ANALYSIS OF HIGH RISE BUILDING ON THE BASIS OF SOIL INTERACTION

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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.

Key Words: **Soil Interaction. Structural analysis, forces, deflection, moment, non linear analysis.**

1.INTRODUCTION

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.

1.1 Soil Structure Interaction

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.

Soil-structure interaction examination assesses the aggregate reaction of these frameworks to a predefined ground movement. The terms Soil-Structure Interaction (SSI) and Soil-Foundation-Structure Interaction (SFSI) are both used to portray this impact in the writing. In this report, the establishment is viewed as a major aspect of the structure, and the term SSI has been received. A seismic soil-structure interaction examination assesses the aggregate reaction of the structure, the establishment, and the geologic media basic and encompassing the establishment, to a predetermined free- field ground movement. The term free-field alludes to movements that are not influenced by basic vibrations or the dissipating of waves at, and around, the establishment. SSI impacts are missing for the hypothetical state of an inflexible establishment bolstered on unbending soil. In like manner, SSI represents the distinction between the reaction of the structure and the reaction of the hypothetical, unbending base condition.

1.2 Methodology

Step-1 Select Geometrical data and modelling of structure using SAP2000.

An RCC Structure is rigid to get together of Beams, Columns, Slabs, and establishment between associated with one another as a solitary unit. For the most part, the uniform load in these structures is from slab to rebar, from beams to the column section to the foundation which thus exchanges the whole load to the soil. In this investigation, we are analysing G+ 10 structures considering three different type of soil cases by expecting distinctive frameworks for load opposing structure demonstrated utilizing Csi- SAP2000. The arrangement and 3-D perspective of the unpredictable building are appeared in the figure beneath.

Step-2: Creating sectional properties of structure.

Step-3: Creating Soil Property

Soil properties such as poisons ration and unit weight is considered from references paper.

Step-4: Creating Soil Mass below the structure:

SAP2000 give us a development alternative to give material properties in a particular way to dole out in structure. In SAP2000 we are allowed to dole out any sort of material as it gives a practical altering device to make the material. For this study we are considering soil solid of 50m x 50m x 50m.

Step-5: Interacting Structure and Soil solid:

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

In this step we are assigning hinged support at the bottom of the structure which is 2 m below the soil mass. In SAP2000 we are allowed to assign out any sort of support condition either fixed, pinned or roller for which we have to tap on end points of the structure.

Step-7: Assigning Load Conditions:

For the investigation of the structure, all the load conditions to the structure are connected. The estimations of configuration loads are computed according to I.S. 875 Part I and II and IS-1893 part I. Dead loads will be computed based on unit weights of materials given in IS 875 (Part I) which will be set up thinking about the materials indicated for development. The forced load is characterized as the heap that is connected to the structure that isn't lasting and can be variable and will be accepted as per IS 87S (Part II).

Selection of parameters of seismic Definition of various soil conditions

a) Selection of Earthquake Zones

The Seismic Zone IV (0.24) is considered in the investigation.

b) Selection of soil condition

For the investigation of the structure three different type of soil conditions are considered to ponder the impact of structure.

Different Earthquake parameters, for example, Zone Factor (Z), Importance Factor (I), Response decrease factor (R), soil condition, damping proportion and so on are characterized for various load cases utilizing the SAP2000 programming.

Step-8: Load Combinations

Step-9: Lateral Effect of load

Seismic pressure is generating in both X and Y direction, causing unstability to the structure which causes unsymmetrical distribution of load to the soil.

Step-10: Analysis of soil structure

Non linear analysis is performed using SAP2000 software, for this analysis soil mass is meshed in elements to determine the minute variation in different elements of the soil.

2. ANALYSIS RESULT

Non linear Analysis

None linear analysis, is a result of the advanced age, going to the fore with the coming of computerized PCs during the 1950s. It pursues on from framework techniques and finite contrast strategies for analysis, which had been created and utilized some time before this time. It is a PC based analysis apparatus for recreating and dissecting building items and frameworks. Non linear analysis is an amazingly intense building structure utility, yet one that ought to be utilized with extraordinary consideration. For instance, it is conceivable to coordinate a framework with PC helped structure programming, prompting a sort of ignorant push-catch analysis in the plan procedure. Shockingly, titanic blunders can be made at the push of a catch, as this notice clarifies.

The fundamental standards hidden are generally straightforward. Consider a body or designing part through which the conveyance of a field variable, for example relocation or stress, is required. Models could be a part under load, temperatures subject to a warmth input, and so forth. The body, for example a one-, a few dimensional strong, is demonstrated as being speculatively subdivided into a gathering of little parts called elements – 'finite elements'. The word 'finite' is utilized to portray the constrained, or finite, number of degrees of opportunity used to display the conduct of every element. The elements are thought to be associated with each other, yet just at interconnected joints, known as hubs . Note that the elements are notionally little districts, not separate substances like blocks, and there are no breaks or surfaces between them. (There are frameworks accessible that do demonstrate materials and structures containing genuine discrete elements, for example, genuine stone work blocks, molecule blends, grains of sand, and so forth, yet these are outside the extent of this course.)

The total set, or gathering of elements, is known as a work . The way toward speaking to a segment as an array of finite elements, known as discretisation, is the first of many key strides in understanding the method of analysis.

Comparative Analysis

Table -1: Sample Table format

1) Soil Mass Analysis

Soil Mass				
		Soft Soil	Medium Soil	Hard Soil
Beam	Node	Fy1kN	Fy2kN	Fy3kN
149	112	54.21	43.26	41.26
149	113	61.23	50.98	48.78
150	113	58.89	47.81	45.41
150	114	56.56	46.43	43.83
151	114	53.67	44.28	41.48
151	115	60.07	49.95	46.95
152	116	77.45	57.17	53.97
152	117	77.19	55.07	51.67
153	117	55.38	43.88	40.28
153	118	60.06	50.35	46.55
154	118	58.91	48.02	44.02
154	119	56.53	46.22	42.02
155	119	58.6	46.57	42.17
155	120	56.84	47.67	43.07

Soil Mass				
		Soft Soil	Medium Soil	Hard Soil
Beam	Node	Mz1kNm	Mz2kNm	Mz3kNm
149	112	34.84	24.95	22.95
149	113	-48.88	-40.39	-42.59
150	113	44.02	34.21	31.81
150	114	-39.37	-31.45	-34.05
151	114	35.84	26.3	23.5
151	115	-45.22	-37.64	-40.64
152	116	51.42	38.38	35.18
152	117	-50.9	-34.17	-37.57
153	117	38	26.47	22.87
153	118	-47.37	-39.41	-43.21
154	118	44.29	69.78	65.78
154	119	-39.54	-31.26	-35.46
155	119	39.56	28.94	24.54
155	120	-36.03	-31.13	-35.73

As shown in Table above it can be observed that stresses are more in Soft soil as compared to other two cases due to its unstable property which causes more deflection and stress to the structure and soil mass.

Bending Moment in each storey

Moment in kN-m			
Storey	**Soft Soil**	**Medium Soil**	**Hard Soil**
Storey10	722.98	636.66	660.23
Storey9	705.5	628.12	635.83
Storey8	688.02	619.58	611.43
Storey7	670.54	611.04	587.03
Storey6	653.06	602.5	562.63
Storey5	635.58	593.96	538.23
Storey4	618.1	585.42	513.83
Storey3	600.62	576.88	489.43
Storey2	583.14	568.34	465.03
Storey1	565.66	559.8	440.63

As observed in above analysis result in table 5.3 it can be observed that bending moment is maximum in soft soil condition due to its expanding and contracting properties which result in heavy structural members.

Shear Force in each storey

Shear force in kN			
Storey	**Soft Soil**	**Medium Soil**	**Hard Soil**
Storey10	377.33	342.11	335.51
Storey9	368.51	337.39	330.02
Storey8	359.69	332.67	324.53
Storey7	350.87	327.95	319.04
Storey6	342.05	323.23	313.55
Storey5	333.23	318.51	308.06
Storey4	324.41	313.79	302.57
Storey3	315.59	309.07	297.08
Storey2	306.77	304.35	291.59
Storey1	297.95	290.63	286.1

As shown in fig 5.3 it can be said that unbalance forces are generated maximum in soft soil due to unsymmetrical distribution of forces.

3. CONCLUSIONS

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

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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