

Geotechnical properties of some tidal flat sediments of Khor-Abdullah coast, southern Iraq

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Abstract - This research involves geotechnical studies for some tidal flat sediments of Khor-Abdulla coast in the southern Basra city. This area has an important strategic location in future, the Iraqi Government intending to establish large engineering projects such as a big Basrah port. Sediment samples have been taken at a depth of 1.25 m to study the physical, chemical, and engineering properties of this region's sediment. The investigation results reveal that its average high natural moisture was 37.5 %, Liquid Limit *LL* 45.5 %, Plastic Limit *PL* 26.5 %, Plasticity Index *PI* 19%. Hence, these sediments show high clay percentages (85-65%). It can be classified as Silty Clay sediments with low plasticity. Engineering tests resulted in average Compression Strength of 206 kN/m², Max. dry density 1.63 g/cm³ while consolidation coefficient 0.15 m²/year, consolidation index (0.28) with initial consolidation 35.5 kN/m², and swelling index 0.071. These factors indicate a weak sediment with low plasticity. Chemical tests results reveal high concentrations of sulfates chlorides, and organic matters. TDS were 30666 mg/l, CaCO₃ 41 mg/l, sulfate 2987 mg/l, Mg 600 mg/l, Ca 46.6 mg/l, and chlorides 1334.2 mg/l. while EC 44.5 mmhos/cm, pH 7.7.

Introduction

Khor Abdullah is considered as an important funnel shape water intake in south Iraq. This Khor lies between Shatt Al-Arab estuary and Bubian Island at the head of the Arabian Gulf (Fig.1). It represents an interface between Mesopotamian basin and Bubian Island. It links Khor Al-Zubair and the Arabian Gulf. This region is located within intertidal flat which is continuously submerged during flood periods, and then appearing at ebb periods (Fig. 2). Hence, it is subjected to a continuous deposition and erosion processes. The investigated area is influenced by the delta of Shatt Al-Arab River which is considered as essential source of fine grains (Khalaf and Ala, 1980; Darmonoian and Lindrist, 1988 in Al-Badran, 1993). However, the sedimentation processes are influenced by the supplies of Shatt Al-Arab river and tidal current of Khor Abdullah channel (Al-Badran, 1993).

It is also, an important navigational channel linking Iraq with neighboring countries. So, it demands exploiting this coastal region and establish a large engineering structures such as Big Basrah port. So, these big projects need wide investigation of the port area and the neighboring lands. This research involves geotechnical studies of some tidal flat sediments.

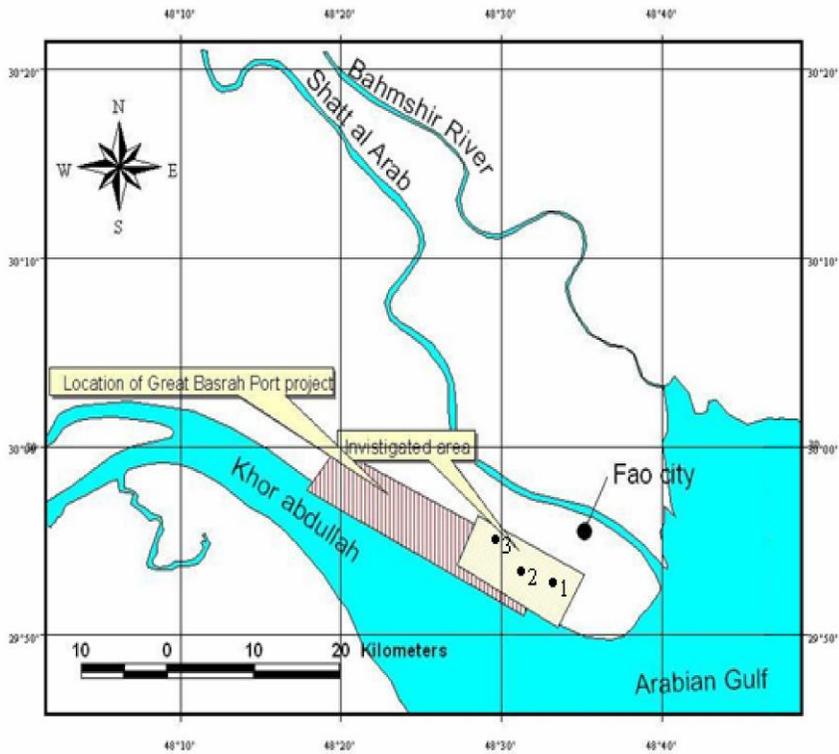


Figure 1. map of Khor Abdullah Coast (south of Basrah) and location of investigated area.

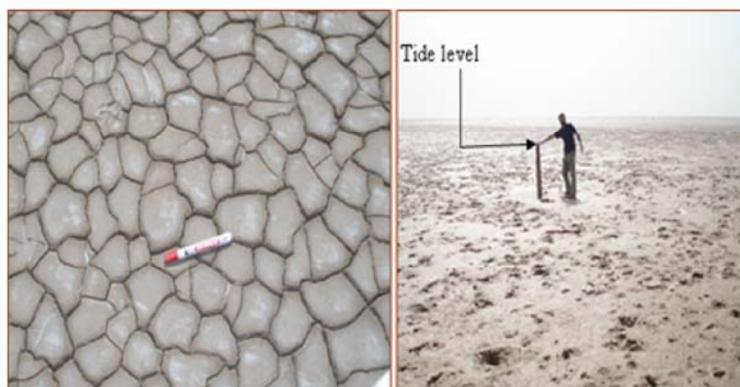


Figure 2. Shows photos of two sites of sampling, in which observe Clay sediment with high salts concentrations (left photos) , and level of tidal water is reach (right photo).

Sampling Method and Testing

Sediment samples were taken from three dug boreholes (1.25 m) depth distributed over a wide area (48 km²). Undisturbed samples were collected using Shelby tube (100mm in diameter). All sediment samples were taken during the ebb periods. While disturbed samples were taken at close to the Boreholes. Tests were carried out according to British Standard (BS) 1377, 1990. Sediment engineering properties were done in the sediment mechanics laboratory, at engineering college and engineering geology lab. at Marine Science Center in university of Basrah. For chemical analysis of these sediments are carried out in the analytical Chemistry Lab. in Marine Science Center. Analytical Standard methods of (APHA, 1992) is used to analyze Mg, Ca, So₄, ES, TDS, CL and HCO₃ while (Page, 1982) is used to CaCo₃ analysis.

Results and Discussion

Physical and engineering properties tests are conducted on these collected sediment samples, which include natural water contents, Atterberg limits, grain size distribution (Fig.3), (Table 1 and 2).

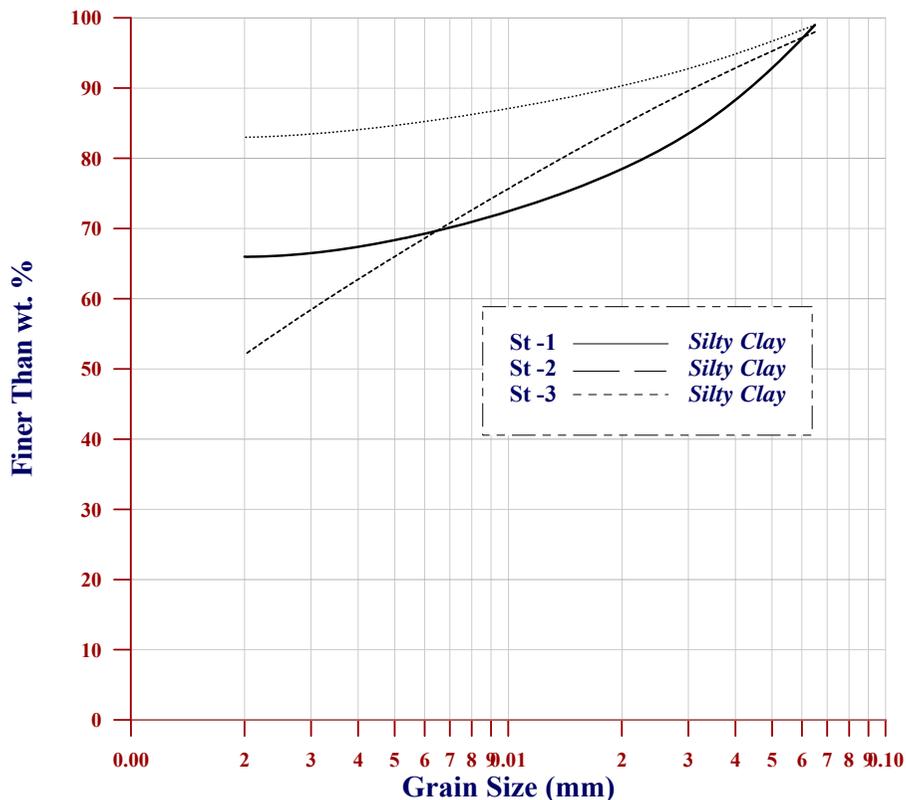


Figure 3. Grain size distribution results of three samples of study area.

Table 1. Atterberg Limits of samples

Sample	Wn%	PL	LL	PI	LI
1.	35	27	46	19	0.421
2.	33	26	47	21	0.33
3.	32	27	44	17	0.29

Table 2. Values of unconfined Compression strength.

Sample	Unconfined Compression strength (σ) KN/m²
1	128.6
2	284.3
3	278.3

The tests results reveal Silty Clay sediments with high percentages of clays (65-85%), which may be termed Clay tidal flat deposits (wasil, 2003). Natural water contents, liquid limits, plastic limits, plasticity index, liquidity index are shown in Table (1). The indices values are very important to assess and classify accordingly. So, if sediment has a liquidity index less than zero sediment may be fractured when subjected to shear force. But, when liquidity index greater than zero and less than one. These kind of sediment will behave plastically. But, when sediment has liquidity index greater than one, this sediment will behave viscously when sheared. (Akawwi, 2002).

The results above were plotted on A-line plasticity chart (Fig-4) shows that these sediments lie above and close to A-line of Clay of low plasticity.

Table (2) shows the average tests results values of unconfined compression strength with an average value (206) kN/m². Figure (5) shows the average max. dry density was 1.63 gm/cm³ with optimum moisture content was 20.8%.

Traditional consolidation tests using Oedometer cell (consolidometer) were performed on the two sediment samples from borholes (1 , 2) according to (ASTM D2435-70).Table (3) shows the computed results using the casagrande methods ($e \log \sigma$) to estimate pre-consolidation pressure (30.9, 30.8 kN/m²) for St1, St2 respectively, became this factor describe the stress history for cohesive sediment (Senol, 2002). Test results reveal that coefficient of consolidation C_v values ranged between (0.13-0.17 m²/y). While consolidation index C_c vales varies between (0.146-0.425). These factors are very important indices to assess the ability of the clay sediment and predict their consolidation settlement.

Table (4) refers to tests results of salt sediments of the studied area which is effected by seawater to the polluted zone of the clay tidal flat. TDS concentrations ranged between (2677.2-3297 mg/l), where calcium carbonate (36.3-45.45 mg/l) which cause a reduction in the index properties of these studied sediments, but on the other side they help to aggregate sediment grains, hence improving shearing resistance (Daham, 2001). Meanwhile these dissolved salts may influence the coefficient is noted by (Al-Amari, 2006). The tests results also reveal that these sediments have high concentrations of sulfates (2677.2-3297 mg/l), and also high concentrations lead to corrode the concrete foundations.

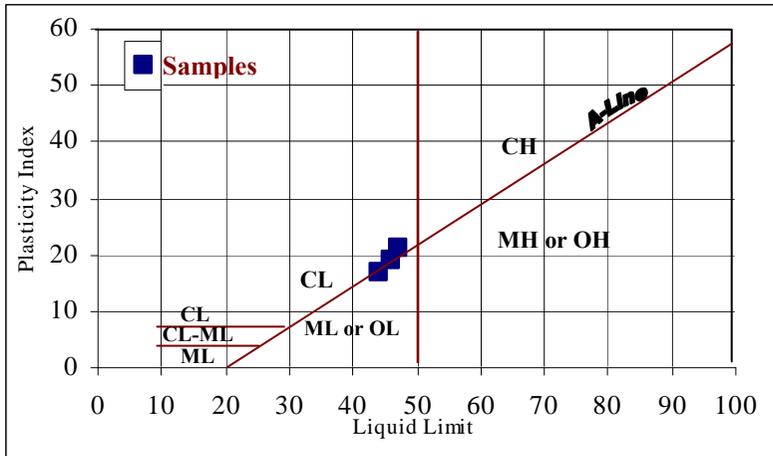


Figure 4. Plasticity chart.

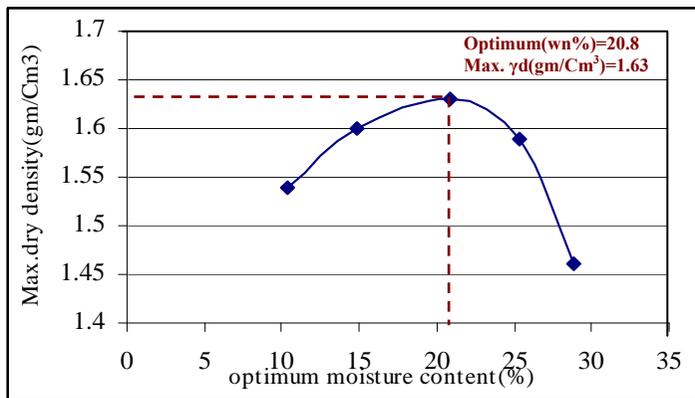


Figure 5. Compaction curve of investigated zone.

Table 3. Results analysis of Consolidation Parameters of study area.

Sample	Cons. Coeff.Cv $m^2/y.$	Cons. Index Cc	Swelling Index Cs	Pre-Con. Pc kN/m ²	Void ratio e _o	Compressibility m _v m ² /kN x10 ⁻³
1	0.1307	0.146	0.0365	30.9	0.888	7.05
2	0.169	0.425	0.106	39.8	0.481	0.873

Table 4. Results of chemicals analysis of investigated area.

According to	Page(1982)	APHA (1992)						
Samples	CaCo ₃ (mg/l)	Mg (mg/l)	Ca (mg/l)	So ₄ (mg/l)	ES (ms/cm)	TDS (mg/l)	Cl (mg/l)	HCO ₃ (mg/l)
St-1	36.36	528	360	2809.22	37.6	24064	1340	305
St-2	43.18	480	200	2677.26	36.2	23168	1136	183
St-3	45.45	792	480	3297	59.7	38208	1526.5	366

Conclusions

From this investigation several conclusions can be drawn, these are:

1. The studied sediments are classified as silty clay sediments with high percentage of clay (65-85%), and also with a high natural moisture contents.
2. Unconfined compression tests reveal low to medium bearing capacity sediments.
3. Their max. Dry densities were low, so they need to be stabilized or reinforced when starting to construct big establishments.
4. These types of sediments are liable to settlement and consolidation.
5. These studied sediments have high concentrations of salt ions and effected by seawater of khor-Abdullah channel.
6. High percentages of calcium carbonate will lower the sediment index properties, which lead to aggregate the grains of these sediments.
7. High contents of sulfates and chlorides enhance the corrosion of the concrete foundations.
8. The study indices that these kinds of sediments should be reinforced by the traditional means such as piles or other new methods.

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الخصائص الجيوتكنيكية لترب المسطحات المدية لنطاق ساحل خور عبد الله جنوب البصرة، العراق

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المستخلص يتضمن البحث دراسة جيوتقنية لبعض المسطحات المدية لنطاق ساحل خور عبد الله جنوب البصرة. يعد منطقة استراتيجة من المتوقع اقامة مشاريع هندسية كبيرة، لاسيما مشروع البصرة الكبير في المستقبل القريب. بينت الفحوصات الفيزيائية والهندسية والكيميائية والمستحصلة في العديد من نماذج الترب وباعماق 1.25 متر ومن مواقع متباعدة. دلت نتائج هذه الترب بأن محتواها الرطوبي الطبيعي عال (37.5 %)، وحد سيولة (15.5 %)، وحد لدونة (26.5 %)، ودليل لدونة (19 %)، واحتوت نسب عالية من الطين (65-85) % صنفت بأنها ذات اللدونة الواطنة. اما نتائج الفحوصات الهندسية ظهر ان معدل مقاومة الانضغاط (206) كيلونيوتن/م²، وبمعدل كثافة جافة عظمى (1.63) غرام/سم³ مقابل افضل محتوى رطوبي (20.8). في حين كان معامل الانضمام (0.15) م²/سنة ودليل الانضمام (0.28)، بينما كان الانضمام الاولي (35.5) كيلونيوتن/م² ودليل انتفاخ (0.071). وجميعها تشير بأنها تربة ضعيفة قابلة للهبوط. أظهرت التحليلات الكيميائية تراكيز عالية من الكبريتات والكلوريدات. حيث بلغت الاملاح الكلية المذابة (30688) ملغم/لتر، والمغنسيوم (600)، والكالسيوم (46.6)، أما الكلوريدات فكانت (1334.2) ملغم/لتر. في حين كانت التوصيلية الكهربائية (44.5) مليسمنز/سم، وتراكيز الاس الهيدروجيني (7.7). جميع هذه العوامل تشير بأن هذه الترب عالية الملوحة متأثرة بالمد البحري.