To Compare Seismic Response of RC Frame with Raft Footing Considering Different Soil Types using Sap2000

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Abstract

One common type of multi-storeyed building having raft foundation resting on different type of soil i.e. soft soil, medium hard soil, hard soil. This multi-storeyed building compared with seismic parameter using software aid. And an attempt is made here to compare seismic parameter on multi storeyed building having raft foundation resting on three different type of soil i.e. hard soil, medium hard soil, and soft soil. And also made to understand the effect of soil flexibility on the performance of building frames resting on raft foundation. Our project involves comparative study of seismic parameter of multistoried building having raft foundation with different soil type using very latest designing software SAP2000. The building is subjected to both the vertical loads as well as horizontal loads. The vertical loads consist of dead load of structural components such as beam, column, slab etc. The horizontal load consist of seismic load. Thus these multistoried will be design for live load, dead load, as per IS 456-2000 and seismic load as per IS 18930-1993 and other than earthquake design load as per IS 875 (part-1, 2, 3). The building will be analyzed for the maximum and a minimum bending moment and shear force by using software SAP2000.
Keyword- Building, Loads, Performance, Raft Foundation, Soil

I. INTRODUCTION

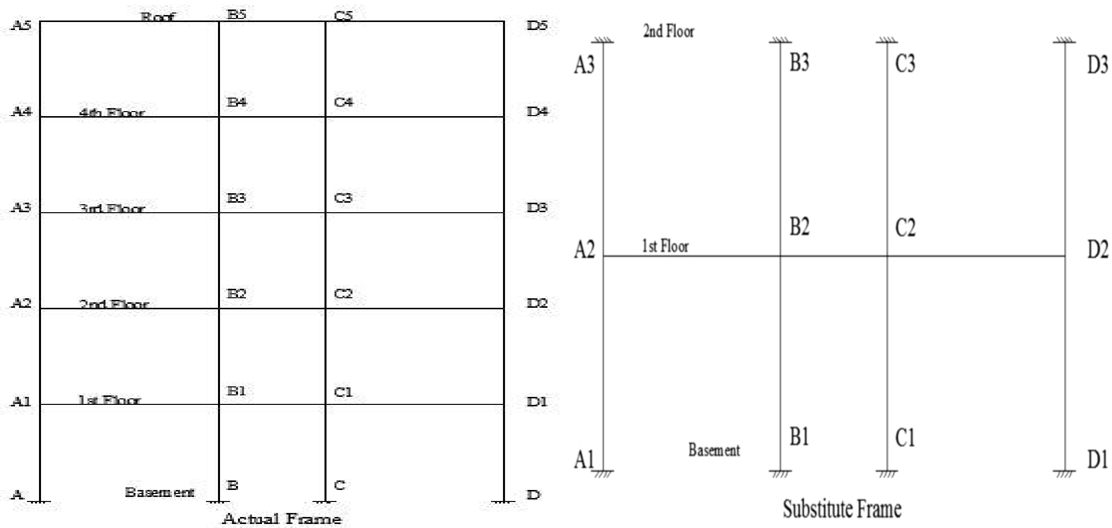
The analysis of a multi-panelled building frame is very cumbersome, since the frame contains a number of continuous beams and columns. As stated the effect of loading on the span upon other spans is much smaller. The moments in any beam or column are mainly due to the load on spans very close to it. Loads on distant spans do not have appreciable effect. Due to this, a simple method of analysis, accurate enough for practical purpose, is used by analyzing a small portion of the frame, called “substitute frame” rather than analysis of the whole frame.

It has been found by exact analysis that the moments carried from floor to floor, through columns, are very small in compaction to the beam moments. In other words, the moments in one floor have negligible effect of the moments of the floor above and below it. Therefore, a substitute frame consists of one floor, connected above and below with their far end either hinged or fixed or restrained. Below figure “Actual Frame” shows a building frame consisting of five storey and three bays. Figure “Substitute Frame”shows the substitute frame for determine bending moment in the second floor. Generally, it is sufficient to consider two adjacent spans on each side of joint considered. The substitute frame gives the results which are safe for all practical purpose.

Types of Substitute Frames: Under ordinary conditions, the following three types of substitute structure are considered sufficient:

1) Three-span structure with two storey columns
2) Substitute frame for wall columns
3) Substitute frame for two panel wide building.

Below figure “Actual Frame” shows the most general substitute frame consisting of three span, two-storey substitute structure with irregular spacing of columns. Figure “Substitute Frame” shows the substitute frame for finding the bending moments in wall columns this consist of three spans and two-storey columns, one of which is the wall column.



Soil Type	*Designation*	*Modulus of Elasticity (kN/m2)*	*Poisson's Ratio (µ)*	*Unit Weight (ϒ) (kN/m3)*
Hard Soil	*E-65000*	*65000*	*0.3*	*18*
Medium Hard	*E-35000*	*35000*	*0.4*	*16*
Soft	*E-15000*	*15000*	*0.4*	*16*

Table 1: Soil Elastic Constants

II. PROBLEM DEFINITION

To Analyzed and design of a RCC residential building (G+10) having Raft foundation resting on different type of soil with consideration of earthquake effect as shown in Fig. with following data.

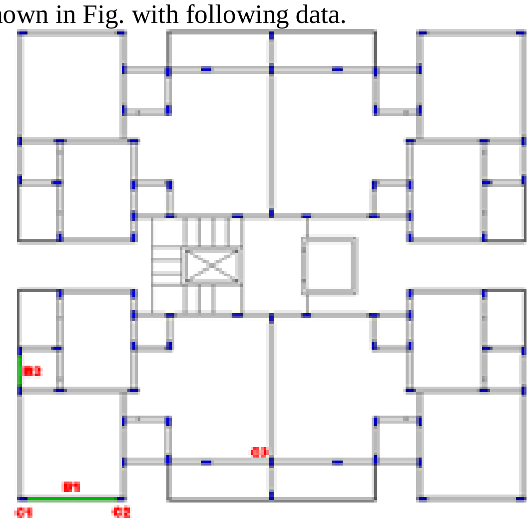


Fig. 1: Plan of Proposed Building

- F_{ck} = 20 N/mm^2
- F_y = 415 N/mm^2
- γ_c = 25 KN/ m^3
- Live load = 3 KN/m^2
- γ_b = 20 KN/m^3
- Thickness of wall = 230 mm
- Super Impose load = 1.5 KN/m^2
- Floor height = 3 m
- Situation of building = Zone-3
- Building type = Residential

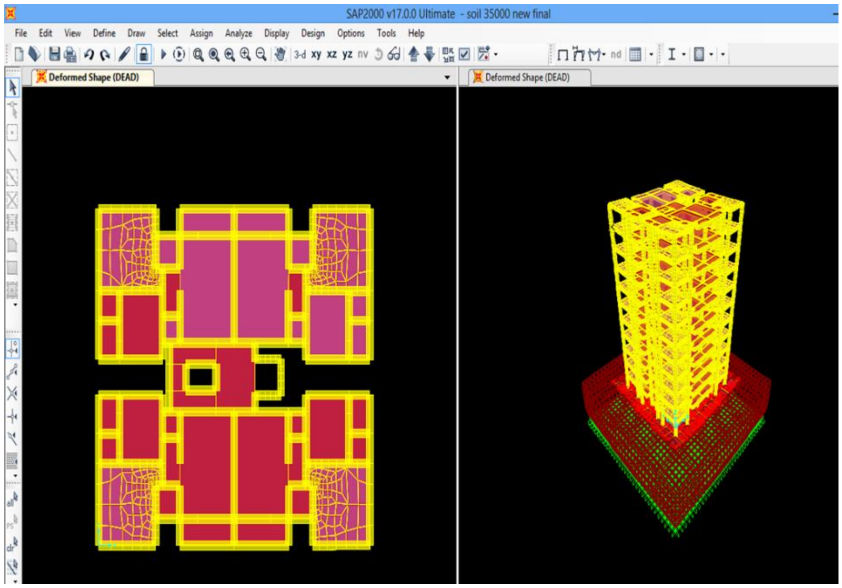


Fig. 2: Deformed Shape of Building after Analysis

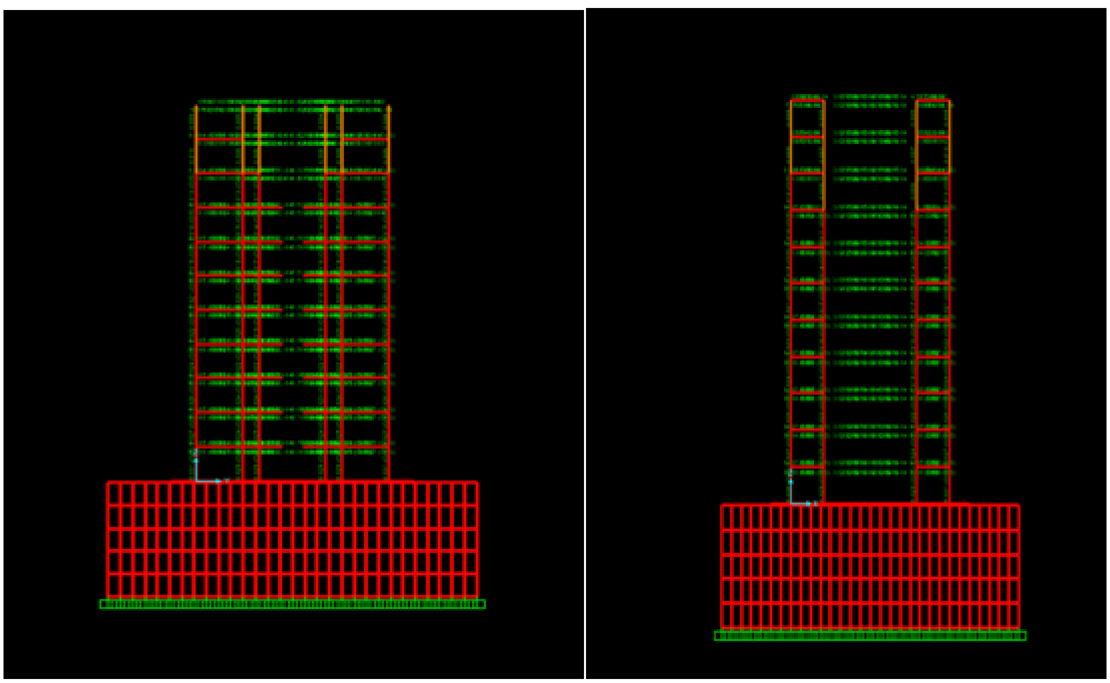


Fig. 3: Area of Longitudinal Reinforcement

III. RESULT AND DISCUSSION

In order to fulfill above discussion, structure model is prepared on SAP 2000 software. The results of different parameters like Axial force, Torsion, Shear force, Bending moment, Drift, Reinforcement details are compared in different Load Combinations as per recommendations given in IS codes.

The different IS Load Combinations are taken in analysis for comparison.

For Axial Force, Torsion, Shear Force, Bending Moment	*1.2(DL+LL+EQ)*
	1.5(DL+EQ)
	0.9DL+1.5EQ
For Reinforcement	*1.5(DL+EQ)*

Table 2: Load Combination As Per Is Code

IV. RESULT OF ANALYSIS

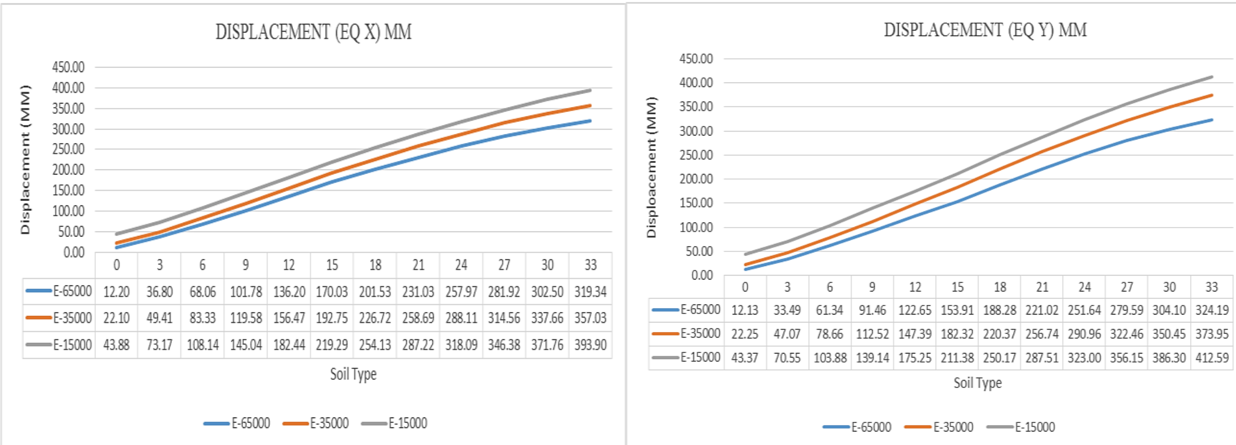


Fig. 4: Displacement (Eq X & Y)

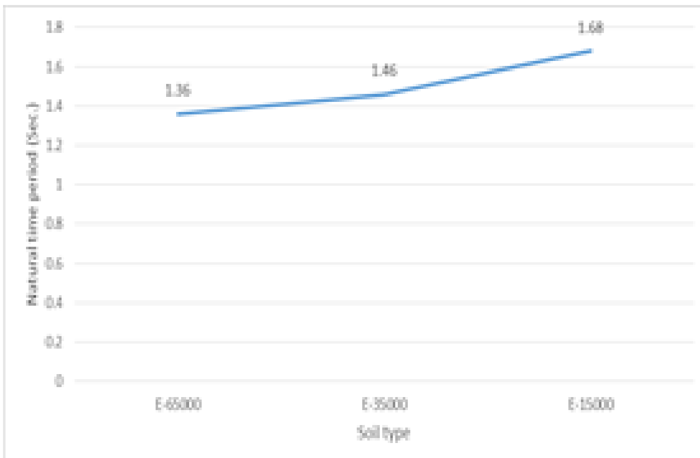


Fig. 5: Natural Time Period

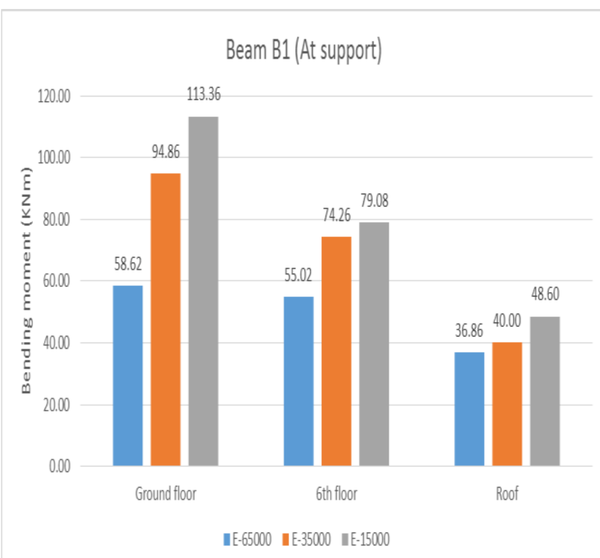


Fig. 6: Bending Moment for Beam B1 (At Support)

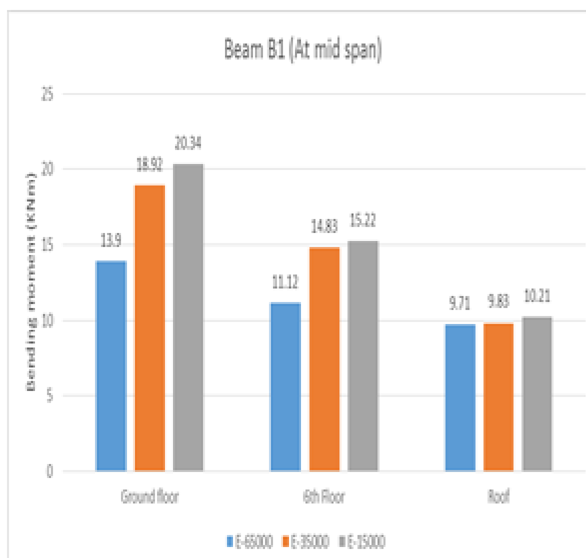


Fig. 7: Bending Moment for Beam B1 (At Mid Span)

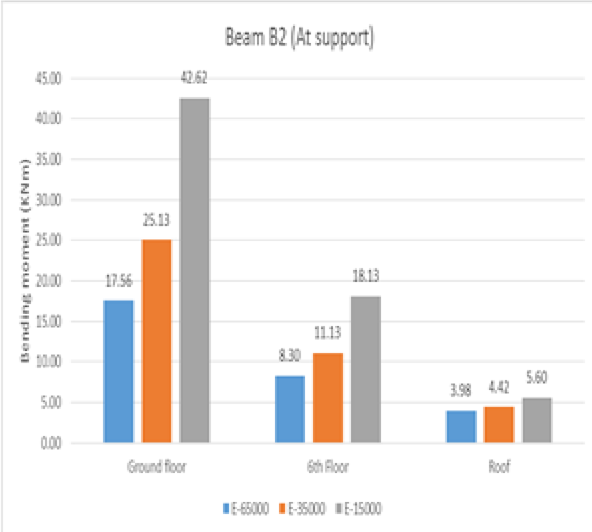


Fig. 8: Bending Moment for Beam B2 (At Support)

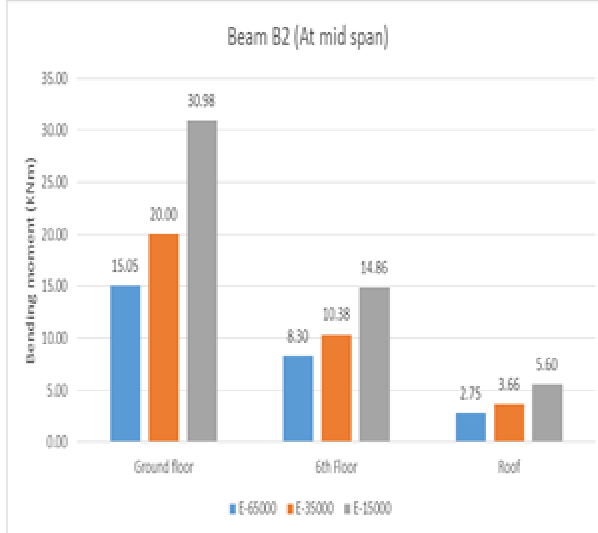


Fig. 9: Bending Moment for Beam B2 (At Mid Span)

Beam No.	*Storey No.*	*Shear Force (KN)*		
		E-65000	*E-35000*	*E-15000*
B1	*G.F*	*56.45*	*79.57*	*105.64*
B1	*6th Floor*	*49.50*	*75.33*	*97.25*
B1	*Roof*	*46.97*	*60.33*	*62.99*

Table 3: Shear Force Data for Beam B1

Beam No.	*Storey No.*	*Shear Force (KN)*		
		E-65000	*E-35000*	*E-15000*
B2	*G.F*	*17.01*	*23.08*	*38.17*
B2	*6th Floor*	*10.40*	*12.93*	*18.17*
B2	*Roof*	*8.03*	*10.02*	*15.08*

Table 4: Shear Force Data for Beam B2

Column No	*Storey No*	*Bending moment (KN-m)*		
		E-65000	*E-35000*	*E-15000*
C1	*G.F*	*133.50*	*189.45*	*322.09*
C1	*Roof*	*77.75*	*83.96*	*101.73*
C2	*G.F*	*117.47*	*206.89*	*357.84*
C2	*Roof*	*72.79*	*88.92*	*109.26*
C3	*G.F*	*103.89*	*159.86*	*287.53*
C3	*Roof*	*55.87*	*68.29*	*89.71*

Table 5: Bending Moment for Column

1) Graphical Representation of Axial Force

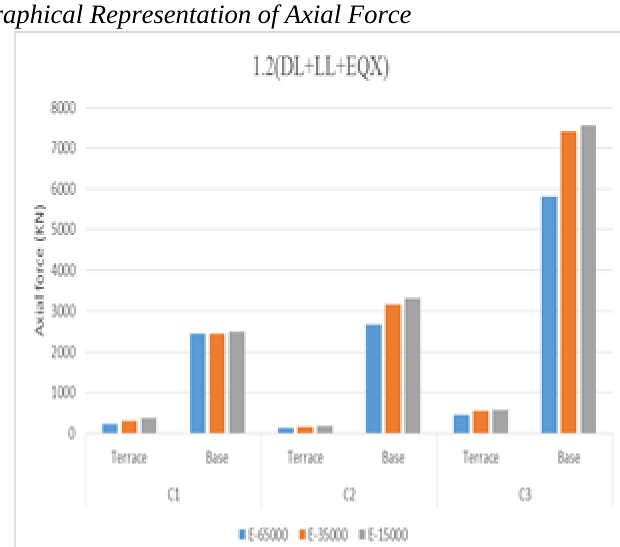


Fig. 10: Load Combination Case-1 (EQX)

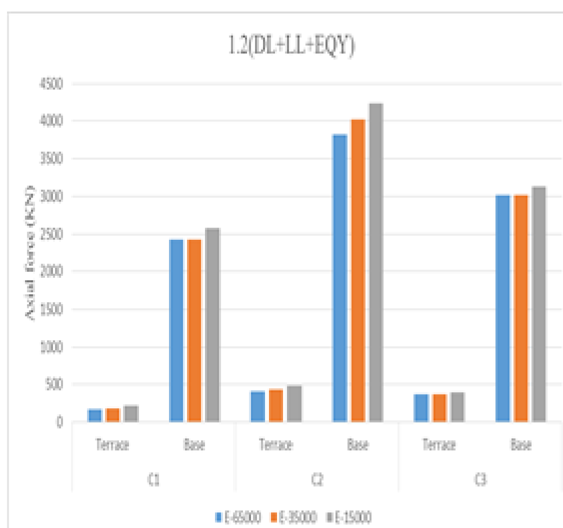


Fig. 11: Load Combination Case-1 (EQY)

2) *Graphical Representation of Shear Force*

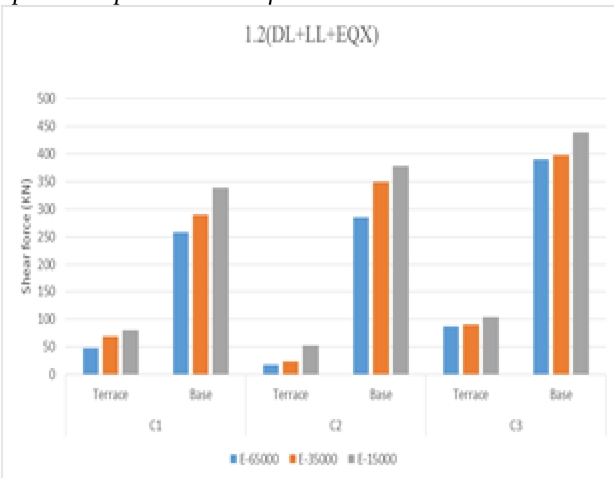


Fig. 12: Load Combination Case-1 (EQX)

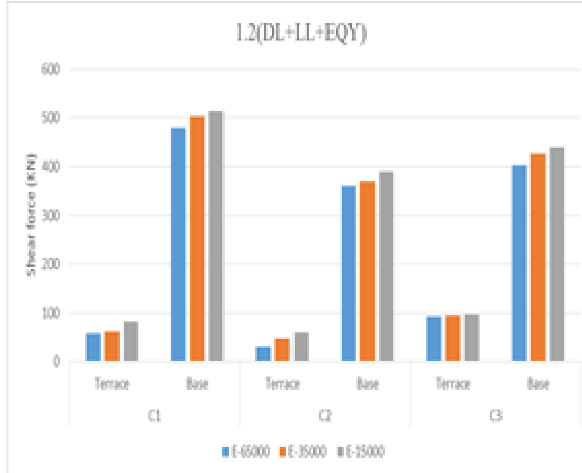


Fig. 13: Load Combination Case-1 (EQY)

3) *Graphical Representation of Bending Moment*

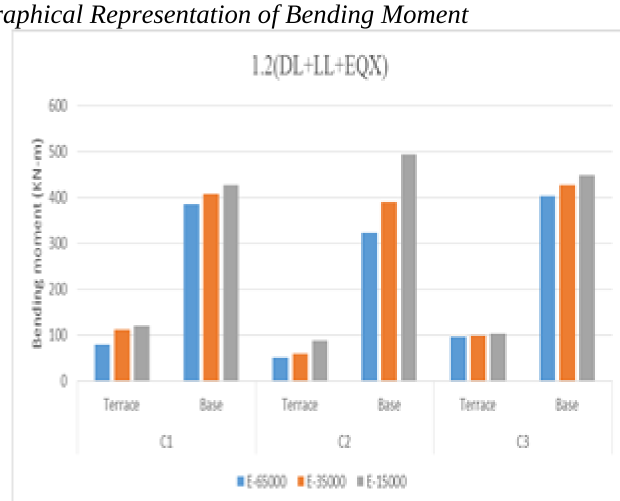


Fig. 14: Load Combination Case-1 (EQX)

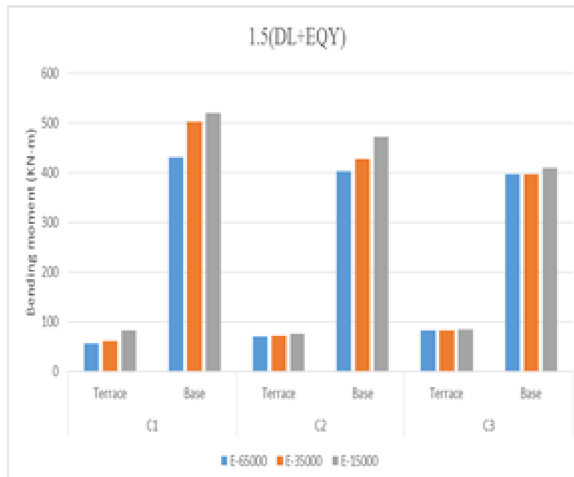


Fig. 15: Load Combination Case-1 (EQY)

V. CONCLUSION

- Natural time period is a primary parameter which regulates the seismic lateral response of the structural frames. The natural time period of structure increases due increasing soil flexibility. For soft soil time period is more than hard soil.
- The Displacement of building at any point is higher for Building resting on soft soil than the hard soil.
- Roof displacement is also increasing due to increasing soil flexibility. For soft soil the roof displacement is higher than the hard soil.
- Beam Moment and Column moment are observed to be increased due to increase soil flexibility. For medium hard soil the difference is about 1.2-1.6 times however for soft soil it is observed to be in the range of 2-2.5 times.
- Increase in soil flexibility causes decrease in the base reaction. For soft soil base reaction decease with higher rate.
- The performance of buildings on soft soil during seismic action could prove more vulnerable than the building on hard soil.
- The value of axial force for column are increase with increasing soil flexibility. For soft soil value of axial force is more than the hard soil.

VI. SCOPE OF FUTURE WORK

- Study can be done by using shear wall to increase the stiffness.
- Study can be done by changing the size of beams and columns with storey heights.
- Study can be done by comparison using pad foundation.
- Cost comparison of building resting on hard soil, medium hard soil, and soft soil.
- Study can be done by comparison of Winkler approach (spring model) and elastic continuum approach (FEM model).

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