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Characteristics of Geology in Khulna City Corporation (KCC) Area, Bangladesh

K.M. Bipul Shahriar[1]*, Md. Rokonuzzaman[2], Liton Rabbani[3]
[1]ACE Consultants Ltd., DOHS Baridhara, Dhaka-1206, Bangladesh
[2]Khulna University of Engineering & Technology (KUET), Khulna-9203, Bangladesh
[3]Tangail Politechnique Institute, Tangail-1900, Bangladesh

Abstract

This study represents the general characteristics of foundation soil in Khulna City Corporation (KCC) area. The KCC is situated in southwestern part in Bangladesh. Lithologically the area is composed of coarse to very fine silty sand, silt, silty clay, clayey silt and clay in various proportion. The SPT (Standard Penetration Test) value of the investigated area range between 0 and 7 from surface to 8 m deep. Here, the liquid limit and the natural moisture content (NMC) range from 32 to 64%, 27 to 65% respectively. The shear strength of the upper subsoil horizons in the investigated area is low. Low shearing strength in the upper soil horizon is indicative of soil vulnerability to excessive settlement under high load. The cohesive nature of upper soil in the KCC area with high colloidal content, high liquid and plastic limit indicate medium to high sensitivity of the soil to moisture that could not support heavily loaded buildings and structures. The problems can be avoided by considering special type of foundation, increasing the width of basements of structures and granular backfilling. Based on geomorphology, stratigraphic litho-succession, soil types, percentage of sand, silt and clay in the soil, liquid limit, plasticity index, NMC, liquefaction, settlement and SPT zonation, the study area have been classified as lowest for urbanization. Considering the factors of geotechnical parameters for design of structural foundations this zone is rated as severe for shallow foundations without replaced the existing soil by well graded sandy material. It is understood from the investigation that the deep foundation is necessary with sufficient pile length (>35 m) is required to resist heavy structural load.

Keywords*: Urban Geology, Khulna City Corporation, Bangladesh*

****Author for Correspondence*** E-mail: Shahriar_briti@yahoo.com

INTRODUCTION

Background

Khulna, the industrial and port city, as well the third largest city located South-West region of Bangladesh. The second largest seaport is only 40 km away from the city. Day after day the population is increasing with a high rate in the city and deciding to live permanently with accommodation. Generally, partially saturated clayey soils having high plasticity are very sensitive to variations in water content and show excessive volume changes. Such soils, when they increase in volume because of an increase in their water contents, are classified as expansive soils. This highly plastic soil may create cracks and damage on the pavements, railways, highway embankments, roadways, building foundations, channel and reservoir linings, irrigation systems, water lines, sewer lines etc. Thereafter, highly plastic soil exhibits undesirable engineering properties under load. They have low shear strengths and tendency to lose shear strength further upon wetting or other physical disturbances. Therefore, these plastic soils are very prone to shear failure due to the constant load over time and considered poor material for foundations.

MATERIALS AND METHODS

Six locations were selected in Khulna City corporation area for determination of geological characteristics in this zone. They are:

1. Rayermahal
2. BaniyaKhamar
3. LabonChora

4. Tuthpara
5. Chararhat
6. ChotoBoyra

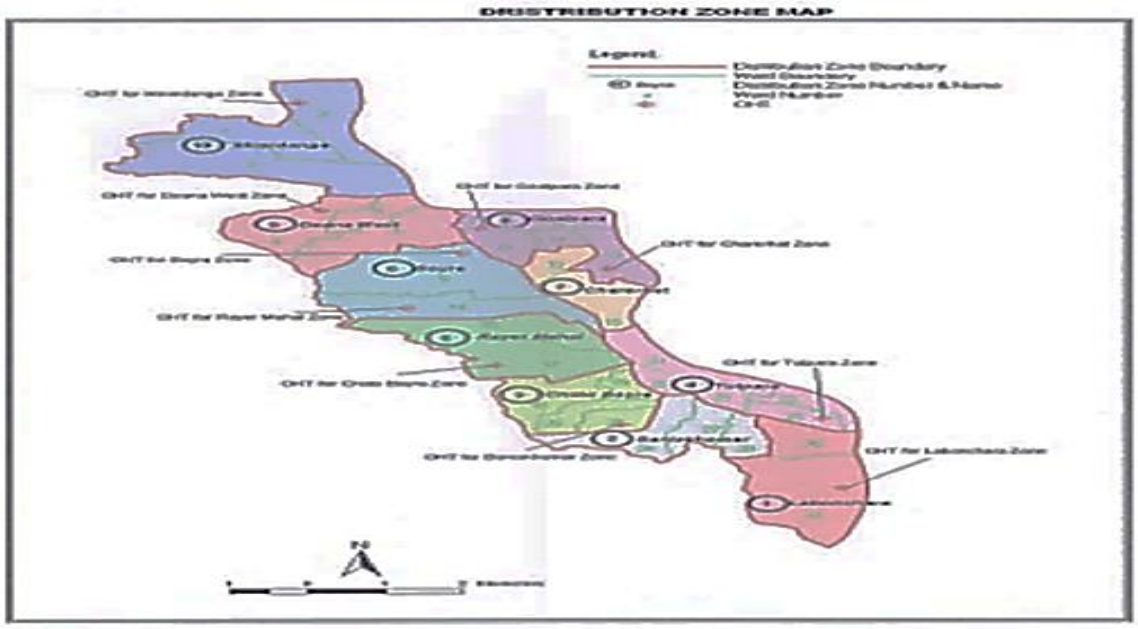

Fig. 1: *Location showing investigated area.*

The geotechnical investigation consisted of field studies, laboratory tests and engineering analysis required for the purpose. The field portion of the investigation consist of test borings and field testing, laboratory studies included tests to determine soil properties including physical and mechanical properties. Test was carried out in accordance with the standards [1–4].

Drilling

At six locations in KCC area was drilled to a depth of 50 m each. The encountered material found [5] is listed below,

Table 1: *Characteristics of Encountered Soil Samples based on Visual Description.*

Location name	Depth (m)	Materials encountered
1. Rayermahal	0.0 to 10.0	Clayey SILT trace sand
	10.0 to 22	
	22.0-30.0	
	30-50.0	Silty SAND
2. BaniyaKhamar	0.0 to 10.0	Clayey SILT
	10.0 to 14.5	Silty SAND
	14.5 to 30.0	Clayey SILT trace sand
	30.0-50.0	Silty SAND trace clay
3. LabonChora	0.0 to 10.0	Clayey SILT
	10.0 to 14.5	Sandy SILT
	14.5 to 30.0	Silty SAND
	30.0-50.0	sandy SILT/silty SAND
4. Tuthpara	0.0 to 19.0	Silty clayey
	19.0 to 30.0	Silty SAND
	30.0 to 50.0	SAND
5. Chararhat	0.0 to 14.5	Silty SAND/SAND
	14.5 to 30.0	Sand with some SILT
	30.0-50.0	Silty SAND
6. ChotoBoyra	0.0 to 5.0	Clayey SILT
	5.0 to 11.5	sandy SILT
	11.5 to 30.0	Silty SAND
	30.0-50.0	

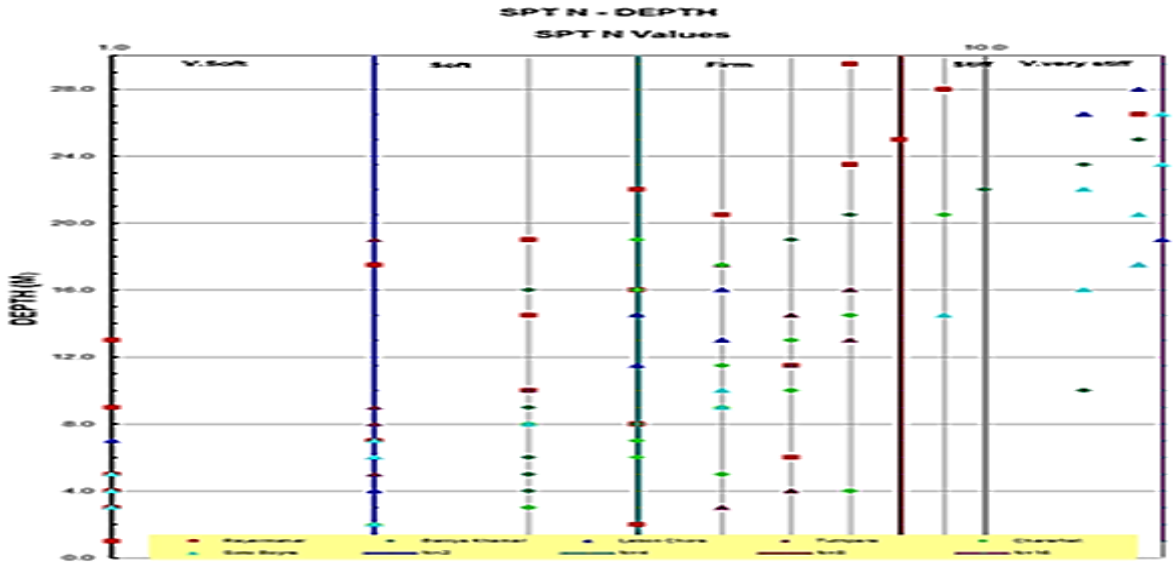

Fig. 2: *SPT (N) vs. Depth (m) Graph.*

Laboratory tests [6, 7, 1] were carried out for selected samples to know the geology of the strata. Several laboratory tests were carried out such as,

1. Specific gravity
2. Wet Unit weight
3. Dry Unit weight
4. Natural Moisture Content
5. Liquid Limit
6. Plastic Limit
7. Plasticity Index
8. Cohesion
9. Angle of internal friction
10. Unconfined Compression Strength

Natural Moisture Content Tests- on selected samples were performed according to ASTM D420-69.

Wet & Dry Density Tests- on selected samples, were performed according to ASTM D420-69.

Atterberg Limits Tests- were performed according to ASTM D423-66 & D424-59.

Particle size distribution Tests-were carried out according to ASTM D421-38 & D422-63.

Unconfined Compression Test-were performed according to ASTM D2166-85.

Direct Shear tests were performed according to ASTM D-3080-72.

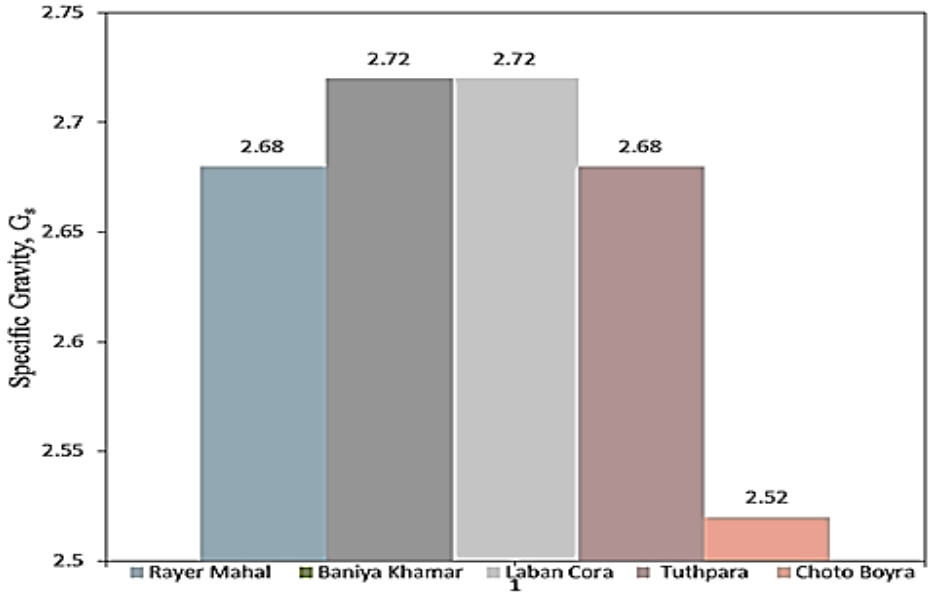

Fig. 3: *Specific Gravity Gs.*

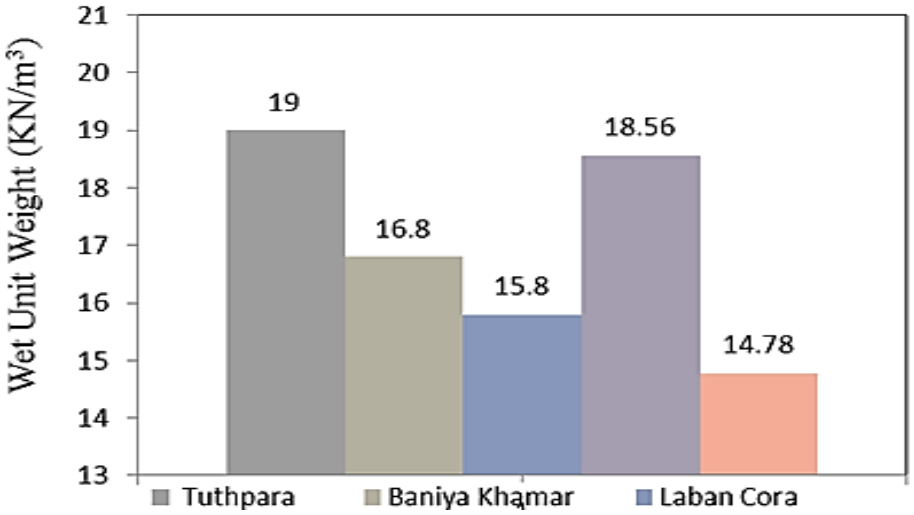

Fig. 4: *Wet Unit Weight.*

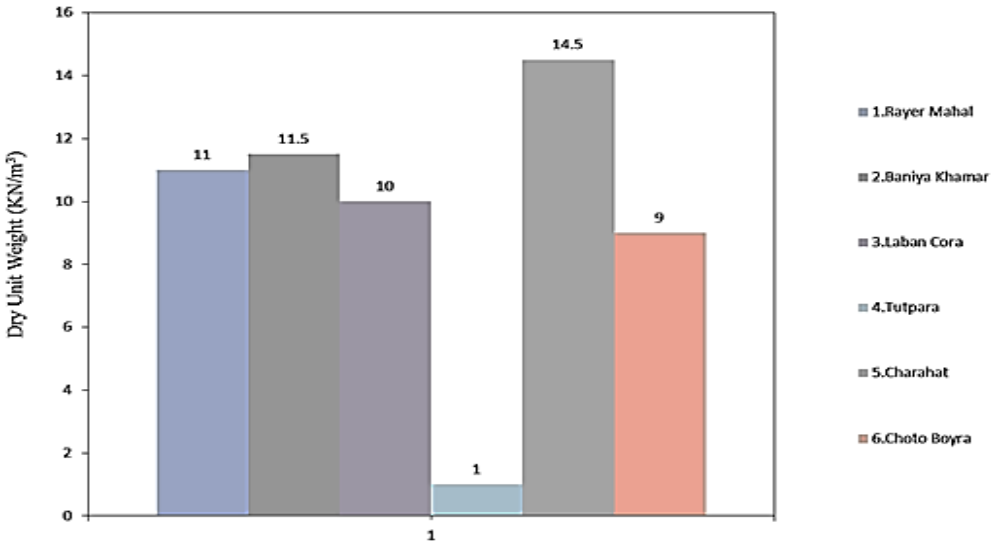

Fig. 5: *Dry Unit Weight (KN/m^3).*

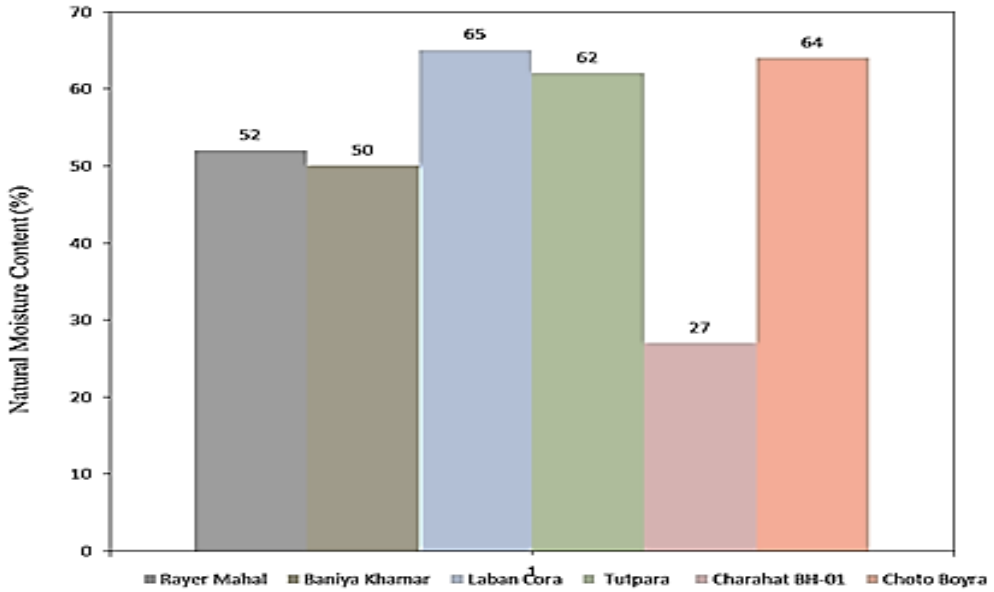

Fig. 6: *Natural Moisture Content.*

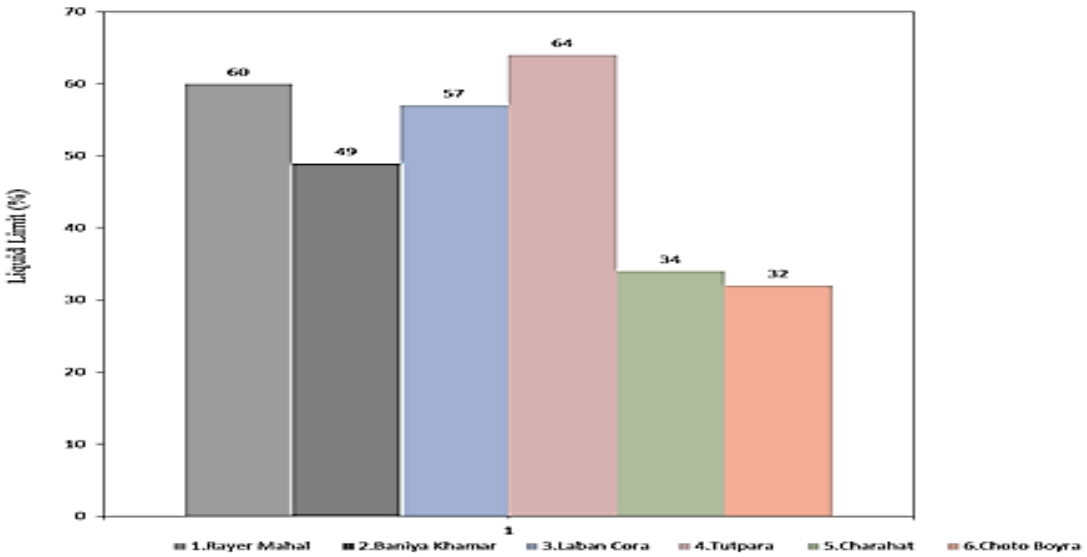

Fig. 7: *Liquid Limit.*

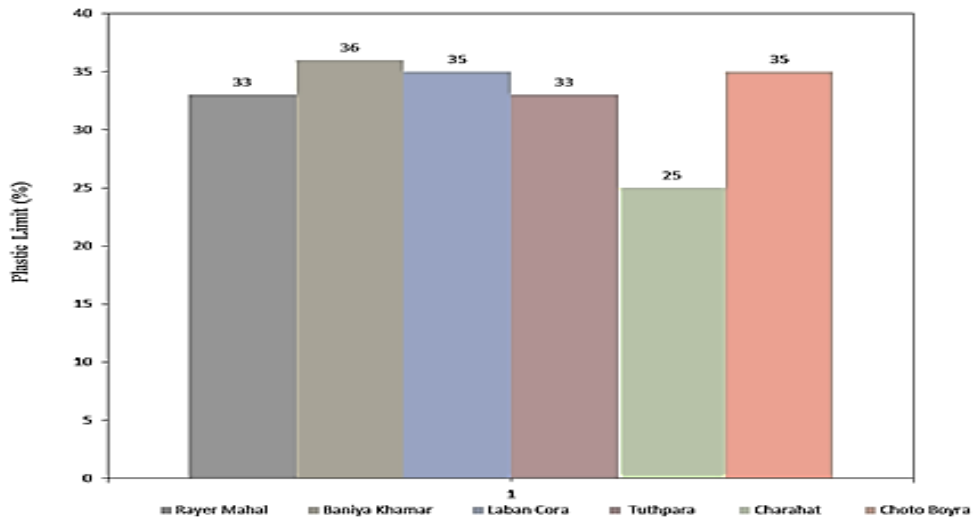

Fig. 8: *Plastic Limit.*

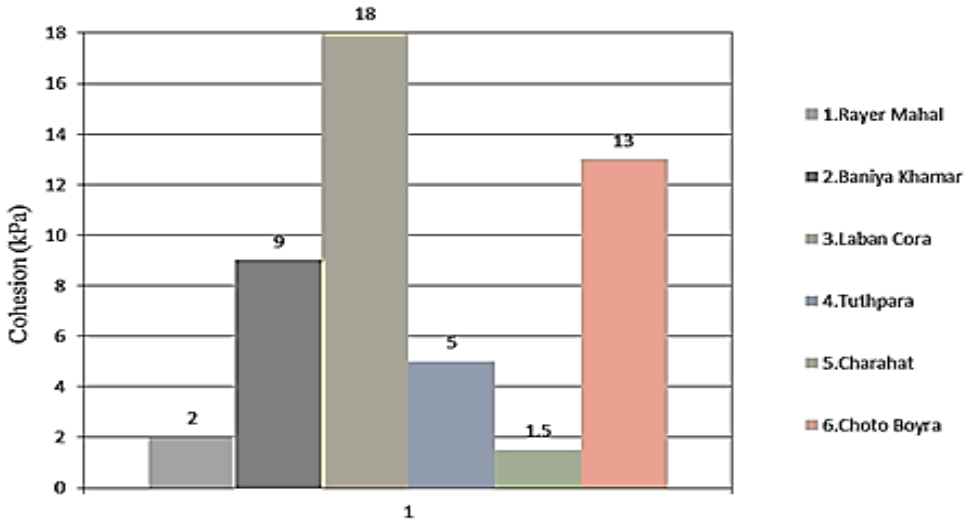

Fig. 9: *Cohesion (Kpa).*

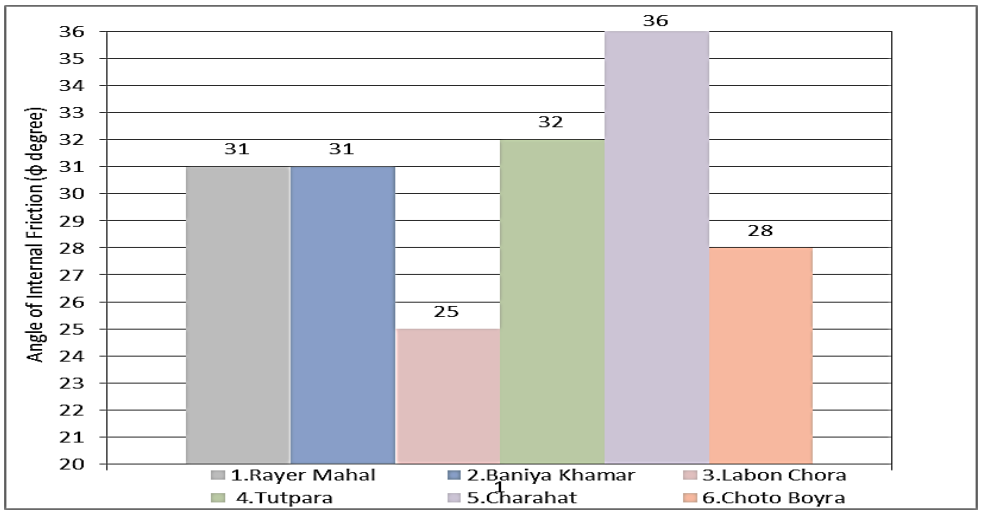

Fig. 10: *Angle of Internal Friction.*

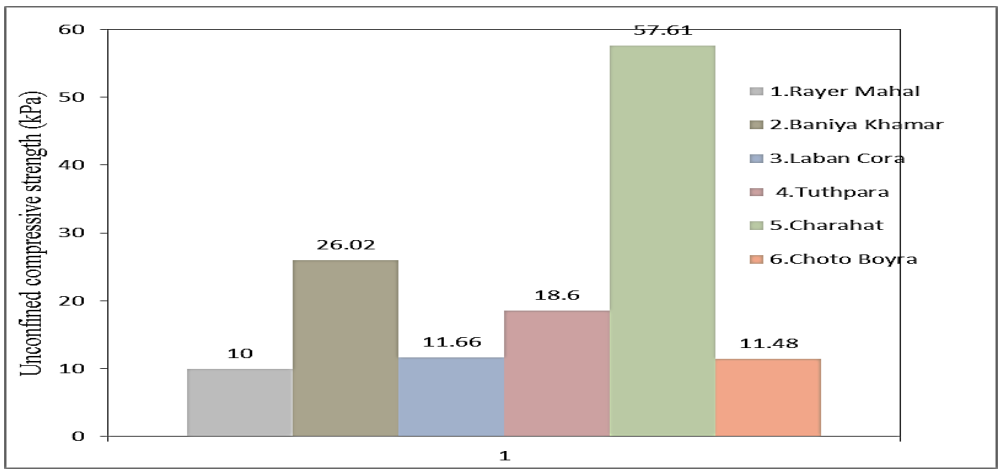

Fig. 11: *Unconfined Compression Strength (UCS).*

RESULTS AND DISCUSSION

Based on the field and laboratory tests [1, 7, 8] results summarization are given below,

Table 2: *Summary of Laboratory Test Results.*

Characteristic	**Result**
Liquid Limit (%)	32-64
Plastic Limit (%)	25-36
Specific Gravity	2.52-2.72
Unconfined Compressive strength (UCS), qu (KPa)	10-57.61
Cohesion, C (KPa)	2-18
Angle of Internal Friction, (degree)	36-25

Table 3: *Encountered Material up to 50.0 m Depth below Existing Ground Level.*

Depth (m)	**Soil description**
0.0 to 10.0	Clayey SILT/ silty CLAY
10.0 to 22.0	Clayey SILT/ silty CLAY with trace sand
22.0 to 30.0	Clayey SILT with locally sand pockets.
30.0 to 50.0	Silty SAND/ SAND with trace SILT/ SAND with locally silt pockets.

The results shows materials are SILT or CLAY and there after silty SAND which represents severe for shallow foundation without treatment [8, 9].

CONCLUSION

The investigation represents of geologic materials and GW within the projects site for use in foundation and excavation design. This investigation is to assess the stability of the site in general and the influence of the construction works, and to provide the design engineers with the required measures to enhance the stability and safety of the site and the design of the foundation.

Considering the factors of geotechnical parameters for design of structural foundations this zone is rated as severe for shallow foundations without replaced the existing soil by well graded sandy material and further compaction. It represents from the investigation that the deep foundation is necessary with sufficient pile length (>35 m) is required to resist heavy structural loads as upper layer is very soft/soft silty/clayey material. For deep excavation lateral side support and dewatering is necessary as ground water table is near to existing ground level sometimes (rainy season/flooding time) above existing ground level. Efficient surface drainage is necessary for both during and after construction. Surface water should be diverted away from the edges of the excavation of building structure.

ACKNOWLEDGEMENT

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