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Analysis and Study the Behaviour of High Rise Residential Building in Different Soil Conditions of Seismic Zone 4

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Abstract - Soil is one of the important factors to be considered in structural engineering. The soil properties affect the structures to a great extent. Before any structural design it is must to analyse the behaviour of soil. In this study three symmetrical building models (G+25) of structure dimension 15x15 metres are analysed. These models are designed for seismic zone IV. Software used for analysis is STAAD Pro v8i. Height of each floor is 3 metres. These models are having different seismic responses for different soil types. Analysis of these models indicates that hard soil is more supportive for high rise buildings. Storey drift and lateral displacement are analysed along Z direction. Soft soil has shown maximum storey lateral displacement and maximum storey drift both. Maximum base shear shown by soft soil is 281.694 kN and for hard soil it is 132.739 kN.

Key Words: structural, symmetrical, STAAD Pro, drift, displacement, base shear

1. INTRODUCTION

Soil-Structure Interaction also known as SSI is one of the major factors to be considered in case of high rise structures. It is the interaction between soil and the structure constructed upon it. The behaviour of soil depends on soil structure and building structure both. Most of the civil engineering structures involve some type of structural element having the direct contact with the soil. This makes the study of soil behaviour more important in case of high rise buildings. Soil should be stable enough which can resist the deformations caused by external forces like seismic forces, structural load of building, etc. A lot of variations are observed among the behaviour of hard, medium and soft soils due to different mechanical and physical properties. Effects of SSI on the hard soil for low rise buildings are negligible. For highways, high rise buildings, heavy structures like dams, nuclear power plants, etc. SSI analysis is must especially when construction to be done on soft soil.

2. LITERATURE REVIEW

Aarti Kishor Shahane, et. Al (2021): Study the Behavior of Multistory Building with Consideration of Non-Structural Element. This paper is published in International Journal of Engineering Research & Technology (IJERT) Vol. 10 Issue 07, July-2021. In this paper a non-structural element is considered to study the behavior of multistory building. It is about the application of a displacement sensitive element like sign board through solved example. Different parameters like base shear, displacement, mass displacement and effect of non structural element of buildings are analyzed with the help of STAAD Pro software. Findings of this paper are that in G+18 building considering two sign boards (Non-structural element) then the maximum model time period is obtained as 6.3216 seconds. Also the maximum mass participation in direction Z is 85.255% and base shear in this direction is calculated as 24301.25 KN. This paper indicates the necessity to analyze the structure with consideration of nonstructural Elements as the additional load is acting on structure to get better behavior of the building.

Neha Pawar (2020): Analysis of G+25 Building In Gurugram Using STAAD Pro and Design Software This paper was published in International Journal for Scientific Research & Development Vol. 8, Issue 4, 2020. In this paper author has chosen the building situated in Gurugram city for the analysis with the help of software STAAD Pro. The main objective of this research paper is to find out stability of a building in the city. Dead load, Live load, Seismic Load and Wind load along with various combinations are taken into account. The G+25 building consists of 8 apartments on a single floor.

Lakshmi S and Neethi B (2020): Study of Structural Behaviour and Analysis of RC Buildings on the Impact of Seismic Pounding Due to Lateral Displacement.This paper was published in International Journal of Engineering Research & Technology (IJERT), Vol. 9 Issue 12, December-2020. This research is about the structural behaviour and analysis of RC Buildings under the impact of seismic pounding due to lateral displacement. As a problem for analysis two 3-D reinforced concrete moment resisting building frames (G+8, G+5) are considered and analyzed through SAP2000. Floor height is taken as 3.2 metres. Rigid diaphragm element of thickness 125 mm is taken for slab analyses. For the observation of pounding, Elcentro's data is used to carry out Time History Analysis.

Deepashree R, et. Al (2020): Evaluation of the Effects of Soil Structure Interaction on a Multistorey RC Building.This conference paper is published in First International Conference on Advances in Physical Sciences and Materials IOP Publishing Conference series 1706 (2020). In this paper a G+13 multi storey building is taken with storey height 3 metres and 6 models are analysed through ETABS software. These models are assumed to be located on Hard soil, Medium Soil and Soft soil. These soils are considered in Zone IV and these models are subjected to response spectrum analysis. These are

analysed with and without considering SSI effects. Spring element method is used to study the behaviour of these building models. The comparison is based on systematic parameters such as storey displacement, storey drift, Storey shear, base-shear, natural period, Storey stiffness and overturning moment. In the paper it is found that the time period in hard-soil is lesser as compared with medium and soft soil. It is highest for soft soil. Soft soil resulted in higher overturning moment in SSI.

Bhalchandra p. Alone, et. Al (2017): Study on seismic analysis of high-rise building by using STAAD Pro v8i. This paper was published in International Journal of Scientific Development and Research (IJSDR) Volume 2, Issue 8 August 2017. In this paper the case study on seismic analysis of high rise building with the help of STAAD Pro software is done. The building consisted of Ground+3 Basements+ 50 storeys taken for the analysis. The main objective of this study is to analyze the building as per code IS 1893-2002 part I criteria for earthquake resistant structure and its dynamic analysis of using response spectrum method. They focused on designing the building with different lateral stiffness systems. The main parameters which are considered in this study to compare the seismic performance of different models are storey drift, base shear, story deflection and time period.

Vaishali M. Tormal, et. Al (2014): Effect of Soil Structure Interaction on Response of Multistorey Building. This paper is published in International Journal of Engineering Research & Technology (IJERT) Vol. 3 Issue 8, August – 2014. This study is about a G+5 space frame resting on a pile foundation. The frame is 18m high with 4×2 bay of each bay is of 5m×5m in plan. The height of each storey is 3m, 200mm thick slab is taken which is provided at top as well as at the floor level. The slab at the top is supported by beam of 300mm width and depth of 400mm, resting on the column of size 300mm×580mm. Dead load is considered according to unit weight of materials used in the construction of frame. Soil modeling is based on discrete independent linear springs.

2. WORK METHODOLOGY

Three models shown in table 2.1 are analysed with the help of software STAAD Pro v8i. All the three models have same structural properties shown in table 2.2. These models are analysed to understand the influence of different soil types on their seismic responses. All the three models are symmetric along their length and width. Plan and isometric 3D view are shown in figure 2.1 and 2.2 respectively.

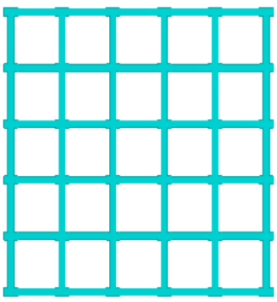

Fig. 2.1 Plan of G+25 Building

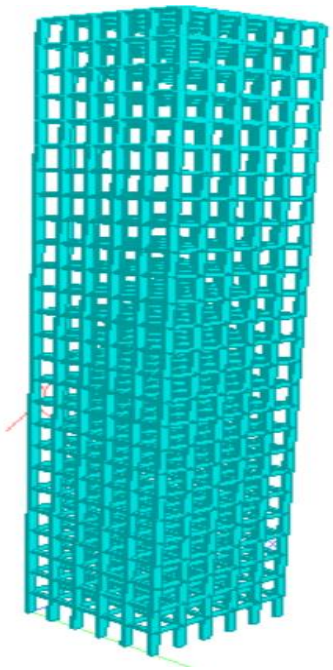

Fig. 2.2 Isometric 3D View of G+25 Building

Table 2.1 Models used for analysis

1.	Model P	RCC Frame Structure	Soft Soil
2.	Model Q	RCC Frame Structure	Medium Soil
3.	Model R	RCC Frame Structure	Hard Soil

Table 2.2 Structural Properties of Model P, Q and R

Sr. No.	Property	Dimensions
1	Plan dimensions	15 x 15 m
2	Number of storey	G + 25
3	Height of each floor	3 m
4	Beam Size	450 x 350 mm
5	Column Size	800 x 450 mm
6	Seismic Zone	IV
7	Zone Factor (Z)	0.24
8	Response Reduction Factor	5.0
9	Structure Type	RCC Frame Building (Value=1)
10	Damping Ratio	0.05
11	Importance Factor (I)	All general buildings (I=1)

3. RESULT AND ANALYSIS

3.1 Storey Drift

As per the given graph obtained from the STAAD Pro analysis it can be observed that Storey Drift for the first model "P" with Type-3 Soft Soil has the maximum value of 8.066 mm along Z direction. Storey Drift for the second model "Q" with Type-2 Medium Soil has maximum value of 6.568 mm along Z direction. Storey Drift for the third model "R" with Type-1 Hard Soil has maximum value of 3.789 mm along Z direction. Above values of storey drifts are maximum at the height of 33 metres from ground for all the models.

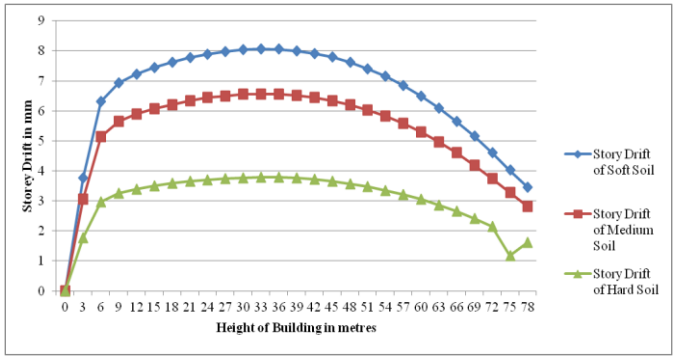

Fig. 3.1 Storey Drift along Z direction for different Soil Conditions

3.2 Storey Lateral Displacement

The following results are obtained from the analysis of different models:-

For the model P (for soft soil) the maximum storey lateral displacement is 175.343 mm along Z direction.

For the model Q (for medium soil) the maximum storey lateral displacement is 142.794 mm along Z direction.

For the model R (for hard soil) the maximum storey lateral displacement is 82.327 mm along Z direction.

Displacement values for different storey of buildings can be seen in the figure 3.2.

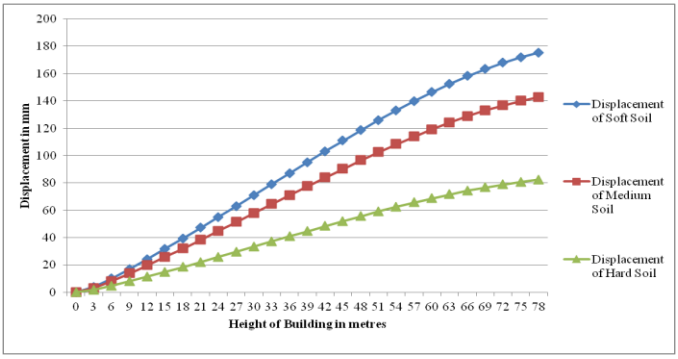

Figure 3.2 Displacement along Z direction

3.3 Base Shear of Different Storey

From the analysis of G+25 building by STAAD Pro it can be observed that the base shear is maximum for soft soil and minimum for hard soil. For soft soil the value of base shear at the storey height of 75 metres is 281.694 kN. Base shear for medium and hard soils is 229.403 kN and 132.739 kN respectively. The values of base shear for different storey is given in the figure 3.3.

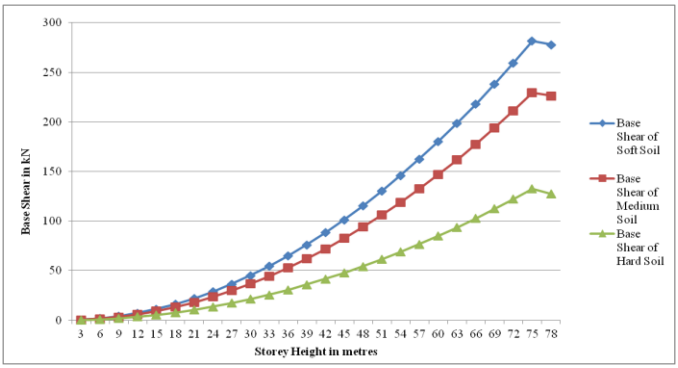

Fig. 3.3 Base Shear of Different Storey

4. CONCLUSION AND DISCUSSION

Three models P, Q and R of same structural dimensions are analysed for soft, medium and hard soil types respectively. These models are symmetrical and giving different results of seismic analysis due to different soil types. Storey drift of model P (soft soil type 3) is approximately two times of the storey drift of model R for hard soil. Storey lateral displacement is minimum for model R and is varying between 0 to 82 mm while for model P it is varying from 0 to 175 mm. Difference between the maximum base shear of models for soft soil and hard soil is 148.955 kN.

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