Impact of Different Soils and Seismic Zones on Varying Height of Framed Structures

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Abstract

To determine the impact of different soils and seismic zones on different heights of framed structures. In high rise building we should concern about all the forces that act on a building, its own weight as well as the lateral forces. In this work, total 48 models are analyzed. To determine the impact of different soil and seismic zones on varying height of framed structure, this work is carried out. Three different soils types are taken as soft, medium and hard. Stories i.e., G+4,G+5, G+6 & G+7 are taken of heights 15m, 18m, 21m & 24m respectively are considered and analyzed for seismic zones II,III,IV & V. SMRF(Special Moment resisting Frame) & IS 1893-2002/2005 are used in STAAD PRO.(V8i) series 4 to analyze all models. This work consist of the analysis of RC framed structure for Maximum Beam End Force (SHEAR-Y in Beam-KN) & Maximum Beam End Force (MOMENT-Z in Beam –KNm. This is to figure out the variation of Maximum Shear force & Maximum Bending moment for all types of heights and to find out the most severe models among all. Height can also be extended beyond 24m and plan size can also be changed for further research point of view.

Keywords: SMRF, Maximum Shear Force & Maximum Bending Moment, IS 1893-2002/2005), STAAD PRO.(V8i) series 4

I. INTRODUCTION

The word earthquake is self-explaining- the earthquakes that means the earth shakes and we feel the vibration caused by these motions. Earthquake are caused due to many reason but most commonly term earthquake is used when shaking the earth's surface is caused due to some disturbance occurring inside the earth.

Whenever the earth is disturbed, vibration are produced. These vibration set out in all directions from the place of their origin. Whenever these vibrations travel, an earthquake is said to have taken place. These vibration are more intense near their sources. As the distance increases, these become weak and slowly die out. More than 10,000 earthquakes occur every year. But most of them are not of great concern for civil engineers, only a few of them, having high intensity, are a causes of major concern.

II. LITERATURE REVIEW

There are many Research works has been done in the direction of seismic forces on multistory buildings.

Girum Mindaye and Shaik Yajdani [2] analyzed a Multi-storey RC Frame Building in Different Seismic Zones. They have considered medium soil types and for all seismic zones. They also considered OMRF for seismic zone- II & III and OMRF & SMRF for seismic zone- IV & V.

Ashis Debashis Behera, K.C. Biswal [3] studied 3D Analysis of building frame using Staad Pro. Building in seismic load combination required more reinforcement than the building under wind load combination (for example beam no 1952 required 7 no of 12 mmØ and 6 no of 12 mmØ bars whereas for wind load combination it required 5 nos of 12 mmØ and 4nos of 12 mmØ).but the deflection and shear bending is more in wind load combination compare to seismic. But in lower beams more reinforcement is required for wind load combination. For column the area of steel and percentage of steel always greater required for wind load combination than the seismic load combination.

Sudhir K Jain, H.J.Shah [5], the design example of a six storey building explained a problem regarding a six storey building with G.F. storey height as 3.4m & typical floor storey height as 5m for a commercial complex has plan of size 22.5m x 22.5m with 7.5m x 7.5m of each grid. The building is located in seismic zone III on a site with medium soil. They considered 230 mm thick brick masonry walls. The self-weight of beam & column were directly calculated by using analysis software. Seismic forces are considered and for ductile detailing required IS codes were also used.

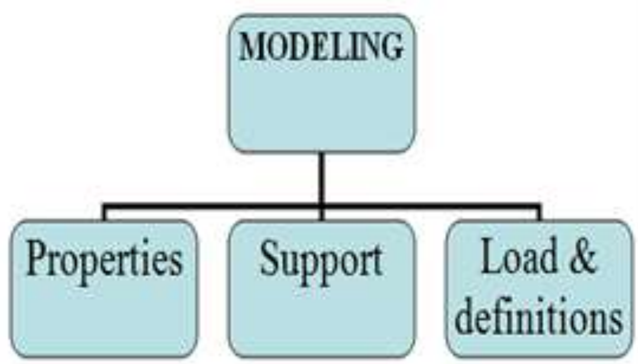
III. OBJECTIVES

1) To find Maximum Beam End Force (Shear-Y in Beam - KN).
2) To find Maximum Beam End Force (Moment-Z in Beam - KNm)
3) To determine the impact of soft, medium & hard soil in different seismic zones.
4) To work on STAAD PRO. to work out the analysis part of the structure.
5) Effect of rigid support is considered and analyzed for the same.

IV. METHODOLOGY

The modeling of framed structures can be modeled by creating models first and then apply loads and finally run analysis to get results.
It consists of 2 steps in this work which are:

A. Modeling



B. Post-Processing:

In this, results can be checked and graphs for the same to be plotted. Three different soils types are taken as soft, medium and hard. Stories i.e., G+4,G+5, G+6 & G+7 are taken of heights 15m, 18m, 21m & 24m respectively are considered.

Table – 1
Data & Dimensions

Size of Plan	12m x 12m (Each grid size 3m x 3m)
Column Size	450mm × 450 mm
Beam Size	300mm × 300 mm
Thickness of Wall	230mm
Slab depth	180 mm
Heights of frames	15m,18m, 21m & 24m
Height of each floor	3.0m
Concrete and steel Grade	M25 and Fe 415
Support condition	Fixed
Brick walls(outer and inner)	230mm & 115mm
Seismic zones	II, III, IV & V
Soil type	Soft, Medium & Hard

C. *Models:*

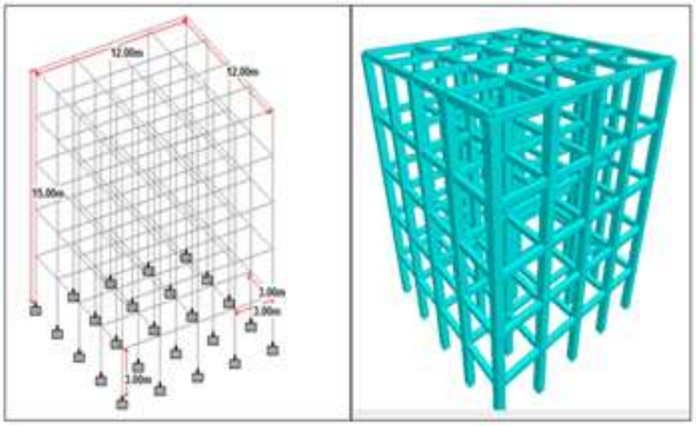


Fig. 1: Model-I (Height: 15m)

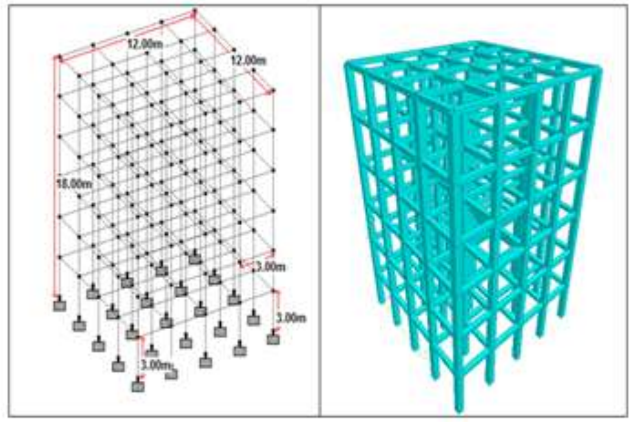


Fig. 2: Model-II (Height: 18m)

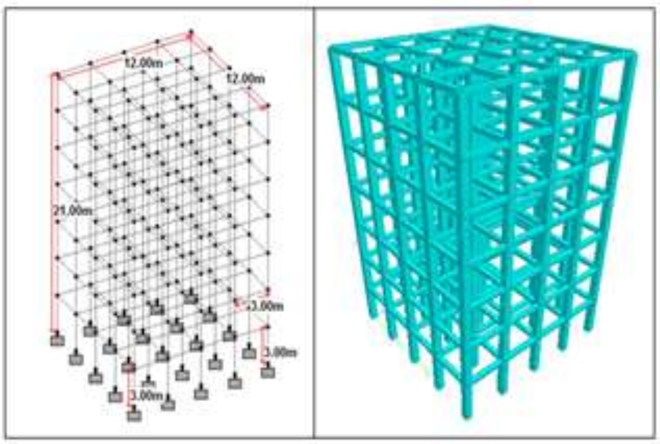


Fig. 3: Model-III (Height: 21m)

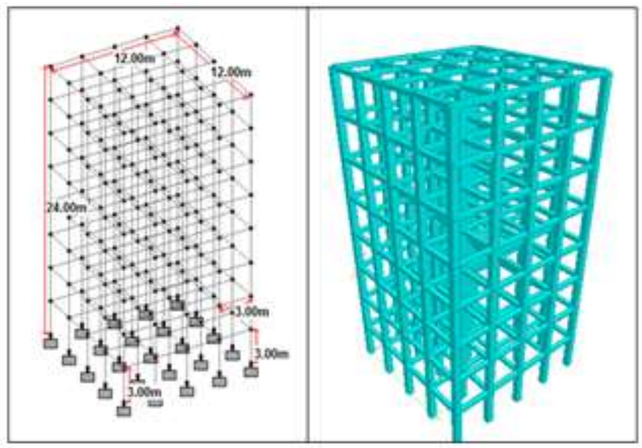


Fig. 4: Model-IV (Height: 24m)

V. RESULTS & DISCUSSIONS

Table – 2
Maximum Beam End Force (Shear-Y in Beam - KN)

MAXIMUM BEAM END FORCE (SHEAR-Y IN BEAM - KN)- SEISMIC ZONE-II								
SOIL CONDITION	*MODEL-1*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-2*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-3*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-4*	*% DECREASE W.R.T. SOFT SOIL*
Soft	*61.416*	*-*	*66.024*	*-*	*68.868*	*-*	*76.188*	*-*
Medium	*61.416*	*0*	*66.024*	*0*	*68.868*	*0*	*72.403*	*4.96*
Hard	*61.416*	*0*	*63.201*	*4.27*	*63.208*	*8.21*	*65.962*	*13.42*

1) The maximum percentage of decreasing maximum Shear force (i.e., 13.42%) is found for Model-4 when compared hard soil strata with soft soil strata.
2) The values of maximum Shear force for Model-1 are same for all soil types of strata (soft, medium &hard).
3) For Model-2, Model-3 & Model-4, the values of Maximum Shear force are decreasing in hard soil strata when compared with soft soil strata & found the least for the same.

Table – 3
Maximum Beam End Force (Shear-Y in Beam - KN)

MAXIMUM BEAM END FORCE (SHEAR-Y IN BEAM - KN)- SEISMIC ZONE-III								
SOIL CONDITION	*MODEL-1*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-2*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-3*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-4*	*% DECREASE W.R.T. SOFT SOIL*
Soft	*70.821*	*-*	*79.533*	*-*	*84.221*	*-*	*97.086*	*-*
Medium	*70.821*	*0*	*79.533*	*0*	*84.221*	*0*	*90.019*	*7.27*
Hard	*70.821*	*0*	*73.887*	*7.09*	*72.576*	*13.82*	*77.138*	*20.54*

1) The maximum percentage of decreasing maximum Shear force (i.e., 20.54%) is found for Model-4 when compared hard soil strata with soft soil strata.

2) The values of Maximum Shear force for Model-1 are same for all soil types of strata (soft, medium &hard).
3) For Model-2, Model-3 & Model-4, the values of Maximum Shear force are decreasing in hard soil strata when compared with soft soil srata & found the least for the same.

Table – 4
Maximum Beam End Force (Shear-Y in Beam - KN)

MAXIMUM BEAM END FORCE (SHEAR-Y IN BEAM - KN)- SEISMIC ZONE-IV								
SOIL CONDITION	*MODEL-1*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-2*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-3*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-4*	*% DECREASE W.R.T. SOFT SOIL*
Soft	*86.267*	*-*	*99.208*	*-*	*106.123*	*-*	*124.95*	*-*
Medium	*86.267*	*0*	*99.208*	*0*	*106.123*	*0*	*114.35*	*4.96*
Hard	*86.267*	*0*	*90.739*	*8.52*	*106.123*	*0*	*95.029*	*13.42*

1) The maximum percentage of decreasing maximum Shear force (i.e., 13.42%) is found for Model-4 when compared hard soil strata with soft soil strata.
2) The values of maximum Shear force for Model-1& Model-3 are same for all soil types of strata (soft, medium &hard).
3) For Model-2 & Model-4, the values of maximum Shear force are decreasing in hard soil strata when compared with soft soil strata & found the least for the same.

Table – 5
Maximum Beam End Force (Shear-Y in Beam - KN)

MAXIMUM BEAM END FORCE (SHEAR-Y IN BEAM - KN)- SEISMIC ZONE-V								
SOIL CONDITION	*MODEL-1*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-2*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-3*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-4*	*% DECREASE W.R.T. SOFT SOIL*
Soft	*109.437*	*-*	*128.72*	*-*	*138.977*	*-*	*166.747*	*-*
Medium	*109.437*	*0*	*128.72*	*0*	*138.977*	*0*	*150.847*	*9.53*
Hard	*109.437*	*0*	*116.018*	*9.86*	*112.754*	*18.86*	*121.864*	*26.91*

1) The maximum percentage of decreasing maximum Shear force (i.e., 26.91%) is found for Model-4 when compared hard soil strata with soft soil strata.
2) The values of maximum Shear force for Model-1 are same for all soil types of strata (soft, medium &hard).
3) For Model-2, Model-3 & Model-4, the values of maximum Shear force are decreasing in hard soil strata when compared with soft soil strata & found the least for the same.

Table – 6
Maximum Beam End Force (Moment-Z in Beam - KNm

MAXIMUM BEAM END FORCE (MOMENT-Z IN BEAM - KNm) - SEISMIC ZONE-II								
SOIL CONDITION	*MODEL-1*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-2*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-3*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-4*	*% DECREASE W.R.T. SOFT SOIL*
Soft	*52.368*	*-*	*60.806*	*-*	*65.400*	*-*	*78.162*	*-*
Medium	*52.368*	*0*	*60.806*	*0*	*65.400*	*0*	*71.429*	*8.62*
Hard	*52.368*	*0*	*55.428*	*8.84*	*54.335*	*16.91*	*59.156*	*24.31*

1) The maximum percentage of decreasing maximum Bending moment (i.e., 24..31%) is found for Model-4 when compared hard soil strata with soft soil strata.
2) The values of maximum Bending moment for Model-1 are same for all soil types of strata (soft, medium &hard).
3) For Model-2, Model-3 & Model-4, the values of maximum Bending moment are decreasing in hard soil strata when compared with soft soil strata & found the least for the same.

Table – 7
Maximum Beam End Force (Moment-Z in Beam - KNm

MAXIMUM BEAM END FORCE (MOMENT-Z IN BEAM - KNm)- SEISMIC ZONE-III								
SOIL CONDITION	*MODEL-1*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-2*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-3*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-4*	*% DECREASE W.R.T. SOFT SOIL*
Soft	*70.025*	*-*	*83.298*	*-*	*90.438*	*-*	*110.021*	*-*
Medium	*70.025*	*0*	*83.298*	*0*	*90.438*	*0*	*99.248*	*9.79*
Hard	*70.025*	*0*	*74.693*	*10.33*	*72.674*	*19.64*	*79.611*	*27.64*

1) The maximum percentage of decreasing maximum Bending moment (i.e., 27.64%) is found for Model-4 when compared hard soil strata with soft soil strata.
2) The values of maximum Bending moment for Model-1 are same for all soil types of strata(soft, medium& hard).
3) For Model-2, Model-3 & Model-4, the values of maximum Bending moment are decreasing in hard soil strata when compared with soft soil strata & found the least for the same.

Table – 8
Maximum Beam End Force (Moment-Z in Beam - KNm

MAXIMUM BEAM END FORCE (MOMENT-Z IN BEAM - KNm)- SEISMIC ZONE-IV								
SOIL CONDITION	*MODEL-1*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-2*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-3*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-4*	*% DECREASE W.R.T. SOFT SOIL*
Soft	*93.568*	*-*	*113.286*	*-*	*123.821*	*-*	*152.499*	*-*
Medium	*93.568*	*0*	*113.286*	*0*	*123.821*	*0*	*136.340*	*10.59*
Hard	*93.568*	*0*	*100.379*	*11.39*	*123.821*	*0*	*106.885*	*29.91*

1) The maximum percentage of decreasing maximum Bending moment (i.e., 29.91%) is found for Model-4 when compared hard soil strata with soft soil strata.
2) The values of maximum Bending moment for Model-1 & Model-3 are same for all soil types of strata (soft, medium & hard).
3) For Model-2 & Model-4, the values of maximum Bending moment are decreasing in hard soil strata when compared with soft soil strata & found the least for the same.

Table – 9
Maximum Beam End Force (Moment-Z in Beam – KNm)

MAXIMUM BEAM END FORCE (MOMENT-Z IN BEAM - KNm)- SEISMIC ZONE-V								
SOIL CONDITION	*MODEL-1*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-2*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-3*	*% DECREASE W.R.T. SOFT SOIL*	*MODEL-4*	*% DECREASE W.R.T. SOFT SOIL*
Soft	*128.883*	*-*	*158.270*	*-*	*173.897*	*-*	*216.217*	*-*
Medium	*128.883*	*0*	*158.270*	*0*	*173.897*	*0*	*191.978*	*11.21*
Hard	*128.883*	*0*	*138.908*	*12.23*	*133.928*	*22.98*	*147.795*	*31.64*

1) The maximum percentage of decreasing maximum Bending moment (i.e., 31.64%) is found for Model-4 when compared hard soil strata with soft soil strata.
2) The values of Maximum Bending moment for Model-1 are same for all soil types of strata(soft, medium &hard).
3) For Model-2, Model-3 & Model-4, the values of Maximum Bending moment are decreasing in hard soil strata when compared with soft soil strata & found the least for the same.

A. For Maximum Beam End Force (Shear-Y in Beam - KN):

1) Seismic Zone-II

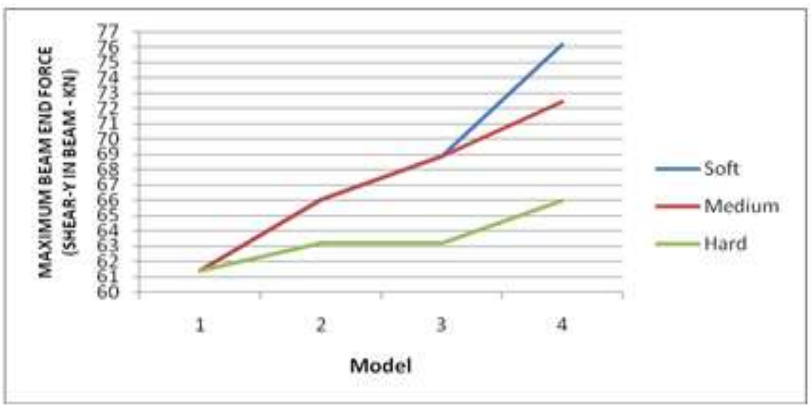


Fig. 5: Graph between Maximum Beam End Force & Model.

2) Seismic Zone-III

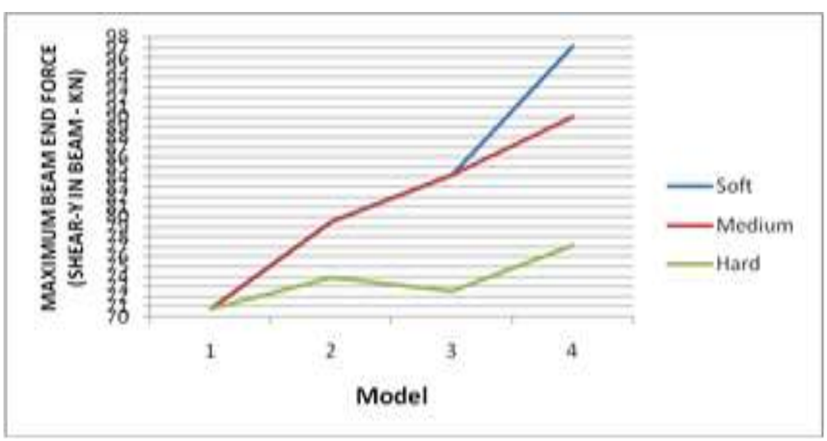


Fig. 6: Graph between Maximum Beam End Force & Model.

3) Seismic Zone-IV

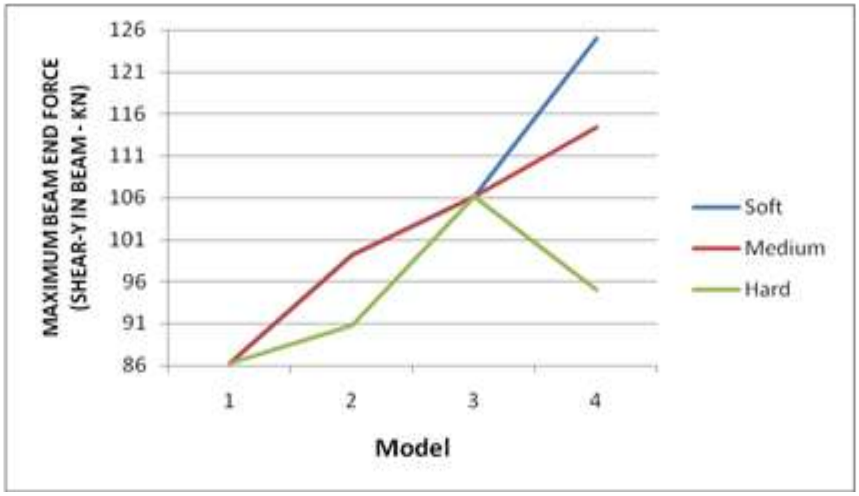


Fig. 7: Graph between Maximum Beam End Force & Model.

4) Seismic Zone-V

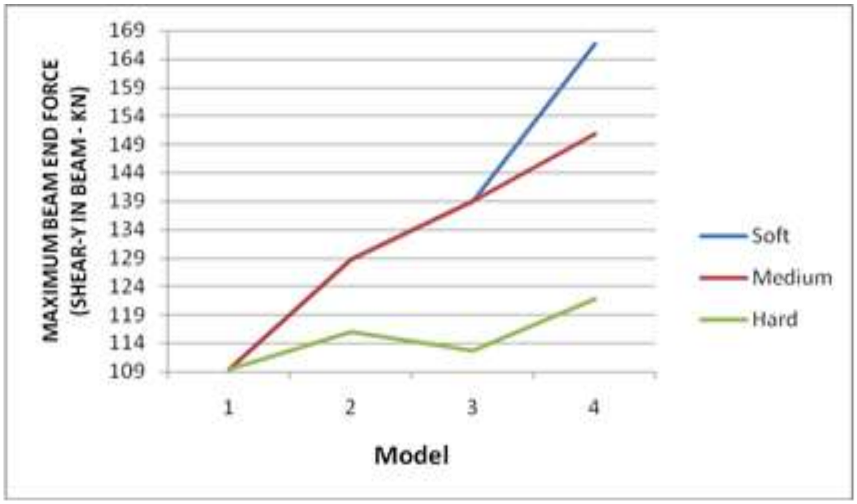


Fig. 8: Graph between Maximum Beam End Force & Model.

B. For Maximum Beam End Force (Moment-Z in Beam – KNm

1) Seismic Zone-II

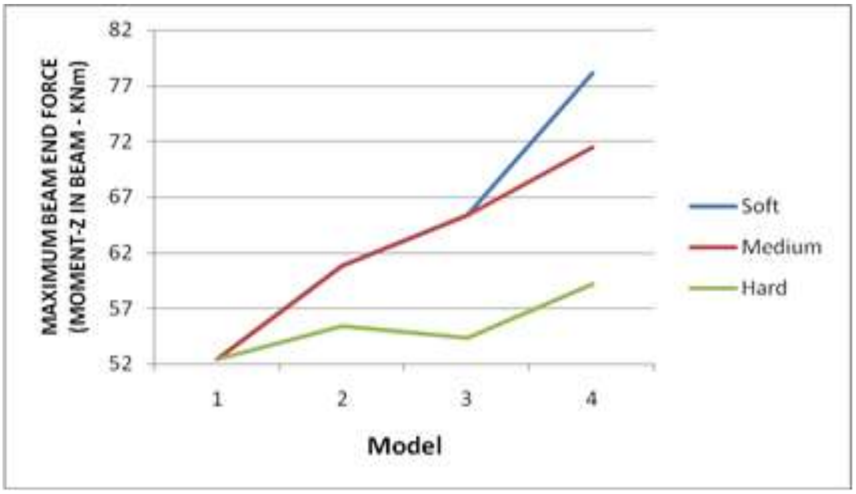


Fig. 9: Graph between Maximum Beam End Force & Model.

2) *Seismic Zone-III*

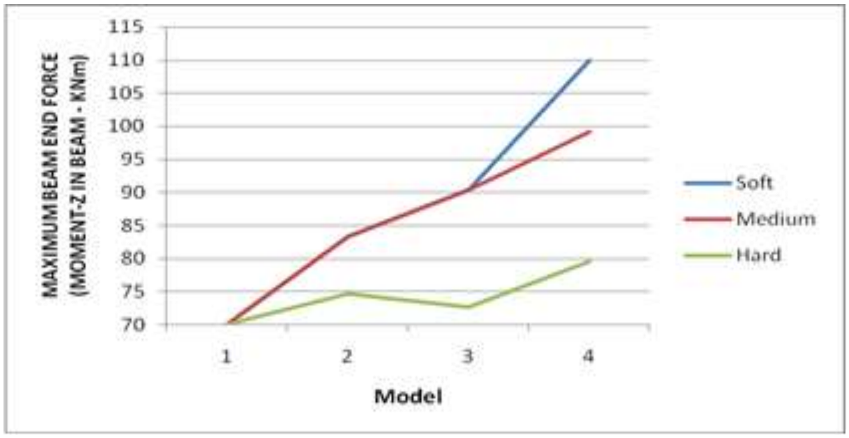


Fig. 10: Graph between Maximum Beam End Force & Model.

3) *Seismic Zone-IV*

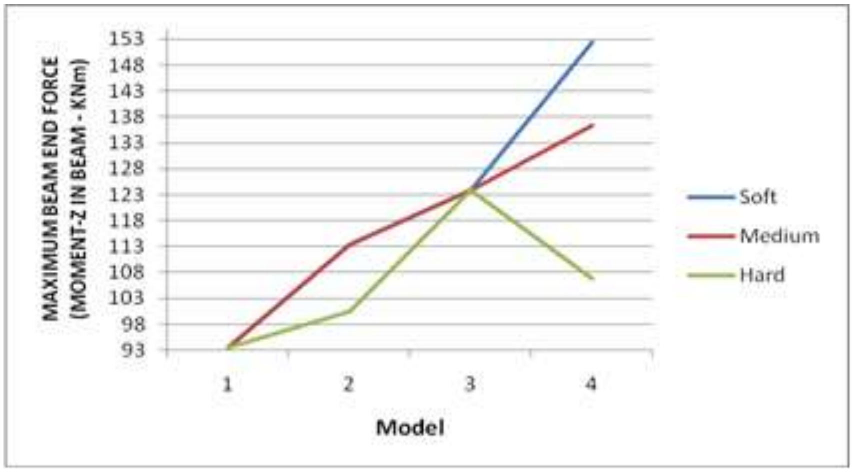


Fig. 11: Graph between Maximum Beam End Force & Model.

4) *Seismic Zone-V*

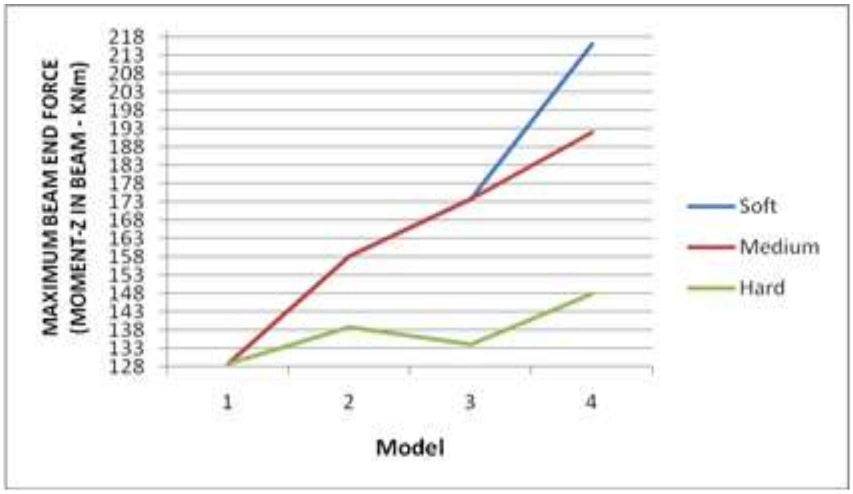


Fig. 12: Graph between Maximum Beam End Force & Model.

VI. CONCLUSIONS

1) As the height of the building frame is increases, the values of maximum beam end force (Shear-Y in beam - KN) & (Moment-Z in beam - KNm) is also increases for soft and medium soil types.
2) For maximum shear forces & maximum bending moment: Seismic Zone-2 & Seismic Zone -4 shows same increase in percentages for medium and hard soil strata in Model-4.

3) In Seismic Zone - 2, Seismic Zone - 3 & Seismic Zone – 5: For Model-2, Model-3 & Model-4, the values of maximum Shear forces & maximum bending moment are decreasing in hard soil strata when compared with soft soil strata & found the least for the same.
4) For Seismic Zone- 4: In Model-3, there is no variation in maximum Shear forces & maximum bending moment among soft, medium & hard soil strata.

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