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Geotechnical properties for sediment of Tigris River reach banks within Tikrit town/ Iraq

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ABSTRACT

The geotechnical, engineering and chemical properties of the sediments of river terraces on the right bank and flood plain on the left bank of Tigris river. The physical tests include (specific gravity, absorption%, moisture content %, atterberge limits, grain size analysis) showed that the dominant component of soil is (gravel) with varied amount of fine components, the engineering tests include direct shear test, CBR, and point load test, while the chemical analyses include gypsum%, T.D.S% and O.M% showed increase in gypsum% and T.S.S% in right bank and increase of O.M%, and decrease of the three ratios in the left bank because the leaching of the sediments. The geotechnical study showed many engineering problems occurs in engineering establishments specially in the river terraces because the high ratios of gypsum and T.S.S.

Introduction

The nature and composition of the land in general and the soil in particular influenced such as porosity of soil, soil texture and soil consistency and soil type such as gravel, sand, silt or clay [1]. The river banks is a important location for the Construction of facilities after the geotechnical assessment of the soil and the river banks geotechnical assessment is a very important factor in determining the validity of the banks to set up facilities on them as the study of these characteristics is very important in determining the validity of banks to set up facilities on them as the study of this is important In the rehabilitation of tourism and river transport. The study area is located in the city of Tikrit within the coordinates (375130-385092) to the east and (3826080-3839806) to the north in fig.(1), as the right bank of the study area includes the city of Tikrit and the left bank includes the Al-Alam area. The important previous studies of the area included the study by [2] studied the sedimentary and mineral properties of the Quaternary sediments on the right side. [3] Studied the geographical assessment of tourism potential in the Salah al-Din Governorate. The sedimentation of the area covered by the Quaternary sediment, which is the flood plain on the left side of the Holocene sediments and the sediments of the River Terraces on the right bank of the Pleistocene period [4]. The study aims to study the physical and mechanical properties for the deposits of the banks of the Tigris River for the purpose of tourism rehabilitation and river transport.

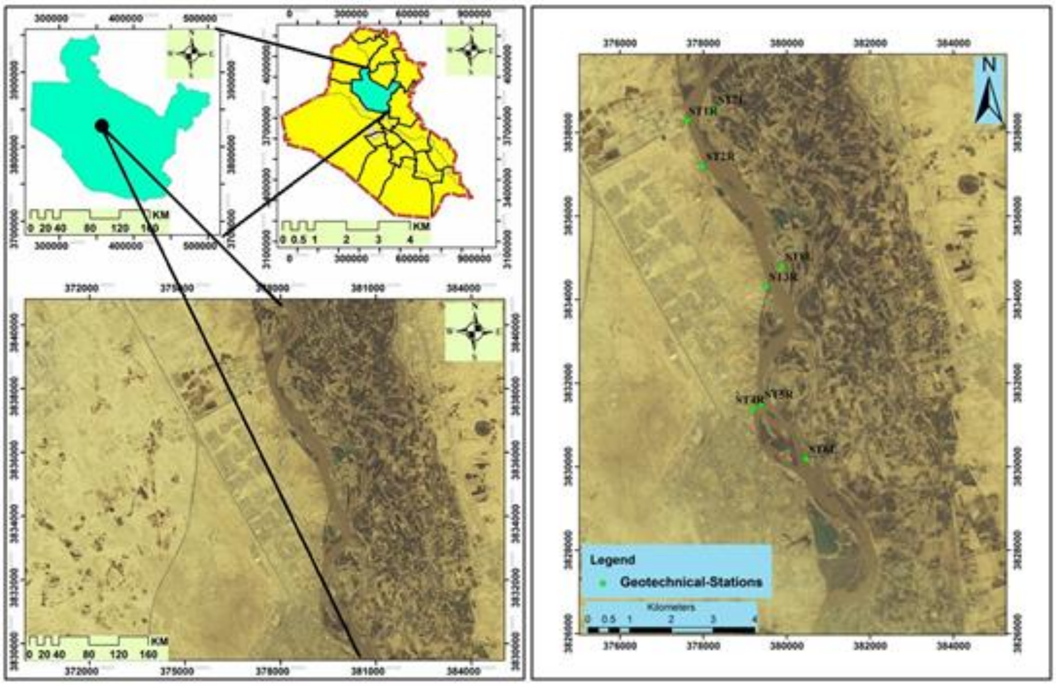

Fig. 1: Location map of the study area

Methodology

Primary stage includes collecting information about the study area by the image data and the maps of the area. Fieldwork included collection of the samples from right side of the river (right bank: ST1R, ST2R, ST3R, ST4R, ST5R) represent Tigris river terraces from five stations represented by eight sample distributed along Tigris river terraces, where one sample was taken for each lithological change and three stations representable by five sample from the left side of the river (the left bank: ST6L, ST7L, ST8L) along the rivers flood plain, which are sandy gravel deposits. The laboratory work stage included physical, mechanical and chemical tests on the samples selected from the study area and the most important of these tests:

Physical tests included:

- Moisture Content [5].
- Specific Gravity Test]6].
- Grain size analysis [7] [8].
- Consistency Limits or Atterburg Limits [9].

Mechanical tests

- Compaction Test [10].
- California Bearing Ratio (CBR) [11].
- Point Load Test [12].
- Direct Shear Test for soil [13].

Chemical tests: [14]

Office stage:

The work stage of the office include that the calculations and analysis of properties and using the program Excel 2010 for calculation.

Results and Discussion

Moisture content

The moisture content values of the samples ranged between (0.3451-3.4635) the minimum moisture content in ST4R No.1 sample because was far the banks. The highest value of moisture content in ST5R No.1 sample that was channel sample in table (1).

Specific Gravity

As in the table (1) the results of the specific gravity for the fine soil and the table (2) the results of Relative density (specific gravity) (OD), Relative density (specific gravity)(SSD), Apparent Relative density (specific gravity) and Absorption (Ab) is depended on mineralogy of the soil and absorption ratio The origin from which the gravel is formed in whether it is sedimentary, Igneous, Metamorphic rocks and the void ratio in the gravel.

Table 1: The moisture content and the Specific Gravity.

Location	Depth (m)	Moisture content%	Specific Gravity
ST1R No.1	2.5	1.6559	2.726
ST1R No.2	1.75	0.5353	2.722
ST2R No.1	1.20	0.5723	2.697
ST2R No.2	2.20	0.7619	2.697
ST2R No.3	5	0.7685	2.705
ST3R No.1	10	0.4391	2.691
ST4R No.1	6	0.3451	2.687
ST5R No.1	Channel	3.4635	2.701
ST6L No.1	0.75	3.3639	2.733
ST7L No.1	0.75	1.3329	2.671
ST8L No.1	1	1.6241	2.761
ST8L No.2	3	2.0357	2.687
ST8L No.3	2.70	2.1746	2.697
ST=station L=Left R= Right			

Table (2) shows the results of the Specific Gravity of soil and the rate of absorption of coarse soil in the study area.

Location	Depth (m)	OD	SSD	Sa	Ab %
ST1R No.2	1.75	2.383	2.438	2.517	2.196
ST2R No.1	1.20	2.471	2.519	2.593	1.891
ST2R No.3	5	2.511	2.542	2.591	1.228
ST3R No.1	10	2.419	2.486	2.590	2.726
ST4R No.1	6	2.364	2.451	2.588	3.656
ST5R No.1	Channel	2.447	2.463	2.488	0.671
ST6L No.1	0.75	2.389	2.414	2.450	1.034
ST7L No.1	0.75	2.469	2.493	2.528	0.929
ST8L No.2	3	2.475	2.498	2.532	0.905
ST8L No.3	2.70	2.424	2.439	2.460	0.616

Sieving Analysis

The result of sieving analysis illustrated in fig.(2),(3),(4),(5),(6),(7),(8),(9),(10),(11),(12),(13) and (14) while the component of each station and type soil illustrated in table (3).

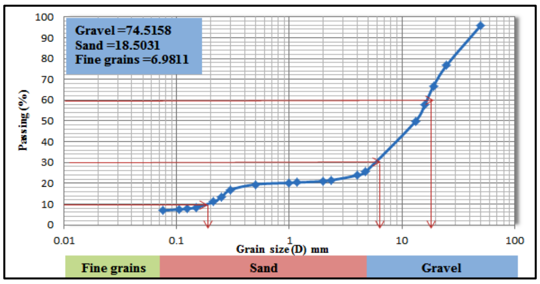

Fig. 2: Grain size analysis for soil in ST1R No.1

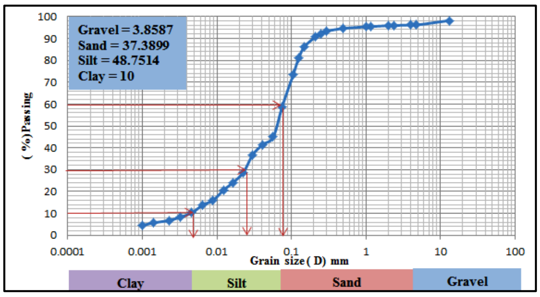

Fig. 3: Grain size analysis for soil in ST1R No.2

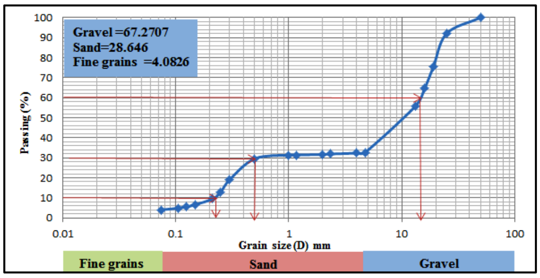

Fig. 4: Grain size analysis for soil in ST2R No.1

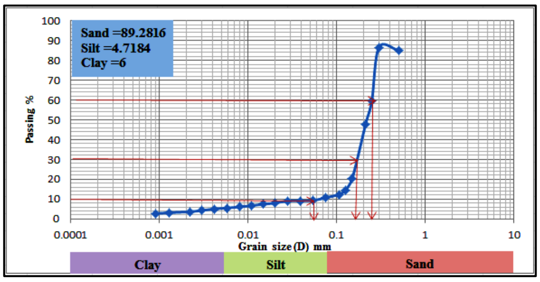

Fig. 5: Grain size analysis for soil in ST2R No.2

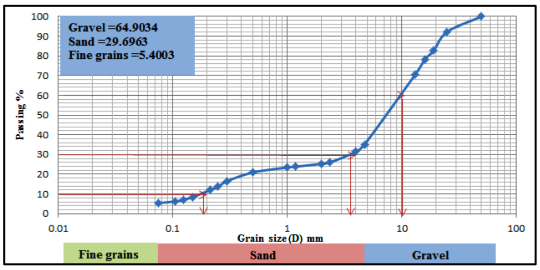

Fig. 6: Grain size analysis for soil in ST2R No.3

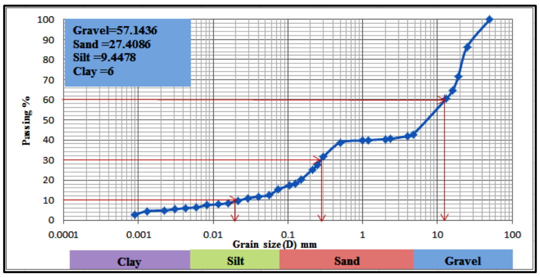

Fig. 7: Grain size analysis for soil in ST3R No.1

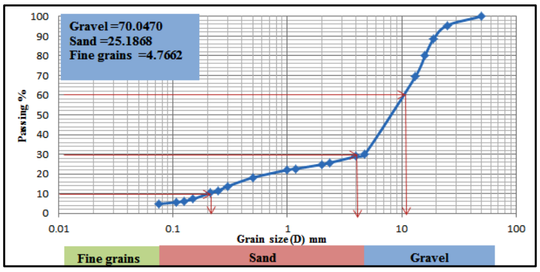

Fig. 8: Grain size analysis for soil in ST4R No.1

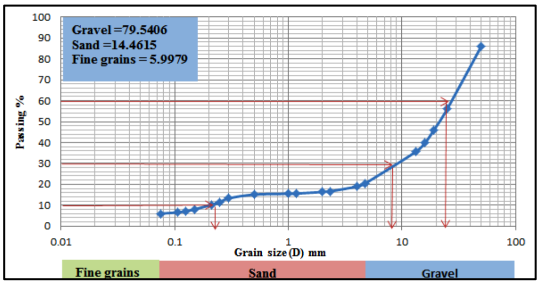

Fig. 9: Grain size analysis for soil in ST5R No.1

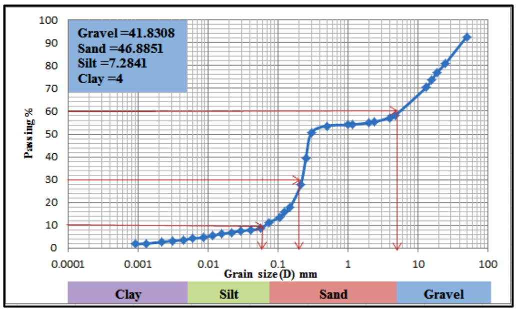

Fig. 10: Grain size analysis for soil in ST6L No.1

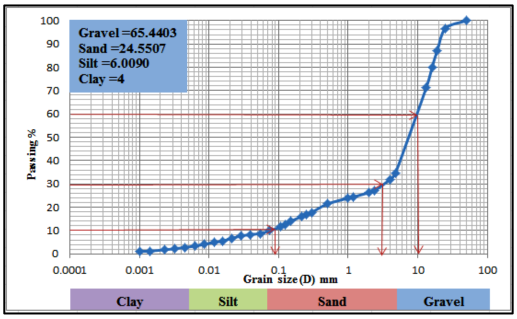

Fig.11: Grain size analysis for soil in ST7L No.1

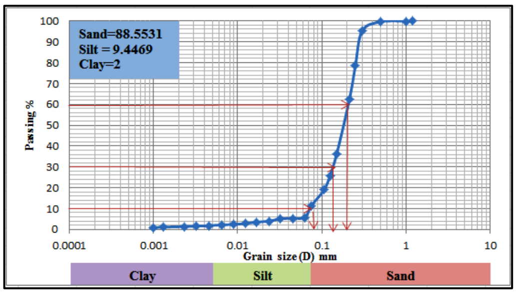

Fig. 12: Grain size analysis for soil in ST8L No.1

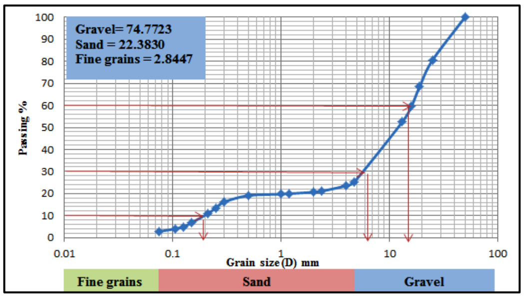

Fig. 13: Grain size analysis for soil in ST8L No.2

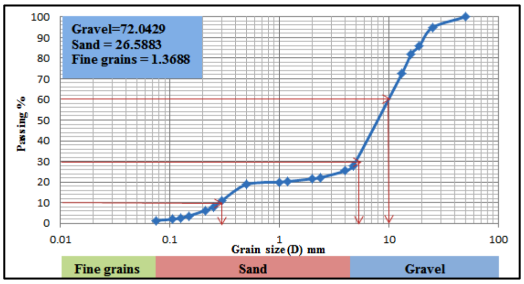

Fig. 14: Grain size analysis for soil in ST8L No.3

Atterberg Limits

Both the liquid limit (L.L) and the plastic limit (P.L) were measured for fine sediment. The tests were measured for samples (ST1R No.1, ST1R No.2, ST2R No.3, ST7L No.1) fig.(15),(16),(17) and (18). The highest plasticity index was obtained in ST1R No.1) with a value of (10.5889) and the lowest plasticity index in the sample (ST1R No.2) and value (1.4867) as table (3) and by comparing the values of the plasticity index of the samples with the table (4), it was shown that the sample are all within the silty plasticity type low plasticity (ML) of the fig. (19) for fine sediment .from the test the samples are gravel within silty fine grains.

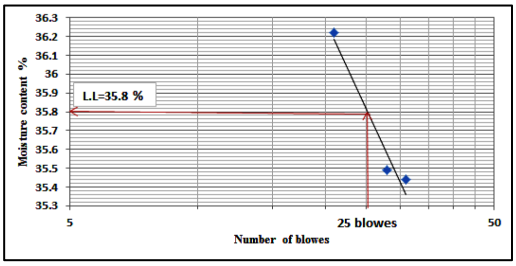

Fig. 15: liquid limit for fine soil in ST1R No.1

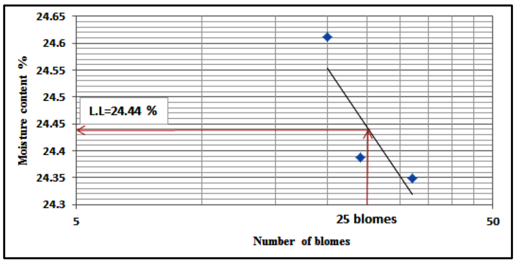

Fig. 16: liquid limit for fine soil in ST1R No.2

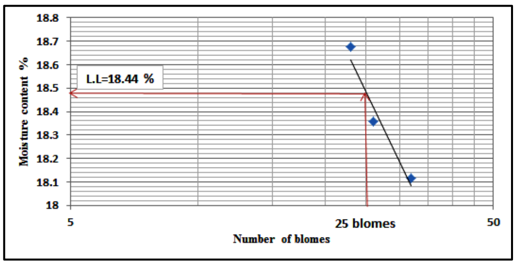

Fig. 17: liquid limit for fine soil ST2R No.3

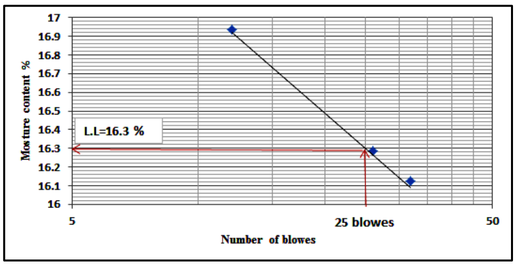

Fig. 18: liquid limit for fine soil ST7R No.1

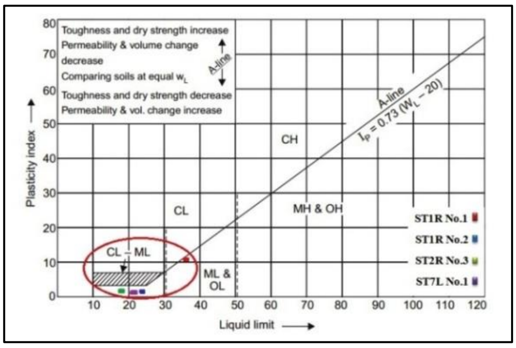

Fig. 19: classification of fine soil according Atterberg limits

Table 3: classification of soil according to USCS

Station	Depth (m)	gravel (%)	sand (%)	salt (%)	clay (%)	L.L	P.L	P.I	Unified classification
ST1R No.1	2.5	3.86	37.39	48.75	10	35.8	25.21	10.59	ML
ST1R No.2	1.75	74.52	18.50	6.98	-	24.44	22.95	1.49	GP-GM
ST2R No.1	1.20	67.27	28.65	4.08	-				GP
ST2R No.2	2.20	0	89.28	4.72	6				SP-SC
ST2R No.3	5	57.14	27.41	9.45	6	18.44	15.47	2.97	GM
ST3R No.1	10	64.90	29.69	5.40	-				GP
ST4R No.1	6	70.05	25.19	4.77	-				GP
ST5R No.1	Channel	79.54	14.46	5.99	-				GP
ST6L No.1	0.75	41.83	46.89	7.28	4				SM
ST7L No.1	0.75	65.44	24.55	6.01	4	16.3	14.00	2.29	GP-GM
ST8L No.1	1	0	88.55	9.45	2				SP-SM
ST8L No.2	3	74.77	22.38	2.84	-				GP
ST8L No.3	2.70	72.04	26.59	1.37	0				GP

Table 4: classification of soil according to plasticity index [15]

Description	PI
Non plastic	0
Slightly plastic	1-5
Low plasticity	5-10
Medium plasticity	10-20
High plasticity	20-40
Very High plasticity	>40

Engineering testing of soil

Compaction Test

The Compaction Test is considered to be an important Test to finding Compaction rate in soil Depending on maximum dry density and optimum water content to access the highest density of the soil, as the Compaction rate increases with the increase of fine deposits which have a compressibility when compared to coarse deposits and the results in table (5).

Table 5: shows Compaction Test

Location	Depth (m)	maximum dry density (gm/cm^3)	optimum water content %
ST1R No.2	1.75	2.16	4.8565
ST2R No.3	5	2.1718	11.1043
ST6L No.1	0.75	2.1038	9.2078
ST7L No.1	0.75	2.36	4.8
ST8L No.1	1	1.741	12.9311

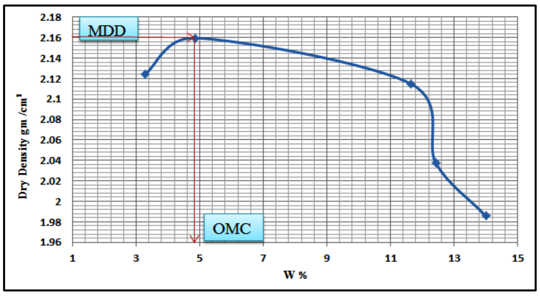

Fig. 20: Compaction test for fine soil ST1R No.2

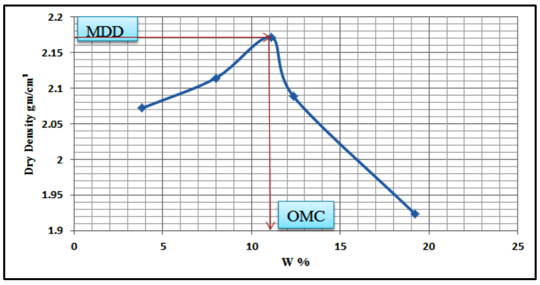

Fig. 21: Compaction test for fine soil ST2R No.3

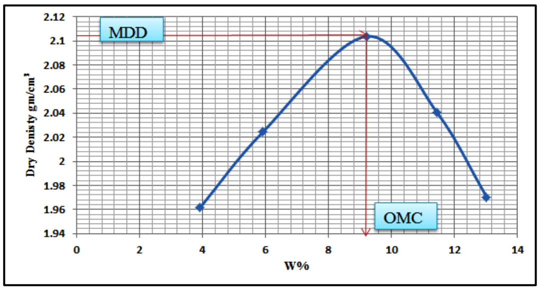

Fig. 22: Compaction test for fine soil ST6L No.1

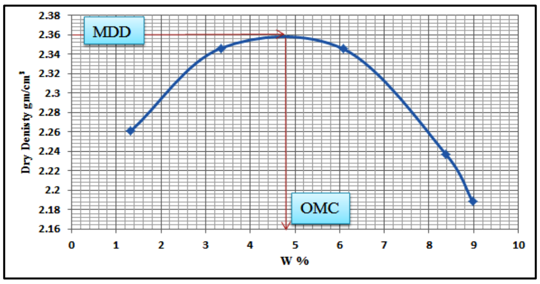

Fig. 23: Compaction test for fine soil ST7L No.1

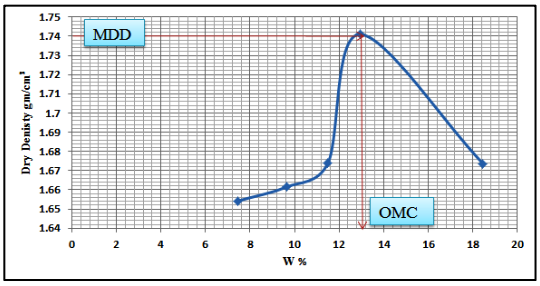

Fig. 24: Compaction Test for fine soil ST8L No.1

Californain Bearing Ratio CBR

The results of CBR were obtained for five samples of five station (ST1R No.2, ST2R No.3, ST6L No.1, ST7L No.1, ST8L No.1) fig.(25),(26),(27),(28) and (29) and Table(6)as well as measuring the percentage of swelling in table (6) and percentage of (CBR %) which depends on the maximum dry density and the optimum moisture content for each sample of soil. We see an increase in the percentage of (CBR% at 95%) with the increase of the dry density of the sample and also the swelling rate increases with mud deposits and the clay minerals which cause swelling.

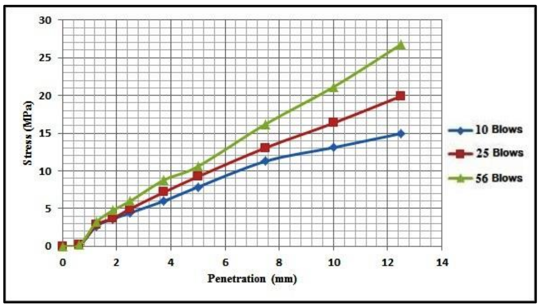

Fig. 25: CBR test for soil of ST1R No.2

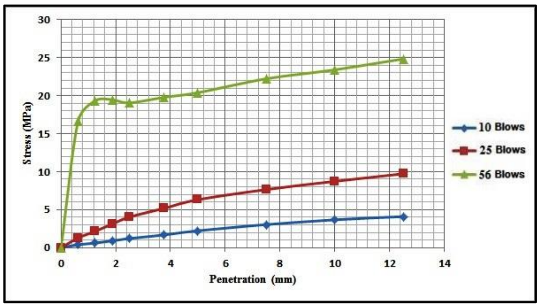

Fig. 26: CBR test for soil of ST2R No.3

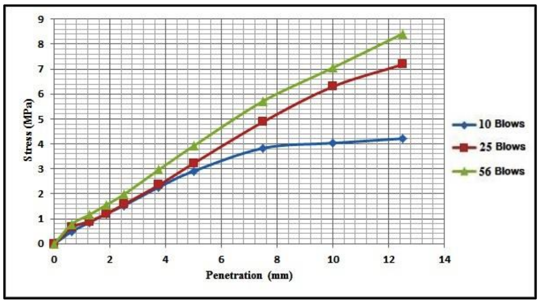

Fig. 27: CBR test for soil of ST6L No.1

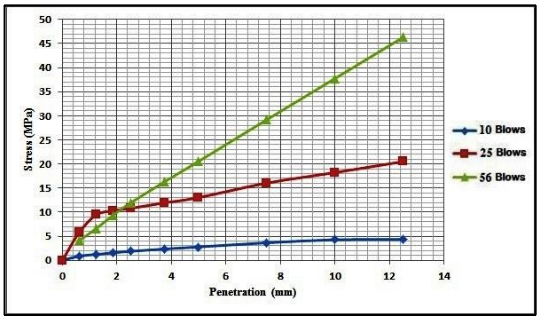

Fig. 28: CBR test for soil of ST7L No.1

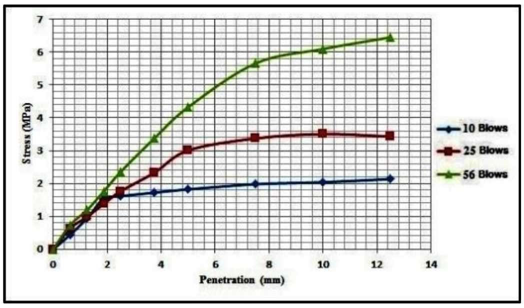

Fig. 29: CBR test for soil of ST8L No.1

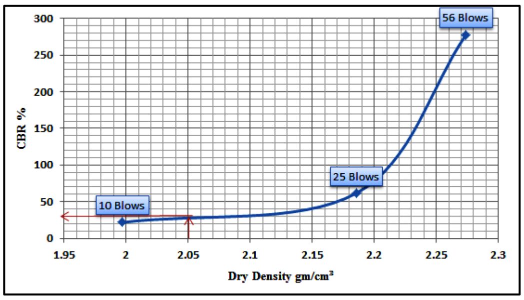

Fig. 30: CBR% for soil of ST1R No.2

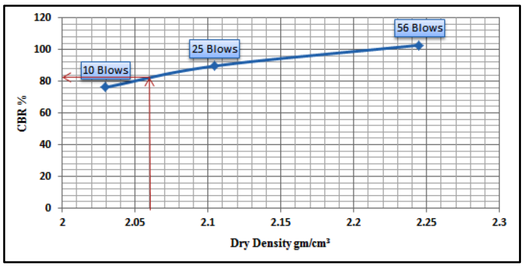

Fig. 31: CBR% for soil of ST2R No.3

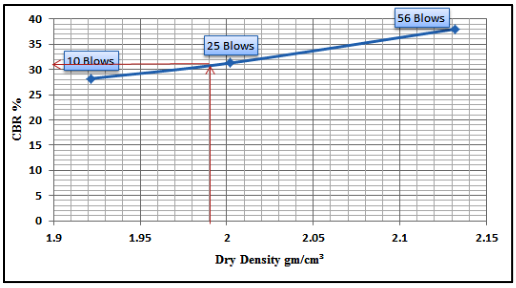

Fig. 32: CBR% soil of ST6L No.1

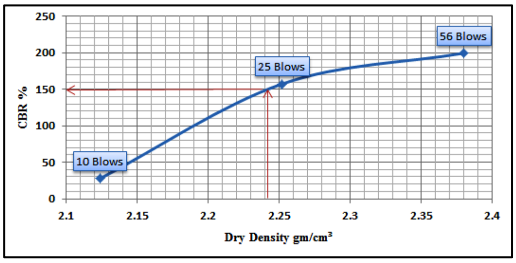

Fig. 33: CBR% for soil of ST7L No.1

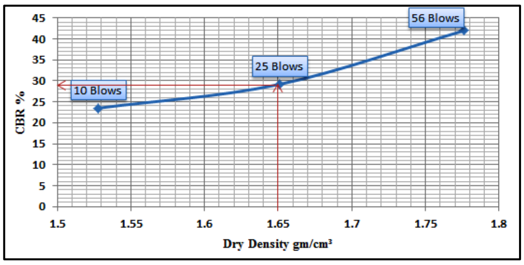

Fig. 34: CBR% soil of ST8L No.1

Table 6: shows the results of the CBR % and swelling

sample	Depth (m)	No. of lows	CBR % (2.5)	CBR % (5.0)	Dry Density 95%	CBR% 95% compaction	Swelling
ST1R No.2	1.75	10	17.7	21.7	2.052	30	0.1680
		25	58.8	61.4			0.1156
		56	277.7	198.2			0.0916
ST2R No.3	5	10	64.5	76.2	2.063	84	0.0633
		25	72.3	89.6			0.1025
		56	87.2	102.8			0.0284
ST6L No.1	0.75	10	22.3	28.2	1.999	31	0.0022
		25	23.0	31.3			0.0218
		56	28.8	38.0			0.0240
ST7L No.1	0.75	10	27.5	27.1	2.228	150	0.0218
		25	157.3	126.6			0.0218
		56	173.4	199.6			0.0218
ST8L No.1	1	10	23.5	17.7	1.654	29	0.0240
		25	25.7	29.2			0.0022
		56	39.3	42.0			0.0022

Direct Shear Test

This test is applied for soil of ST2R No.2 and ST8L No.1 were obtained for soil shear coefficients (C) (9KN / m^2) for both samples as in Figs. (35) and (36), which are affected by the roughness of the soil the increase in coarse of the soil it causes decreasing in cohesion value but in the fine soil causes increases in cohesion value. The value of internal friction angle (Ø), in (ST2R No.2) was (32°) in ST8L No.1 (26°), in table (7)

Table 7: shows the values of cohesion (c) and the internal friction angle (Ø)

Sample	Depth	C(Kpa)	Ø
ST2R No.2	2.20	9	32°
ST8L No.1	1	9	26°

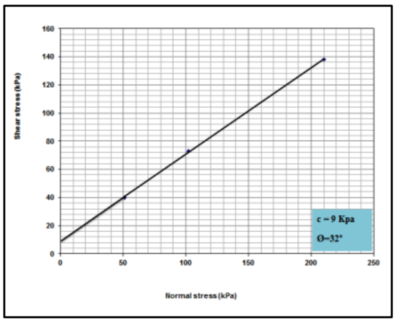

Fig. 35: Direct Shear Test for soil of ST2R No.2

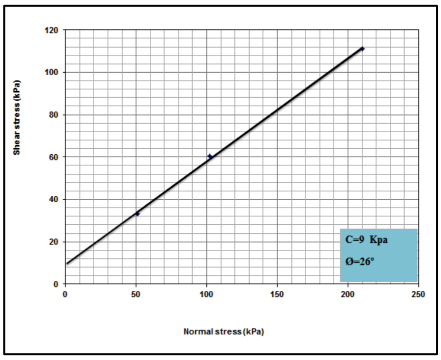

Fig. 36: Direct Shear Test for soil of ST8R No.1

Point Load Teat

It is an indirect method of measuring the uniaxial compressive strength (UCS) . Thus, UCS can be measured in Table (9), UCS is classified according to the classification in [16] table (8) .

Table 8:(UCS classification)[16]

Strength(MPa)	Term
Less than 1.25	Very weak
1.25-5.00	Weak
5.00-12.50	Moderately weak
12.50-50	Moderately strong
50-100	Strong
100-200	Very Strong
Over 200	Extremely Strong

Table 9: Results of UCS and classification according to[16].

Location	Depth (m)	UCS (Mpa)	Classification
ST1R No.2	1.75	144.84-263.71	Very Strong - Extremely Strong
ST2R No.1	1.20	68.43-247.96	Strong - Extremely Strong
ST2R No.3	5	86.90-420.04	Strong - Extremely Strong
ST3R No.1	10	20.19-317.54	Moderately strong - Extremely Strong
ST4R No.1	6	95.21-323.72	Strong - Extremely Strong
ST5R No.1	Channel	134.51-414.33	Very Strong - Extremely Strong
ST6L No.1	0.75	121.88-225.86	Very Strong - Extremely Strong
ST7L No.1	0.75	124.47-222.67	Very Strong - Extremely Strong
ST8L No.2	3	34.62-291.62	Moderately strong - Extremely Strong
ST8L No.3	2.70	103.96-199.19	Very Strong

Chemical Analysis

Chemical properties are a very important factor in knowing the chemical behavior of the soil and the range of soil capacity to the external factors affecting it, such as erosion and weathering. The results of tests in table (10).

Table (10) shows the results of Gypsum%, PH and TSS% for the sample of soil study area

Location	(m) Depth	Gypsum ratio	Classification	pH	TSS%
ST1R No.1	2.5	2.18	Very Low gypsum	8.27	4.68
ST1R No.2	1.75	1.21	Very Low gypsum	7.86	3.03
ST2R No.1	1.20	9.08	Low gypsum	8.05	15.67
ST2R No.2	2.20	1.05	Very Low gypsum	7.81	3.61
ST3R No.1	10	3.63	Low gypsum	8.21	5.11
ST4R No.1	6	13.15	Medium gypsum	8.08	19.61
ST5R No.1	Channel	1.97	Very Low gypsum	8.11	4.03
ST6L No.1	0.75	2.61	Very Low gypsum	8.01	4.11
ST7L No.1	0.75	4.82	Low gypsum	7.88	5.37
ST8L No.1	1	2.45	Very Low gypsum	8.07	3.61
ST8L No.2	3	5.02	Low gypsum	7.76	6.01
ST8L No.3	2.70	3.81	Low gypsum	7.81	5.89

Conclusions

1-The values of the specific weight of the soil under study indicate that there is a difference in values. The reason for this variation is due to the difference in the metal structure of both coarse and fine granules 2-Non-plasticity the soil is mostly coarse soil composed of gravel mixed with fine soil and in different proportions, which are poor graded soil. The optimum water content ranged from (12.9311-4.8565%).

3-The maximum dry density values ranged between 2.36-1.741gm/cm3) (CBR) (5.0) ranged between (199.6-21.7) and CBR (95%) values of dry density ranged between (% 150-29).

4-The values of swelling ranged between (0.0022-0.1680).

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الخواص الجيوتكنيكية لترسبات ضفاف قطاع نهر دجلة داخل مدينة تكريت /العراق

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الملخص

درست الخواص الجيوتكنيكية للترسبات على ضفتي النهر شملت ايجاد الخواص الفيزيائية والهندسية والكيميائية للترسبات وبواقع (8) محطات ممثلة ب (13) نموذج حيث ان ترسبات الشرفات النهرية تغطي الضفة اليمنى للنهر بينما ترسبات السهل الفيضي تغطي الضفة اليسرى للنهر وان التربة الخشنة من نوع الحصى هي السائدة مع نسب متفاوتة من الترسبات الناعمة وتم ايجاد الوزن النوعي ونسب الامتصاص للترسبات اما في ما يتعلق بالفحوصات الهندسية فشملت ايجاد نسبة التحميل الكالفورني (CBR%) وفحص القص المباشر لايجاد عوامل المقاومة القصية وفحص حمل النقطة لاستنباط قيم المقاومة الانضغاطية غير المحصورة للحصى اما بالنسبة للتحاليل الكيميائية للترسبات فلوحظ زيادة في نسب الجبس والاملاح الكلية الذائبة في ترسبات الضفة اليمنى وقلتها في الضفة اليسرى وزيادة المواد العضوية في الضفة اليسرى ومن خلال الخواص الجيوتكنيكية للترسبات على الضفتي النهر تبين ان ترسبات الشرفة النهرية بحاجة الى معالجة عند اقامة المنشأت الهندسية عليها لاحتوائها على نسب عالية من الجبس والاملاح الكلية الذائبة.