

Study of Geotechnical Assessments for The Foundation and Construction of Civil Work at Tharparkar District, Sindh, Pakistan

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Abstract: This study evaluates engineering properties of soils for the foundation in Tharparkar district. Three boreholes were investigated in the study area at the depths of 8m, 9m and 9m respectively. The area is mainly divided into three zones, i.e. BH-01, BH-02 and BH-03. Groundwater was not encountered in any borehole. The soil profile of all three boreholes are low dense to medium dense at 2.0m to 6.0m and the 7.0m to 9.0m depths respectively. Overburden depth was very dense (N-values ranges from 8 to 17 and 33 to more than 50 numbers). Laboratory results reveal that moisture content goes 4.8 to 6.4%, Soils are non-plastic in all three boreholes. The granular soils specify the angles of internal friction (ϕ) varying from 24° – 33° in respective boreholes; while in the collected samples granular soils have cohesion of 2.4 to 2.5kPa. According to AASHTO soil classification, the material belongs to the type of granular soil and in the group of A-3. Furthermore, finding of the examinations is robust for the development of structures, transmission line foundations and other civil works to observe the stability and quality of good foundation for the most part in Thar zone, particularly in the studied area.

Keywords: Geotechnical characteristics, soil foundation, civil work, Tharparkar.

Introduction

The study area is located about 28 km in the southeast of Islamkot and 68 km in the east of Mithi in district Tharparkar. It lies between $24^{\circ} 43' 41''$ to $24^{\circ} 50' 18''$ latitude and $70^{\circ} 17' 35''$ - $70^{\circ} 26' 17''$ longitude (Fig. 1). The area is easily accessible by four-wheel vehicle.

The present study includes geotechnical characteristics of the Tharparkar soil, in-situ drilling and soil tests such as field standard penetration test, collection of undisturbed and disturbed soil samples. The chemical testing of soil samples was carried out in the laboratory. Geotechnical laboratory tests of these samples included, particle size analysis, Atterberg's limit, and direct shear tests to classify and determine the behavior of soil. Overall, three boreholes were drilled in different locations at depths of 8m, 9m and 9m, respectively (Fig. 4). According to Khan et al. (2019) straight rotary rig drilling method is used to drill boreholes. Bentonite clay powder was circulated as a drilling fluid to give constancy to boreholes (Dimitri and Judd, 1970, Braja, 1975). Present study investigates a portion of the geotechnical hazards on enormous structural designing tasks and recommends a portion of the alternatives that can be considered for eradicating these dangers.

Geological Setup

Thar Desert has about 75,000 km² area in south-east Pakistan. Hussain et al. (2004) discussed it mainly

constitutes sand dunes comprising longitudinal, transverse, and barchan type A significant part of the southern part of the desert includes stable longitudinal slopes. In contrast, transverse and barchan type sand edges occur at the north-side in the intermediary zones among Cholistan, Thal and Thar deserts (Shah, 1977, Kazmi and Jan, 1997).

Materials and Methods

For the present study the field work was carried out at Tharparkar district and a total of three bore holes were drilled up to 10 meters depth (Fig. 2). For structuring properties, the bore holes were drilled for the most over the top depth of 10 meters, through the assistance of straight rotatory rig. The soil tests were conducted at each interval of 1 meter to ensure the degree of accuracy in the design. In situ, standard penetration test (SPT) is commonly carried out for examining the geotechnical properties of subsoil. It is an easy and economical test for the study of the relative density of soils and estimated shear strength parameters. SPT is overall used for the most planned structures for testing in-situ soil "Penetration Resistance Test". At the same time, the split spoon sampler is used to obtain soil from the sub-surface, Schmertmann and Smith, (1978).

The evaluation of geotechnical examination for any area is not possible without high quality water and soil tests from the surface and sub-surface. Hereafter, undisturbed soil tests were taken by pitcher tube from granular strata and Denison/Shelby tube sampler from compacted soil. The undisturbed soil tests was

assembled through Shelby tubes from different depths and samples were waxed in order to protect their moisture and each sample were named with mention their depth and without losing moisture sample waxed properly, samples were brought to laboratory for further testing as par ASTM standards. In contrast, undisturbed samples were taken at 5 meters interval for undisturbed soil sample was set considering how the sediment brought of the soil makes the recovery of undisturbed samples difficult. The boreholes location and GPS coordinates of the inspecting area and investigated actual depths are determined and showed in table 1 and fig 2.

Table 1 Showing the coordinates of studied area.

BH No.	Proposed depth (m)	Actual Depth (m)	Easting	Northing	Distance (m)
BH # 1	15	8	640865.91	2744396.97	
BH # 2	10	9	643326.83	2743307.95	2691.113
BH # 3	15	9	645324.25	2740736.34	3256.204

Laboratory Techniques

The soil properties tests were set up as explained by the prescribed methods and its strength, as noted in the ASTM standards. The subsequent laboratory tests were evaluated for sieve analysis, direct shear test ASTM D-3080 (1996), Atterberg’s Limit test, Natural Moisture Content test and chemical tests of soil samples were also assessed: e.g., sulphate, chloride, and organic matter contents. One of four samples was selected for sieve analysis while all the four samples were processed accordingly: Washing, Drying, and Sieving: 500 grams of each sample were taken to conduct sieve analysis, in pursuance of this standard mesh sizes (19.1 mm 12.7 mm, 9.52mm, 4.75, 2.00 mm, 1.00 mm, 0.5 mm, 0.25 mm, 0.125 mm, and 0.0625 mm with a pan at the bottom) were selected for samples. The sieve analysis investigations were carried following the principles of ASTM D 422-63 and AASHTO, (1988).

Results and Discussion

Three boreholes were drilled based on the investigation and classification of soil (Table 1). The standard penetration test (SPT) was performed at an interval of one meter. This revealed a lower value to the moderate value, which shows loose material from 1 to 3m and moderately medium dense sand with silt from 3 to 6m N-value is increasing with depth. It further indicates loose to dense and highly dense silty sand layer with a minor amount of small gravels (Fig 3).

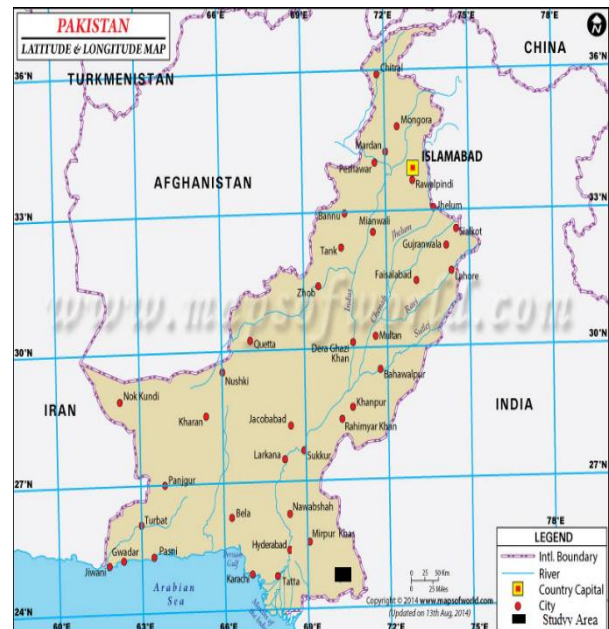


Fig. 1 Index map of Pakistan showing the studied area.

The borehole log 2 showed that the strata were same silty sand and are light brown dry and loose to medium dense, fine non-plastic, loose from 1 to 4m and dense 4 to 6m and very dense at 6 to 9m, respectively (Fig. 4). Finally, in the borehole log 3, the strata are a little different from the previous borehole. The value from 1 to 4m is loose, 4 to 7m is medium dense, and from the 7 to 10m N-values increased more than 50 (Fig. 5).

In the field investigation the SPT, N-values were increasing with depth, at the depth of 6 to 9m and refusal was observed in studied boreholes. The groundwater table was not found in any borehole during investigations. The moisture content of soil is ranging from 4.6 to 6.8% in dry seasons. The results of all samples showed that the silt particle is ranging from 7 to 11%, gravels content from 0 to 3% and sand fraction 85 to 93%.



Fig. 2 Location point of boreholes (Source: Google Map).

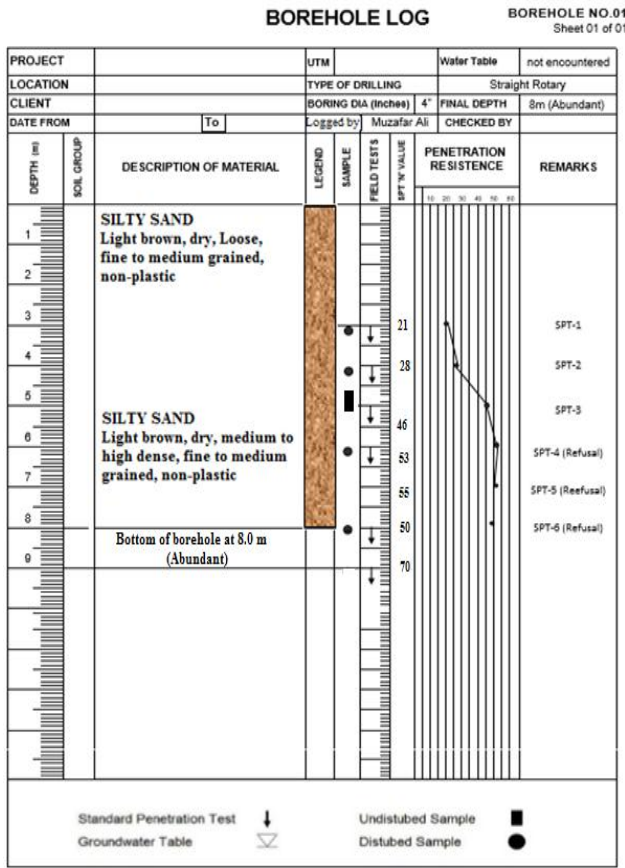


Fig. 3 Borehole log 1.

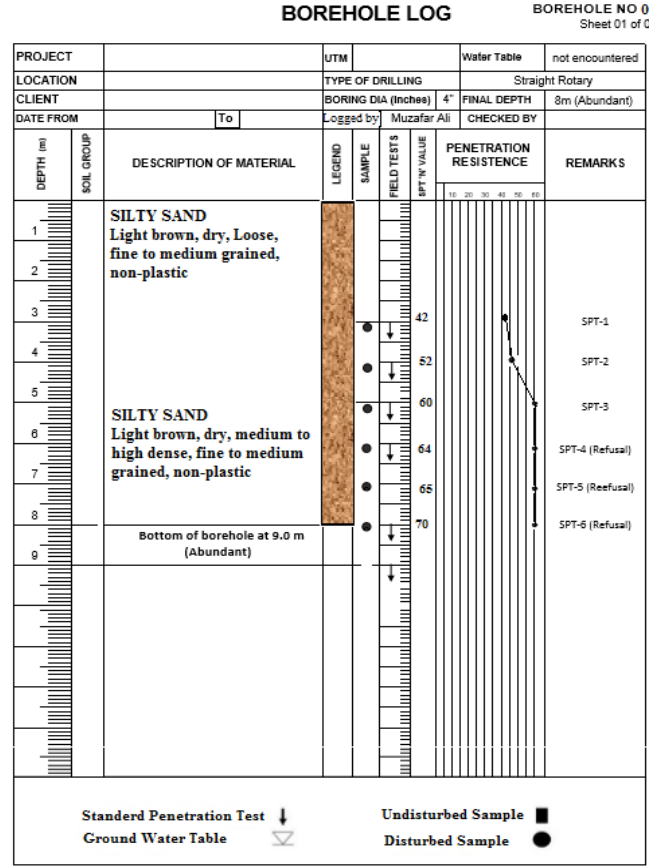


Fig. 5 Borehole log 3.

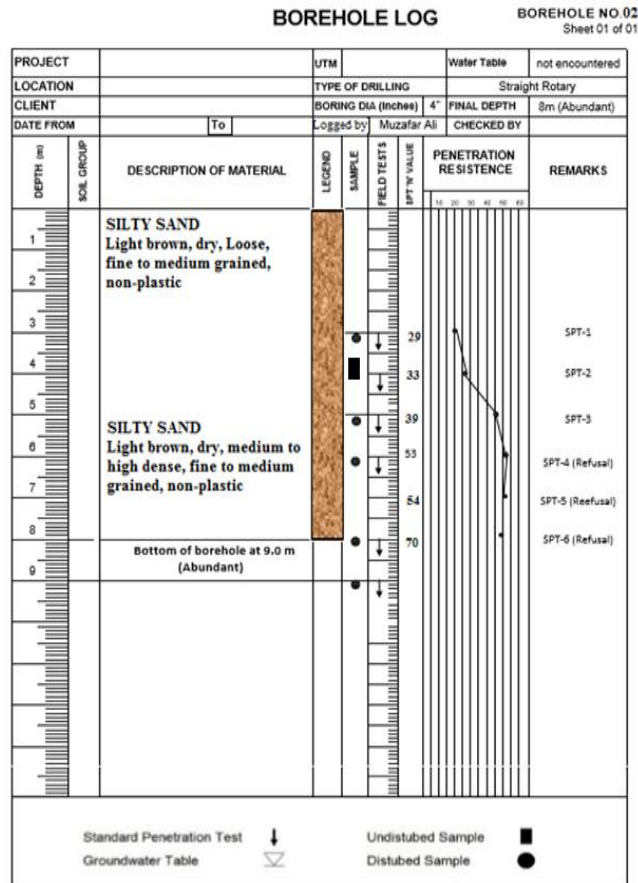


Fig. 4 Borehole log 2.

Laboratory tests from borehole-1, 2 and 3 are shown in Table 2. Different depths disturbed sample (DS), undisturbed sample (UDS) and standard penetration test (SPT) were collected. Disturbed sample DS was extended up to each 1 m, UDS up to 5 m and also SPT test performed at each 1 m respectively.

Table 2 Laboratory test results

Sr. No.	Borehole No.	Sample No.	Depth (m)	Sieve Analysis (% Passing)						NMC (%)	Bulk Density (kN/m ³)	Direct Shear (C (KPa) Φ°)	SO ₂ (%)	Cl (%)	Organic Matter (%)
				#4	#10	#40	#100	#200	0.01mm						
1	BH-01	SPT-2	3.0-3.45	97	95	94	53	10	-	-	-	-	0.008	0.005	0.059
2		UDS-1	5.0-5.90	100	99	99	69	12	-	4.8	15.7	2.4	33	-	-
3		SPT-1	3.0-3.45	99	96	94	70	09	-	-	-	-	-	-	-
4	BH-02	UDS-1	4.0-4.90	100	100	99	31	08	-	6.4	-	2.5	24	-	-
5		SPT-4	6.0-6.45	100	100	100	39	11	-	-	-	-	-	-	-
6	BH-03	SPT-2	3.0-3.45	100	98	97	54	07	-	-	-	-	-	-	-
7		SPT 7	5.0-5.45	97	96	87	61	10	-	-	15.4	-	-	-	-

Equivalent parameters for all three bore holes are considered to find a cohesive relationship between them. Hence, the tests were conducted as per significant ASTM, ASHTOO standards. Tests are performed with AASHTO standards.

Subsoil investigation test results show that the subsoil mostly consists of granular soil having cohesion 2.4-2.5KPa with the angle of friction 24° to 33°. The

chloride, sulphate, and organic matter contents were found to vary from 0.02 to 0.06 %, 0.02 to 0.3 % and 0.03 to 1.05 % respectively (Fig. 6, Table 2).

Conclusion

The study was examined in order to classify the geotechnical properties of the underlying subsoil in the studied area, for the design purpose of foundation and construction of civil work.

On the bases of this in the field and laboratory test results are concluded as under:

Soils of studied area according to AASHTO classification system falls into A-3, non-plastic; the material is granular and falls in the group of A-3. The Thar desert sand dunes are weak against disturbance. These aeolian sands, particularly at shallow depths, are valuable to the unexpected settlement in view of the collapse of the soil structure. During drilling operation, these depths need special attention. Further investigation and field testing is required to understand the complex nature of this class of soils.

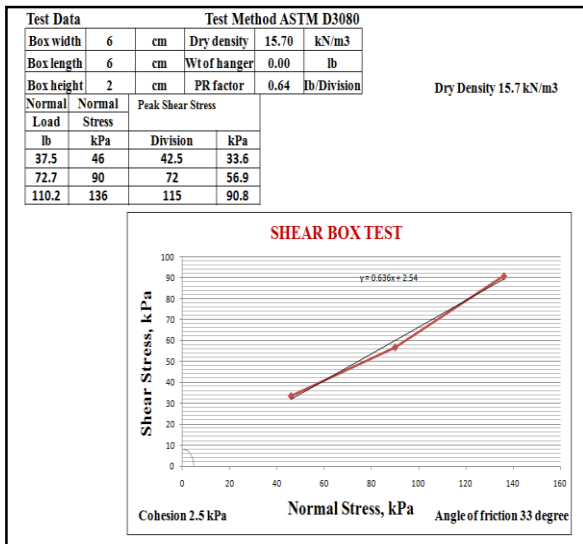


Fig. 6 Direct shear box test result.

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