GEOTECHNICAL CHARACTERISTICS OF SOIL SAMPLES FROM HILLY TERRAINS OF PORTBLAIR

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ABSTRACT: This paper attempts to present the history of geological formations and explore the subsoil of Port Blair especially at levels of foundation bearing stratum. The geologic setting of the site primarily consists of early eocene ophiolitic rocks with ultramafic igneous intrusions. Standard Penetration Test is carried out on 5 boreholes whose locations are distinctly chosen where prospective built up constructions of a new medical college are likely to impose significant load concentrations. The site is located 800m away from the shorelines and along a natural finite slope of height 111m and inclined at 35° to horizontal. This paper evaluates the properties of soil samples extracted from SPT soil samplers. Soil properties such as Atterberg limits, Grain size analyses, Dry density, Light Compaction and Direct Shear values at different depths are determined to identify the trend along the depth. This preliminary Geotechnical Characterization comes as an essential approach to add on to the very minimally available subsurface data of the islands and eventually, help in evaluating the geotechnical instabilities that might occur due to the growing developments of the regions.

KEYWORDS: Site Exploration, Site Characterization, Subsurface Exploration, Drilling, Standard Penetration Test, Andaman Islands

1 INTRODUCTION:

The Andaman basin comprising the Andaman and Nicobar group of Islands and their adjoining offshore areas, is located in the southeastern part of Bay of Bengal between latitude 6°N to 14°N and longitude 92°E to 94°E. Geographically it covers an area of more than 40,000 sq.km upto 200m isobath(Chatterjee,1967). The predominantly hilly terrains of Port Blair combined with average maximum daily temperatures ranging between 24-31°C and peak rainfall as high as 3000 cm makes the region highly favorable for intense weathering of rocks. With sufficient vegetation to prevent the soils being transported as sediments, an accumulation of residual soils has resulted over the regions as a consequence. Port Blair being a rapidly developing economy mainly due to increase in the inflow of international tourists, the construction industry has received a significant uplift. As a result 99% percent of timber dwellings have been replaced to concrete structures with minimum 2 storeys.

As Port Blair is designated as zone 5 in earthquake rating scale i.e. the most severe earthquake zone, there is potential risk of failure of built up structures and natural slopes due to earthquake shaking. The site selected for subsurface investigation is a part of a proposed medical college located very near to the coastal zone along a natural slope trending down 35° approximately from a height of 111m from the sea level. (Figure1). Site reconnaissance was conducted to observe the local topography, evidence of erosions, landslides; etc. The site has never been used for any previous construction activities and consisted lush green forests. The level of water table as observed in the surrounding wells is well beneath the significant depth required for the foundations. Structurally, some rock outcrops exhibit a homogenous ophiolitic formation and consist of narrow parallel folds and eastward dipping thrusts.

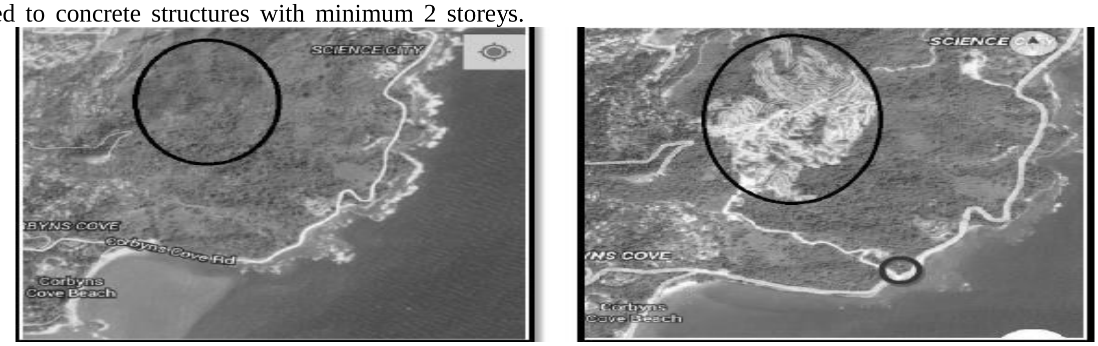

Fig 1: Aerial image of the site before and after clearing vegetation. Red circle is the access point.

2 PROPERTIES OF TOP SOIL:

Trial pits were made at places where weathered rocks were encountered and along the slide zones. A total of 4 test pits were excavated for top soil characterization transverse to the slope. The size of the test pits are 1 x 1 x 1.5m. The figure shows the location and area of exploration. The soil samples collected from all the test pits are tested in the laboratory for Natural moisture content , Specific gravity ,Particle size distribution, Atterberg limit, Field density test and Procter compaction test .All tests are performed as per standard procedures given in IS codes 2720. The top soil was pale brown, well compacted, and can be graded as SW-SC with approximately 59% of rounded and sub angular coarse to fine sand, 27% hard angular gravel and 14% plastic fines with high dry strength as observed from the grain size distribution curves and consistency limits(Table 1).

Also the water content of the soil is relatively close to the optimum moisture content of the soil corresponding to maximum dry density showing that the soil is in dense state. No large variation in soil deposits existed over the distances of the test pits as shown in the graph (Figure 3).

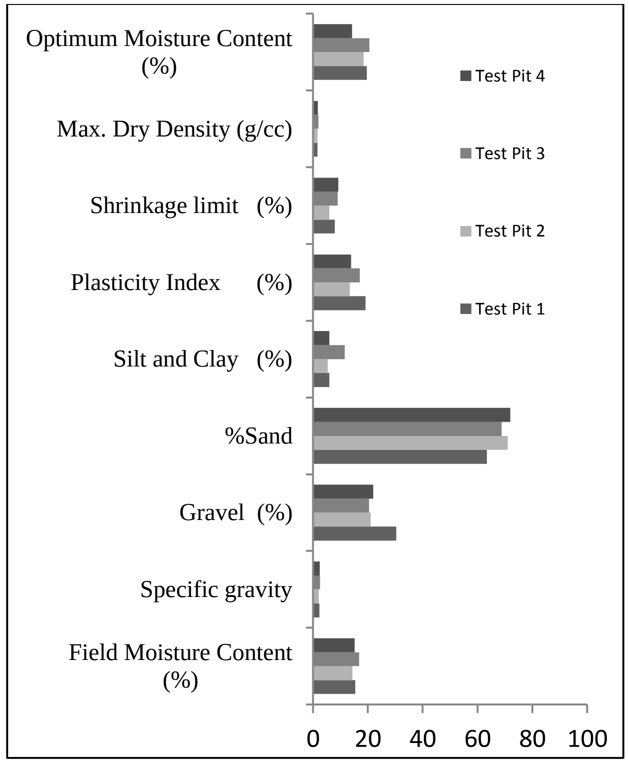

Fig 2: Variation of soil properties in test pits

Table 1: Index Engineering properties of soil from Test pits.

Test pit no.	Field Moisture Content	Specific Gravity	Liquid Limit %	Plastic Limit %	Plasticity Index %	shrinkage limit	Gravel %	coarse sand%	medium sand%	fine sand %	silt and clay%	Field Density (g/cc)	Max. Dry Density(g/cc)	Optimum Moisture Content
1	15.4	2.59	43.20	33.66	9.54	7.93	17.2	12.0	49.0	5.6	16.9	1.562	1.536	17.8%
2	14.35	2.69	39.00	32.76	6.24	5.976	25.6	11.2	36.8	7.2	19.8	1.706	1.616	14.20%
3	16.847	2.42	38.60	32.58	6.02	8.953	27.0	11.2	39.4	6.0	16.7	1.558	1.628	17%
4	15.19	2.64	43.80	35.92	7.88	9.205	24.8	15.2	35.4	4.8	18.2	1.668	1.576	13.60%

3 STANDARD PENETRATION TESTING AND SAMPLE COLLECTION

The geology of the slope as derived from the result of the test pits shows that the top layer of the slope consist of sandy gravel layer i.e well graded sand with very little fines. Based on the shape of the building obtained from base plan of the particular site the bore holes are located at positions of extreme foundations and at the center of the building. The total numbers of bore holes made were 5. As per IS **1892- 1978,** the spacing of bore hole is preferred as 50 meters and the diameter of bore hole is kept 100mm. The length of the slope is approximately 111 meters. Its height from mean sea level is 52 meters. The inclination of the slope vertical to horizontal is 1:0.7 with angle of inclination approximately 34°. The three dimensional image of the slope presenting the location of bore holes and test pits is given below (Figure 3).The standard penetration test is performed as field test for the in situ soil anticipating it to be sensitive to the disturbance in subsoil conditions. The penetration resistance is reported in number of blows of the weight to drive the spoon 305mm.Sampling of soils were done at depths 1.8m, 3.3m,4.8m and 6.3m from ground levels. The field N values were corrected for overburden pressure, type of sampler (spilt-spoon), hammer efficiency (60%), Borehole diameter. Water table was not encountered in any bore holes.

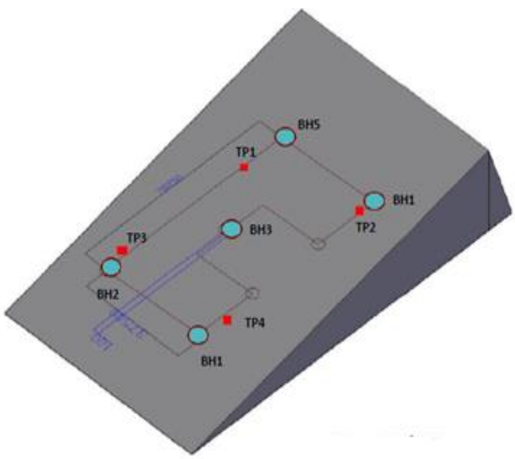

Fig 3: Location of Test Pits and Bore holes

The significant depth corresponding to 10% of superimposed load was found out to be 9m from ground level. However soil samples could not be retrieved as the SPT sampler experienced a rebound at very shallow depths between 3 to 6m, indicating dense and compact sand layers with gravel.

4 SUMMARY OF LABORATORY RESULTS:

The variability of soil properties along the depths of each borehole are presented in figure 4. There has been a consistent presence of gravels in soils at all depth in each bore hole.The increasing values of penetration resistance N (blows/305mm) down each bore hole from N=19 to N=53, indicate the relative density of the soil from a medium state to very dense state. Generally presence of clay in ophiolitic soils has slightly high swelling potential. However the range of high plasticity index values due to the dominant presence of coarser particles might expect to alleviate this condition. Hydraulic conductivity is expected to be high in such deposits which can be confirmed with specific tests.

The direct shear results of every bore hole sample showed an increase in thickness of the specimen during shear and a marked peak point in the stress-strain curve. The friction angles of soil might be attributed by the smaller initial void ratios and enhanced interlocking due to better distribution of particle sizes observed along the depth .It can be appreciated that with increase in confining pressure the soil will suffer less decrease in angle of internal friction due to the gradation it possesses.

5 CONCLUDING REMARKS:

The determination of soil profile is an essential step to indicate how geological history influence soil properties. Disturbed or partially disturbed, but representative samples are collected from test pits and bore holes and are subjected to simple laboratory and field tests such as natural moisture content, Atterberg limit, particle size distribution, density etc. From the experimental study of the soil parameters the results are consistent with the geological formations that comprise of basic rocks commonly described as ophiolitic deposits. Based on the index and engineering properties of the collected soil , the soil sample can be classified as Clayey silty sand with gravel proportions. Although the study was made on few samples detailed investigations can be carried out on need basis. The values of soil properties reveal subsurface information based on local geological condition that can be suitably referred for foundation designs and road construction. The shear strength parameters determined in this study can also be used for finding safety factor for slope analyses.

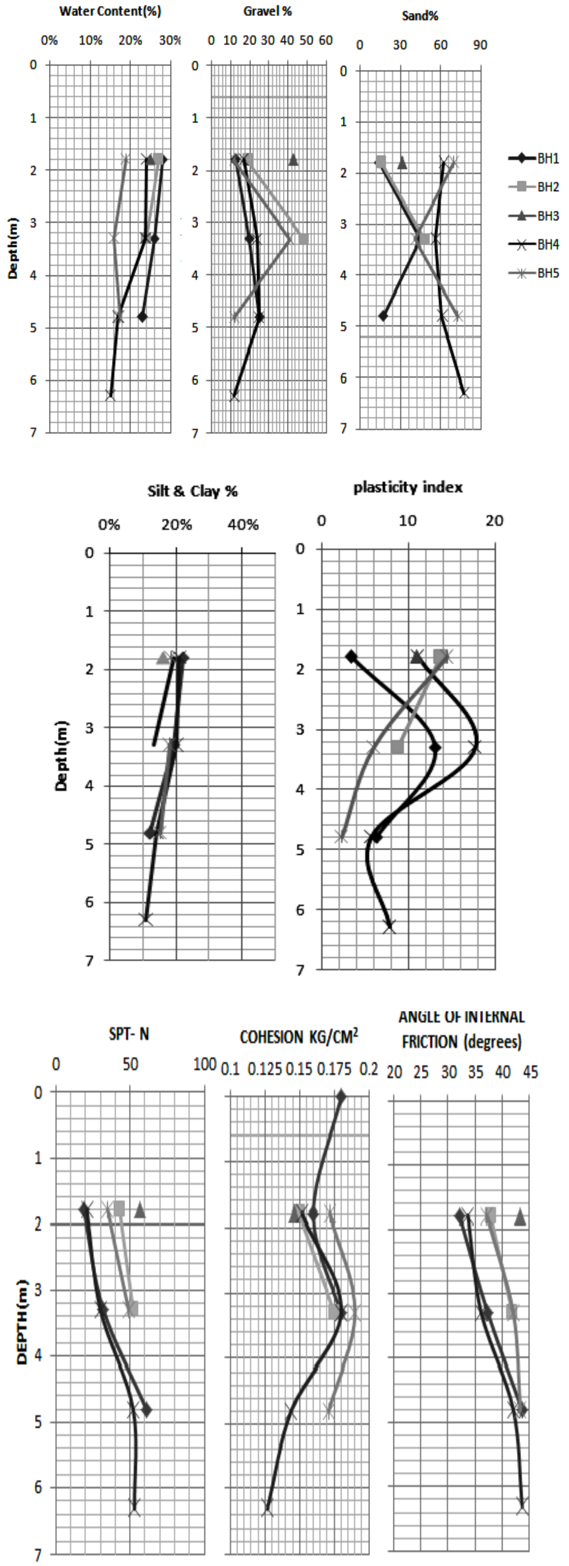

Fig.4: Variability of soil properties with depth

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