Y

e. Storey Stiffness

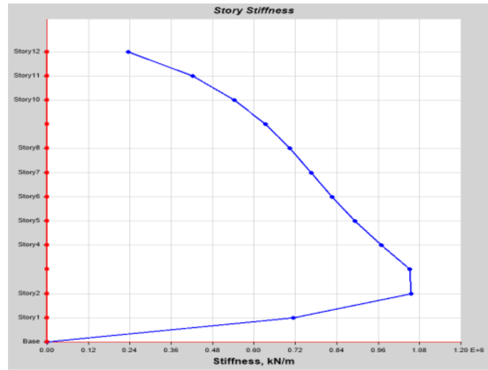

Figure.13: Storey stiffness values of a building without floating columns for EQ X

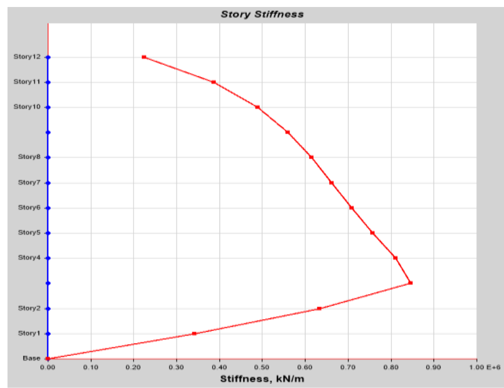

Figure.14: Storey stiffness values of a building without floating columns for EQ Y

f. Base Shear

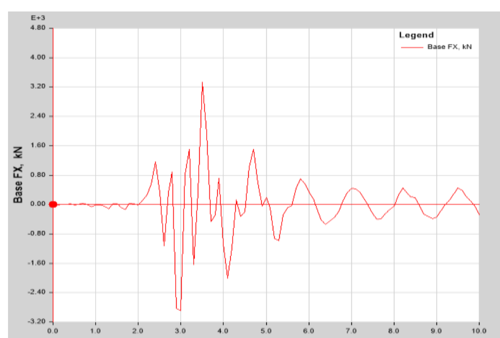

Figure.15: Base shear values of a building without floating columns at different time periods

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The maximum base shear occurred in building without floating columns is 3333.67 KN at 3.5 sec.

B. Results of Building with floating columns

a. Lateral Loads

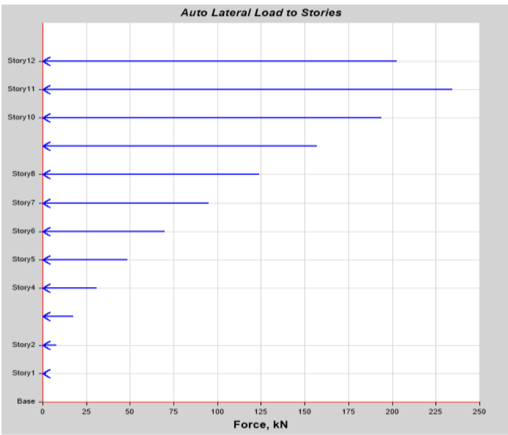

Figure.16 Lateral loads on stories in X-direction for a building with floating columns

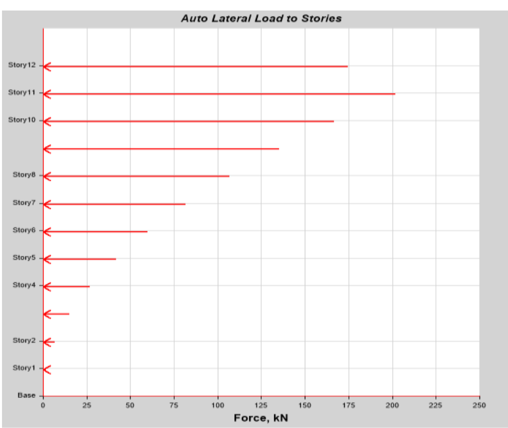

Figure.17 Lateral loads on stories in Y-direction for a building with floating columns

b. Story Displacements

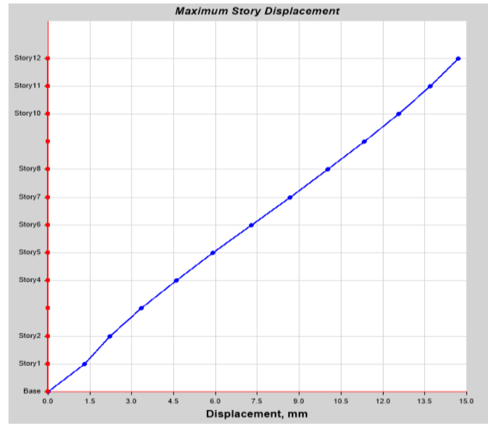

Figure.18: Storey displacements of a building with floating columns for EQ X

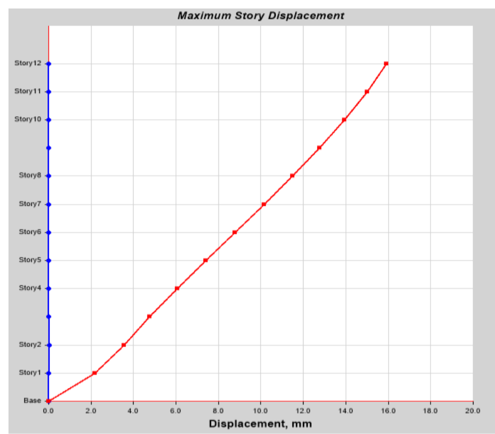

Figure.19: Storey displacements of a building with floating columns for EQ Y

The storey displacements of a building with floating columns in X-direction are increasing with respect to Y-direction. The storey displacements of a building with floating columns are 50% less than the building without floating columns.

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c. Story Drifts

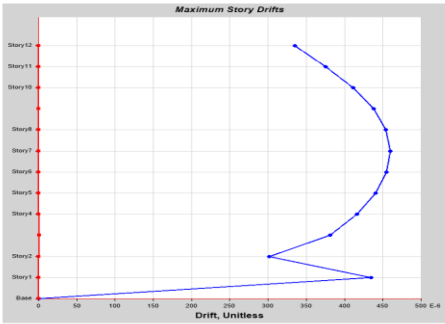

Figure.20: Storey drifts of a building with floating columns for EQ X

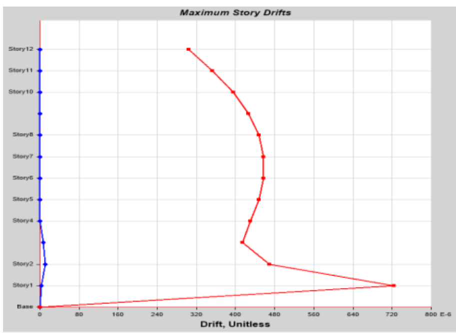

Figure.21: Storey drifts of a building with floating columns for EQ Y

The storey drifts of a building with floating columns in Y-direction are increasing with respect to X-direction. The storey drifts of a building with floating columns are 60% less than the building without floating columns.

d. Story Shears

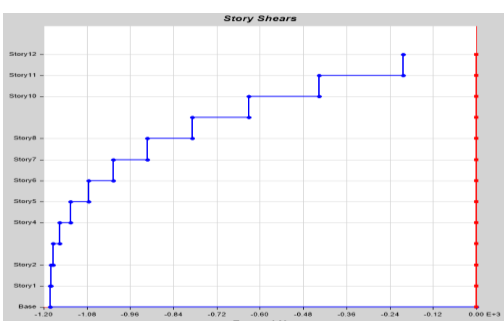

Figure.22: Storey shears of a building with floating columns for EQ X

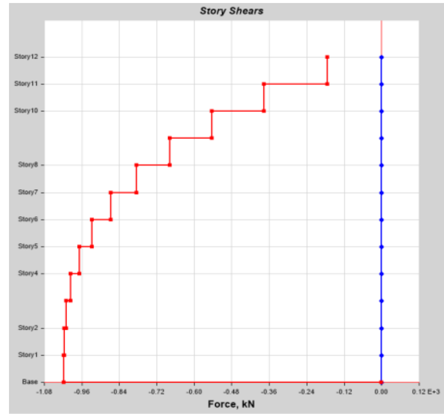

Figure.23: Storey shears of a building with floating columns for EQ Y

e. Storey Stiffness

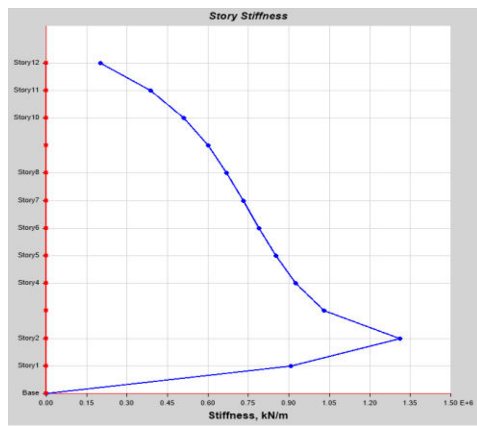

Figure.24: Storey stiffness values of a building with floating columns for EQ X

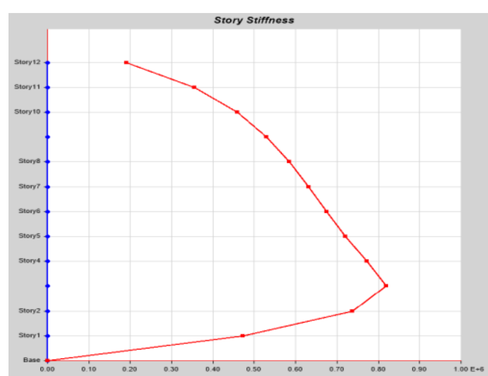

Figure.25: Storey stiffness values of a building with floating columns for EQ Y

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It was observed that building with floating column is stiffer than the building without floating columns.

f. Base Shear

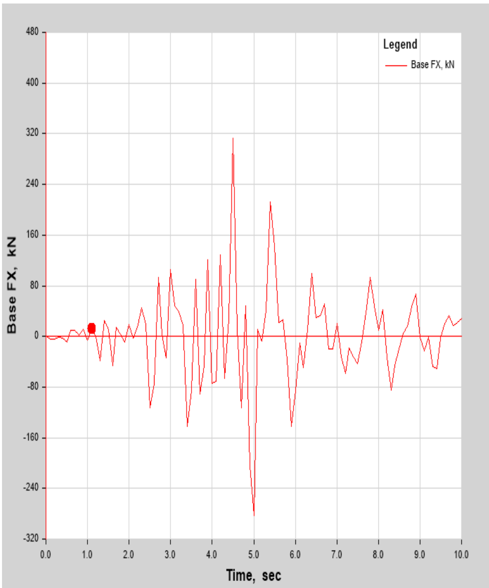

Figure.26: Base shear values of a building with floating columns at different time periods

The maximum base shear occurred in building with floating columns is -283.4257 KN at 5 sec.

5. CONCLUSION

The behaviour of multi-storey building with and without floating column is studied under different earthquake excitation. The compatible response spectrum, time history and Elcentro earthquake data has been considered. A finite element model has been developed to study the dynamic behaviour of multi -story frame. The static and free vibration results obtained using present finite element code is validated. The dynamic analysis of frame is studied with and without floating columns. It is concluded that

- The storey displacements of a building with floating columns in X-direction are increasing with respect to Y-direction. The storey displacements of a building with floating columns are 50% less than the building without floating columns.
- The storey drifts of a building with floating columns in Y-direction are increasing with respect to X-direction. The storey drifts of a building with floating columns are 60% less than the building without floating columns.
- The storey shears of a building with floating columns in X-direction are increasing with respect to Y-direction. The storey shears of a building with floating columns are 48% less than the building without floating columns.
- It was observed that building with floating column has less base shear as compared to building without floating column. The maximum base shear occurred in building with floating columns is -283.4257 KN at 5 sec and the maximum base shear occurred in building without floating columns is 3333.67 KN at 3.5 sec.
- It was observed that in building with floating column has more time period as compared to building without floating columns.
- With increase in ground floor column the maximum displacement, inter storey drift values are reducing. The base shear and overturning moment vary with the change in column dimension.
- The lateral loads on a building with floating columns are 45% less than the building without floating columns.
- It was observed that building with floating column is stiffer than the building without floating columns.

FUTURE SCOPE

This study can be extended by providing the floating columns in different storeys and at different locations. We can study in severe earthquake zones by providing the earthquake resistant structural elements to the building with floating columns.

7. REFERENCES

a. Maison Bruce F. and Neuss Carl F., "Dynamic analysis of a forty four story building", Journal of Structural Engineering, Vol. 111, No. 7, Page No:1559- 572,July, 1985.ISSN: 2395 -0056

b. Maison and Ventura (1991)ISSN: 0924-0829 Pages 7787-7594

c. Arlekar Jaswant N, Jain Sudhir K. and Murty C.V.R, (1997), "Seismic Response of RC Frame Buildings with Soft First Storeys". Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi.

d. Awkar J. C. and Lui E.M, "Seismic analysis and response of multistory semirigid frames", Journal of Engineering Structures, Volume 21, Issue 5, Page no: 425-442, 1997.

e. Agarwal Pankaj, Shrikhande Manish (2009), "Earthquake resistant design of structures",PHI learning private limited, New Delhi.

f. Balsamoa A, Colombo A, Manfredi G, Negro P & Prota P (2005), "Seismic behavior of afull-scale RC frame repaired using CFRP laminates". Engineering Structures 27 (2005) 769–780.

g. Bardakis V.G., Dritsos S.E. (2007), "Evaluating assumptions for seismic assessment ofexisting buildings ".Soil Dynamics and Earthquake Engineering 27 (2007) 223–233.

h. Brodericka B.M., Elghazouli A.Y. and Goggins J, "Earthquake testing and responseanalysis of concentrically-braced sub-frames", Journal of Constructional Steel Research, Volume 64, Issue 9, Page no: 997-1007, 2008.

i. Garcia Reyes, Hajirasouliha Iman, Pilakoutas Kypros, (2010),"Seismic behaviour ofdeficient RC frames strengthened with CFRP composites". Engineering Structures 32 (2010) 3075-3085.

j. Hartley Gilbert and Abdel-Akher Ahmed, "Analysis of building frames" Journal ofStructural Engineering, Vol. 119, No. 2, Page no: 468-483, 1993.

k. K. N. V. Prasada Rao, K. Seetharamulu, and S. Krishnamoorthy, "Frames with staggeredpanels: experimental study", Journal of Structural Engineering, VOL 110, No. 5, Page no: 1134-1148, 1984.