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ANALYSIS OF A MULTISTOREY BUILDING FRAME FOR LATERAL FORCES AT SLOPING STRATA UNDER THE EFFECT SEISMIC FORCES USING STAAD.PRO.

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ABSTRACT

In these modern days the buildings are made to satisfy our basic aspects and better serviceability. It is not an issue to construct a building any how it is, important to construct an efficient building which will serve for many years without showing any failure. the project titled " analysis of a multistorey building frame for lateral forces at sloping strata under the effect seismic forces using staad.pro ", The spectrum analysis of a G+8 storey RCC building on varying slope angle i.e. 0º,10º,15º is used considering all the four seismic zones (ii,iii,iv,v) with three type of soil considered (soft, medium, hard). The Structural analysis software STAAD Pro v8i is used to study effect of sloping ground during earthquake. The analysis the analysis the effect of sloping ground on structural forces. The comparative study of results as lateral forces, max bending moment, maximum axial force and story wise displacement as the demonstrate is analyzed by spectrum analysis

KEYWORDS: structural analysis, lateral forces, staad, beam column forces, displacement.

I. INTRODUCTION

In 21st century because of colossal populace the no.of ranges in units are diminishing step by step. Barely any years back the populaces were not all that immense so they used to remain in Flat system(due to vast zone accessible per person).But now a day's kin favoring Vertical System(high rise working because of lack of area).In elevated structures we should worry about all the strengths that follow up on a building ,its own particular weight and additionally the dirt bearing limit .For outside strengths that demonstration on the building the shaft, section and support ought to be sufficient to balance these strengths effectively. What's more, the dirt ought to be adequate to pass the heap effectively to the establishment.

For free soil we favored profound establishment (pile).If we will do such a great amount of figuring for a tall structure physically at that point it will require greater investment and also human blunders can be happened. So the utilization of STAAD-PRO will make it simple. STAAD-PRO can take care of run of the mill issue like Static investigation, Seismic examination and Natural recurrence. This kind of issue can be unraveled by STAAD-PRO alongside IS-CODE. Besides STAAD-PRO has a more noteworthy favorable position than the manual system as it gives more exact and exact outcome than the manual method.

Seismic Behavior Of Multistory Building On Slope

Most of hilly regions in northern India where seismic activities are common, buildings are required to be constructed on sloping ground due to scarcity of plain land. In hilly regions, engineered construction is constrained by local topography resulting in the adoption of either a step back or step back & set back configuration as a structural form for buildings. sloping ground and leveled ground, by using response spectrum method. buildings in hilly regions have experienced high degree of damage leading to collapse though they have been designed for safety of the occupants against natural hazards

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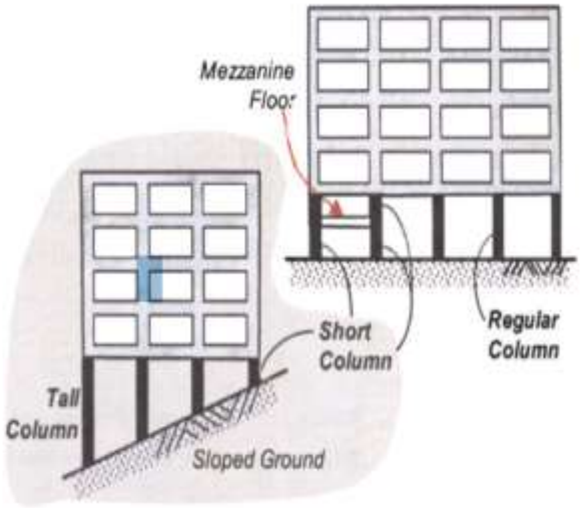

Fig:1.1 sloping ground

II. RESEARCH RELATED TO OUR STUDY

Vrushali et. al. (2015) Studied the effect of earthquake on high rise building (G+15) resting on sloping ground using STAAD.Pro software for structural analysis and design, same loading conditions are considered in each case and comparative study is done considering different sloping angels as (0º, 7.5º, 15º& 22º) and observed that Buildings resting on sloping ground have more lateral displacement compared to buildings on plain ground, the critical bending moments is increased on 22° slope than 7.5° slope and 15° slope ground and after designing, it is concluded that steel quantity on sloping ground is more than on plain ground for same cross section of column and beam.

Sujit kumar et. al. (2014) observed the behavior of sloping ground structures considering inclinations of (7.5º, 15º) under seismic forces. Considering seismic zones comparison has been done on sloping ground and plane ground building. Here G+ 4 storeys are taken with same properties and loadings for its conduct and comparison. Observed that bending moment in column increases with increase in sloping angle of the ground whereas axial force in columns remains almost same.

Aslam hussain et. al. (2014) presented a comparative study on effect of different wind velocity on different sloping ground (0 º,5 º,10 º & 15 º degrees) using STAAD.Pro software for modeling 2-d frame and analysis. And observed Maximum bending moment in beams for different building heights increases with increase in the wind velocity whereas minute change in moment on beam due to slope change, and Max moments in column increases with increase in the wind velocity as well as ground slope.

P. M. Mohite et. Al, (2014) presented a comparative study of G+6 storey structure in hard strata with different ground slopes of 26°,28°,30° and considering seismic zone III using analysis software STAAD.Pro and observed Top storey displacement of building resting on plain ground is less than that of building resting on sloped ground, Top storey displacement of setback stepback building is less than that of step back building and Use of bottom ties gives effective response of hilly building.

G Suresh et. Al, (2014) studied dynamic analysis of a 3-dimensional frame using response spectra method in which comparative study has been done on stepback and step back set back buildings on a sloping ground and observed the fundamental time period, storey displacement, base shear and concluded that step back set back buildings are more suitable in sloping ground.

S. Pradeepet. Al, (2014) studied the G+2 model with same loading and properties in a hard soil considering seismic analysis according to IS 1893 (Part 1): 2002 to determine either short column or long column will attract larger Earthquake forces using MS Excel, STAAD.Pro and ANSYS and observed that The short column is stiffer as compared to the tall column, and it attracts moreseismic forces and observed that in displacement as the column on sloped ground shows very less displacement while compare to the column on plane ground.

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Hemal J shah et. Al, (2014) presented a comparative study of plain ground and sloping ground of 23 degree and 27 degree slope are considered with same loading conditions and properties for 5 storey and 10 storey in medium soil and seismic zone is taken as zone V structure dynamic analysis has been done using SAP2000 and it is observed that the building on 23 degree slope has lowest time period so it is more rigid building and gives higher earthquake forces.

Kalyanrao et. Al, (2014) studied sloping ground structure subjected to seismic load as assessed in ATC40 and FEMA356. Here pushover analysis is done using analyzing software ETABS in which three cases of ground is considered asset-back, step-back or step-back setback to study the behavior of structures during earthquake relies on the dissemination of mass and solidness in both planes and it is concluded that the maximum base shear is induced in Set-back-Step-back structure. here base shear got by "pushover analysis" builds the execution indicate as thought about the configuration base shear and it is finished up that Step-back-Set-back structure may be favored on sloping ground which increases the performance.

Pradeep Kumar Ramancharlaet. Al,(2013) observed the behavior of a building on varying sloping angles i.e. 15degree, 30 degree**,** 45 degree and 60 degree is studied using shear wall in different location and contrasted and the same on the level ground. structure is analyzed as per IS 456 and subjected to earthquake loads.It was observed that as the slope angle is increasing, building is becoming stiffer. Two types of analyses were conducted viz., lateral load analysis and incremental dynamic analysis. It was observed from the initial results that the columns on the higher side of the slope i.e., short columns were subjected to more shear force then longer columns on the lower side.

Agrawal et al. (2011) presented a comparative study of different wind characteristics pertaining to dynamic wind load for three terrain categories namely: suburban, heavy sub-urban and urban as given in different international wind codes and standards. The different codes used in his study include Japanese, Australia, New-Zealand, American, British, European,Canadian, Hong-Kong, Chinese and Indian [existing (1987) as well as proposed (2011)]. The differences in various codes standards for the above parameters have been discussed with reasons.

Bakhshi et al. (2011) observed that the structure with lower height or number of stories in which parameters dominant in seismic loading and with increasing in height of buildings, rate of influence of wind load along the height is larger than seismic loading and the results of wind and earthquake characteristics was compared in the form of power spectral density (PSD). Dynamic wind force in not constant along the height but also it becomes larger and more intense with increasing height. In his research the effect of dynamic time history wind load is considered and when it's applied along the height of tall buildings, the fluctuating wind speed is simulated as an ergodic multivariate stochastic process, and the Fast Fourier Transform is needed to estimate the fluctuating wind speed components acting on the structure. Peak drift and displacement are two important parameters for comfort criteria that affect human perception to motion in the low frequency range of 0-1 Hz encountered in tall buildings.

III. METHODOLOGY

The study is done as:
Step-1 selection of building geometry,G+8 symmetric structure with semi rigid diaphragm is considered.

Step-2 Selection of sloping angle of ground (as 0o, 10o and 15o).

Step-3 dynamic analysis (response spectrum) method as per 1893 part-1 2002 is used considering all the four seismic zones (ii, iii, iv & v) with three types of soil considered (soft, medium & hard).

Step-4 selection of load combinations as per I.S. 875-part-5

Step-5 Modelling of building frames using STAAD-Pro v8i software.

Step-6 Analysis considering different height of building frame and different angle sloping ground frame models and each load combinations (36 cases).

Step-7 Comparative study of results as lateral forces, Max bending moments, Maximum Axial force, Max displacements, story wise displacement, Maximum shear force , Maximum Axial force.

IV. MODELLING

STAAD-PRO was born giant. It is the most popular software used now days. Basically it is performing design works.

There are four steps using STAAD- PRO to reach the goal. Prepare the input file:

1. Analyze the input file.
2. Watch the results and verify them.
3. Send the analysis result to steel design or concrete design engines for designing purpose.
4. Prepare the input file First of all we described the structure. In description part we include geometry, the materials, cross sections, the support conditions. Analyze the input file.
5. We should sure that we are using STAAD-PRO syntax. Else it wills error.
6. We should sure that all that we are inputting that will generate a stable structure. Else it will show error.
7. At last we should verify our output data to make sure that the input data was given correctly. Watch the results and verify them.
8. Reading the result take place in POST PROCESSING Mode. First we choose the output file that we want to analyze (like various loads or load combination) Then it will show the results.
9. Send the analysis result to steel design or concrete design engines for designing purpose.
10. If someone wants to do design after analysis then he can ask STAAD-PRO to take the analysis results to be designed as design .The data like Fy mainFc will assign to the view.
11. Then adding design beam and design column. Running the analysis it will show the full design structure.

Following loading is adopted for analysis:

a) Dead Loads

a. Self wt. of slab considering 125mm thk. Slab = 0.125*25 = 3.1225 kN/m^2

b. Floor Finish load = 1 kN/m^2

c. Infill Load = .10 x 3 x 18.5 = 5.55 kN/m

b) Live Loads:

a. Live Load on typical floors =3 kN/m^2

c) Seismic forces:

All frames are analyzed for all the 4 earthquake zones. The seismic load calculation are as per IS: 1893 (part-1)-2002.

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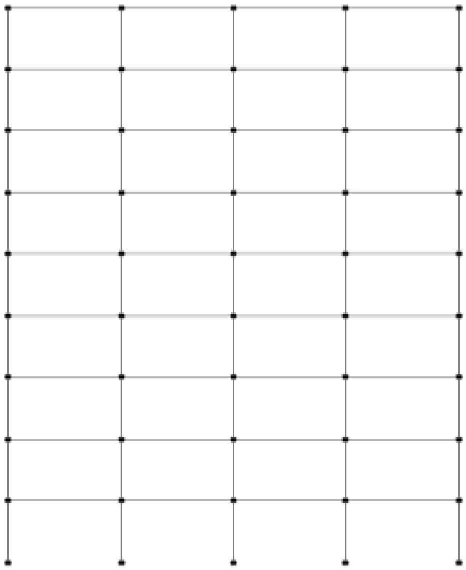

fig: 4.1 elevation 0 º slope

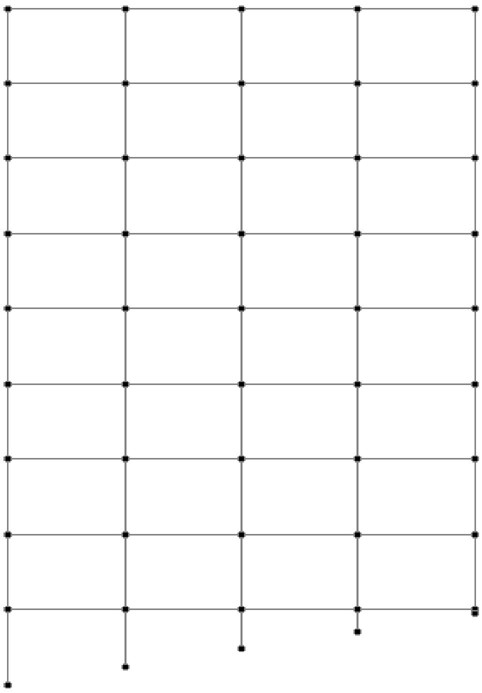

fig: 4.2 elevation 10º slope

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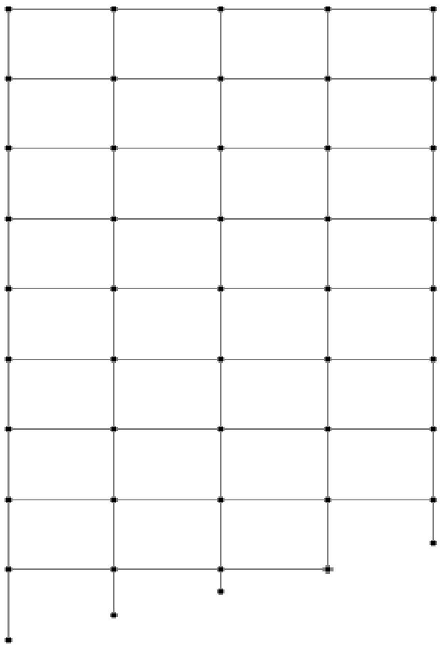

fig: 4.3 elevation 15º slope

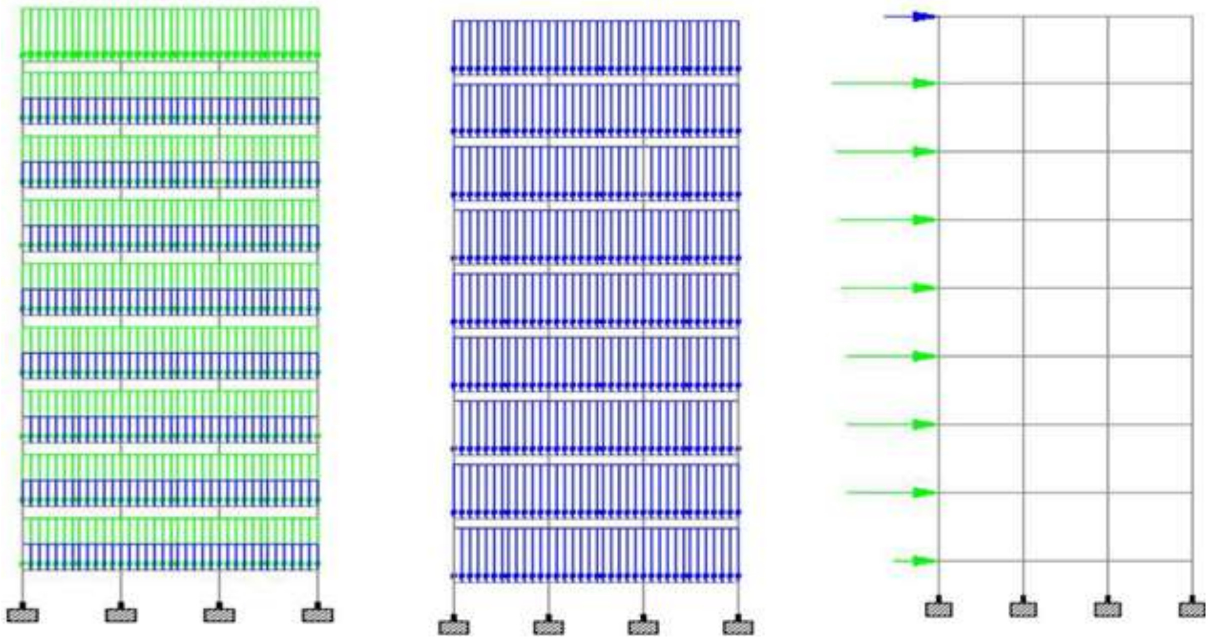

Figure: 4.4 lateral loadings

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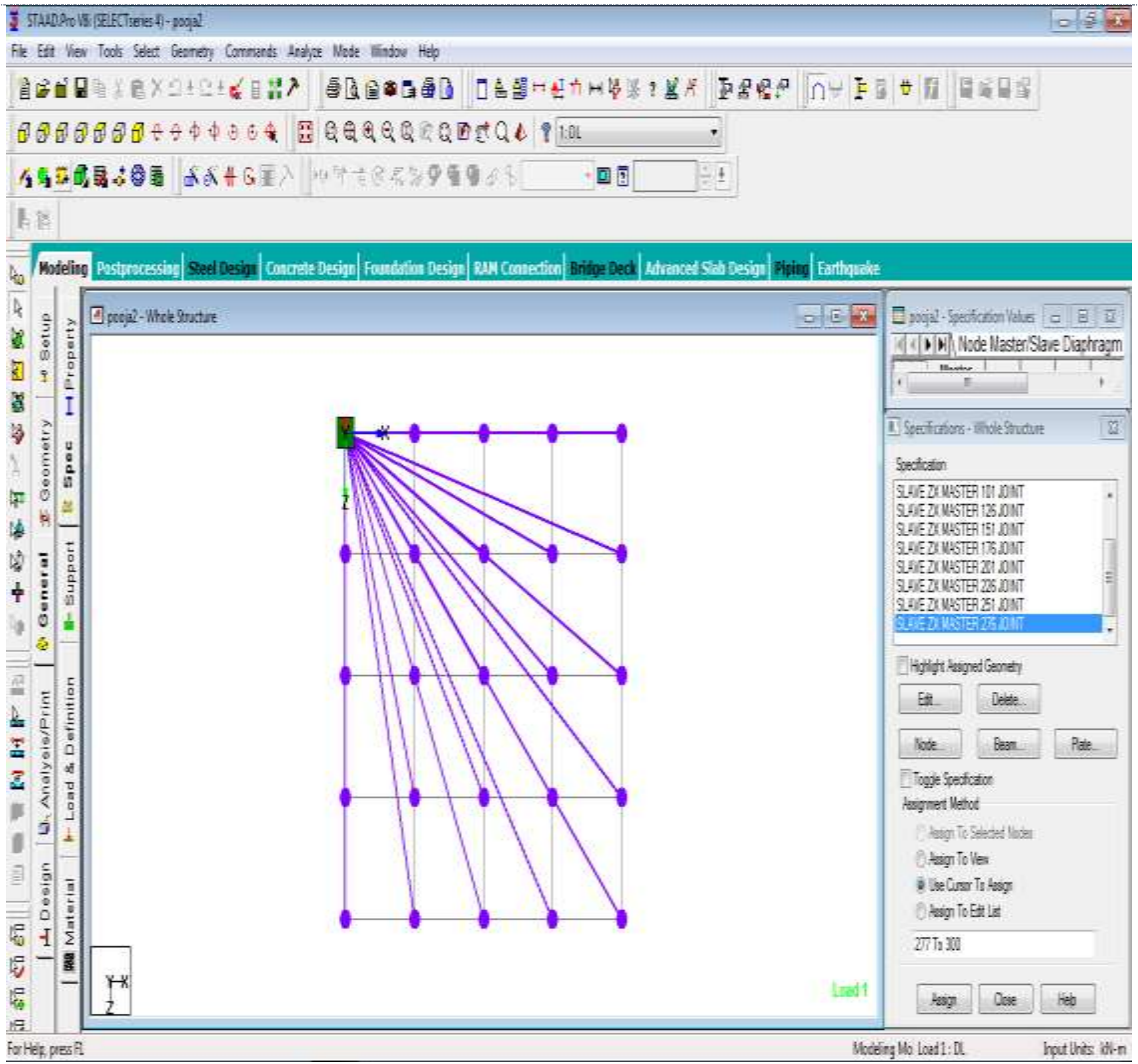
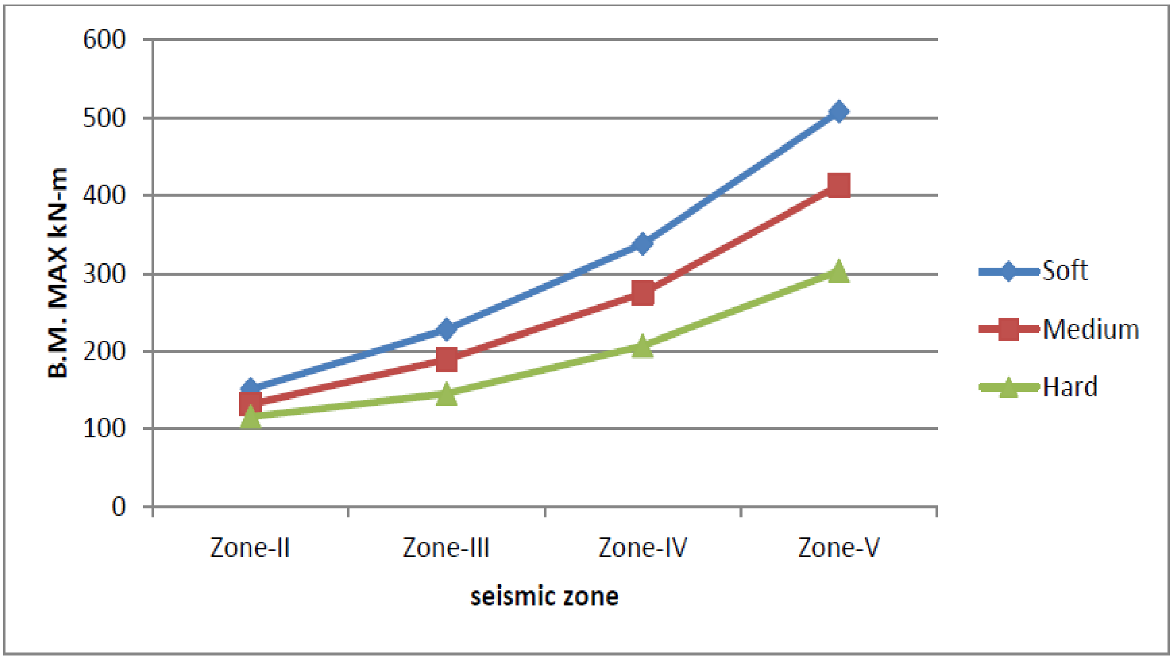


Figure 4.5 : Semi rigid diaphragm

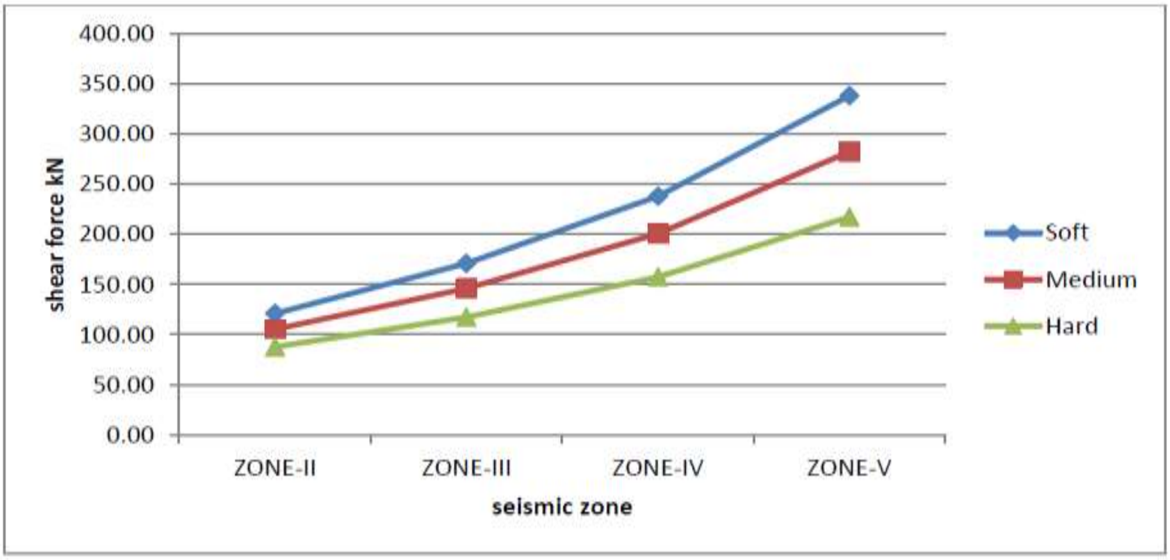
V. ANALYSIS AND RESULTS

The result of various analysis for different ground slopes (0o, 10o, 15o) are presented and a comparative study between results of different slopes and plane ground ismade to analyses the effect of sloping ground on structural forces.

Result at 0º slope



As per above graph bending moment maximum is in Soft soil and minimum in hard soil, therefore hard soil is comparatively more capable and reduces reinforcement require.



It is observed that maximum shear force is found in soft soil whereas minimum in hard soil, therefore hard soil is considered good.

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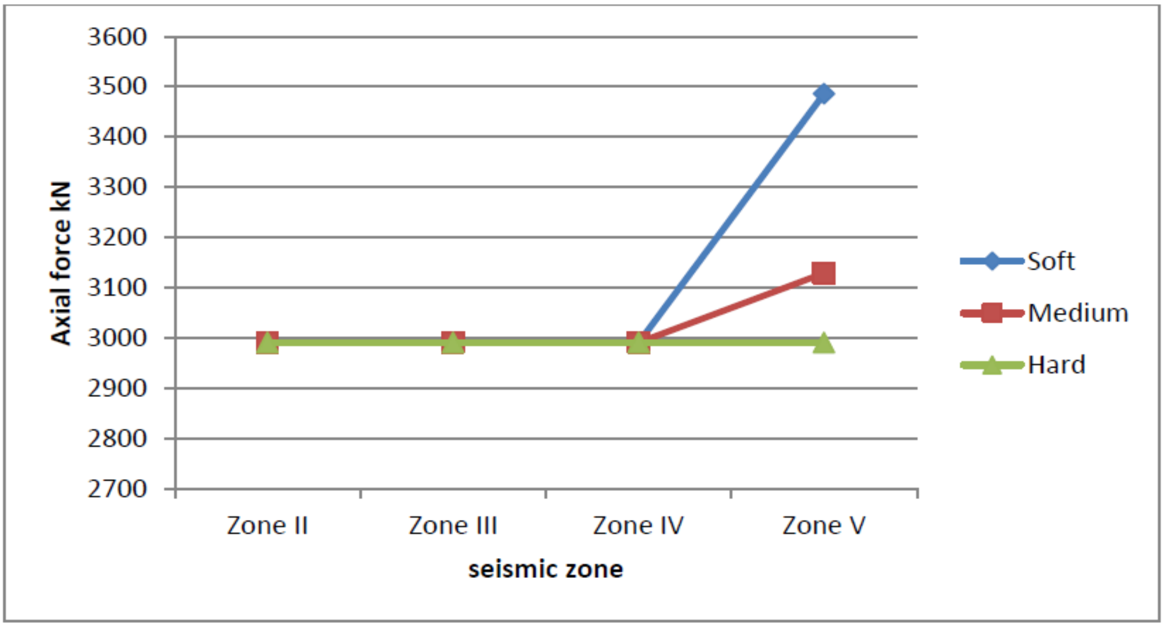
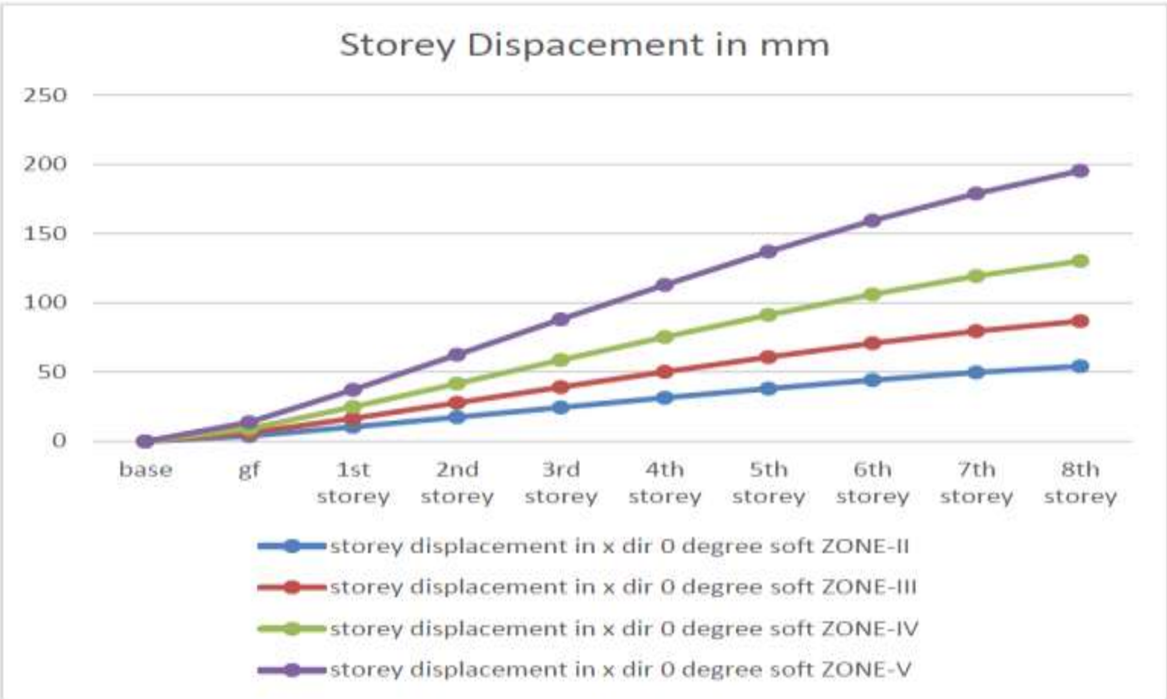


Uniform result in axial forces is observed in all zones except zone IV and V. which shows gradual increase in axial forces at higher zones With respect to soil type.



Storey displacement shows that as the intensity of zone is increasing displacement in increasing in a parallel manner with increase in slopes

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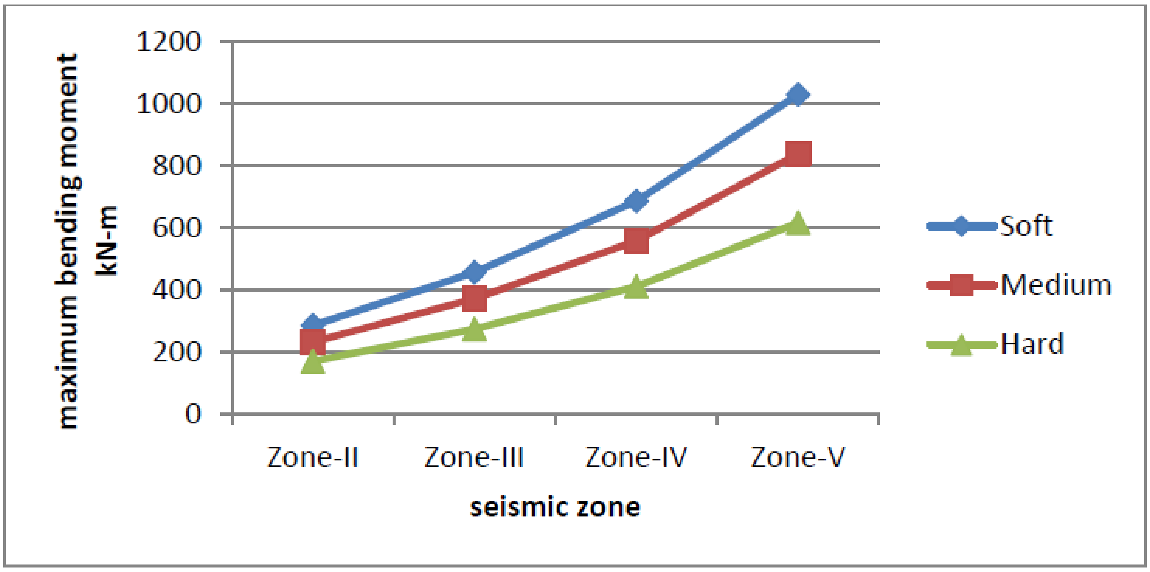
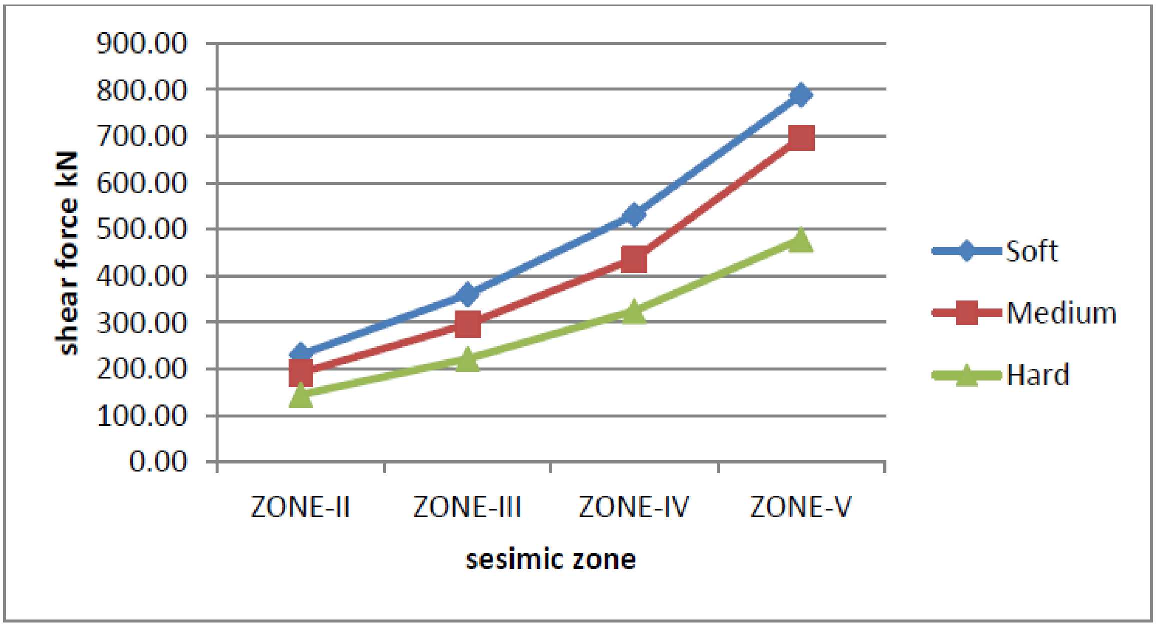
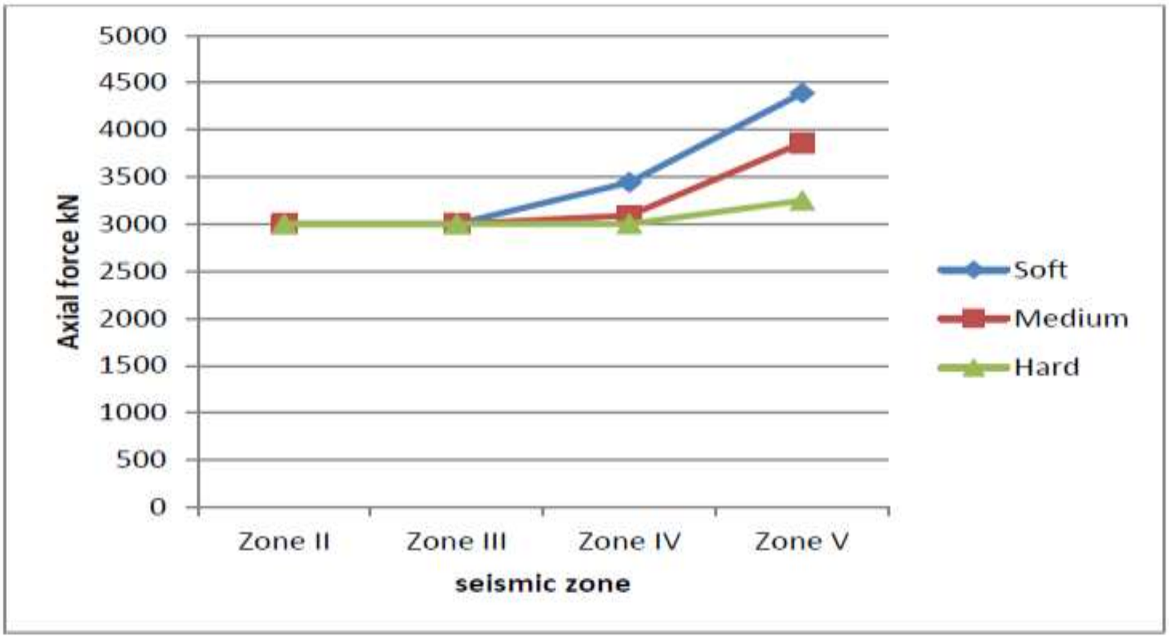
Results at 10° slope:



As per above graph bending moment maximum is in Soft soil and minimum in hard soil, therefore hard soil is comparatively more capable and reduces reinforcement require.



It is observed that maximum shear force is found in soft soil whereas minimum in hard soil, therefore hard soil is considered good



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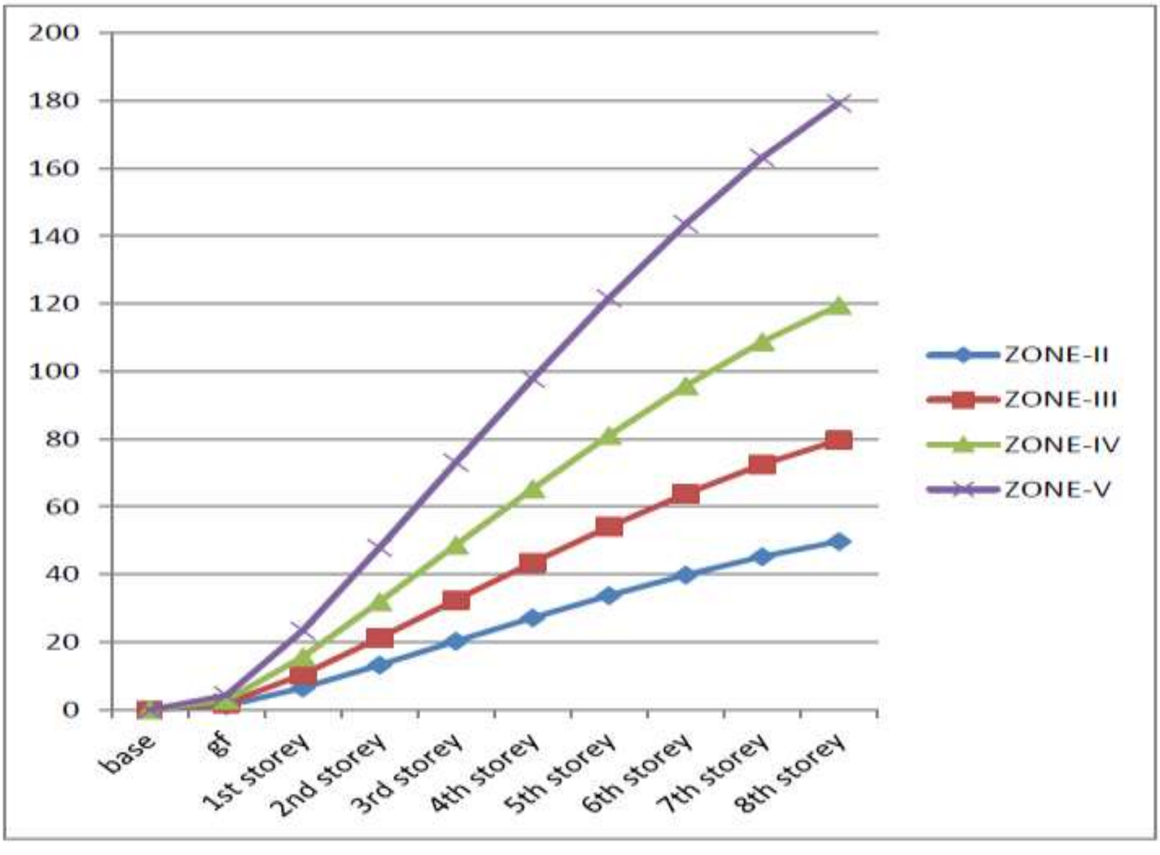

Storey displacement shows that as the intensity of zone is increasing displacement in increasing in a parallel manner with increase in slopes

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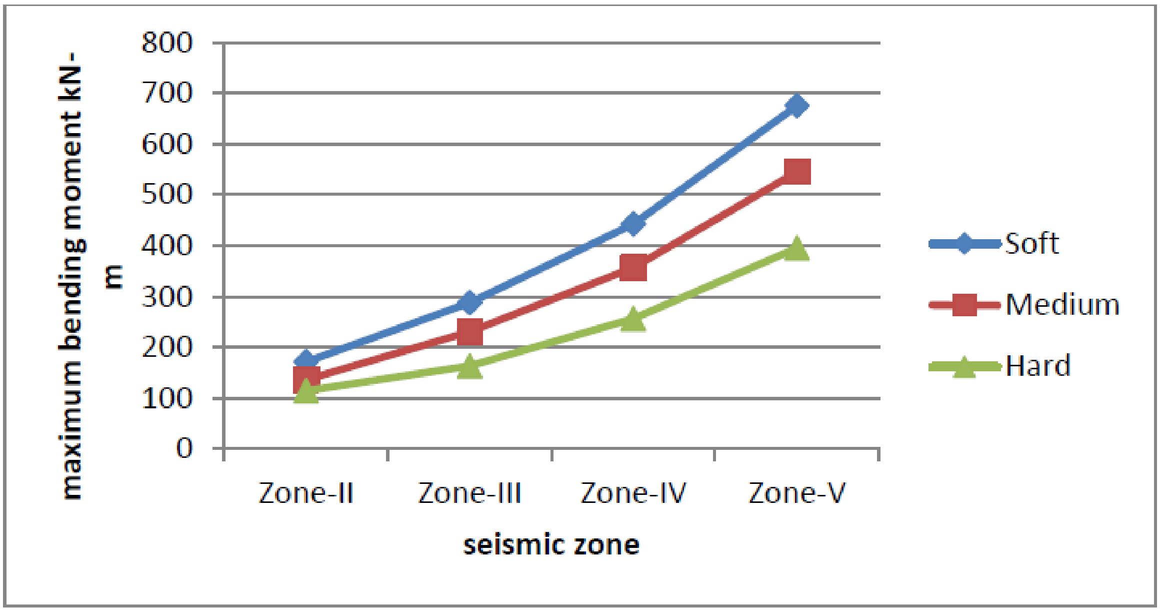
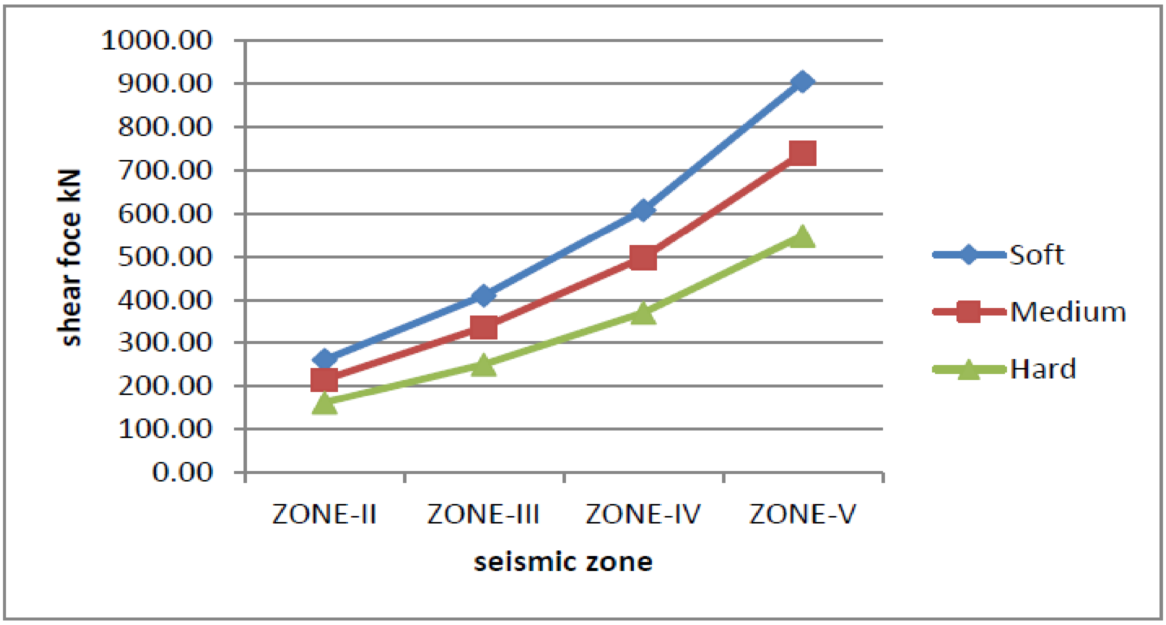
Results at 15° slope



As per above graph bending moment maximum is in Soft soil and minimum in hard soil, therefore hard soil is comparatively more capable and reduces reinforcement require



It is observed that maximum shear force is found in soft soil whereas minimum in hard soil, therefore hard soil is considered good.

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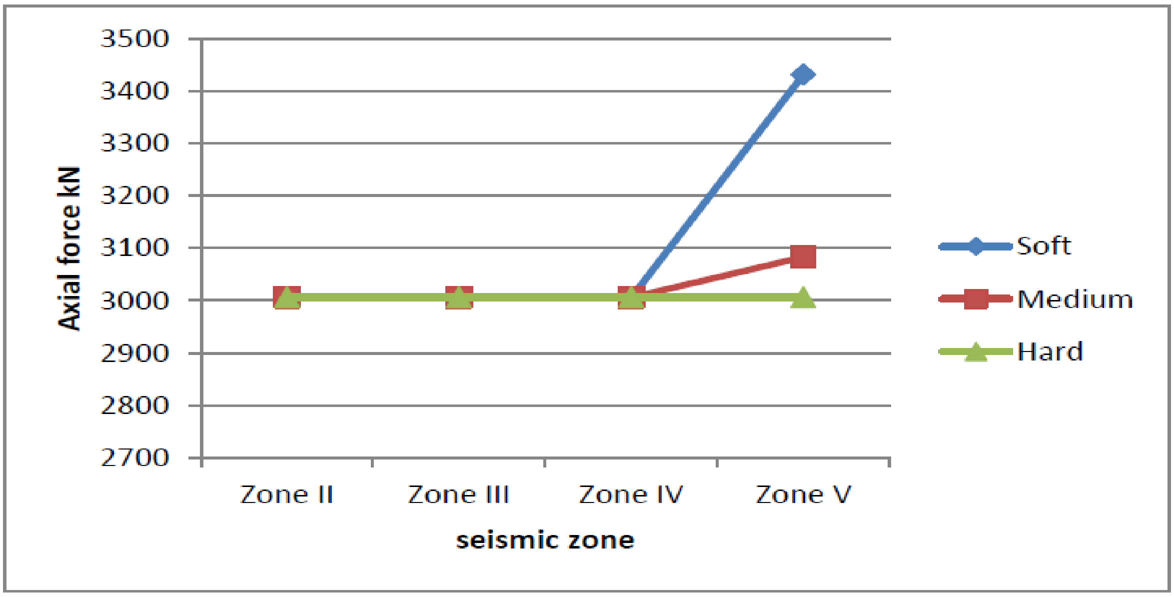
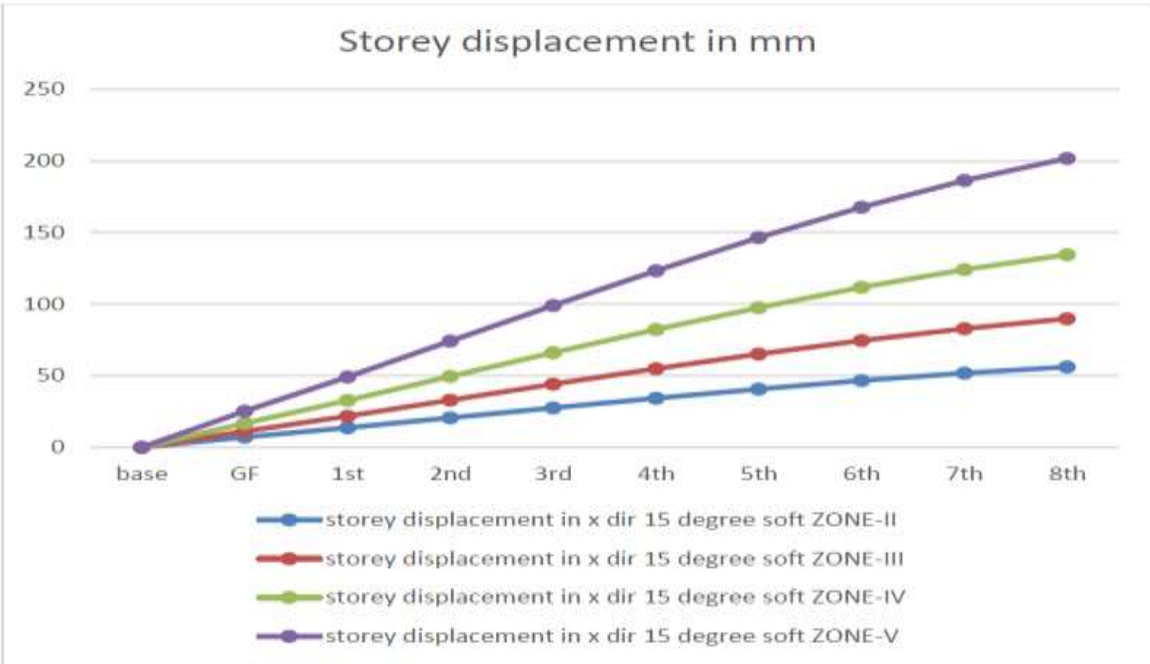


Uniform result in axial forces is observed in all zones except zone IV and V. which shows gradual increase in axial forces at higher zones With respect to soil type.



Storey displacement shows that as the intensity of zone is increasing displacement in increasing in a parallel manner with increase in slopes

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Table 5.1: B.M. in zero degree plain.

Type of Soil	BENDING MOMENT MAXIMUM (KN-m) in 0^0.			
	Zone II	Zone III	Zone IV	Zone V
Soft	148.32	226.09	334.009	504.136
Medium	130.89	187.67	278.41	411.19
Hard	112.411	141.86	203.403	301.06

Table 5.2: B.M. in 10 degree plain.

Type of Soil	BENDING MOMENT MAXIMUM (KN-m) in 10^0			
	Zone-II	Zone-III	Zone-IV	Zone-V
Soft	283.217	447.102	683.182	1027.221
Medium	212.642	371.363	556.676	828.143
Hard	175.284	271.43	411.714	614.245

Table 5.3: B.M. in 15 degree plain.

Soil Type	BENDING MOMENT MAXIMUM (KN-m) in 15^0			
	Zone-II	Zone-III	Zone-IV	Zone-V
Soft	172.675	286.806	441.648	673.91
Medium	138.746	231.32	354.419	542.566
Hard	111.142	162.562	252.282	394.361

Table 5.4: Maximum Shear force in 0 degree plain

Soil Type	Shear force (kN) in 0^0 slope			
	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Soft	120.92	170.92	237.77	338.05
Medium	105.17	146.10	200.54	282.20
Hard	87.85	117.47	157.31	217.35

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Table 5.5: Maximum Shear force in 10 degree plain

Soil Type	Shear force (kN) in 10°slope			
	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Soft	221.52	363.12	533.78	782.19
Medium	194.89	295.45	433.16	695.76
Hard	143.36	221.42	324.17	474.34

Table 5.6: Maximum Shear force in 15 degree plain

Soil Type	Shear force (kN) in 15°slope			
	ZONE-II	ZONE-III	ZONE-IV	ZONE-V
Soft	263.56	420.04	609.02	902.99
Medium	213.62	326.54	494.77	736.61
Hard	165.27	241.18	362.73	543.51

Table 5.7: Maximum axial force (KN) in 0 degree plain.

Soil type	Axial force kN in 0°slope			
	Zone II	Zone III	Zone IV	Zone V
Soft	2986.916	2986.916	2986.916	3487.253
Medium	2986.916	2986.916	2986.916	3131.163
Hard	2986.916	2986.916	2986.916	2989.928

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Table 5.8: Maximum axial force (KN) in 10 degree plain.

Soil type	Axial force kNin 10°slope			
	Zone II	Zone III	Zone IV	Zone V
Soft	3004.783	3004.783	3441.708	4384.194
Medium	3004.783	3004.783	3091.061	3863.223
Hard	3004.783	3004.783	3002.783	3253.418

Table 5.9: Maximum axial force (KN) in 15 degree plain.

Soil type	Axial force kNin 15°slope			
	Zone II	Zone III	Zone IV	Zone V
Soft	3003.617	3003.617	3003.617	3431.136
Medium	3003.617	3003.617	3003.617	3085.366
Hard	3003.617	3003.617	3003.617	3007.617

VI. CONCLUSION

1) In response spectrum analysis, Base shear is increase 12 % in sloping ground building compare to building on plain ground.
2) In response spectrum analysis, Axial force is almost same in all three types of building but moment increase 62 % and 7 % in sloping ground building compare to building on plain ground
3) 15 degree sloped frame experiences maximum storey displacement due to low value of stiffness of short column while the 0 degree frame experiences minimum storey displacement.

In the above chapter it is clearly shown that frame with consideration of slab stiffness provides a variation of 0.98 to 1.01 times in axial forces of column compared to frame without consideration of slab stiffness. There is no significant change in axial force of columns for the given loading. Torsional and bending moment in columns are negligible and the change is insignificant due to introduction of slab.

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