# Comparative Case Study for Soil Investigationa Foundation of G+7 Storied Building Near Seashore

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**ABSTRACT -** Soil investigation and foundation design are crucial components in the construction of any building, especially when it is situated near a seashore. The type of soil and its characteristics play a vital role in determining the appropriate foundation design for a building. For a G+7 storied building near a seashore, the foundation design must take into account the soil's ability to withstand various forces such as wind and waves, as well as the potential for erosion and liquefaction. To ensure the safety and stability of the building, a thorough soil investigation must be undertaken in order to identify the features and traits that the soil has. The soil investigation process involves collecting samples of the soil and analyzing them in a laboratory. Tests such as soil classification, moisture content, shear strength, and permeability tests are conducted to determine the soil's bearing capacity and other key characteristics. The designing a course may be adapted to the app's particular soil characteristics as per the results of that same soil study. A deep foundation such as a pile foundation or raft foundation may be necessary to provide adequate support and stability for the building. The use of reinforcements such as steel bars and concrete can also improve the foundation's strength and durability. In conclusion, soil investigation and foundation design are critical components of constructing a G+7 storied building near a seashore. Proper soil investigation can help determine the most suitable foundation design for the site's specific soil conditions, ensuring the building's safety and stability for years to come.

***Keywords: Soil investigation, foundation, G+7 storied building, sea shore.***

## I. INTRODUCTION

India is one of the emerging power in the world which depends on the creation of sustainable infrastructure requiring airways, highways, railways, ports, harbors, housings, irrigation, dams, bridges, canals, tunnels, pipelines, water treatment plants, sewerage systems, landfills and variety of structures required to satisfy the needs of sectors such as energy, power, telecommunication, health, education, IT-enabled services, financial services, etc. Due to the ever-increasing demand for infrastructural development for dwellings, and buildings the need of this study is required for the soil investigation of multi-storied seashore buildings. Two different penetration tests will be applied on the sample soil strata for the seashore building that are the standard penetration test and the plate load test. Post the application of the test the results will be studied and a comparative analysis will be carried out between the two tests.

The fast growth of the global community, the depletion of inland supplies, and the need for responsible growth of the world's economy have bolstered humankind's attempts to improve its capacity for resource extraction and space utilization in the ocean. Very Huge Floating Facilities (VLFS) are one of the maritime constructions that have garnered decades-long interest in ocean usage. Much study has been conducted on the uses of various sized VLFS like hovering docks, flowing runways, float hotels, hovering petroleum infrastructure, and sometimes even mobile towns. In the building of foundations, it is essential to account for settlement, two conditions must always be satisfied The first condition is that there must be an adequate factor of safety against bearing capacity failure. The second condition is that the differential settlements of the foundations must not be great enough to damage the structure, Because of this second requirement,

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settlement prediction forms an important part of foundation design.

### 1.1 Soil Investigation: -

The soil's characteristics constitute a crucial part of the ground architecture. In geotechnical design, the most important factors to take into account are moisture in the soil level, cohesiveness, angle of friction, specific gravity, effectuated, permeability, plastic viscosity, and size and shape. These characteristics are essential in determining the soil's carrying capacity and slope protection. Ground Improvement (SI) by hole drills and samples provides the most reliable value of the necessary soil parameters for geotechnical engineering but is lengthy, costly, and intrusive. In order to enable swift and widespread computations and measurements of ground structural engineering at various situations of soil, and to be a major element in the predictive model of soil mistakes or mudslides, an alternative method of evaluating soil characteristics that are quick, non-destructive, and good for the environment is crucial. As an alternative to disturbing soil quality, the geomagnetic approach has shown to be an effective instrument for characterizing subterranean profiles.

**Fig: 1. Near soil investigation services**

In construction site investigation, geophysics techniques (electric resistance, thermal, gravity, electromagnetic, etc.) are becoming commonplace. Electrical impedance surveys are among the most effective instruments for defining subterranean profiles while disturbing soil quality. Geoscientists and research scientists have utilized devices to measure earth resistance for many years to explore and investigate the continental mantle in quest of oil, gemstones, etc. Many studies have been conducted over the years to enhance the methodologies, tools, and data analysis in order to acquire more precision and specificity.

### 1.2 Offshore geotechnical investigation

The offshore geotechnical investigation involves the study of the physical properties and behavior of soil and rock beneath the seabed. This is important for a variety of reasons, involves the planning and building of marine infrastructure such as drilling rigs and wind farms, and subsea pipelines.

**Fig: 2. Offshore geotechnical investigation**

Offshore geotechnical investigations are typically carried out by specialist contractors who have the necessary equipment, expertise, and experience to work in a challenging offshore environment. They may also work closely with other professionals such as marine engineers and geologists to ensure that the design of offshore structures is both safe and cost-effective.

#### 1.2.1 Geological and geotechnical characteristics of the Soil

The topsoil geological and geophysical properties in a project area can vary greatly depending on the specific location. Here are some general points to consider:

**Soil Type:** The soil type refers to the general classification depending on the mechanical and chemical qualities of an environment Common soil types include sand, clay, silt, and loam.

**Soil Profile:** The soil profile refers to the different layers of soil that exist below the surface. These layers can have different properties, such as texture, color, and composition, that can affect their suitability for different types of construction.

**Soil Bearing Capacity**: Carrying the strength of the ground is its capacity to bear a weight neither setting or moving. This is an important consideration for construction projects, as it determines the type and size of foundation that will be needed.

**Presence of Underground Water Sources:** The existence of subsurface waterways, including such reservoirs or groundwater systems, might impact the soil's resilience and building appropriateness. If the water level is just too high, it may degrade the soil and destabilize the country.

### 1.3 Groundwater Issues in Construction

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In soil pore holes and rock-forming fissures, rainwater is located under the Planet's surface. The flow of rainwater under the surface is a basic feature that regulates the hardness and deformability of soil, hence influencing the soil's capacity to support tensile stresses.

Because of the relative deformation of liquid, soil medium has extremely particular physical attributes when it's completely soaked. These traits have influence under the subsoil level or tables.

**Fig: 3. Groundwater Issues in Construction**

Typical difficulties with freshwater in development include:

- unsteady sub-grade;
- unsteady excavations and water damage;
- involved In construction setbacks and price increases

Frequent environmental issues after building works:

• Broken and irregular flooring

• Leaky pipes, moist cellars, and mold development

• Walls with cracks and inconsistencies

• Slippery slope and concrete structures

• Slow foundational development

**Objectives of the study**

- determining the site's topsoil & qualities for foundational software architecture.
- Evaluate the carrying capability of the subsoil and the possibility of ground movement.
- To study the existence and features of any possible geological and geotechnical owing to seismicity..
- To evaluate the groundwater level and its impact on the foundation design.
- To identify any potential soil erosion or soil instability issues that may affect the foundation stability.

## II. PROBLEM STATEMENT

To conduct a comprehensive soil investigation and foundation design for a G+7 storied building to be constructed near the seashore. The objective is to ensure that the foundation design can withstand the soil conditions and environmental factors specific to the location, including potential soil liquefaction, wave impact, and other coastal hazards. The ultimate goal of this soil investigation and foundation design is to ensure the safety, stability, and longevity of the G+7 storied building, while also taking into account the unique environmental factors associated with its location near the seashore.

## III. LITERATURE REVIEW

Paul C. Jenning et.al suggested that For the mechanics of construction interactions, the earth is represented by a linear viscoelastic quarter, while the building is represented by an oscillator with n freedom levels. Examined are both the earthquake reaction and the stable reaction to harmonic stimulation. Provided the interacting system has n + two important resonant frequencies, the game's reaction is simplified to the summation of the reactions of decelerated nonlinear oscillations exposed to changed resonant frequencies. The use of shear failure and conical penetrating experiments to soil research, engineering, and quality assurance for a motorway levee erected on a tannic subsurface with many loading phases was discovered by Hideo Hanzawa et al. From the two tests, the outcomes of the soil study and different methodologies and quality control connections are reported. The compressive stress and amount of consolidation after development calculated first from the cone vulnerability scanner are displayed and contrasted to those predicted from the app's settling data.

H. E. Barnes et.al investigated Borrow and projected cut portions of substantial size may be measured with higher precision and speed using the conductivity approach than by manual auguring and earth weeknights. In a few cases, the study of residual soils using the resistance approach has shown the existence of substances not discernible from surface morphology and the deep weeknights often used. When Nguyen Thi Nu et al. evaluated the influence of sodium content and initial ph on soil attributes, they soaked the soil for 10 days in various sodium content and pH value treatments. The testing findings demonstrated that the median salt concentration of the study region's soil properties ranged from 0.31% to 1.58%, indicating varying degrees of saltwater pollution. The investigation also revealed that a rise in salt or aluminum concentration decreased the shear strength and raised the fluid limits and compressive indices.

Leif Rise et.al et al. a soil assessment was undertaken on the proposed site of the platforms in this region. The goal of the geologic research detailed in this work was to determine the causes of the detected fluctuations. Important map depicting the locations of the research region. It is hypothesized that the changes in mechanical qualities of the 80-meter-thick till layer resulted mostly from compacted under frozen ice in the most recent glacier. Hisyam Jusoh et al. demonstrated that by associating conductivity measurements with soil characteristics, a potential soil inquiry evaluation could be made. The soil's characteristics are the most crucial part of ground engineering. In geomechanical construction, the most important factors to take into account are moisture in the soil level, cohesion, friction coefficient, bulk modulus, effectuated, permeability, plastic viscosity, and diameter. These characteristics are crucial for determining the soil's maximum capacity and slope protection.

According to Prof. Agbede et.al et al. Analyzed the geological qualities of the soil sustaining the Egbogha structure, which has been exhibiting severe roof fissures. The ground surrounding the structure was sampled for laboratory testing. Natural moisture, grain size, Specific gravity, compression, and consolidating were always the parameters investigated. This indicated that the observed fractures in the investigated building may have been caused by the expanding soil underpinning the building's foundations. During the rainy season, there is a significant penetration of rainwater into the foundations, which, upon cessation, leads in asymmetrical heave and has a significant impact on the walls via fractures. Aminu Sulaiman et al. illustrated the sources of fractures in a freshly constructed structure in which some damaging fractures emerged quickly after work was completed. The majority of these fissures manifested in nearly every one of the sidewalls as well as other structural parts, such as beams and columns, and they have various patterns. Using scouting surveying, construction examination, and lab testing, the sources of these damaging fissures were investigated using three fundamental methodologies.

Azade Mehria et.al The influence of land use strategy on soil erosion rate decrease in the Gharesoo River Basin, Golestan Province, Iran. To simulate possible soil erosion, the Revised Universal Soil Loss Equation (RUSLE) was combined with Geographical Information System (GIS). This study revealed that the application of planning for land use in the Gharsoo River Basin aids in preventing soil erosion. This original study methodology may serve as a foundation for the ecological and complete administration of major rivers. In this research, Xingwu Duan et al. created an approach for assessing soil erosion at the local scale using the Chinese Soil Loss Formula (CSLE) and 0.5 meters tall View of the world Satellite photos, out of which conservation of water and soil engineering practices were interpreted and incorporated into the prototype as the E component. This research proposes a practical method for enhancing the precision of global soil depletion assessment. It will be valuable for arranging land use and SWC design process in regions with complicated topography and agricultural practices, and will presumably help soil management and food and nutrition security. T. Lunne et al. have shown that these advancements have significantly increased the validity and utility of the CPT in soil studies and construction. Nonetheless, significant obstacles remain to be overcome in the future. Throughout the last 40 years, the authors have had gratifying interactions with a vast number of friends in the marine ground survey sector, too numerous to list by title.

Marcus Laaksoharju et.al. This study examined the financial and ecological effects of these geomorphological phenomena by employing sociological survey techniques and land-use and land analyses. Using a questionnaire, interviewing, plus Digital Shore Analysis Method (DSAS) 4.2 software with recovered seashores from 1926 field survey sheets and a 2008 Landsat ETM? picture to evaluate coastline alteration between both two time periods. G.A. Athanasopoulos et al. demonstrated that on 15 June 1995, the Greek seaside town of the area was jolted by a powerful, close-to-the-epicentrum earthquake that causes huge property destruction as well as fatalities. The center-raised portion of the town sustained the greatest amount of destruction, while the seaside sector escaped largely untouched.

## IV. METHODOLOGY

The methodology for soil investigation typically includes conducting a geotechnical survey to gather information on the soil type, depth of soil layers, and groundwater levels. This data is again examined to establish the soil's yield stress, which is the greatest weight it can hold before significant settling or collapse. The survey may also include tests to assess soil stability and potential for liquefaction, which can occur in loose, saturated soils during earthquakes or other seismic activity.

Overall, the methodology for soil investigation and foundation design for a G+7 storied building near

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the seashore is a critical aspect of ensuring the safety and stability of the building. It requires careful consideration of the soil conditions and building loads, and the selection of appropriate foundation types and designs to minimize the risk of settlement, failure, or other structural problems.


**Fig: Methodology Flowchart**

The methodology for soil investigation and foundation design for a G+7 storied building near a seashore should be comprehensive and thorough to ensure the safety and stability of the structure. Here are the general steps that should be followed:

**Site investigation:** The first stage is to gather intelligence on the geology and geotechnical attributes of the location via a site inspection. This can include reviewing geological maps, conducting geophysical surveys, and drilling boreholes to obtain soil samples.

**Soil testing:** Once soil samples have been obtained, they should be tested to determine their strength, density, permeability, and other relevant properties. Unreinforced and reinforced tests (SPT), cone security testing (CPT), or earth resistance testing may be performed.

**Sea level rise analysis:** Considering the sea level rise projection in the next 50 years should be considered to design the foundation for the building.

**Foundation design:** Based on the results of the site investigation and soil testing, a suitable foundation design should be developed. This may involve designing deep or shallow foundations, selecting appropriate foundation materials, and designing for potential settlement and liquefaction issues.

**5. Seismic design:** Designing the building structure considering seismic forces, especially when the site is near the seashore where seismic activity is high.

**Building code compliance:** It is essential to ensure that the foundation design meets all relevant building codes and regulations.

**Construction supervision:** During construction, the foundation design should be closely monitored to ensure that it is being implemented correctly.

**Regular maintenance:** A building located near a seashore may be exposed to harsh environmental conditions such as salt and humidity, Thus, preventative maintenance must be performed to prolong the life of the structural frame.

Overall, the methodology for soil investigation and foundation design for a G+7 storied building near a seashore should be comprehensive, involve a combination of different testing methods, and take into account potential issues that may arise due to the location of the building. According to the findings of both the soil analysis, a foundation design can be developed. The foundation design may involve the use of deep or shallow foundations, depending on the soil conditions and building loads. Deep foundations, such as piles or caissons, are typically used when the soil is weak or when the building loads are high. Shallow foundations, such as footings or rafts, are used when the soil is relatively strong and the building loads are low

## V. CASE STUDY

### OTM Accommodation Building at Sea Shore of Dockyard, Mumbai

Site location:- The proposed site is located at Naval Dockyard, Colaba, Mumbai.
Colaba or (ISO: Kolb) is a neighborhood in the Indian city of Mumbai.
It is one of Mumbai's four landmasses, the others being Worli,
Bandra, and Malabar Hill.
During the 16th and 17th centuries under Portuguese administration, the peninsula had

recognized as Kolbhat Once the Brits seized the island's authority in the final years of the 17th century, it was referred to as Kolio..
The site location map for the site is as below:

**Fig:- Site Location**

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PROPOSED CONSTRUCTION: Soil investigation in respect of the provision of OTM ACCN for CCDT (Mumbai), Naval Dockyard.

**Geology of Site location:**

The geology of Mumbai relates to the geological of Mumbai, an archipelago metropolis. Back Bay and Bandra restoration are the most significant Mumbai redevelopment zones in the Arabian Sea. Black Deccan basalt flows and its acidic and basic varieties going back to the late Mesozoic and late Cretaceous geologic time form the town's foundation bedrock. Due to the existence of three active faults nearby, Bombay is situated in a seismically susceptible area. Originally, the five islands of Maharashtra were comprised of 22 hills. The majority of them had been demolished to link the islands by filling up the shallows. There seem to be three hill groups inside the municipal borders that include the remaining hills. The Ghatkopar Hills are located close to the Ghatkopar subway station.

## VI. DATA COLLECTION

The site investigation was carried out under the guidance and supervision of the authorized representative of AN-ICON Engineering Technologies & Infrastructure Developments Pvt. Ltd and officials of Military Engineering Services.

## VI. RESULTS

**Foundation design analysis:**

| Test | Uncertainty at 95% confidence |
|---|---|
| Plastic Limit | ± 0.396 |
| Liquid Limit | ± 0.396 |
| Grain size analysis | ±0.554 |
| Specific gravity | ± 0.396 |
| Direct shear test | ±0.423 |

The foundation design analysis for a G+7 storied building near a seashore would need to take into account the soil conditions, water table, and potential for seismic activity in the area. The construction must guarantee that the foundations is robust enough to sustain the tower's load and withstand transverse wind pressure, waves, and earthquakes. Depending on the site conditions, the foundation may need to be designed using piles, caissons, or other specialized techniques to provide the required support and stability.

**Soil investigation analysis:**

The soil investigation analysis would involve testing the soil at the site to determine its properties, including bearing capacity, shear strength, and settlement characteristics. The investigation would also need to assess the potential for soil liquefaction, which can occur in loose, saturated soils during earthquakes or other seismic events. The results of the soil investigation analysis would inform the foundation design, ensuring that the foundation is designed to withstand the specific soil conditions at the site and minimize the potential for settlement or failure.

Therefore we can say that the design and analysis of a G+7 storied building near a seashore would require careful consideration To guarantee a secure and steady construction, a variety of elements, such as soil types, groundwater level, due to earthquakes, and storm and wave pressures, must be considered.

The geomorphologic structure of the study area is covered with sand dunes, sandstone outcrops, beaches with hedging, and beach Puente dredging The heavier metals are substantially enriched near to the stream, exceeding 60 to 70 percent of or before data. The contents drop progressively increasing distances from of the river's beginning.

## LABORATORY TESTS

When drilling was completed, materials were sent to a research center for additional analysis. At the laboratories, materials were categorized and relevant specimens were chosen for examination.

**Table: Laboratory Tests**

| Sr. No. | Test | Code of Reference |
|---|---|---|
| 1 | Sieve analysis | IS 2720 Part 04: 1985 |
| 2 | Atterberg's Limit | IS 2720 Part 05: 1985 |
| 3 | Specific Gravity | IS 2720 Part 03: 1980 |
| 4 | Direct Shear Test | IS 2720 Part 13: 1986 |
| 5 | Free Swell Index | IS 2720 Part 40: 1977 |
| 6 | Natural Moisture Content | IS 2720 Part 2: 1973 |

**Table: Tests and their limits**

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**Table: SBC recommended**

| BH no. | Depth (m) | Width (m) | SBC (t/m²) | Recommended SBC (t/m²) |
|---|---|---|---|---|
| 01 | 1.50 | 1.50 | 5.97 | 5.50 |
| | 3.00 | 1.50 | 13.18 | 13.00 |
| | 4.50 | 1.50 | 19.38 | 19.00 |
| | 6.00 | 1.50 | 25.82 | 25.50 |
| | 7.50 | 1.50 | 32.49 | 32.00 |
| | 9.00 | 1.50 | 39.41 | 39.00 |
| | 10.50 | 1.50 | 46.56 | 46.50 |
| 02 | 1.50 | 1.50 | 6.28 | 6.00 |
| | 3.00 | 1.50 | 12.45 | 12.00 |
| | 4.50 | 1.50 | 18.30 | 18.00 |
| | 6.00 | 1.50 | 24.37 | 24.00 |
| | 7.50 | 1.50 | 30.67 | 30.50 |
| | 9.00 | 1.50 | 37.18 | 37.00 |
| | 10.50 | 1.50 | 43.92 | 43.50 |

**Table: Summary of Safe Bearing Capacity**

| BH no. | Depth of pile | Diameter of pile | Axial Compression (t) with F.O.S. 3.0 | Safe Vertical Pull-out Capacity (t) F.O.S. 3.0 |
|---|---|---|---|---|
| 01 | 5.0 | 0.30 | 5.740 | 6.040 |
| | 10.0 | | 11.480 | 12.081 |
| | 15.0 | | 17.220 | 18.121 |
| | 5.0 | 0.45 | 8.610 | 9.286 |
| | 10.0 | | 17.220 | 18.572 |
| | 15.0 | | 25.830 | 27.857 |
| | 5.0 | 0.60 | 11.480 | 12.681 |
| | 10.0 | | 22.960 | 25.363 |
| | 15.0 | | 34.440 | 38.044 |
| | 5.0 | 0.90 | 17.220 | 19.923 |
| | 10.0 | | 34.440 | 39.846 |
| | 15.0 | | 51.660 | 59.770 |
| 02 | 5.0 | 0.30 | 5.651 | 5.95 |
| | 10.0 | | 11.304 | 11.90 |
| | 15.0 | | 16.956 | 17.86 |
| | 5.0 | 0.45 | 8.478 | 9.15 |
| | 10.0 | | 16.956 | 18.31 |
| | 15.0 | | 25.434 | 27.46 |
| | 5.0 | 0.60 | 11.304 | 12.51 |
| | 10.0 | | 22.608 | 25.01 |
| | 15.0 | | 33.911 | 37.52 |
| | 5.0 | 0.90 | 16.956 | 19.66 |
| | 10.0 | | 33.911 | 39.32 |
| | 15.0 | | 50.867 | 58.98 |

**Summary Of Plate Load Test**

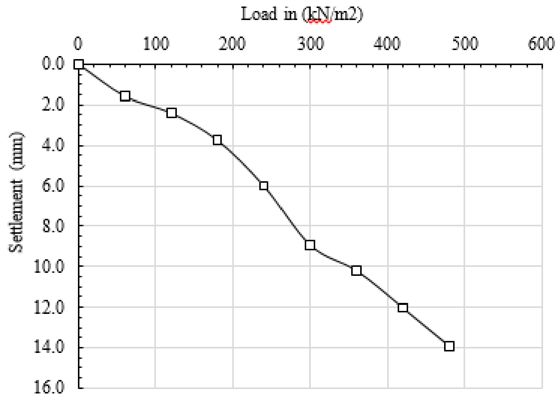



**Fig: Load curve**

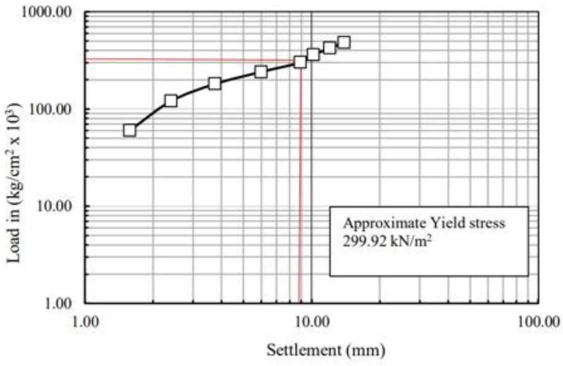



**Fig: settlement curve**

## DIRECT SHEAR TEST

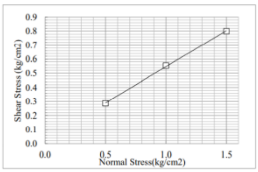
Weight of sample taken (gm): (Test performed at Bulk density) Water added (ml): (Test performed at Bulk density) Load factor (kg): 0.24

| Displacement (cm) | Divisions on proving ring | | | load in Kg | | | Area corrected cm² | shear stress (kg/cm²) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0.5 Kg/cm² | 1.0 Kg/cm² | 1.5 Kg/cm² | 0.5 Kg/cm² | 1.0 Kg/cm² | 1.5 Kg/cm² | | 0.5 Kg/cm² | 1.0 Kg/cm² | 1.5 Kg/cm² |
| 0.05 | 17 | 29 | 41 | 4.08 | 6.96 | 9.84 | 35.40 | 0.1153 | 0.1966 | 0.2780 |
| 0.1 | 17 | 31 | 59 | 4.08 | 7.44 | 14.16 | 34.80 | 0.1172 | 0.2138 | 0.4069 |
| 0.15 | 18 | 32 | 62 | 4.32 | 7.68 | 14.88 | 34.20 | 0.1263 | 0.2246 | 0.4351 |
| 0.2 | 19 | 35 | 66 | 4.56 | 8.40 | 15.84 | 33.60 | 0.1357 | 0.2500 | 0.4714 |
| 0.25 | 19 | 37 | 72 | 4.56 | 8.88 | 17.28 | 33.00 | 0.1382 | 0.2691 | 0.5236 |
| 0.3 | 20 | 41 | 74 | 4.80 | 9.84 | 17.76 | 32.40 | 0.1481 | 0.3037 | 0.5481 |
| 0.35 | 20 | 43 | 77 | 4.80 | 10.32 | 18.48 | 31.80 | 0.1509 | 0.3245 | 0.5811 |
| 0.4 | 22 | 46 | 78 | 5.28 | 11.04 | 18.72 | 31.20 | 0.1692 | 0.3538 | 0.6000 |
| 0.45 | 22 | 48 | 79 | 5.28 | 11.52 | 18.96 | 30.60 | 0.1725 | 0.3765 | 0.6196 |
| 0.5 | 22 | 54 | 80 | 5.28 | 12.96 | 19.20 | 30.00 | 0.1760 | 0.4320 | 0.6400 |
| 0.55 | 23 | 55 | 80 | 5.52 | 13.20 | 19.20 | 29.40 | 0.1878 | 0.4490 | 0.6531 |
| 0.6 | 23 | 56 | 82 | 5.52 | 13.44 | 19.68 | 28.80 | 0.1917 | 0.4667 | 0.6833 |
| 0.65 | 23 | 58 | 83 | 5.52 | 13.92 | 19.92 | 28.20 | 0.1957 | 0.4936 | 0.7064 |
| 0.7 | 24 | 59 | 84 | 5.76 | 14.16 | 20.16 | 27.60 | 0.2087 | 0.5130 | 0.7304 |
| 0.75 | 25 | 58 | 85 | 6.00 | 13.92 | 20.40 | 27.00 | 0.2222 | 0.5156 | 0.7556 |
| 0.8 | 26 | 58 | 85 | 6.24 | 13.92 | 20.40 | 26.40 | 0.2364 | 0.5273 | 0.7727 |
| 0.85 | 26 | 56 | 84 | 6.24 | 13.44 | 20.16 | 25.80 | 0.2419 | 0.5209 | 0.7814 |
| 0.9 | 26 | 56 | 84 | 6.24 | 13.44 | 20.16 | 25.20 | 0.2476 | 0.5333 | 0.8000 |
| 0.95 | 28 | 55 | 80 | 6.72 | 13.20 | 19.20 | 24.60 | 0.2732 | 0.5366 | 0.7805 |
| 1 | 28 | 55 | | 6.72 | 13.20 | 0.00 | 24.00 | 0.2800 | 0.5500 | 0.0000 |
| 1.05 | 28 | 54 | | 6.72 | 12.96 | 0.00 | 23.40 | 0.2872 | 0.5538 | 0.0000 |
| | | | | | | | | 0.2872 | 0.5538 | 0.8000 |

| Normal Stress (kg/cm²) | Shear Stress (kg/cm²) |
|---|---|
| 0.5 | 0.287 |
| 1.0 | 0.554 |
| 1.5 | 0.800 |

**Test Results**

| | |
|---|---|
| Cohesion (kg/cm²) | 0.01 |
| Angle of internal Friction (ϕ) | 27.15 |




**The vertical Load capacity of pile**
**Table:- Vertical Load capacity**

| Sr.no. | N | $\bar{N}$ | L (m) | B (m) | $A_p$ (m²) | $A_s$ (m²) | $Q_u$ (kN) | $Q_{safe}$ (t) |
|---|---|---|---|---|---|---|---|---|
| 1 | 20.5 | 21.50 | 5.0 | 0.30 | 0.07 | 4.71 | 56.31 | 5.74 |
| 2 | 21 | 21.50 | 10.0 | 0.30 | 0.07 | 9.43 | 112.62 | 11.48 |
| 3 | 23 | 21.50 | 15.0 | 0.30 | 0.07 | 14.14 | 168.93 | 17.22 |
| 4 | 20.5 | 21.50 | 5.0 | 0.45 | 0.16 | 7.07 | 84.46 | 8.61 |
| 5 | 21 | 21.50 | 10.0 | 0.45 | 0.16 | 14.14 | 168.93 | 17.22 |
| 6 | 23 | 21.50 | 15.0 | 0.45 | 0.16 | 21.21 | 253.39 | 25.83 |
| 7 | 20.5 | 21.50 | 5.0 | 0.60 | 0.28 | 9.43 | 112.62 | 11.48 |
| 8 | 21 | 21.50 | 10.0 | 0.60 | 0.28 | 18.86 | 225.24 | 22.96 |
| 9 | 23 | 21.50 | 15.0 | 0.60 | 0.28 | 28.29 | 337.86 | 34.44 |
| 10 | 20.5 | 21.50 | 5.0 | 0.90 | 0.64 | 14.14 | 168.93 | 17.22 |
| 11 | 21 | 21.50 | 10.0 | 0.90 | 0.64 | 28.29 | 337.86 | 34.44 |
| 12 | 23 | 21.50 | 15.0 | 0.90 | 0.64 | 42.43 | 506.79 | 51.66 |

**Table:- Uplift pile capacity**

| ϒc | $\bar{N}$ | L (m) | B (m) | Wp (kN) | As (m2) | Skin friction (kN) | $Q_{uplift}$ (kN) | Safe uplift (t) |
|---|---|---|---|---|---|---|---|---|
| 25 | 21.5 | 5.0 | 0.30 | 8.84 | 4.71 | 168.93 | 59.26 | 6.04 |
| 25 | 21.5 | 10.0 | 0.30 | 17.68 | 9.43 | 337.86 | 118.51 | 12.08 |
| 25 | 21.5 | 15.0 | 0.30 | 26.52 | 14.14 | 506.79 | 177.77 | 18.12 |
| 25 | 21.5 | 5.0 | 0.45 | 19.89 | 7.07 | 253.39 | 91.09 | 9.29 |
| 25 | 21.5 | 10.0 | 0.45 | 39.78 | 14.14 | 506.79 | 182.19 | 18.57 |
| 25 | 21.5 | 15.0 | 0.45 | 59.67 | 21.21 | 760.18 | 273.28 | 27.86 |
| 25 | 21.5 | 5.0 | 0.60 | 35.36 | 9.43 | 337.86 | 124.40 | 12.68 |
| 25 | 21.5 | 10.0 | 0.60 | 70.71 | 18.86 | 675.71 | 248.81 | 25.36 |
| 25 | 21.5 | 15.0 | 0.60 | 106.07 | 28.29 | 1013.57 | 373.21 | 38.04 |
| 25 | 21.5 | 5.0 | 0.90 | 79.55 | 14.14 | 506.79 | 195.45 | 19.92 |
| 25 | 21.5 | 10.0 | 0.90 | 159.11 | 28.29 | 1013.57 | 390.89 | 39.85 |
| 25 | 21.5 | 15.0 | 0.90 | 238.66 | 42.43 | 1520.36 | 586.34 | 59.77 |

## VII. CONCLUSION

- The construction of a G+7 storied building near a seashore requires careful consideration of soil investigation and foundation design. The tower's foundations should be constructed to resist the structural characteristics of the project's soil and the effects of the aquatic domain. A comprehensive soil study is required to evaluate the project's soil structure, hardness, and durability. This will help to determine the appropriate type of foundation system to use, such as a shallow foundation or deep foundation, and the required depth and diameter of the foundation elements.

1. The laboratory test result summary shows that the soil is sandy type of soil (non-plastic in nature).

2. Safe Bearing Capacity (SBC) for square isolated footings of width 1.5m at different depths has been listed.

3. SBC for square and rectangular raft footings has been tabulated in the table, for different allowable settlement values.

4. The Bearing Capacity for pile foundation has been provided in the tables for different pile diameters and lengths.

5. The pile calculations provided are based on the laboratory evaluation of the soil. However test piles have to be made on the site and shall be tested for their appropriate capacities.

- In addition, the foundation design must take into account the effects of wave action, wind forces, and potential erosion due to the proximity to the sea shore. The tower's foundations should be constructed to resist the structural characteristics of the project's soil and the effects of the aquatic domain. A comprehensive soil study is required to evaluate the project's soil structure, hardness, and durability. Climate change may increase the risk of flooding and storm surge, which could impact the stability of the foundation and the safety of the building.
- In conclusion, a thorough soil investigation and careful foundation design are critical to ensuring the safety and stability of a G+7 storied building near a sea shore. It is important to work with experienced geotechnical engineers and architects who have experience designing buildings in coastal areas and are familiar with the unique challenges posed by this environment.

## REFERENCES

1. lunne, T. (2010). The CPT in offshore soil investigations - a historic perspective. *2nd International Symposium on Cone Penetration Testing*, *1*(March 2015), 43.
2. Society, S. (1973). *Dynamics of building-soil i n t e r a c t i o n by paul c. jennings and jacobo bielak*. *63*(1), 9–48.
3. Yukio Sato, Hiroshi Yamakose, Y. S. (1970). NII-Electronic Library Service. *Chemical Pharmaceutical Bulletin*, *43*, 2091. http://www.mendeley.com/research/geology-volcanic-history-eruptive-style-yakedake-volcano-group-central-japan/
4. Barnes, H. E., & Engineer, S. (1926). *Soil Investigation Employing A New Method of Layer-Value Determination for Earth Resistivity Interpretation*. *I*(56), 26–36.
5. Nu, N. T., Duong, N. T., Son, B. T., & Thinh, P. H. (2020). Investigation of salt, alum content in soft soils and their effects on soil properties: Case study in Coastal areas of Vietnam. *Iraqi Geological Journal*, *53*(2 A), 19–34. https://doi.org/10.46717/igj.53.2a.2rw-2020-08-02
6. Saettem, J., Rise, L., Rokoengen, K., & By, T. (1996). Soil investigations, offshore mid Norway: A case study of glacial influence on geotechnical properties. *Global and Planetary Change*, *12*(1–4), 271–285. https://doi.org/10.1016/0921-8181(95)00024-0
7. Gowda, J. P., & Kumar, S. C. P. (2017). Segmentation of White Blood Cell using K-Means and Gram-Schmidt Orthogonalization. *Indian Journal of Science and Technology*, *10*(6), 1–5. https://doi.org/10.17485/ijst/2017/v10i6/111205
8. Yunusa, G. H., Hamza, U., Abdulfatah, A. Y., & Suleiman, A. (2013). Geotechnical investigation into the causes of cracks in building: A case study. *Electronic Journal of Geotechnical Engineering*, *18 N*(11), 2823–2833.
9. Yunusa, G. H., Hamza, U., Abdulfatah, A. Y., & Suleiman, A. (2013). Geotechnical investigation into the causes of cracks in building: A case study. *Electronic Journal of Geotechnical Engineering*, *18 N*(January), 2823–2833.
10. Mehri, A., Salmanmahiny, A., Tabrizi, A. R. M., Mirkarimi, S. H., & Sadoddin, A. (2018). Investigation of likely effects of land use planning on reduction of soil erosion rate in river basins: Case study of the Gharesoo River Basin. *Catena*, *167*(July 2017), 116–129. https://doi.org/10.1016/j.catena.2018.04.026
11. Duan, X., Bai, Z., Rong, L., Li, Y., Ding, J., Tao, Y., Li, J., Li, J., & Wang, W. (2020). Investigation method for regional soil erosion based on the Chinese Soil Loss Equation and high-resolution spatial data: Case study on the mountainous Yunnan Province, China. *Catena*, *184*(February 2018), 104237. https://doi.org/10.1016/j.catena.2019.104237
12. Ashok Kumar, T., Thyagaraj, T., & Robinson, R. G. (2018). Distress of an industrial building constructed on an expansive soil: A case study from India. *Proceedings of the Institution of Civil Engineers: Forensic Engineering*, *171*(3), 121–126. https://doi.org/10.1680/jfoen.18.00005