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(Research Article)

Impact of varying soil conditions on the design of tall building foundations

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Abstract

Above the past two decades, there has been a significant rise in the construction of tall structures over 150m in height, with an almost exponential development rate. Numerous similar structures have been built throughout the Middle East and Asia, and many more are proposed or now under development. Buildings over 300m in height are posing new engineering difficulties, especially in terms of structural and geotechnical design. Wind analysis is critical when it comes to big structures. Geotechnical engineers, in particular, are progressively abandoning empirical techniques in favor of state-of-the-art methods when designing foundations for super-tall structures. Numerous studies have investigated the structural behavior of tall structures with SSI by taking into account a variety of factors such as foundation type, soil conditions, lateral stresses, and the ratio of the flexural stiffness of the beam and column. Very few studies on the soil-structure interaction of tall structures in clayey soil conditions, especially in Indian seismic zones, have been conducted. In zone III, a G+18-story rectangular structure with a 3 m floor-to-floor height was assessed using the E-tabs software. The selected plan is rectangular in shape. The structure has been evaluated for static and dynamic wind and seismic forces. Structures have been developed for use in circumstances of hard, medium, and soft soil.

Keywords: Soil Conditions; Foundations; Large Buildings; ETABS.

1. Introduction

1.1. General

Indian population is estimated at 1,282,390,303 as of 2015 and India has become second most populous country in the world. Vertical growth of built environment is unavoidable for providing shelter and workspace for them. Dynamic analysis of tall buildings with all considered safety factors has become a challenge for Civil Engineers. Earthquake resistant tall buildings behaving well in all type of soil conditions, especially in soft soils are necessary to be constructed. Wind analysis is also important in case of tall buildings.

1.2. Tall Buildings

The last two decades have seen a remarkable increase in construction of tall buildings in excess of 150m in height, and an almost exponential rate of growth. A significant number of these buildings have been constructed in the Middle East and Asia, and many more are either planned or already under construction. “Super-tall” buildings in excess of 300m in height are presenting new challenges to engineers, particularly in relation to structural and geotechnical design. Wind analysis is important in case of tall buildings. Figure 1 shows the significant growth in the number of such buildings either constructed. Many of the traditional design methods cannot be applied with any confidence since they require extrapolation well beyond the realms of prior experience, and accordingly, structural and geotechnical designers are being forced to utilize more sophisticated methods of analysis and design. In particular, geotechnical engineers involved

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in the design of foundations for super-tall buildings are increasingly leaving behind empirical methods and are employing state-of-the art methods.

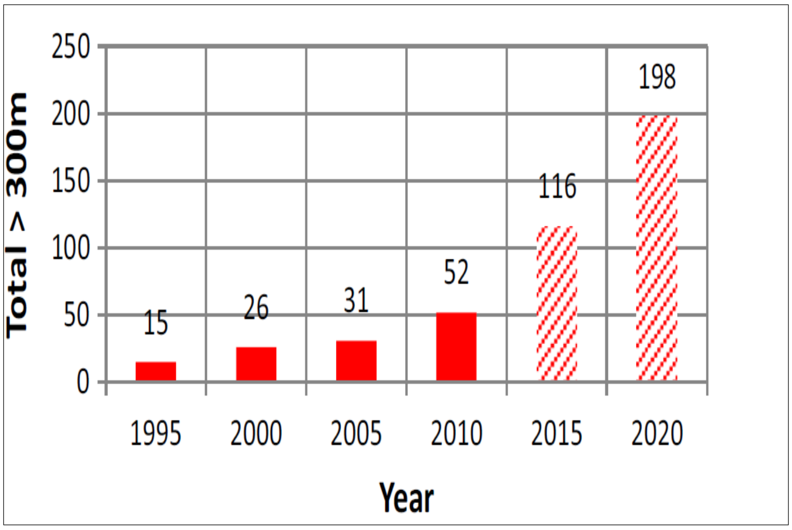

Figure 1 Total number of buildings in excess of 300 m tall.

The investigations have been carried out by many researchers on the structural behaviour of tall buildings with SSI (Soil Structure Interaction) by considering many parameters like foundation type, soil conditions, lateral forces, ratio of flexural stiffness of beam and column etc. Very few investigations have been carried out on soil-structure interaction of tall buildings under clayey soil conditions, particularly in Indian seismic zones.

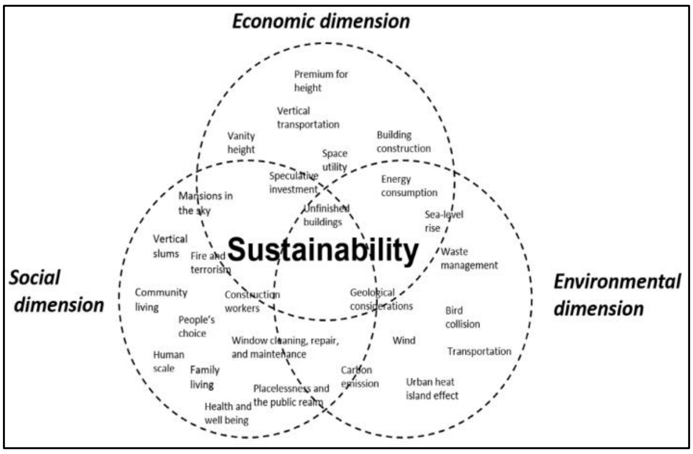

Figure 2 Development of Tall buildings

1.3. Typical High-Rise Foundation Settlements: -

Before discussing details of the foundation process, it may be useful to review the settlement performance of some high-rise buildings in order to gain some appreciation of the settlements that might be expected from two foundation types founded on various deposits. Table 1.1 summarizes details of the foundation settlements of some tall structures founded on raft or piled raft foundations. The average foundation width in these cases ranges from about 40m to100m. The results are presented in terms of the settlement per unit applied pressure, and it can be seen that this value decreases as the stiffness of the founding material increases. Some of the buildings supported by piled rafts in stiff Frankfurt clay have settled more than100mm, and despite this apparently excessive settlement, the performance of the structures appears to be quite satisfactory. It may therefore be concluded that the tolerable settlement for tall structures can be well in excess of the conventional design values of 50-65mm. A more critical issue for such structures may be overall tilt, and differential settlement between the high-rise and low-rise portions of a project.

1.4. Foundation Design Issues

The following issues will generally need to be addressed in the design of foundations for high-rise buildings:

- Ultimate capacity of the foundation under vertical, lateral and moment loading combinations.
- The influence of the cyclic nature of wind, earthquakes and wave loadings (if appropriate) on foundation capacity and movements.

1.4.1. Overall settlements

- Differential settlements, both within the high-rise footprint, and between high-rise and low-rise areas.
- Possible effects of externally-imposed ground movements on the foundation system, for example, movements arising from excavations for pile caps or adjacent facilities.
- Earthquake effects, including the response of the structure-foundation system to earthquake excitation, and the possibility of liquefaction in the soil surrounding and/or supporting the foundation.
- Dynamic response of the structure-foundation system to wind-induced (and, if appropriate, wave) forces.
- Structural design of the foundation system; including the load-sharing among the various component of the system (for example, the piles and the supporting raft), and the distribution of loads within the piles. For this, and most other components

1.5. Foundation Design Process

The process of foundation design is well-established, and generally involves the following aspects:

- A desk study and a study of the geology and hydrogeology of the area in which the site is located.
- Site investigation to assess site stratigraphy and variability.
- In-situ testing to assess appropriate engineering properties of the key strata.
- Laboratory testing to supplement the in-situ testing and to obtain more detailed information on the behavior of the key strata than may be possible with in-situ testing.
- The formulation of a geotechnical model for the site, incorporating the key strata and their engineering properties. In some cases where ground conditions are variable, a series of models may be necessary to allow proper consideration of the variability.

Preliminary assessment of foundation requirements, based upon a combination of experience and relatively simple methods of analysis and design. In this assessment, considerable simplification of both the geotechnical profile(s) and the structural loadings is necessary.

1.6. Factors Affecting Foundation Selection

The factors that may influence the type of foundation selected to support a tall building include the following:

- Location and type of structure.
- Magnitude and distribution of loadings.
- Ground conditions.
- Access for construction equipment.
- Durability requirements.
- Effects of installation on adjacent foundations, structures, people.
- Relative costs.
- Local construction practices.

1.7. Types of Foundations

1.7.1. Shallow foundation

Foundations with depth less than 3 meter are shallow foundations. Such foundations are used for structures that do not carry much load. They are also used in case the soil has a low weight bearing capacity.

Types of shallow foundations are:

- Isolated footing or column footing

- Combined footing
- Cantilever or strap footings
- Mat/Raft footings
- Wall Footings
- Raft footing

1.8. Deep foundation:

Foundations with depth greater than 3 meter are deep foundations. They are deep below the finished ground surface such that their base bearing capacity is not affected by surface conditions.

Types of deep foundations: -

- Pile foundation
- Piers
- Caissons
- Pile foundation

1.9. Soil Condition

The definition of soil condition, which is a crucial component of analysis in earthquake engineering, is "The physical condition of the soil and its dynamic properties, which can be divided into; hard soil (Rocky), medium soil, and soft soil (loose)." When comparing the ground motion of Freefall to the basement motion caused by interaction forces, the engineering community only talked about SSI in the context of structural engineering. Structure vibration is caused by the force and deformation in the supporting soil, which also results in base shear, moment, and displacement.

Many studies on the impact of soil-structure interaction (SSI) on the seismic responses of the structures have been carried out in the last few decades. It was discovered that the basic frequency of the response decreases and the energy dissipation changes as a result of the interaction between the soil and the structure. This is explained by radiation and material damping in the soil. Even if the structures are located in the same area, have the same layout, and experienced the same magnitude of earthquake, the patterns of damage that arise from the earthquake differ. This indicates that a number of variables, including ground motion characteristics, the state of the soil beneath foundations, the structural system of design, mass, stiffness, and vertical irregularities, influence the damage pattern.

2. Literature review

[1] K. Vishnu Haritha, Dr.I. Yamini Srivalli [1] In this paper equivalent static method is used for analysis of wind loads on buildings with different aspect ratios. The aspect ratio can be varied by changing number of bays. Aspect ratio 1, 2, 3 were considered for present study. The analysis is carried out using ETAB.

[2] B. Dean Kumar and B.L.P. Swami [2] In this paper the present work, the Gust Effectiveness Factor Method is used, which is more realistic particularly for computing the wind loads on flexible tall slender structures and tall building towers. In this paper frames of different heights are analyzed and studied.

[3] Yin Zhou and Ahsan Kareem [3] In this paper "Gust loading factors for design applications" Wind loads on structures under the buffeting action of wind gusts have been treated traditionally by the "gust loading factor" (GLF) method in most major codes and standards around the world. The equivalent static wind loading used for design is equal to the mean wind force multiplied by the GLF. Although the traditional GLF method can ensure an accurate estimation of the displacement response, it fails to provide a reliable estimate of some other response components. In order to overcome this shortcoming, a more realistic procedure for design loads is proposed in this paper.

[4] Wakchaure M. R., Gawali Sayali [4] In this paper the gust effectiveness factor method takes into account the dynamic properties of the structure, the wind-structure interactions and then determines the wind loads as equivalent static loads. Wind loads are determined based on gust effectiveness factor method. The critical gust loads for design are determined. After the application of calculated wind loads to the building models prepared in finite element software package ETAB's 13.1.1v. Having different shapes are compared in various aspects such as story displacements, story drifts, story shear, axial forces in column etc. Based on the results, conclusions are drawn showing the effectiveness of different shapes of the structure under the effect of wind loads.

[5] Mohammed Asim Ahmed, Moid Amir, Savita Komur, Vaijainath Halhalli [5] In this paper presents displacement occur in different story due to wind in different terrain category. Three models are analyzing using ETABS 2015 package. Present works provides a good source of information about variation in deflection as height of model changes and percentage change in deflection of same model in different terrain category.

[6] Pahwa Sumit P, Devkinandan Prajapati, Utkarsh Jain [6] In this paper project contains a brief description and analysis of Symmetrical frame having 30 story building with shear wall and without shear wall with different types of soil condition for highly seismic area i.e. zone-5, thoroughly discussed structural analysis of a building to explain the application of shear wall. The design analysis of the multi storied building in their project was done through software STAAD.Pro.

[7] Sangtiani Suraj, Simon J [7] In this paper an attempt was made to compare the Performance of the three Structural Systems in all four earthquake zones Base shear, time period, top story displacement, story Drift, seismic weight of structure, and results were compared to arrive the foremost economical structure in a specific Earthquake Zone for a particular plan.

2.1. Research gap

Significant insights into structural reactions can be gained from the literature review that is now available on the study and design of large building foundations under seismic and wind loads. The existing corpus of work lacks a thorough investigation of how different soil conditions affect foundation design and frequently ignores the variety in soil qualities. Although some research discusses the relationship between soil and structure, more thorough studies are required to particularly examine how tall buildings behave dynamically when exposed to different types of soil. Furthermore, local specificity is frequently disregarded, and little research has taken into account the distinctive soil compositions found in various locations. Additional research is needed in the areas of integrating cutting-edge analytical tools and improving design codes to include factors unique to soil conditions. Furthermore, there is a research void in the area of verifying numerical models against empirical data to improve forecast accuracy. Closing these gaps would advance our knowledge in a more comprehensive way and provide experts working in the construction and safety of huge buildings with insightful knowledge.

3. Methodology

Following is flowchart of work for Project: -

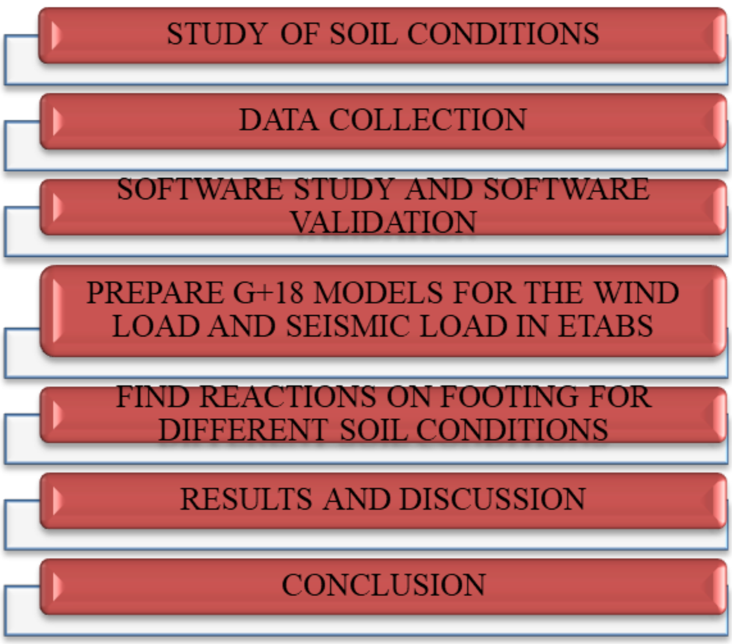

Figure 3 Flowchart

- A study looking at how wind load behaves dynamically on reinforced concrete buildings. The following is the methodology that was developed to meet the stated goals: 1. Gathering pertinent research information from textbooks, reference books, research papers online, national and international journals, and other sources to familiarize oneself with prior findings.
- Determining the extent of additional study that needs to be done on high-rise structures affected by wind.
- Specify the parameters of the specimen to be studied, such as height, building plan size, input parameters from the IS code, material specifications, member specifications, and so on
- The analysis and 3D model development are done using the E-TABS program. The Indian standard IS-875-Part 3: 2015 serves as the basis for the lateral loads that must be applied to the buildings
- The creation of a discussion summary and comparison of findings that have a major impact on how tall building foundation designs differ depending on the soil conditions.
- The outcome and the conversations.
- The analysis's findings will be used to form a conclusion.

3.1. General

Generally speaking, wind load must be taken into account while designing tall buildings. Guiding principles for performing dynamic studies for wind loads in accordance with IS 875(Part 3): 2015.There are simultaneous positive and negative pressures present when wind interacts with a building. To avoid wind-induced building failure, the structure must be strong enough to withstand the applied loads from these pressures. The structural system must then transmit the load applied to the building envelope through the foundation and into the earth. Building height, internal pressure, geography, exposed fundamental wind speed, and building shape all affect how much wind pressure there is.

This study's primary goal is to analyse tall residential buildings against wind loads in accordance with Indian Standard Codes of Practice IS 875(Part 3):2015, and then compare the findings with those produced by the E-Tabs program. Initially, an investigation should be conducted into the building's base shear sensitivity in relation to its placement near wind zones in Pune, India. Assuming that the building is located in Pune, the wind load on it is computed. The most important load to take into account for the design of tall buildings is the lateral load. To monitor the impact of wind on tall buildings, a study including G + 18 stories is conducted for analysis. It extracts the structural response resulting from load combinations and lateral loads. The impact of lateral loads on the structural system's tensile forces, base shear, maximum story drift, moments, and displacements is examined. Extended 3D (Three Dimensional) Analysis of Building Systems is what the acronym ETABS stands for. This is predicated on software that uses finite elements and the stiffness matrix.

4. Problem statement

In this research, non-linear dynamic analysis of multi-story R.C.C. buildings has been performed using ETAB software in zones III on a G+18-story rectangular building with a floor-to-floor height of 3 meters. The chosen layout has a rectangular shape. Both static and dynamic wind and seismic forces have been examined in relation to the structure. For the structure, hard, medium, and soft soil conditions have been chosen.

The load along wind or drag load is calculated using the gust factor approach. Although the gust factor method has been included in the code since IS 2015, not all types of constructions can completely utilize these methods for computing load across-wind or other components. Nonetheless, a designer may utilize the gust factor technique to compute all aspects of the stress on a structure, utilizing any theory that is now in existence. Consequently, the analysis takes into account the following parameters.

4.1. Aim and Objectives

To look into how tall buildings with different soil conditions behave when their foundations are subjected to wind action

4.2. Objectives

- To use wind loads in accordance with IS 875 Part III.
- To look into how tall buildings in terrain category 2 behave when subjected to wind loads in various soil types, such as soft, medium, and hard soil.
- To interpret how various soil conditions affect the way tall building foundations are designed.

5. Modelling

5.1. General

This chapter provides a quick overview of the ETAB 2016 program and the steps involved in modelling a given scenario.

5.1.1. Software Analysis and Design Procedure

- •Describe Story Data and Plan Grids
    - Describe Material Properties
    - Specify Frame Parts
    - Specify Slab Areas
    - Describe load cases
    - Draw Frame Members, or Beam Objects.
    - Draw Frame Members, or Column Objects.
    - Designate Slab Areas
    - Set Limitations
    - Assign Workloads
- • Examine Input Data in a Table Format
    - Execute the Examination
    - See Graphical Analysis Results
    - Create the Concrete Frame Part

5.1.2. Prepare Model in ETABS

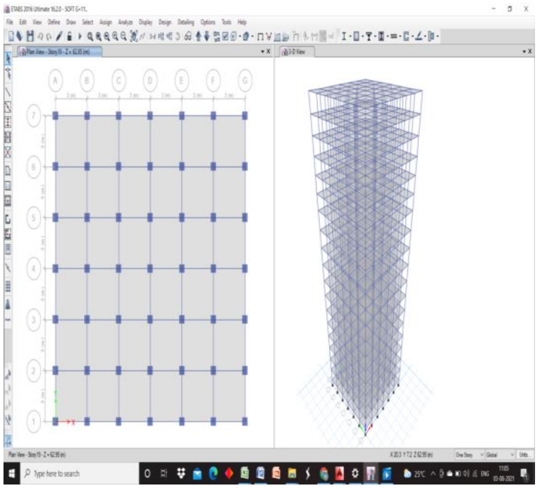

Figure 4 Prepare modeling in ETABS**.**

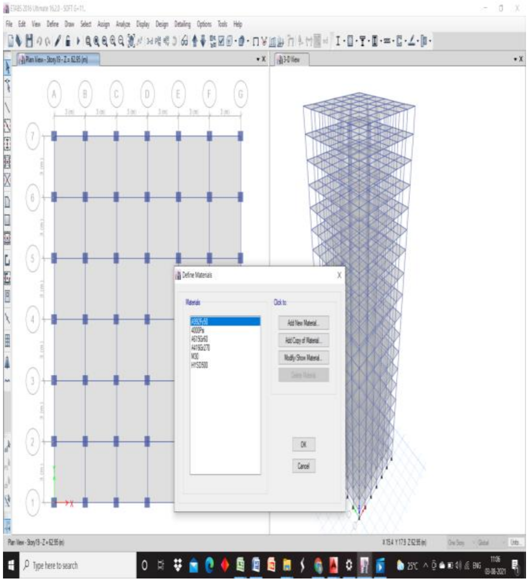

Figure 5 Define material property**.**

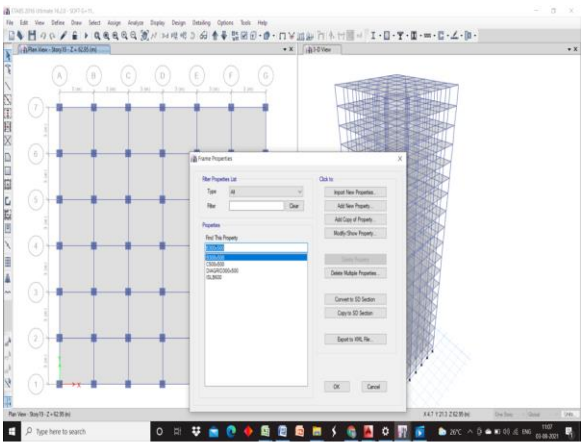

Figure 6 Define Member properties.

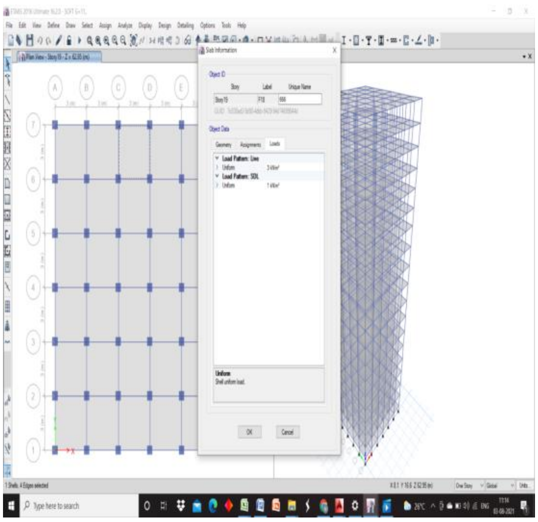

Figure 7 Assign Live and dead loads.

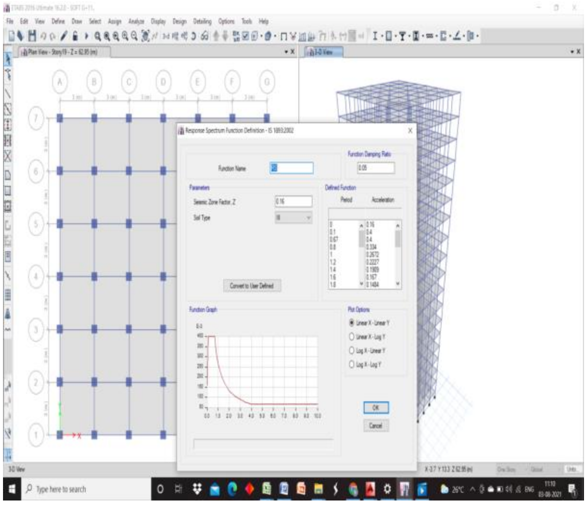

Figure 8 Define soil property and zone factors

5.2. Software Development 3D FEM Model High Rise Structure Having Different Soil Conditions

Table 1 Models

MODEL 1	**G+18 IN SOFT SOIL**
MODEL 2	G+18 IN MEDIUM SOIL
MODEL 3	G+18 IN HARD SOIL

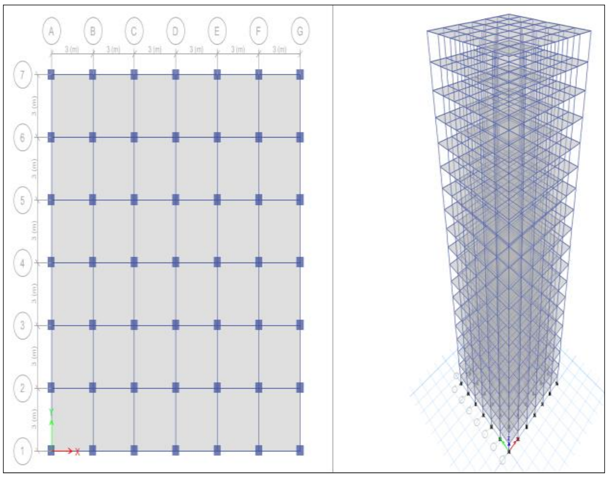

Figure 9 2D and 3D View Model.

5.3. G+18: Design Reactions

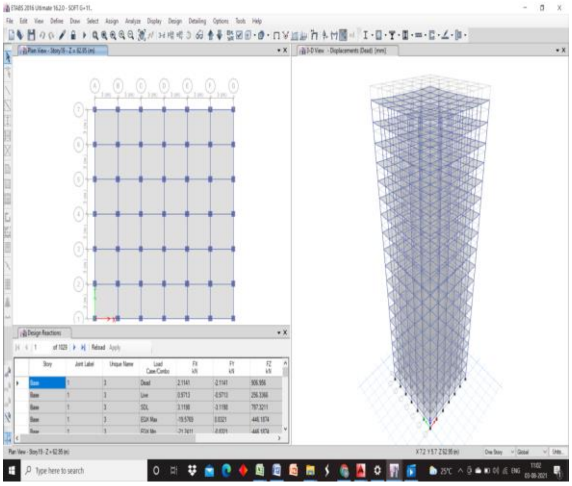

Figure 10 Design reaction for Soft Soil.

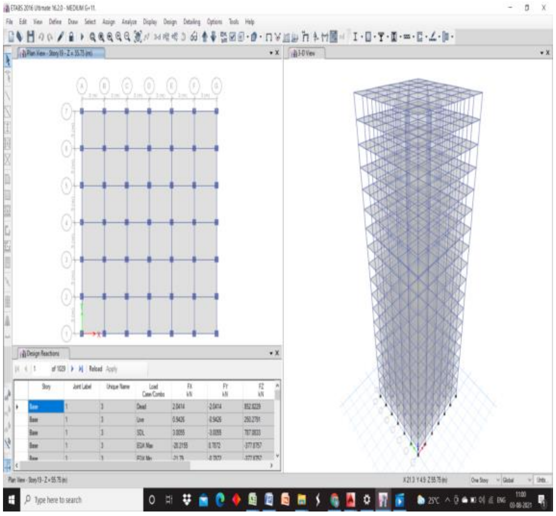

Figure 11 Design reaction for medium Soil.

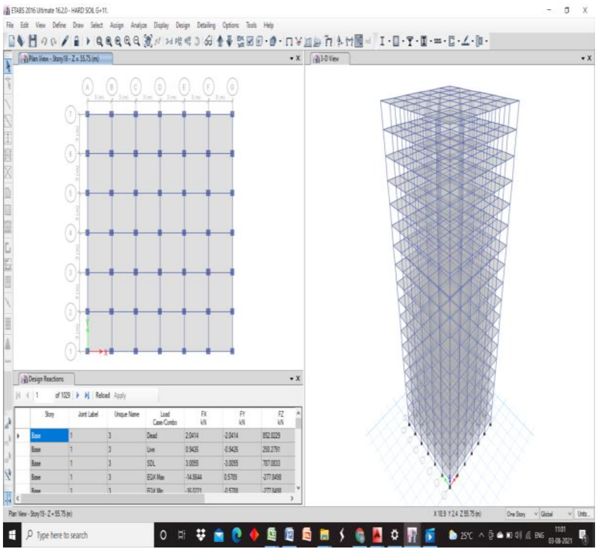

Figure 12 Design reaction for Hard Soil.

6. Result and discussion

6.1. Introduction

In this project, ETABS software in zones III was used to analyze a G+18-story rectangular building with a floor-to-floor height of 3 meters utilizing non-linear dynamic analysis of multi-story R.C.C. buildings. The chosen layout has a rectangular shape. Both static and dynamic wind and seismic forces have been examined in relation to the structure. For the structure, hard, medium, and soft soil conditions have been chosen. One popular technique for computationally resolving differential equations that arise in mathematical modelling and engineering is the finite element method (FEM). Results are given below: -

Table 2 Models

MODEL 1	G+18 IN SOFT SOIL
MODEL 2	G+18 IN MEDIUM SOIL
MODEL 3	G+18 IN HARD SOIL

6.1.1. Story Displacement

6.2 G+18: - Story Displacements for Symmetric in Plan Building Resting on Soft Soil, Medium Soil and Hard Soil in X – Direction

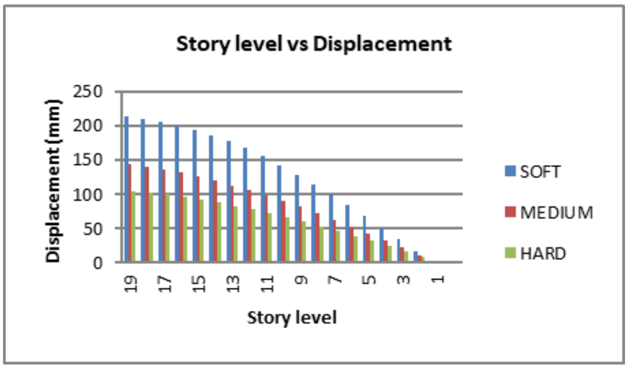

Figure 13 G+18: Story Displacement -X.

The findings of story displacement-X of G+18 are shown in graph 6.1 above. Soft soil is shown to have the highest results of displacement value. The range of values for story displacement for hard soil is 0-110, for medium soil it is 0-150, and for soft soil it is 0-220.

6.3 G+18: - Story Displacements for Symmetric in Plan Building Resting on Soft Soil, Medium Soil and Hard Soil In Y – Direction

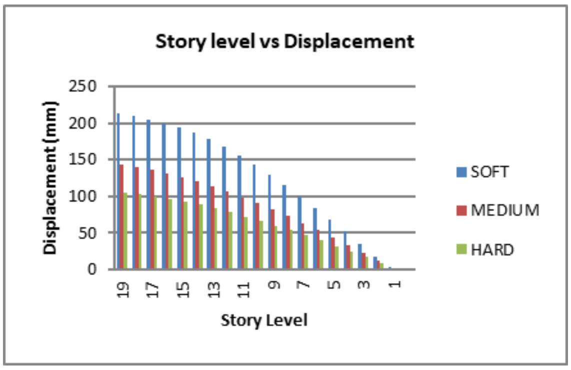

Figure 14 G+18: Story Displacement -Y.

The findings of the story Displacement-Y of G+18 are shown in graph 6.2 above. Soft soil is shown to have the highest displacement value results. The range of values for story displacement for hard soil is 0-110, for medium soil it is 0-150, and for soft soil it is 0-220.

6.2. Design Reactions

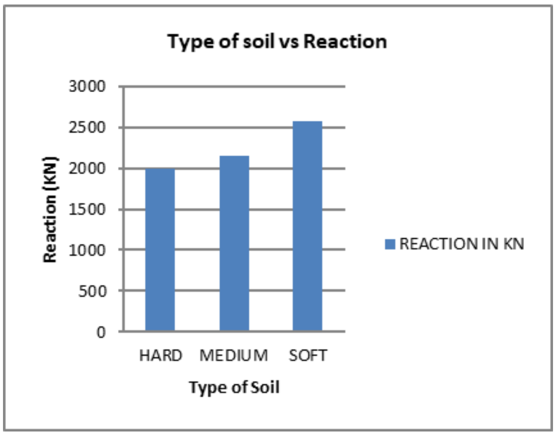

Figure 15 G+18: Design Reaction**.**

The findings of the G+18 Design Reaction are shown in the graph above (graph 6.3). Soft soil yields the highest Design Reaction value. There are three different design reaction values for soil: 1993 KN for hard soil, 2152 KN for medium soil, and 2580 KN for soft soil.

6.3. Story Drift

6.4 G+18: Story Drift

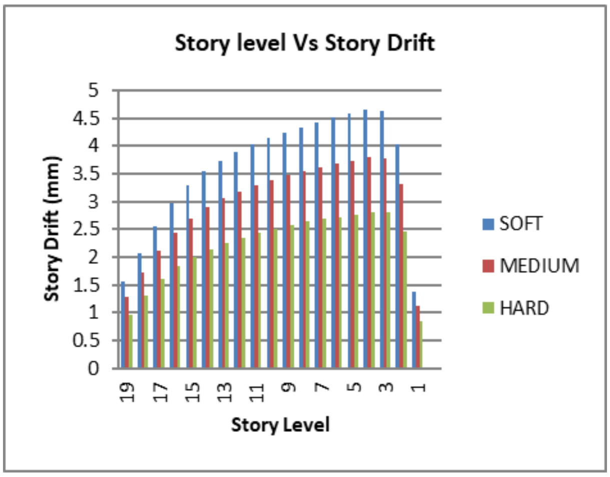

Figure 16 G+18: Story Drift-X

The findings of story Drift-X of G+18 are shown in graph 6.4 above. Soft soil is shown to have the highest story drift value results. There are three story displacement values for hard soil, four story displacement values for medium soil, and five story displacement values for soft soil.

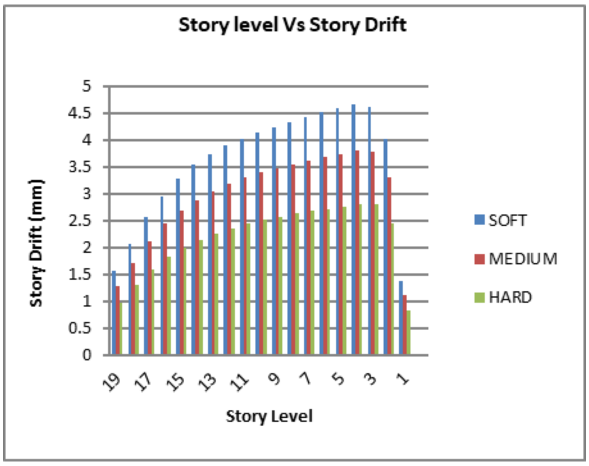

Figure 17 G+18: Story Drift- Y.

The results of the story displacement-Y of G+18 are shown in graph 6.5 above. Soft soil yields the highest results of displacement value, as can be seen. There are three story displacement values for hard soil, four story displacement values for medium soil, and five story displacement values for soft soil.

6.4. Base Shear

6.5 G+18:- Base Shear for A symmetric in plan building on Soft Soil, Medium Soil and Hard Soil for X-direction

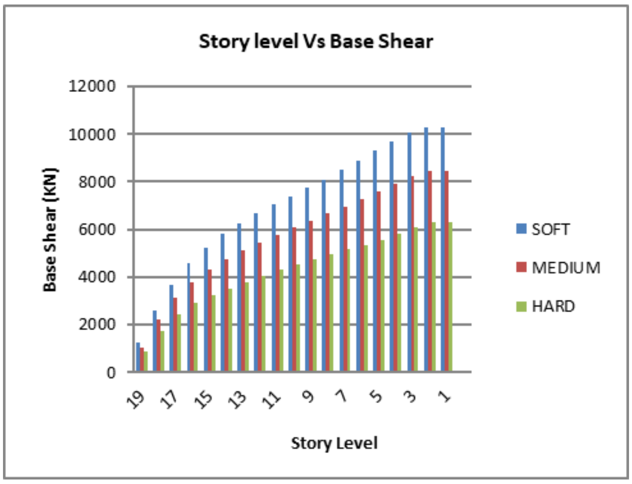

Figure 18 G+18: Base Shear- X.

The results of the story displacement-Y of G+18 are shown in graph 6.6 above. Soft soil is shown to have the highest values of displacement value. For hard soil, the story displacement value falls between 0 and 6500, for medium soil, between 0 and 8500, and for soft soil, between 0 and 10500.

6.6 G+18:- Base Shear for A symmetric in plan building on Soft Soil, Medium Soil and Hard Soil for Y-direction

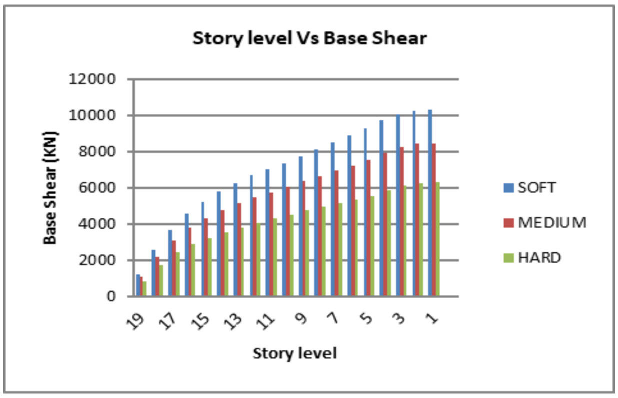

Figure 19 G+18: BASE SHEAR- Y.

The results of the story displacement-Y of G+18 are shown in graph 6.7 above. Soft soil is shown to have the highest values of displacement value. For hard soil, the story displacement value falls between 0 and 6500, for medium soil, between 0 and 8500, and for soft soil, between 0 and 10500.

7. Conclusion

The entire study could be helpful in developing design recommendations for building frames that take soil flexibility into account when designing for seismic activity. This study examines the effects of SSI and wind on typical multi-story buildings that are at rest. A G+18-story rectangular building in zone III with a floor-to-floor height of 3 meters was assessed using the ETABS algorithm. The plan that was selected is rectangular in shape. The analysis of the structure has taken into account both static and dynamic wind and seismic forces, as well as the various soil conditions. These variations have a direct impact on the foundation's design parameters, including depth, width, and reinforcement, as well as on the structure's displacement and story drift.

The all conclusion is concluding from the following parameters

- The graph displays the results of story Displacement-X of G+18; soft soil has the largest displacement value. The story displacement values of hard soil, medium soil, and soft soil are 0-110, 0-150, and 0-220, respectively
- The graph displays the results of story Displacement-Y of G+18; soft soil has the largest displacement value. The story displacement values of hard soil, medium soil, and soft soil are 0-110, 0-150, and 0-220, respectively.
- The results of the G+18 Design Reaction analysis show that soft soil has the highest Design Reaction value, as the graph illustrates. The value of the design reaction for hard soil is 1993 KN, the value for medium soil is 2152 KN, and the value for soft soil is 2580 KN.
- The graph illustrates the maximum story drift value values for soft soil in the story Drift-X of G+18. There are three story displacement values for hard soil, four story displacement values for medium soil, and five story displacement values for soft soil.
- The highest results of displacement value for soft soil are shown in the graph for the story displacement-Y of G+18. There are three story displacement values for hard soil, four story displacement values for medium soil, and five story displacement values for soft soil.
- The highest results of displacement value for soft soil are shown in the graph for the story displacement-Y of G+18. For hard soil, the story displacement value falls between 0 and 6500, for medium soil, between 0 and 8500, and for soft soil, between 0 and 10500.
- The highest results of displacement value for soft soil are shown in the graph for the story Displacement-Y of G+18. For hard soil, the story displacement value falls between 0 and 6500, for medium soil, between 0 and 8500, and for soft soil, between 0 and 10500.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] K. Vishnu Haritha, Dr.I. Yamini Srivalli (2013) "Effect of Wind on Tall Building Frames- Influence of Aspect Ratio". International Journal of Research in Civil Engineering, Architecture & Design Volume 1, Issue 1, July-September, 2013, pp. 01-06, © IASTER 2013 ISSN Online: 2347-2855, Print: 2347-8284

[2] B. Dean Kumar and B.L.P. Swami (2010) "Wind effects on tall building frames-influence of dynamic parameters" Indian Journal of Science and Technology Vol. 3 No. 5 (May 2010) ISSN: 0974- 6846

[3] Yin Zhou and Ahsan Kareem (1999) "Gust loading factors for design applications" J. Struct. Div., ASCE, 93(ST3), 11-34.

[4] Wakchaure M. R., Gawali Sayali (2015) "Effects of Shape on Wind Forces of High-Rise Buildings Using Gust Factor Approach" International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 8, August 2015.

[5] Mohammed Asim Ahmed, Moid Amir, Savita Komur, Vaijainath Halhalli (2015) "Effect of wind load on tall buildings in different terrain category" IJRET: International Journal of Research in Engineering and Technology.

[6] Pahwa Sumit P, Devkinandan Prajapati, Utkarsh Jain (2017) "A Study of 30-Story Dual System Building with Different Soil Conditions" Sumit P ahwa.et.al. Int. Journal of Engineering Research and Application. ISSN: 2248-9622, Vol. 7, Issue 7, (Part -1) July 2017.

[7] Sangtiani Suraj, J Simon (2017) "Performance of tall buildings under Lateral loads with different type of Structural systems" International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 3, March 2017, pp. 1014–1022 Article ID: IJCIET_08_03_103 ISSN Print: 0976-6308 and ISSN Online: 0976-6316.

[8] Umamaheshwara.B, Nagarajan.P (2016) "Design Optimization and Analysis of Shear Wall in High Rise Buildings Using ETABS" International Journal for Research in Applied Science & Engineering Technology (IJRASET) www.ijraset.com Volume 4 Issue VIII, August 2016 IC Value: 13.98 ISSN: 2321-9653.

[9] Susheel S M, Sanjith J, Vidyashree B S , Ranjith A (2016) "analysis of tall building in chikkamagaluru region" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 06 ,June-2016 ISSN: 2395-0072.

[10] Jadhav A. A., Dr. Kulkarni S. K., Galatage A. A. (2016) "comparison of the effect of earthquake and wind loads on the performance of rc framed shear wall building with its different orientation" Vol-2 Issue-6 2016 IJARIIE-ISSN (O)-2395-4396.

[11] K. Rama Raju, M.I. Shereef, Nagesh R Iyer, S. Gopalakrishnan (2013) "analysis and design of rc tall building subjected to Wind and earthquake loads" The Eighth Asia-Pacific Conference on Wind Engineering, December 10–14, 2013, Chennai, India.

[12] Singla Sarita, Kaur Taranjeet, Kalra Megha and Sharma Sanket (2012) "Behaviour of R.C.C. Tall Buildings Having Different Shapes Subjected to Wind Load" Proc. of Int. Conf. on Advances in Civil Engineering 2012.

[13] Amer Hassan, Shilpa Pal, (2018) "Effect of soil condition on seismic response of isolated base buildings" International Journal of Advanced Structural Engineering volume 10, pages249–261 (2018).

[14] Md Ahesan, Md Hameed1, Salman Shaikh (2019) "Effects of Wind Load on Rc Buildings by Using Gust Factor Approach" International Journal of Emerging Technologies and Innovative Research ISSN: 2349-5162, Vol.6, Issue 5, page no.329-335, May-2019.

[15] Prof. Syed Farroqh Anwar, Mr.Mohd Hashmath, Mohd Aslam Share Khan(2016) "Study On Soil Structure Interaction And Base Isolated System For Seismic Performance Of Structures Resting On Different Types Of Soils" Global Journal Of Engineering Science And Researches , ISSN 2348 – 8034 3(10): October 2016