Effect of Soil Structure Interaction on The Dynamic Behavior of Building

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Abstract- *In the conventional technique of analysis flexibility of soil, mass is omitted which is in all likelihood to have an effect on the overall performance of the structure. In the proposed study a try is made to apprehend the effect of soil flexibility on the overall performance of building frames. As the traditional evaluation technique does not address the soil-structure interaction explicitly, the effect of soil-structue interaction on the reinforced concrete structure is studied using the response spectrum method. Three G+6 story building on three kinds of soil interaction are modeled and subjected to an earthquake. Buildings resting on a fixed base. Dynamic analysis is carried out by the use of the Response Spectra of IS: 1893-2002. Etabs 2016 is used for developing those models. The impact of SSI on diverse structural parameters i.e. Base shear, story shear, story displacement, story flow and overturning moment are studied and discussed. The study shows that the SSI significantly influences the reaction of the structure. The effects brought about a criterion indicating that considering SSI in seismic design, for buildings on medium and soft soil is essential.*

Keywords- Soil Structure Interaction, Seismic Response, Response Spectrum, Story Shear, Story Displacement, Etabs 2016.

I. INTRODUCTION

1.1 General:

Earthquakes are among the most devastating natural disasters people have faced over history. Since civilization has advanced, and demand for all sort of buildings and other type of systems has elevated, with the development of civilization over the past century, homes and, infrastructure have accelerated exponentially in quantity and size, which inherently has expanded the dangers related to earthquakes. Even over the last few years direct and indirect results with the aid of earthquake results in hundreds of fatalities when affecting densely populated areas like in Southern Sumatra - Indonesia (2009), Haiti Region (2010), Southern Qinghai - China (2010) and Japan (2011), with 1,117; 316,000; 2,968 and 20,352 fatalities respectively.

Indian sub-continent is highly vulnerable to herbal screw ups like earthquake, draughts, floods etc. In October 2005, a 7.6-magnitude earthquake devastated Kashmir, Pakistan, toppling homes and originating landslides that buried extra than 85000 people. The 2001 Bhuj earthquake become the first example of an Indian earthquake causing collapses of current multi-storey buildings, due to the fact the earlier earthquakes had took place in rural or semi-city settings. Approximately 14,000 deaths on this earthquake created unprecedented attention among professionals, lecturers and the overall public, and opened up some of home windows of opportunity for capacity-building for seismic safety. Since the layout of earthquake resistant homes commenced assumption made that supports are fixed and traditionally, soil-structure inter play consequences had been ignored in seismic layout of systems, on the grounds that they were believed to only have favourable results. The lengthening of the length shifts the shape reaction to the spectral department of decrease accelerations which implies a discount of inertia forces within the structure. However, along contemporary reaction spectrum analysis ideas soil shape interaction outcomes are identified to no longer necessarily have beneficial but even may additionally have very detrimental effects for the response of the superstructure Gazetas [1], [2], Mylonakis & Gazetas [3].

The global fashion shift toward Earthquake resistance design inside the seismic engineering branch implies an increasing consciousness on displacements rather than on inertia forces, which makes right attention of soil structure interplay a important factor. Additionally, the failure of foundations their selves and feasible outcomes of soil failure have turn out to be a extra important difficulty in seismic layout. The effects of soil shape interaction had been subjective to analyze for about 1/2 a century, but are nonetheless under discussion. Code provisions relating to soil-shape interaction these days are nonetheless very restrained and instantly forward processes to account for soil structure interaction in design aren't protected in most codes. Simplified dynamic analysis strategies are normally used as a starting point, wherein the function and viable effects of soil-shape inter play in there action frequently remain unclear. In

earthquake engineering practice, it's miles well-recognized now that the foundation fabric on which a building is constructed may have interaction dynamically with the shape during its reaction to earthquake excitation to the volume that the most stresses and deflections within the device are modified appreciably from the values that would had been developed if it had been on a inflexible foundation. However, forty years in the past whilst the strategies of evaluation of structural reaction to earthquake motions have been just starting to be advanced, such interplay consequences had been taken into consideration to be of little consequence, and therefore were unnoticed.

1.2 Scope:

On the contrary research activities at universities everywhere in the global already are far ahead, providing lots of know-how on this field. The connection with engineering practice however seems to be one way or the other lost, which forms a trouble for training engineers dealing with design of structures in seismically lively areas. The present study is concentrated at a R.C.C. building models, those typically meets the conditions regarding raft foundation in different types of soil.

1.3 Objectives:

The Objective of proposed work are as follows,

1. To take a look at soil-structure interaction effects on seismic behaviour of reinforced concrete frame structure loaded and designed according to the Indian Standard Codes.
2. To assess the impact of soil structure interaction on numerous dynamic properties of R. C. frame such as natural time period, base shear, roof displacement, beam moment, column moment, etc.
3. To look at the impact of soil structure interaction on fixed bases. To have a look at impact of soil structure interaction of R. C. frame structure on different sorts of soil

II. BACKGROUND

Soil Structure Interaction (SSI) is an interdisciplinary subject of endeavour. It lies on the intersection of soil and structural mechanics, soil and structural dynamics, earthquake engineering, geophysics and Geo-mechanics, material science, computational and numerical strategies, and other diverse technical disciplines. Its origins trace back to the late nineteenth century, evolving and maturing gradually inside the resulting a long time and throughout the first half of of the 20 th century. SSI advanced rapidly within the second half stimulated mainly via the wishes of the nuclear energy and offshore industries, by using the debut of powerful computer systems and simulation tools consisting of finite elements, and by means of the desire for upgrades in seismic safety. The significance of soil-structure interplay both for static and dynamic hundreds has been properly set up and the associated literature covers as a minimum 30 years of computational and analytical procedures for solving soil–structure interplay problems. Since 1990s, extremely good effort has been made for substituting the classical techniques of design via the brand new ones primarily based on the concept of performance-based seismic design. In addition, the necessity of estimating the vulnerability of existing structures and assessing reliable methods for their retrofit have significantly attracted the eye of the engineering community in most seismic zones throughout the world.

III. RESEARCH METHODOLOGY

The following has been adopted for the execution of the dissertation work.

1) Foundations are considered to be resting on four different types of soil such as Soft soil, medium soil, and hard soil.
2) Building models designed and checked for loads as per IS: 456:2000
3) Total 3 numbers of models have been analyzed to fulfill the objectives.
4) Analysis has been carried out for G+6 stories considering fixed support on different soil conditions.
5) Analysis has been carried out considering seismic zone V for all models (soil conditions)
6) Results have been demonstrated in the form of tables and graphs.
7) Finally, the seismic performance of all these R.C. buildings has been compared and conclusions have been drawn.

IV. MODELLING

Statement of Problem:

In this study various numbers of structures are modelled and analyzed which are same in plan and same height of building i.e. number of story variations. All columns, beams and structural slabs were included in the model of each building**.** All models are subjected to dynamic analysis with the help of ETABS 2016. The dimension of all the beams and columns are design according to IS 456-2000 .The building is

designed to resist dead load, live load & seismic load. As per IS 1893:2002.

The following seismic parameters were used to calculate the seismic forces and design.

Zone factor = 0.36 (Zone V)
Importance factor = 1.5 (Commercial Building)
Response reduction factor = 5 Special moment resting frame (SMRF)

The other detailed description is as follows:

1. Size of Building: 18m X 18m.
2. Floor to floor height: 3.0 m
3. Parapet height: 1 m
4. Slab thickness: 150 mm
5. Wall thickness: 230 mm
6. Grade of concrete (Beam): M25
7. Grade of concrete (Column):M25
8. Grade of steel: Fe 500
9. Density of concrete: 25 kN/m3
10. Density of masonry wall: 20 kN/m3
11. Size of Beam:300X450mm
12. Size of Column: 300X500mm

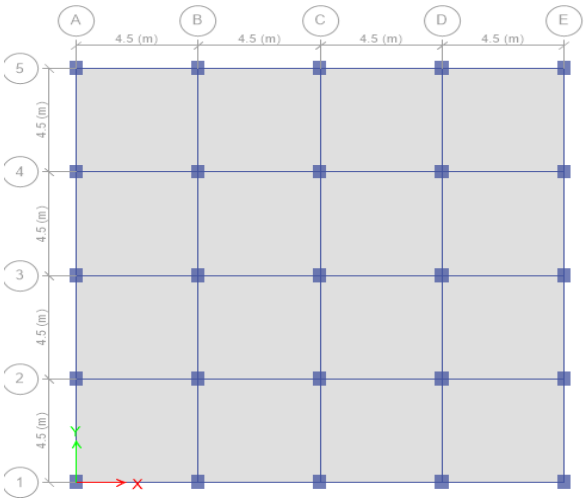

Fig. 1 Plan

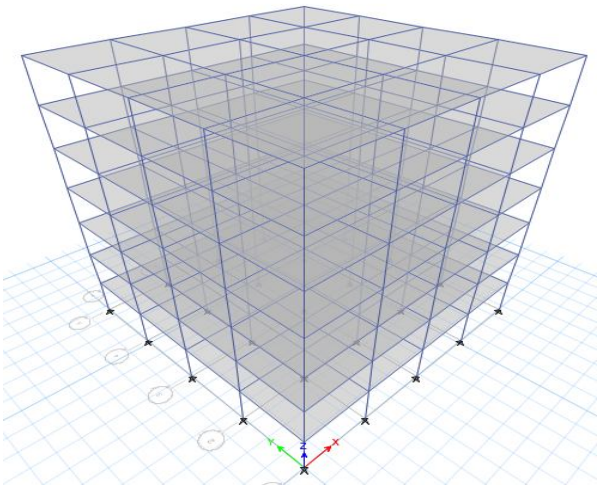

Fig. 2 Elevation

V. RESULT

A. Story Shear

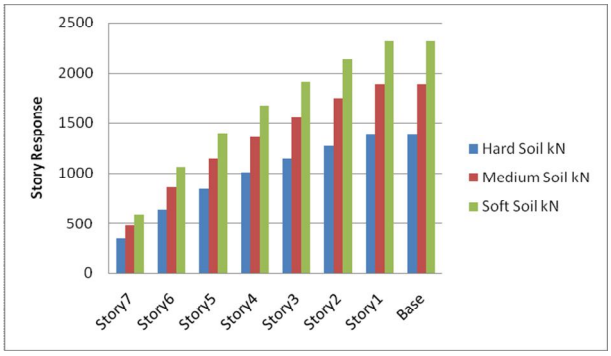

Table 1. Story Shear

Here the table 1 shows the story response and the story shear at each storey. The Base Shear for the Soft soil is more as compared to the hard and medium soil.

B. Story Displacement

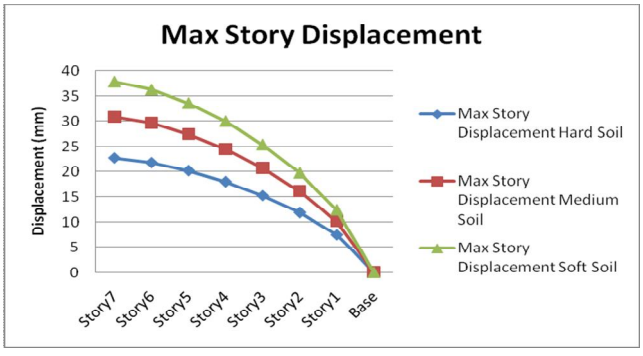

Table 2. Story Displacement

Here the table 2 shows the Story displacement at each storey. The story displacement is maximum for the Soft soil as compared to the hard and medium soil.

C. Story Drift

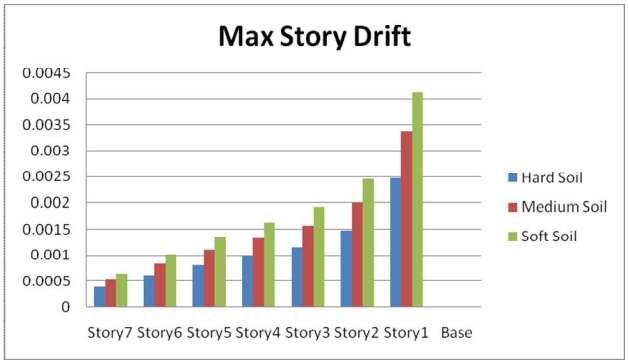

Table 3. Story Drift

Here the table 3 shows the Story drift at each storey. The story drift is the unit less quantity.

D. Overturning Moment

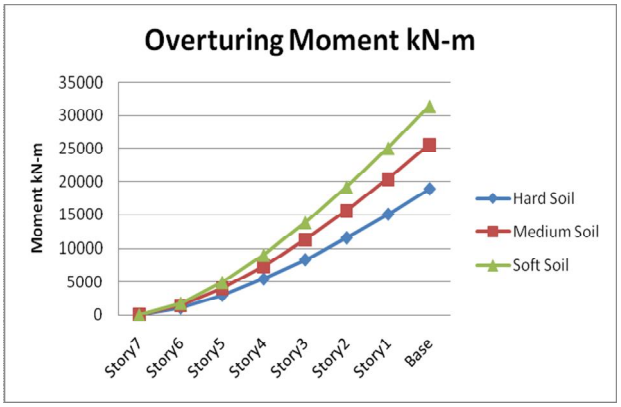

Table 4. Overturning Moment

Here the table 4 shows the overturning moment of the building for different soil.

VI. CONCLUSION

1) An increase in soil flexibility will increase the response of the structure. Base shear, story shear, story displacement, story drift and overturning moment are observed to be growing as soil flexibility will increase.
2) As the stiffness of the subsoil decreases, the consequences of the soil-structure interaction become extra dominant and unfavourable to the seismic conduct of RC constructing frames.
3) Results from the FEM model are more powerful for soft soil, therefore this method can be adopted for evaluation of structure resting on soft soil.
4) It is essential to recall the soil-structure interaction impact while structures is resting on free soils.
5) The results show that which include soil in a model of structure does not always have beneficial consequences, as regularly believed. Analyses conducted display that structure models with soil included have much higher values of story displacements.

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