SEISMIC ANALYSIS OF MULTI-STOREY BUILDING WITH FLOATING COLUMNS USING ETABS

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ABSTRACT: **Now a day multi-storey buildings are constructed for the purpose of residential, commercial etc., with open ground storey is becoming common feature. For the purpose of parking all, usually the ground storey is kept free without any construction except columns. Buildings which have discontinuity of columns and building having columns which transfer load to the beams in lateral direction are called as floating column building. A column is meant to be an upright member ranging from footing level and conveying the load to the lowest. The term floating-column is additionally an upright member that ends (due to subject field design/ web site situation) at its lower level (termination Level) rests on a beam that may be a horizontal member. The beams successively transfer the load to alternative columns below it. Such columns in structures will be analyzed and designed. Results are compared in the form of Storey displacements, Storey Shear with & without columns. Also the Zone wise results are compared using tables & graph to find out the most optimized solution. ETABS 2015 has been utilized for analyzing the above Building Structure.**

KEYWORDS- **Response Spectrum, Grid Slab, Time history, Nonlinear Analysis and ETABS.**

1. INTRODUCTION
1.1: GENERAL

Portal frames are the structures which have beams and columns that are connected by rigid joints. Floating columns are the structures which have columns that rest on beams, beam being the support to the columns on 1st slab and above the structure the bottom ground floor is kept open by using minimum number of columns which would take the entire load that will come from beams to the basement columns and transfer it to the earth. Floating column structures are the structures which are of more interest of architects all over the world. Because of the advantage that more open space is available due to the limit use of columns without many obstacles. These are more commonly used in urban areas where space is an issue. All the recent multi-storey buildings are made by the concept of floating columns. These structures are not included in is code because these structures cannot sustain seismic forces and likely to get damaged. Many buildings in Gujarat Bhuj area where found was constructed with open 1st storey that collapsed in earthquake in 2001.the conventions structures are recommended for areas in seismic zones. These structures are not dynamically reliable; the static reliability of structures with floating column is required to be studied.

FLOATING COLUMN:

The floating column is a vertical member which rest on a beam and doesn't have a foundation. The floating column act as a point load on the beam and this beam transfers the load to the columns below it. But such column cannot be implemented easily to construct practically since the true columns below the termination level are not constructed with care and hence finally cause to failure.

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.

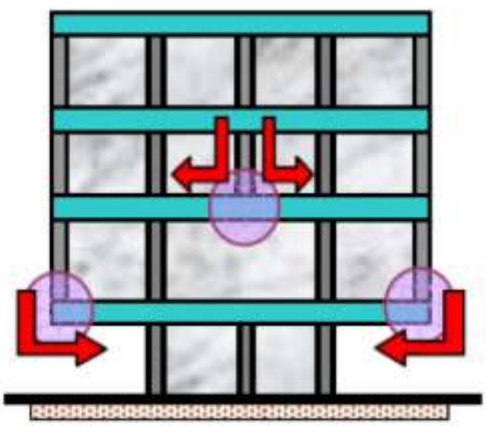

Fig-1.1: Floating column

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. Floating columns are competent enough to carry gravity loading but transfer girder must be of adequate dimensions (Stiffness) with very minimal deflection.

2. OBJECTIVES

The main objectives of the proposed work are:

1. To model the building using software ETABS Ver 2016 for analysis purpose.
2. To carry out Linear Dynamic analyses for different cases by varying the location of floating columns floor wise.
3. To study the structural response of the building models with respect to following aspects-
   - Storey displacement.
   - Storey drifts.
   - Base Shear.

3. METODOLOGY

In the proposed work there are 2 models of buildings, building without floating column and building with floating column at different floor levels. Comparing seismic parameter such time period, base shear, storey displacement, storey drift for both models. Seismic analysis is done by linear static and linear dynamic method by using ETABS.

3.1 ANALYTICAL PROCEDURES

METHODS OF ANALYSIS:

1. Linear Static: Linear analysis techniques give a good suggestion of elastic capability of the structures and indicate where first yielding will arise. The linear static method of analysis is limited to undersized, reliable buildings.

2. Linear Dynamic: In IS:1893,2002 (Part 1) two methods, one Seismic factor and other Response Spectrum method is described to carry out the analysis for Earthquake forces. One Table (in Clause 4.2.1) is also provided to decide upon the method to be used, depending upon structure elevation and seismic zone. At the lowermost of this table, it is evidently mentioned that structures with irregular shape and/or irregular dissemination of mass and stiffness in x and/or y plane, shall be analyzed as per Response Spectrum approach. For all practical reasons, no structure is uniform in all the respects (i.e. mass/stiffness, shape distribution in x and y plane). This means that for no structures, the Seismic Co-efficient method shall be helpful. Response Spectrum approaches, being time elapsing and tiresome process, mostly, computer applications are possible.

3. Non-linear Static: In a nonlinear static analysis technique the building model integrates directly the nonlinear force-deformation features of individual components and elements due to inelastic physical response. Several methods (ATC40, FEMA273) existing and all have in common that the nonlinear force–deformation features of the building is characterized by a Pushover curve, PO curve of base shear vs. top translation, obtained by subjecting the building model to monotonically augmenting lateral forces or augmenting translations, distributed over the peak of the building in correspondence to the first mode of vibration until the building disintegrates. The maximum translation likely to be experienced during a given earthquake is determined using either highly damped or inelastic response spectra.

3.2 STRUCTURAL MODELLING:

SPECIFICATIONS	
Height of the structure	21m
Number of floors	7
Floor area	600m^2
Live Load	3KN/m^2
Density of RCC considered	25KN/m^3
Thickness of slab	150mm
Depth of beam	300mm
Width of beam	300mm
Dimension of column	300x300mm
Height of each floor	3m
Live load	3KN/m^2
Live load after applying reduction factor	3 X 0.25 = 0.75KN/m^2
Roof live load	2KN/m^2
Seismic zones	V
Zone factor	0.36
Importance factor	1
Soil type	Hard (I) and Medium (II)

Response reduction factor	5 (special moment resisting frame, SMRF)
Material used	M25, Fe 500
Damping	5%

MODEL-1: Structure without floating column

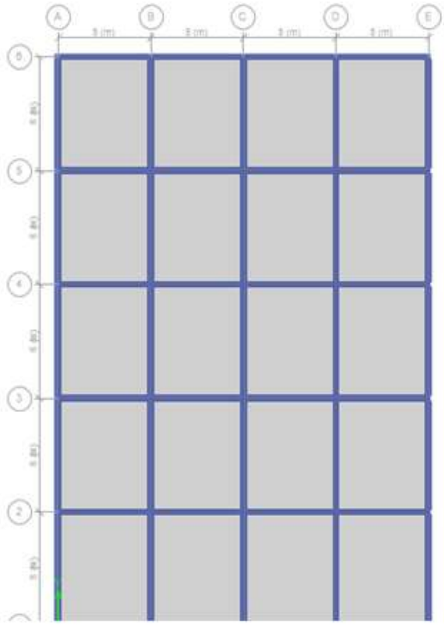

Fig-3.2(a): PLAN

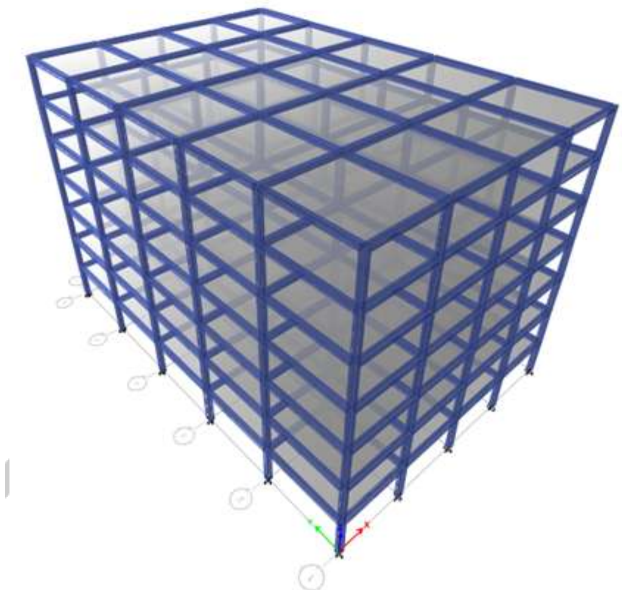

Fig-3.2(b): 3D-ELEVATION

4. RESULTS AND DISCUSSION

4.1 MODEL-1:
For zone-V and hard soil

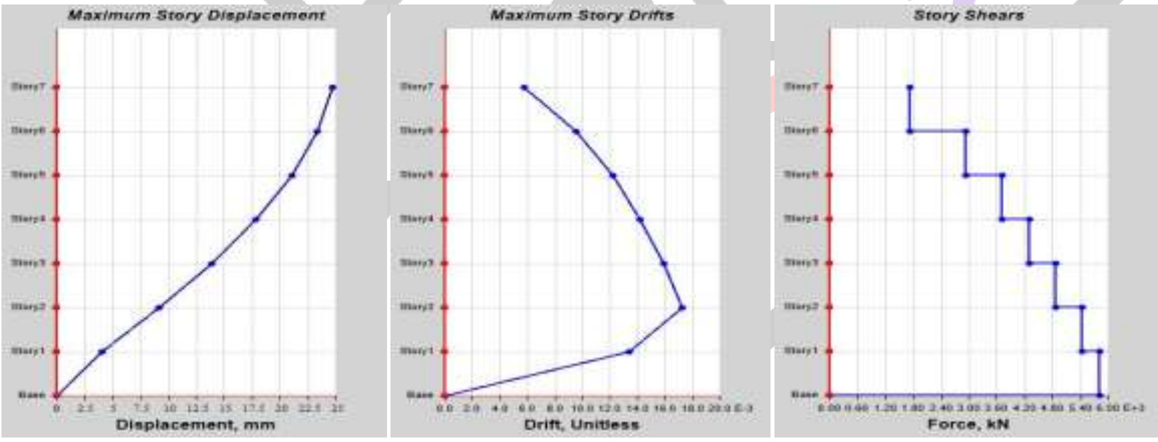

Fig-4.1: Storey Displacement ,Storey Drifts, Base Shear

- From Fig-4.1 Maximum and Minimum Storey Displacement found to be in X direction 24.7mm and 4.02mm for Storey-7 and Storey-1. Maximum and Minimum Storey Displacement found to be in Y direction 0.004221mm for Storey 1 and 0.003221mm for Storey7.
- Maximum and Minimum Storey Drifts in X direction found to be for storey 2 0.017275 and storey 7 0.005731 and in Y direction for storey 1- 1.40E-05 and storey4-6.00E-06.
- Base Shear decreasing gradually from Storey 1 (5819.0152kN) to Storey 7(1717.7437kN) as storey height increases base shear decreases. Base shear is maximum at base only.

For zone-V and Medium soil

Fig-4.2: Storey Displacement, Storey Drifts, Base Shear.

- From Fig- 4.2 Maximum and Minimum storey displacement found to be in X direction 18.18mm and 3.0mm for Storey7 and Storey1. Maximum and minimum storey displacement found to be in Y direction 0.003436mm for Storey1 and 0.002126mm for Storey5.
- Maximum and Minimum storey drifts in X direction found to be for Storey 2 0.012765 and Storey 7 0.004523 and in Y direction for Storey 1 1.10E-05 and Storey4 5.00E-06.
- Base Shear decreasing gradually from Storey 1 (4353.4799kN) to Storey 7(1384.2836kN) as storey height increases base shear decreases base shear is maximum at base only.

4.2 Model -2:
For Zone-V and Hard soil

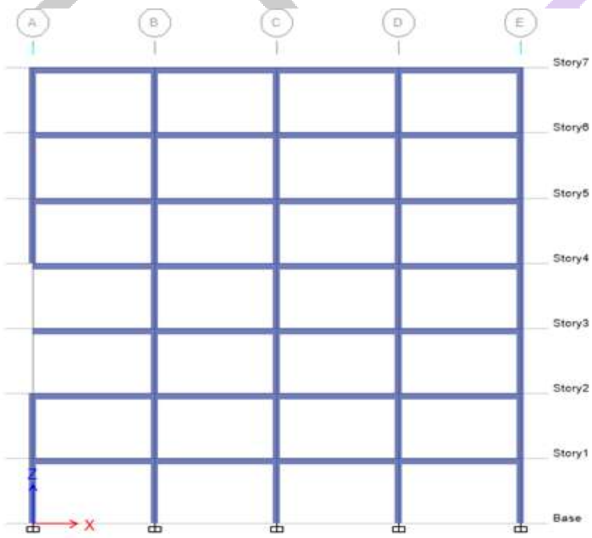

Fig-4.3: Elevation of Model-3

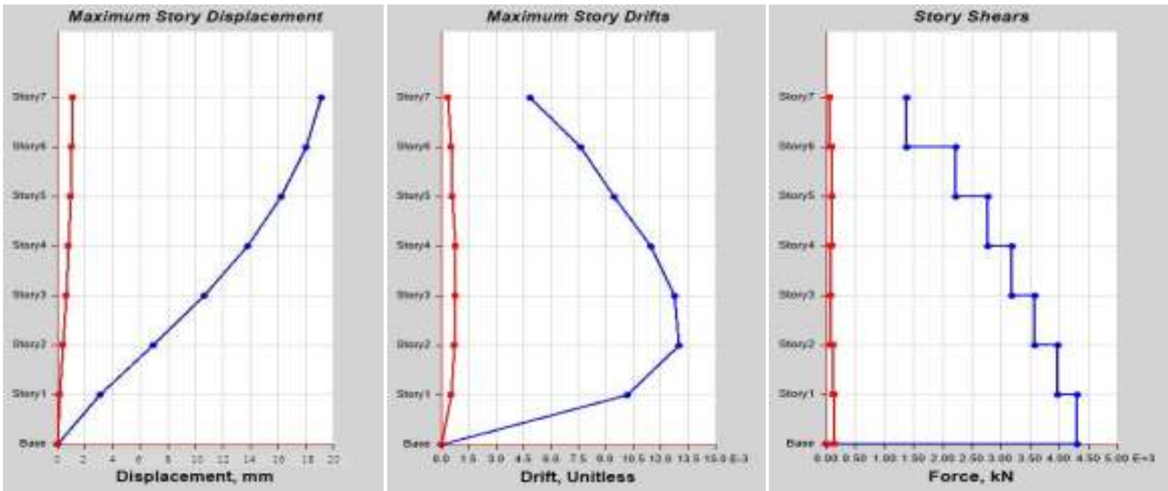

Fig-4.4: Storey Displacement, Storey Drifts, Base Shear

- From Fig-4.15 Maximum and Minimum Storey Displacement found to be in X direction 19.1mm and 3.05mm for Storey 7 and Storey 1.Maximum and Minimum Storey Displacement found to be in Y direction 1.13mm for Storey 7 and 0.17mm for Storey1.
- Maximum and Minimum Storey Drifts in X direction found to be for Storey 2 0.012988 and Storey 7 0.004843 and in Y direction for Storey 3 0.000787 and Storey6 0.000359.
- Base Shear decreasing gradually from Storey 1 (4314.0677kN) to Storey 7(1378.6686kN) as storey height increases base shear decreases. Base Shear is maximum at base only.

For zone-V and Medium soil

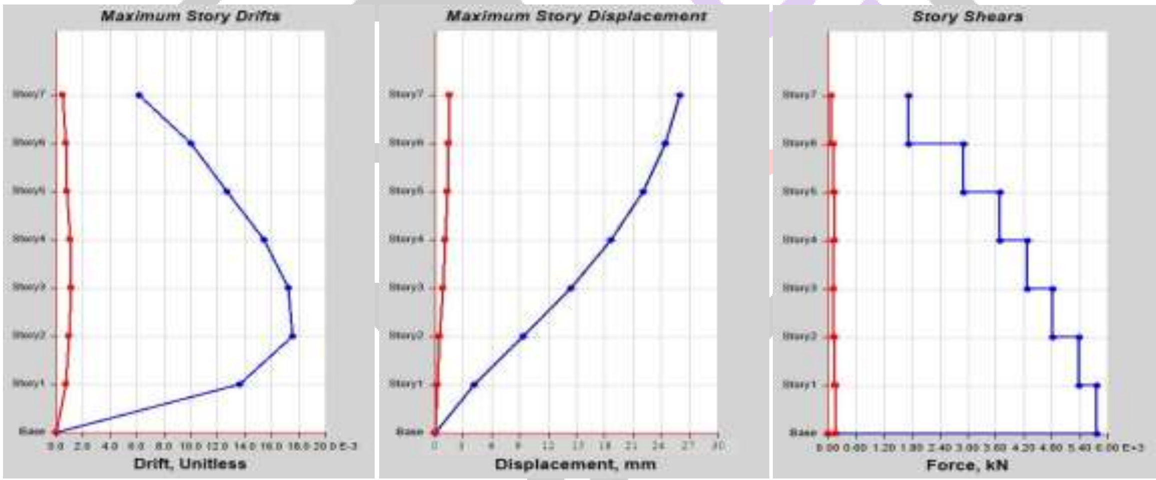

Fig-4.5: Storey Displacement, Storey Drifts, Base Shear

- From Fig-4.5Maximum and Minimum Storey Displacement found to be in X direction 25.95mm and 4.09mm for Storey 7 and Storey 1.Maximum and Minimum Storey Displacement found to be in Y direction 1.53mm for Storey 7 and 0.22mm for Storey1.
- Maximum and Minimum Storey Drifts in X direction found to be for Storey 2 0.017578 and Storey 7 0.006166 and in Y direction for Storey 2 0.000972 and Storey7 0.000469.
- Base Shear decreasing gradually from Storey 1 (5766.7957kN) to Storey 7(1714.3024kN) as storey height increases base shear decreases. Base Shear is maximum at base only.

4.3 MODEL -3:

For Zone-v and hard soil

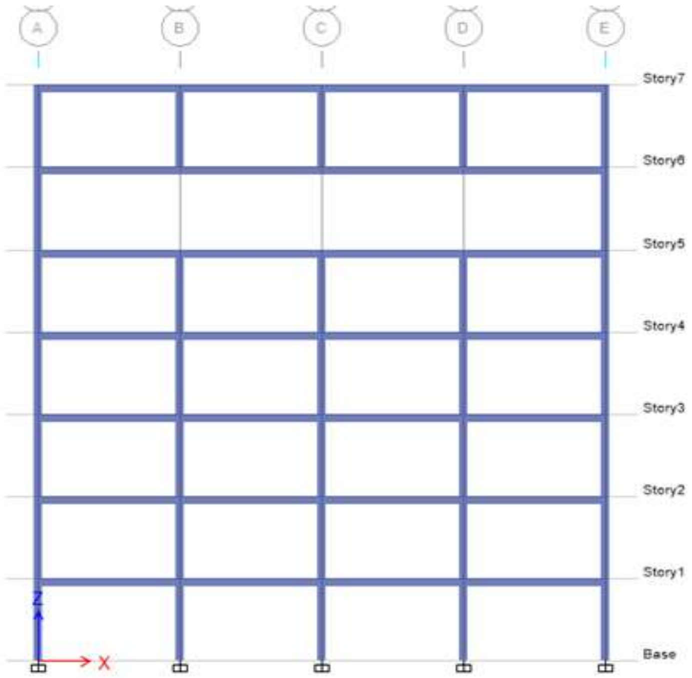

Fig-4.6: Elevation of Model-3

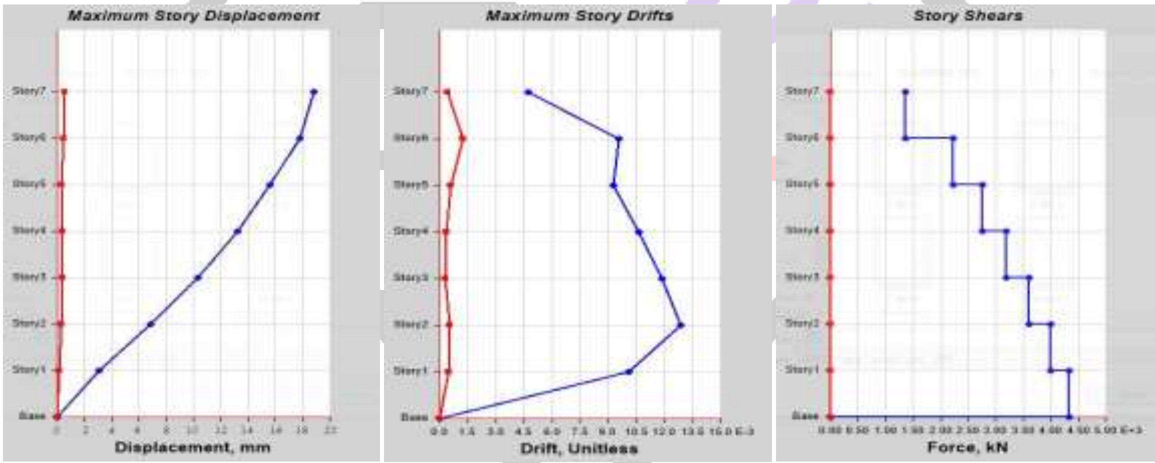

Fig-4.7: Storey Displacement, Storey Drift, Base Shear

- From Fig-4.7 Maximum and Minimum Storey Displacement found to be in X direction 18.8mm and 3.04mm for Storey 7 and Storey 1. Maximum and Minimum Storey Displacement found to be in Y direction 0.57mm for Storey 7 and 0.15mm for Storey1.
- Maximum and Minimum Storey Drifts in X direction found to be for Storey-2 0.012903 and Storey-7 0.004747 and in Y direction for Storey-6 0.001226 and Storey-3 0.000304.
- Base Shear decreasing gradually from Storey 1 (4321.4253kN) to Storey 7(1363.4856kN) as storey height increases base shear decreases. Base Shear is maximum at base only.

For Zone-V and Medium Soil

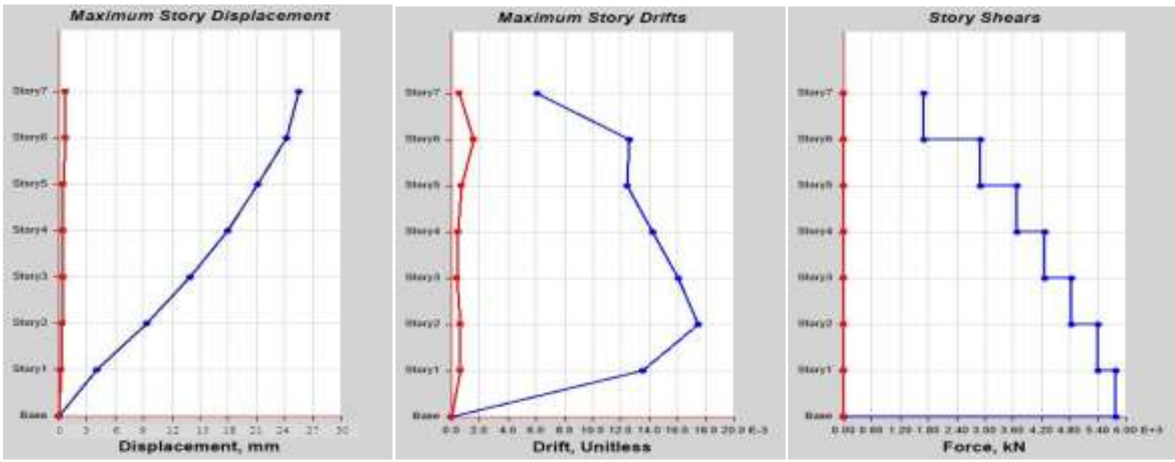

Fig-4.8: Storey Displacement, Storey Drift, Base Shear

- From Fig-4.8 Maximum and Minimum Storey Displacement found to be in X direction 25.54mm and 4.07mm for Storey 7 and Storey 1. Maximum and Minimum Storey Displacement found to be in Y direction 0.75mm for Storey 7 and 0.18mm for Storey1.
- Maximum and Minimum Storey Drifts in X direction found to be for Storey 2 0.017469 and Storey 7 0.006081 and in Y direction for Storey 6 0.001574 and Storey3 0.00039.
- Base Shear decreasing gradually from Storey 1 (5785.2726kN) to Storey 7(1707.0735kN) as storey height increases base shear decreases. Base Shear is maximum at base only.

5. CONCLUSIONS

Building with and without floating columns are considered for the analysis. All building frames had plan symmetry. Response spectrum analysis was conducted for each building located in hard soil and medium soil and corresponding story displacements, story drifts, and base shear were compared.
Results can be summarized as follows:

1. According to results obtained, the storey shear force was found to be maximum for the first storey and it decreased to a minimum in the top storey.
2. According to results obtained, it was found that building located in medium soil experience 25%larger base shear than building located in hard soil.
3. The building with floating column at bottom stories experiences same base shear but has larger inter storey drifts when compared with the building with floating column at the periphery of the building.
4. Building located in hard soil exhibits less displacement and drifts when compared with building located in medium soil.
5. Building without floating column shows 35% lesser displacement when compared with the buildings with floating columns.

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