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Analysis of a Heighted Multistory Building Frame Considering Sub Base Soil Interaction Considering Lateral Forces

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ABSTRACT

Lateral forces are now a days considered as the most important load to be applied for designing a tall structure. around the world it has different provisions as per country code but the factor is same to reisst lateral forces and to analyze the structure for concern region zone and base shear. for seismic analysis the most important part to be consider is soil. as soil is the main part from where shakes appears and applied to the structure.

In India seismic provision I.S. 1893-I also consider soil effect over the structure. In this research work we are analyzing a G+10 Symmetrical structure which is placed 2 m beneath the soil mass to perform soil structure interaction considering seismic zone IV and soil type consider is soft, medium and hard.

It is concluded that soft soil shows low stability and stiffness to the structure as compared to other two type of soil which may cause structure failure and displacement above permissible limit.

Keywords : Soil Interaction. Structural Analysis, Forces, Deflection, Moment, Non Linear Analysis

I. INTRODUCTION

Since the hazards occurring all over the world due to seismic pressure is increasing and causing damage to the infrastructure and people, thus for designing structures prone to resist such tremors are necessary. As we all know seismic hazards generally occurs due to movement in tectonic plates beneath the earth therefore foundations and soil pressure below the structure should be analyze for safe distribution of vertical pressure of the building. Soil interaction is one of the most important aspect which is been considered by engineers and architects from several years after the examination of impacts on structure due to earthquake all around the globe.

Soil structure interaction is analyzed by interacting the combine effect of base of the structure and soil beneath. The layers of structure stated on deformable soil redistributes forces and moment because of soil interaction, in such case symmetric examination is not effective and might is inappropriate.

The interaction impact is increasingly usymmetrically if there should be an occurrence of multi-storeyed buildings because of overwhelming loads and may

turn out to be additionally distorted when such buildings are exposed to seismic hazards.

In general, Soil Structure Interaction (SSI) is widely accepted being a simple and highly impactful technique having several advantages which should be considered in every structure design. SSI courses of action of seismic pressure are optional and empower architects to analyze the structure. Base shear Vb of the structures is considering soil-structure interaction (SSI) as a beneficial effect. The crucial idea behind the plans is that the soil structure system can be displaced with a proportionate fixed-base model with a progressively drawn-out period and normally a greater damping extent. A huge part of the structure codes utilizes effect of different soil types, which is necessary for analysis of structure at different soil regions and studying effect of structure on different type of soil. Since soil properties also have effect on the structure stability due to its swelling and shrinking conditions. In explanatory manner it can be said that structure stability depends on soil type (properties) and have been considered in I.S. 1893-I:2016.

This research work presents an explanatory comparison of a high rise symmetrical structure of G+10 storey considering seismic zone IV with three different soil conditions i.e. soft soil, medium soil and Hard strata, In this study we are interacting structure and soil using analysis tool SAP2000.

The process of investigating Soil-Structure Interaction (SSI) starts with identification of the structure as per earthquake designing. It is crucial to understand the basic reaction of the forces generated due to soil structure interaction that stimulates an effect to the structure. This is one form of application of seismic forces on a structure.

The soil-structure interaction can be defined as the process in which the response from the soil influences the motion of the structure and the motion of the given structure affects the response from the soil. This is a phenomenon in which the structural displacements and the ground displacements are independent to each other.

Soil-structure force are mainly interaction forces that can occur for every structure. But these are not able to change the soil motion in all conditions.

Soil flexibility is the effect considered for SSI, as in the case, soft soil enlarges the chances for the prevalence of Soil Structure interaction effects. This is for a given structure and a site that has a free - field seismic excitation.

Objectives:

The primary objectives of this study is as follows:

1. To check the stability of tall structure analyzing soil structure interaction.
2. To perform comparative analysis of three different type of soil.
3. To Analyze the interaction of soil and column where column support end is provided 2 m beneath the soil.
4. To justify the utilization of soil interaction in seismic design of the structure.

II. LITERATURE REVIEW

Supriya and Reddy (2019) this research paper presented the effects of soil interaction on building frame design parameters as change of modulus of sub-grade reaction from 0.010 to 0.050 N/mm3 the analysis was done on parameters namely shear force, bending moment and settlements for different footing sizes of 1mx1m to 4.5mx4.5m the effect of SSI was quantified using finite element analysis. The conclusion derived from the research paper stated

that the shear force and axial force value in the beam and column is constant from finite element analysis was not having considerable difference. The analysis was predicting that percentage difference in bending moment in beam, column and footings was at lower EFS value i.e 0.010N/mm3 at lower footing size 1mX1m was greater than when compared to higher EFS value i.e 0.050N/mm3 at higher footing size 4.5mX4.5m which considers soil interaction. But in case of the footings they undergo some settlement the percentage difference of settlement was 14.41% and 6.72% at lower EFS value i.e 0.010N/mm3 at lower footing size 1mx1m when compared to higher EFS value i.e 0.050N/mm3 at higher footing size 4.5mx4.5m respectively, which considers soil interaction.

Magade S. B and Prof. Patankar J. P(2018) this research paper presented different parameter such as soil structure interaction, types of soil, stiffness of infill walls, and location of walls influences time period, displacement and base shear of building frame considerably. Hence it was important to consider to all these parameters in the analysis of structures. Shear walls located in the central part of the multistoried building gives lesser displacement and more base shear compared to other locations.

Hailu Getachew Kabtamu et. al. (2018) this research paper dynamic analysis of Soil Structure Interaction (SSI) effect on multi story reinforced concrete (RC) frame founded on soft soil (flexible base) and comparison was made with fixed base. Two model 2D RC frames with 7 and 12 story are selected for analysis. Winkler Spring and half space direct method models are used for flexible base for the frames founded on two types of soft soils with shear velocity Vs < 150 m/s Asper Seismic Codes of Chinese GB50011-2010 Soil IV and Ethiopian ES8-2015 soil D. The frames are subjected to strong ground motion matched to response spectrums of soft soil of Chinese GB50011-2010 and Ethiopian ES8-2015 for linear time history analysis. The dynamic analysis result showcased Spring and Fixed base mass participation 90% reaches in 2 or 3 modes but in direct method 11 to 30 modes for story 12 and 7 respectively.

Outcome of the Literature survey:

The researchers have tried to find out the modifications observed in structural stability due to seismic load and soil properties.

following are the outcomes of literature review:

- Frame with lateral load resisting members resist lateral forces and provide stability.
- Structure stability also depends on soil type.
- High rise Structure need to resist lateral forces for its stability and safety.

III. Methodology

Step-1 Select Geometrical data and modelling of structure using SAP2000.
Step-2: Creating sectional properties of structure.
Step-3: Creating Soil Property
Step-4: Creating Soil Mass below the structure:
Step-5: Interacting Structure and Soil solid:

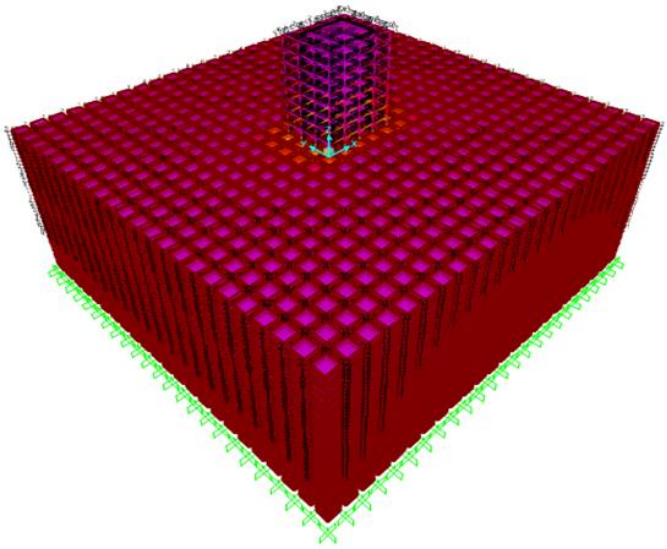

Fig 1: Structure with soil interaction

Step-6 Assigning hinged support at the soil soilid and structure.

Step-7: Assigning Load Conditions:

Step-8: Comparative Analysis

Table 1 : Geometrical data

Description	Value
HEIGHT OF BUILDING	33 m (G+10)
Length	26 m
width	26 m
column	0.5 x 0.5 m
Beam size (main)	0.3 x 0.25 m
Soil Type	As per I.S. 1893-I:2016
Soil Mass	50 x 50 x 50 meter
Support type	Fixed support

IV. RESULTS AND DISCUSSION

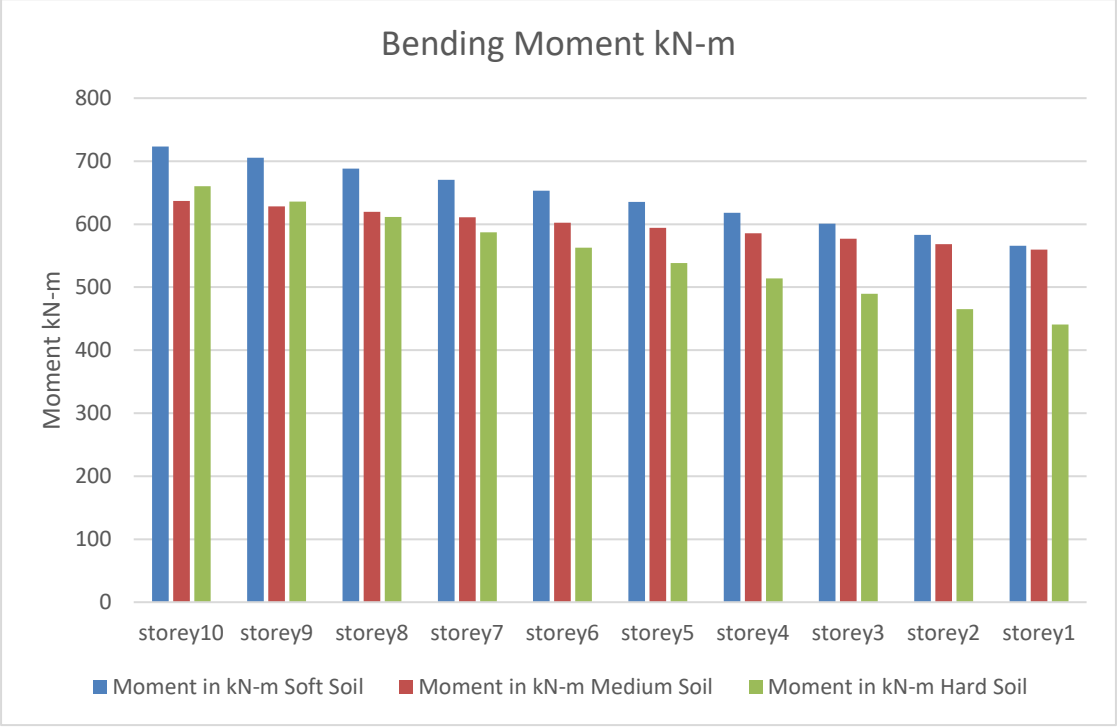

Fig 2 : Bending Moment

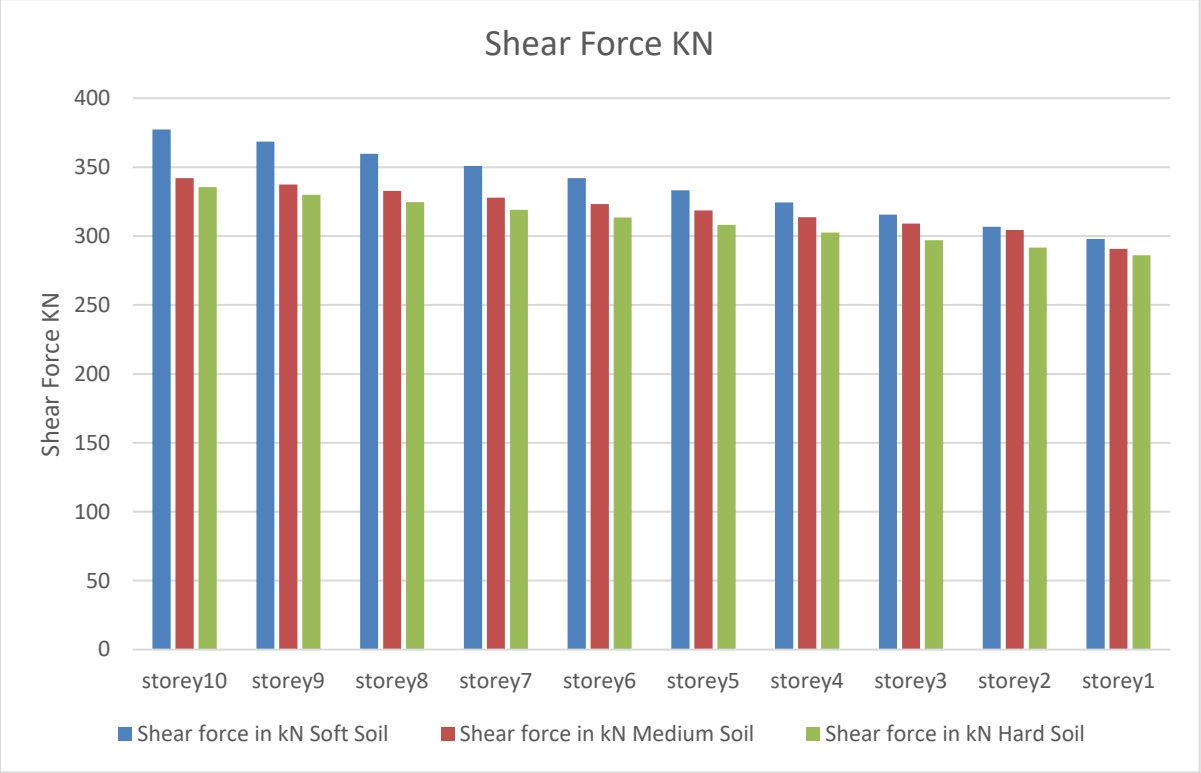

Fig 3 : Shear Force

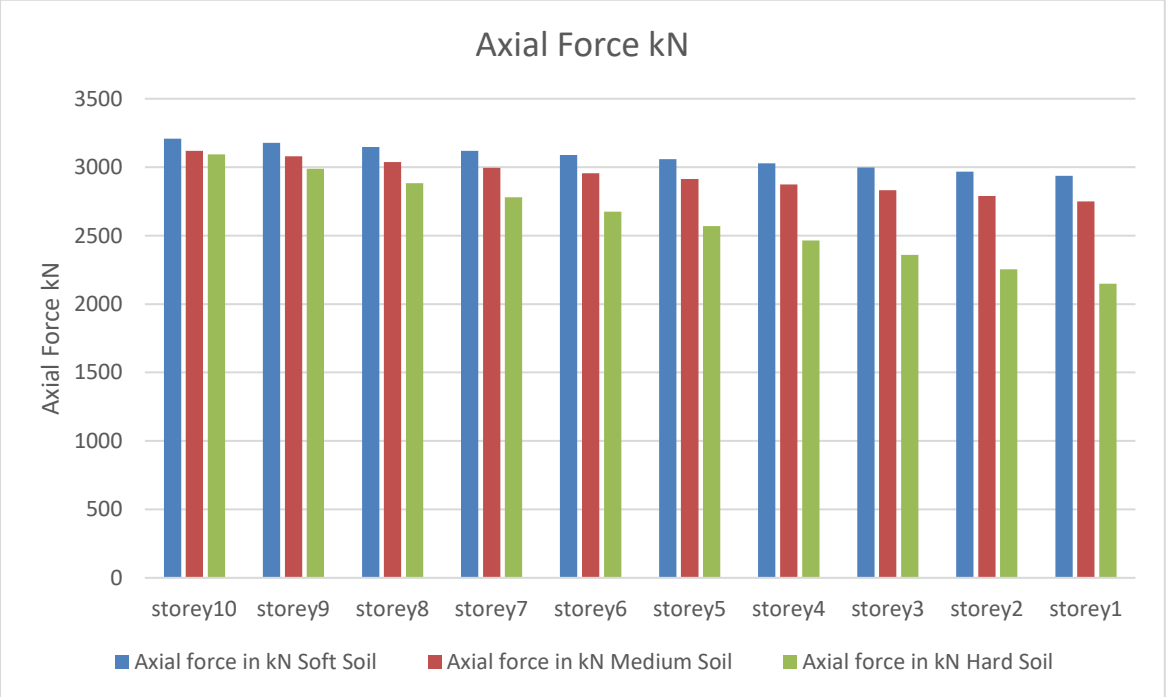

Fig 4 : Axial Force

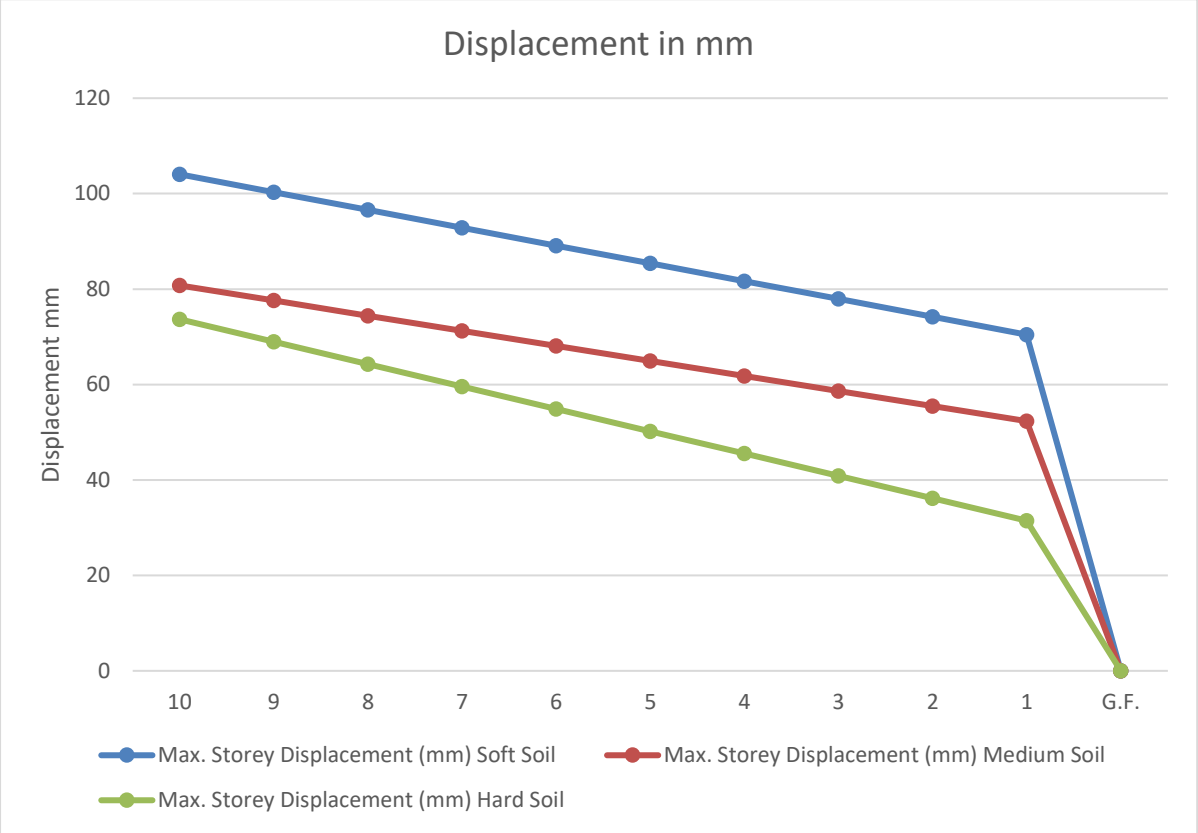

Fig 5 : Displacement

V. CONCLUSION

This study explores the SSI effect on the overall risk of a high rise building structure with respect to two failure modes: strength in terms of plate and joint forces, moment, Displacement and Support reaction at the base of the structure:

1 It is observed in the above analysis that hard strata soil is 11.20 % more stable in resisting Shear forces.

2 It is observed that effect of lateral forces is more in soft soil as compared to medium soil and hard soil, variation of 8.79% is observed.

3 It is observed that soil mass is meshed finitely in SAP2000 which provide accurate and linear results.

4 It can be concluded that there is variation in the cases i.e. structure under soft soil, medium soil and hard soil, as forces and moment are varying by 11% and 9 % respectively.

5 The consideration of SSI shows a complete conflicting effect on the seismic fragility and risk depending on the two different soil failure modes. This has a positive effect regarding the strength failure mode, but this brings a negative effect regarding the displacement failure mode.

6 It is observed that effect of structure is upto 18 m depth in soft soil whereas in medium soil it is resisted upto 17.58m whereas hard soil is most suitable and distribution effect only upto 12 m depth

VI. SUMMARY

Here it can be concluded that the soil properties effect the overall stability of the structure and it is

justify that for designing lateral forces soil type have major role in analysis.

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