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Study of Geotechnical Characteristics for the Deposits of the Samarra Dam Reservoir and the Upper Tigris Tharthar Arm Area and Their Engineering Suitability

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ABSTRACT

The research included finding the geotechnical properties of the Samarra Dam Reservoir sediments in three locations and the Tharthar Depression sediments in four locations. Physical tests showed that the moisture content of the sediments varies according to the flood and drought seasons. The moisture content was studied during August in the year 2023 and the month of January in the year 2024, and the results showed a clear difference. Between the months, the moisture content (wc%) value in August was (11%_5%), and in January the moisture content (wc%) was (40%_26.2%). While it appears from the results of the specific gravity (G.S.) that it ranges (2.62_2.7), the results of the volumetric analysis showed that the predominant percentage of the deposits of the study area is sand, ranging from (40%_60%), which is mostly sand deposits mixed with silt, with varying percentages of clay. From the plasticity limits, the results showed the liquidity limit L.L (19.1%_24.79%), the plasticity limit P.L (11.22%-14.99%), and the plasticity coefficient P.I (5.83%-9.8%). The plasticity diagram revealed the quality of the ML-type sediments. The mechanical tests conducted for the sediments were direct shear tests where values were: Cohesion (C) (0_4) and internal friction angle values (Ø) (36^0_46^0), and from the standard compaction test (Proctor) it was revealed that the value of the optimum water content (OMC) (9%_17%) and the values of dry density (MDD)) (1.46_1.61). Chemical tests showed that the deposits are basic with low organic content and contain gypsum and chlorides at levels exceeding 1%, which leads to negative effects such as corrosion, cracking, and moderate effects from sulfates. However, caution is required regarding corrosion and cracking. The deposits also contain sulfates and soluble salts in moderate amounts, but attention should be paid to avoid corrosion and cracking. These deposits are of the type transported by water, which has led to changes in their engineering properties. Mineralogical study showed that the deposits in the study area, especially in the Samarra Dam reservoir, contain a high proportion of quartz and carbonate minerals and lack clay minerals. This is due to the fact that the predominant proportion of the deposits is sand, which gradually increases in clay minerals from the entrance of the Tharthar regulator to the end of the Tharthar Channel, but their proportion remains relatively small. But their percentage remains somewhat small. It cannot be used in construction industries such as brick and ceramic manufacturing, and the reason is that most of the sediments in the study area are sandy. It can be used in the manufacture of filters to purify the river stream of sewage waste, as well as in concrete mixes. It can also be used in the manufacture of sand bricks after treating them with certain proportions of limestone, and it is also used for agricultural purposes.

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دراسة الخصائص الجيوتقنية لرواسب خزان سد سامراء ومنطقة أعالي ذراع دجلة الثرثار ومدى صلاحيتها للأغراض الهندسية

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الملخص

تضمن البحث دراسة الخصائص الجيوتقنية لرواسب خزان سد سامراء في ثلاثة مواقع ورواسب منخفض الثرثار في أربعة مواقع. أظهرت الاختبارات الفيزيائية أن محتوى الرطوبة في الرواسب يختلف وفقًا لفصول الفيضانات والجفاف. تمت دراسة محتوى الرطوبة خلال شهر أغسطس من عام 2023 وشهر يناير من عام 2024، وأظهرت النتائج اختلافًا واضحًا بين الشهرين. حيث كانت قيمة محتوى الرطوبة (Wc%) في أغسطس تتراوح مابين (11%_5%)، بينما كانت في يناير تتراوح مابين (40%_26.2%). من ناحية أخرى، أظهرت نتائج الوزن النوعي(Gs) أنها تتراوح بين (2.62_2.7)، في حين أظهرت نتائج التحليل الحجمي أن النسبة السائدة من الرواسب في منطقة الدراسة هي الرمال، والتي تتراوح مابين (40%_60%)، وهي في الغالب رواسب رملية مختلطة بالغرين، مع نسب متفاوتة من الطين. من خلال حدود اللدونة، أظهرت النتائج أن حد السيولة L.L يتراوح مابين (19.1%_24.79%)، وحد اللدونة P.L مابين (11.22%_14.99%)، ومؤشر اللدونة P.I مابين (5.83%_9.7%). وكشف مخطط اللدونة عن جودة الرواسب من النوع غرينية واطئة اللدونة. أما بالنسبة للاختبارات الميكانيكية التي أجريت على الرواسب، فقد شملت اختبارات القص المباشر، حيث كانت قيم التماسك (C) تتراوح مابين (0_4)، وزاوية الاحتكاك الداخلي (Ø) مابين (360_460). ومن اختبار الدمك القياسي (بروكتور)، تبين أن قيمة المحتوى المائي الأمثل (OMC) تتراوح مابين (9%_17%)، وقيم الكثافة الجافة (MDD) مابين (1.46_1.61). أظهرت الاختبارات الكيميائية أن الرواسب أساسية ذات محتوى عضوي منخفض، وتحتوي على الجبس والكلوريدات بنسبة تزيد عن 1%، مما يؤدي إلى تأثيرات سلبية مثل التآكل والتشقق والتأثيرات المعتدلة من الكبريتات. ومع ذلك، يجب الحذر من التآكل والتشقق. كما تحتوي الرواسب على كبريتات وأملاح ذائبة بكميات معتدلة، ولكن يجب الانتباه إلى عدم حدوث التآكل والتشقق. هذه الرواسب من النوع الذي يتم نقله بواسطة المياه، مما أدى إلى تغير في خصائصها الهندسية. أظهرت الدراسة المعدنية أن رواسب منطقة الدراسة، خاصة في خزان سد سامراء، تحتوي على نسبة عالية من معادن الكوارتز والكربونات وتفتقر إلى معادن الطين. ويعود السبب في ذلك إلى أن النسبة السائدة من الرواسب هي الرمال، والتي تزداد تدريجياً من مقدمة ناظم الثرثار حتى نهاية قناة الثرثار من معادن الطين، ولكن نسبتها تبقى صغيرة إلى حد ما. ولا يمكن استخدام هذه الرواسب في صناعات البناء مثل تصنيع الطابوق والسيراميك، وذلك لأن معظم الرواسب في منطقة الدراسة رملية. ومع ذلك، يمكن استخدامها في صناعة المرشحات لتنقية مجرى النهر من النفايات الصرف الصحي، وكذلك في خلطات الخرسانة. كما يمكن استخدامها في صناعة الطابوق الرملي بعد معالجتها بنسب معينة من الحجر الجيري، بالإضافة إلى استخدامها لأغراض زراعية.

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Introduction

The study of the geotechnical properties of river sediments is a vital topic in the fields of geology and geotechnical engineering, as these sediments play a significant role in shaping natural environments and determining soil characteristics in surrounding areas. River sediments are formed through continuous transportation and deposition processes influenced by hydrological and atmospheric factors, which result in variations in their physical, chemical, and hydraulic properties. These studies contribute to understanding the nature of river sediments in terms of grain size, mineral composition, and organic matter content, as well as evaluating their mechanical response to stress and their load-bearing capacity. Such information is essential for developing safe engineering solutions for the design of bridges, dams, and foundations in areas near rivers (Badawi, 2018).

The Samarra system is part of the flood water control system in the Tigris River. The system consists of two main concrete structures: The Samarra Dam, next to which is the hydroelectric sample, and the Tharthar Regulator, located on the right side of the Tigris River.

This system plays an important role in controlling flood water in the Tigris River by diverting the water surplus from the river's absorption at the back of the Samarra Dam to the Tharthar Depression through the Tharthar Regulator and its subsequent channel and securing irrigation water for the Al-Ishaq irrigation project. This is done by raising the water level upstream of Samarra Dam and maintaining it throughout days of the year, in addition to generating electrical energy through the hydroelectric sample built on the Samarra Dam (Ministry of Water Resources Dams and Water Resources Research Center Report/Samarra and Nazim al-Tharthar Dam Administration/Final Report 2020).

In recent years, large amounts of sediment have been deposited at the dam gates in the reservoir area and the flood channel to Tharthar Lake.

This study aims to evaluate the geotechnical characteristics of the deposits in the study area and determine the suitability of these deposits for manufacturing building materials, and how to exploit these huge quantities of sediments transported by the Tigris River.

The city of Samarra is in an urban movement, studying the properties of sediments to benefit from them with the possibility of establishing a factory for building materials and employing a workforce, thus preserving the most important water resource (the Tigris River) in the country.

Location of the study area

The study area is located north of the capital Baghdad at coordinates 430 51.2, north 34011,45 west, and 7 sites were chosen to collect the samples (3 samples from the reservoir and 4 samples from the Tharthar Channel).

Table 1: Coordinates of the study area according to the geographic coordinates system.

	X	Y
sample (1) to the right of the Samarra Dam reservoir	43.843119	34.201398
sample (2) to the left of the Samarra Dam reservoir	43.86051	34.201629
sample (3) in the middle of the Samarra Dam reservoir	43.852692	34.201332
sample (4) entrance of Nazim al-Tharthar	43.842976	34.192683
sample (5)	43.848264	34.148562
sample (6)	43.776423	33.820253
sample (7) the point where the Tharthar Channel meets Tharthar Lake	43.590256	33.79672

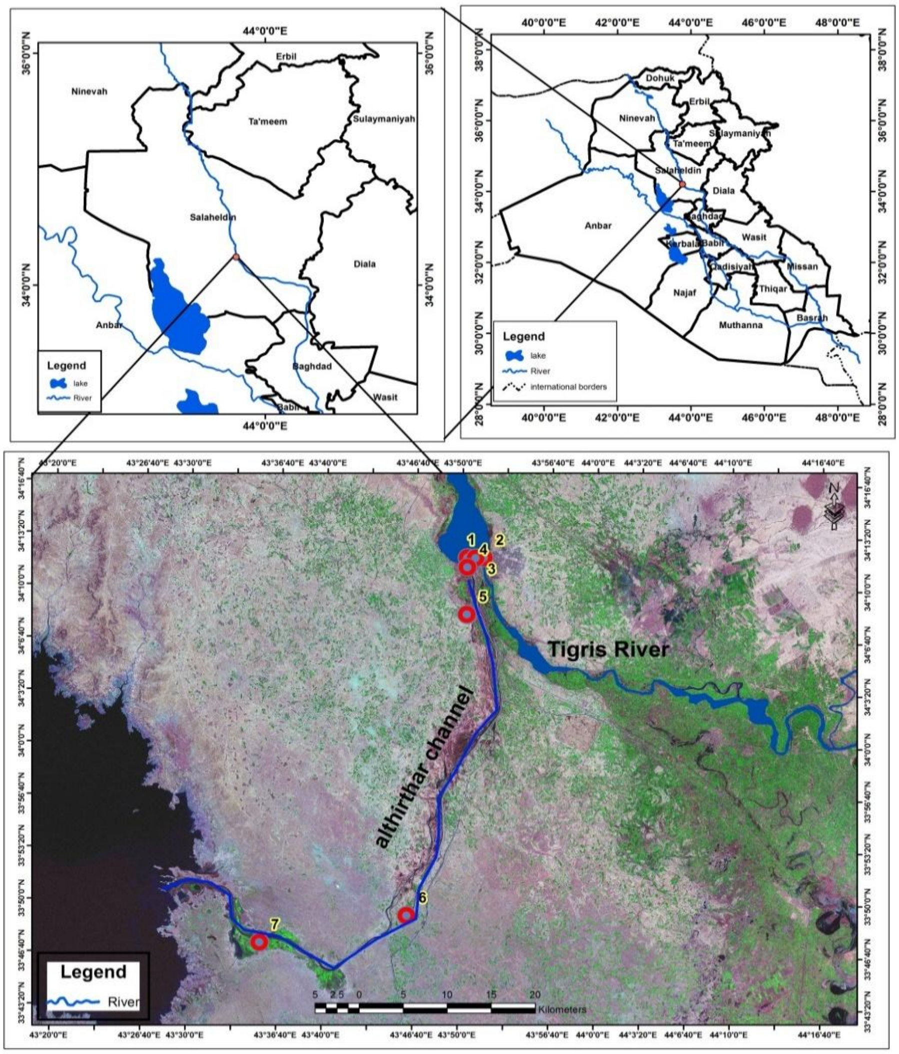


Fig. 1. Location of the study area and locations of the samples.

Research Methodology

Field Work

The field work includes sediment sample collection from specific sites and samples from sediment dredging sites. The samples were stored inside tightly sealed plastic bags. The sites' locations were determined using GPS, and the coordinates were projected onto the site map of the area under study. The samples were saved and transported to the laboratory.

Laboratory Work

Necessary tests to evaluate the samples' geotechnical properties are conducted as follows:

Physical tests:

These tests were conducted at the Department of Civil Engineering, Faculty of Engineering, Samarra University.

1. Water Content

It is defined as the amount of water present within the pores of the soil. It represents the percentage of the mass or weight of the water present within the soil sample to the weight or mass of solid particles of the same sample and is expressed by the following equations (Abboud and Zarak, 2015):

$Wc=Ww/Ws\times100$……………… (1)

$Wc=W-Ws/Ws\times100$…………….(2)

Where: (*W*) Original sample weight (in gm). (*Ws*) Weight of solid particles of soil (in gm). (*Ww*) Weight of water in the sample (in gm). (*Wc*) Water Content.

The test was conducted according to specifications (ASTM D 2216-10, 2010). The water content values for the study area depended on the rainfall and the flood season. The water content was measured during seasonal periods of rain and dry days. Table 2 shows the water content during August, whereas Table 3 displays the water content during January.

Table 2: Water content of samples from the study area during August.

No.	Weight before drying	Weight after drying	Water weight	water content
1	100	90.28	9.72	%10.76
2	100	90.3	9.7	%10.74
3	100	91.1	8.9	%9.7
4	100	93.8	6.2	%6.6
5	100	95	5	%5.2
6	100	95	5	%5.2
7	100	90	10	%11

Table 3: Water content of samples from the study area during January.

No.	Weight before drying	Weight after drying	Water weight	water content
1	100	74.1	25.9	34.9%
2	100	77.6	22.4	28.8%
3	100	75.3	24.7	32.8%
4	100	72.5	27.5	37.9%
5	100	79.21	20.79	%26.2
6	100	74.6	25.4	%34
7	100	71.2	28.8	%40.4

2. Specific gravity (G_S)

Specific gravity is defined as the weight of a certain volume of soil particles at a certain temperature to the weight of the same volume of distilled water at the same temperature; in other words, it is the unit weight of soil particles to the unit weight of water (ASTM-D,854-02,2004). It is calculated from the equations:

$GsT_1 = W_3 / (W1 + W3) - W2$ ………(2)

$GsT_{20} = GsT1.\ A$..……....…………. (3)

Where: (*W1*) Weight of a 500 ml volumetric bottle filled with distilled water. (*W2*) Weight of the volumetric bottle with the soil mixture and distilled water. (*W3*) Weight of dried soil. (*GsT1*) specific gravity value before correction. (*A*) Thermal correction factor, which represents the quotient dividing the specific gravity of water at a specific temperature by the specific gravity of water at 20°C. (*GsT20*) value of specific gravity of the corrected soil sample.

The soil quality is determined based on the specific gravity (Das, 1982)

Table 4: Classification developed by Das (1982).

Specific gravity	Soil type
2.63-2.67	Sand
2.65-2.7	Silt
2.67-2.9	Clay and Silty Clay
Less than 2	Organic soil

Table 5: Results of the specific weight of the samples under study and their classification according to Das (1982).

No.	W1	W2	W3	T	A	Gs	Soil (depending on Das, 1982)
1	618.2	680	98.5	22	0.9996	2.68	Clay and Silty Clay
2	618.2	677.5	95	22	0.9996	2.66	Silt
3	618.2	678.21	97	22	0.9996	2.62	Sand
4	651.9	711.66	96.5	24	0.9991	2.62	Sand
5	651.9	712	96	24	0.9991	2.67	Clay and Silty Clay
6	618.2	677.7	94.9	22	0.9996	2.68	Clay and Silty Clay
7	618.2	711.7	94	22	0.9996	2.7	Clay and Silty Clay

3. Grain size analysis

The method of analysis is determined by using sieves. The grain size of coarse soil that has a grain size larger than 0.075 mm is measured. These sieves are moved manually or mechanically using an electric vibrator for a period of 15 minutes according to the American standard (ASTM D422-63 (Reapproved 2007 and 2014).

Wet analysis is done for granules whose particle size is less than 0.075 mm. After conducting a sieve and wet analysis test of the granules and testing the grain size and passing percentage, the relationship is drawn on semi-logarithmic paper (Figures 2 to 8).

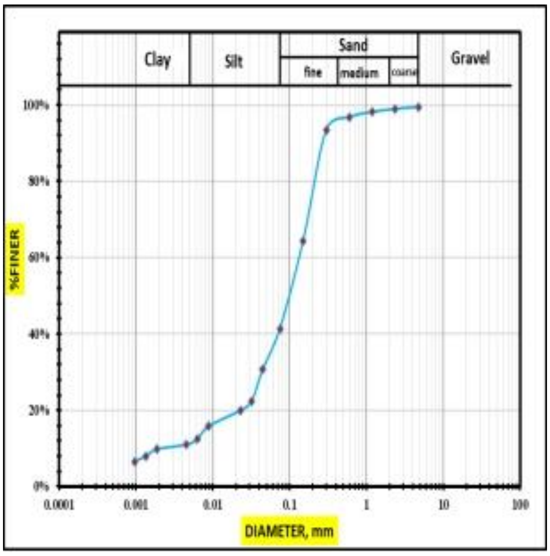


Fig. 2. Size gradient for sample (1)

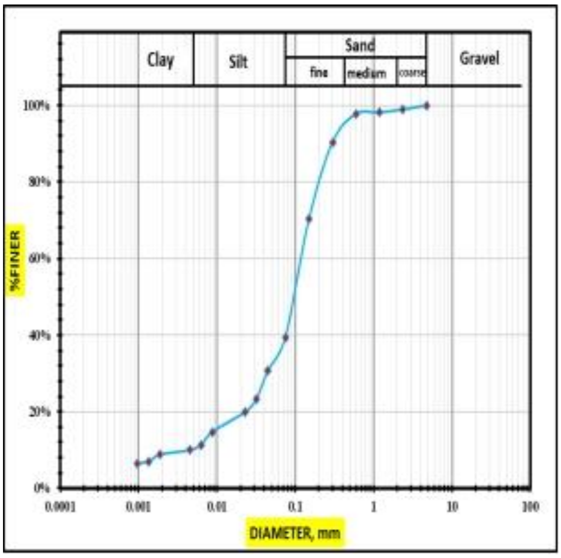


Fig. 3. Size gradient for sample (2)

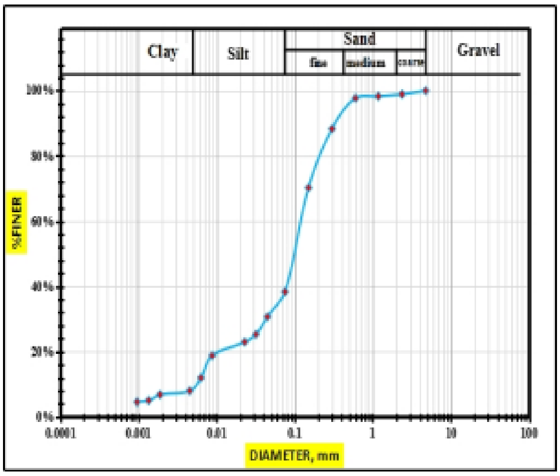


Fig. 4. Size gradient for sample (3)

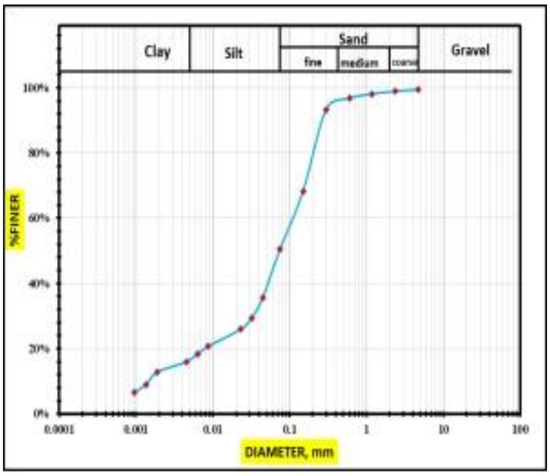


Fig. 5. Size gradient for sample (4)

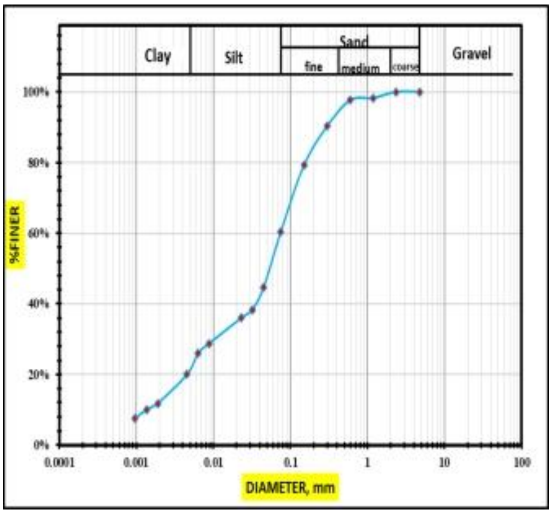


Fig. 6. Size gradient for sample (5)

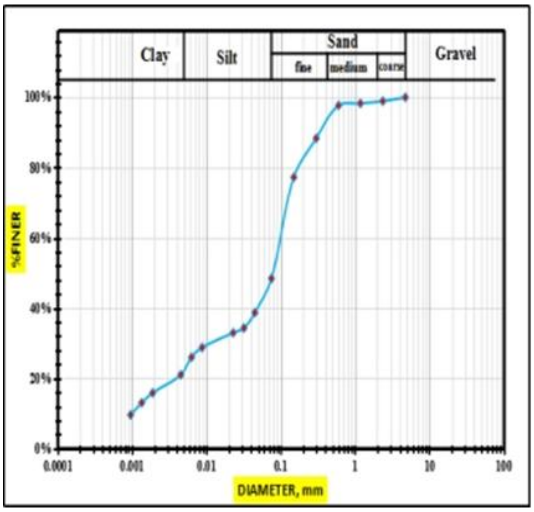


Fig. 7. Size gradient for sample (6)

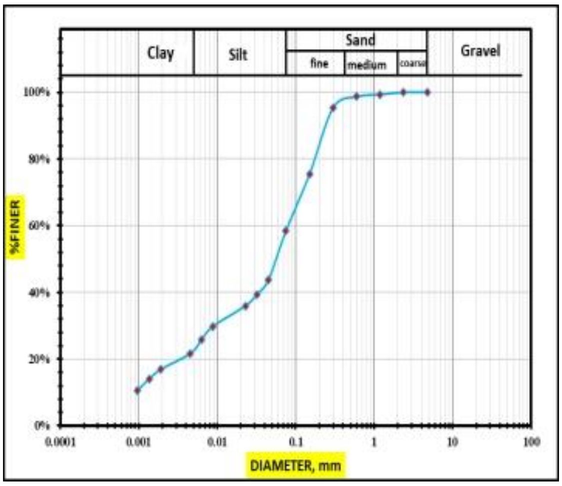


Fig. 8. Size gradient for sample (7)

Table 6: Results of grain size analysis of sediments in the study area.

No.	Sand%	Slit %	Clay %
1	59	30	11
2	61	29	10
3	62	29	9
4	50	33	17
5	40	38	22
6	52	26	22
7	42	35	23

4. Atterberg Limits

The Swedish scientist Atterberg (1911) is considered the first to establish the limits of soil texture. Soil texture is defined as the lowest water content or percentage of soil moisture at which a change occurs in the state of the soil, as it shows a clear change and different behavior when the percentage of moisture in it changes, and its effect appears clear, especially in clay soils (Braja and Das, 2018)

Atterberg limits are of great importance in soil classification, and the American standard is adopted:

1. Liquidity limit (L.L) is defined as the lowest water content that keeps the soil in a fluid state but has a low shear resistance (Braja and Das, 2018).

2. The plasticity limit (P.L) is the lowest water content that separates the plastic state from the semi-solid state (Braja and Das, 2018).

3. Plasticity Index (P.I) is the water content at which the soil remains in a plastic state and is calculated by the difference between the limits of fluidity and plasticity (Braja and Das., 2018).

$$P.I = L.L - P.L \text{ .... } (4)$$

Where: L.L = Liquidity limit; P.L = plasticity limit; P.I = Plasticity Index.

Soil quality was evaluated based on the liquidity limit criteria established by Braja and Das (2018)

The relationship between the liquidity limit and the plasticity Index, as reported by Capper and Cassie (1974), forms the basis for soil quality evaluation.

Table 7: The liquidity limit for the study area is described based on Braja and Das (2018)

No.	Liquid limit	Soil Description (Braja and Das, 2018)
1	19.1	Very low liquid limit
4	21.48	Low liquid limit
5	23.30	Low liquid limit
7	24.79	Low liquid limit

Table 8: Plasticity for study area Classification based on (Braja and Das, 2018)

No.	P. L	P. I	Classification by Braja and Das (2018)
1	11.22	7.88	Moderately plastic
4	15.65	5.83	Poorly plastic
5	14.36	8.94	Moderately plastic
7	14.99	9.8	Moderately plastic

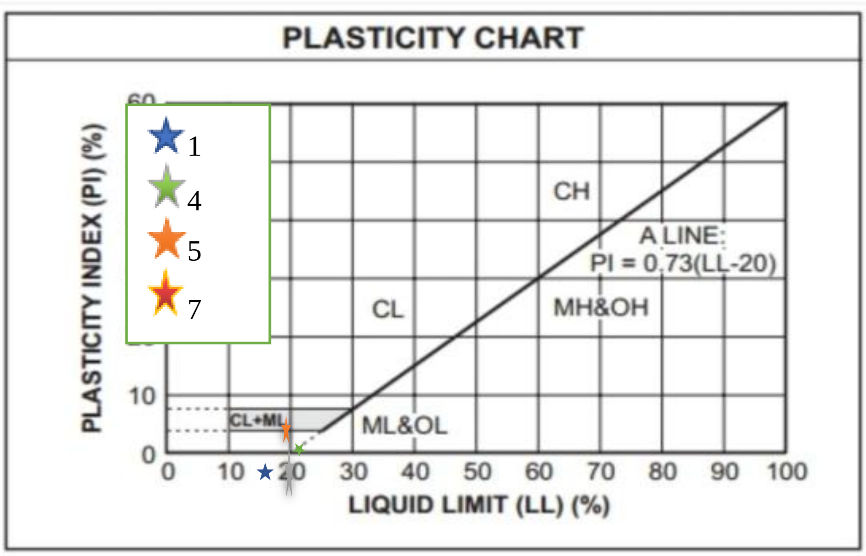


Fig. 9. Plasticity of sediments of the study area, depending on (Capper and Cassie, 1974), Plasticity chart

The Unified Soil Classification System (USCS) is a system used to classify soils based on their grain size and texture. Soils are divided into two main groups: coarse-grained soils (such as sands and gravels) and fine-grained soils (such as clays and silts). The classification relies on laboratory tests like sieve analysis and Atterberg limits, with soils represented by abbreviated symbols (e.g., GW, CL) that indicate their type and engineering properties (Das and Sobhan, 2018)

The soil quality was according to the unified soil classification system for sediments in the study area:

Sample (1)_ SP -SM
Sample (4)_SP-SM
Sample (5)_ML
Sample (7)_ML

2-Mechanical tests

1. Direct shear test

It is the process of sliding one layer of soil over another layer within the soil mass, and this occurs as a result of the application of forces

Horizontal direction of sliding (Braja and Das, 2018). Shear resistance can be defined as the resistance that the soil exhibits against sliding that occurs as a result of external forces affecting it (Hassan et al., 2022). Lobe resistance includes two main elements:

a.Internal friction angle: It is the resistance resulting from the friction of soil particles against each other due to the sliding and rotation of these particles (Braja and Das, 2018)

It is the resistance resulting from the forces that attempt to hold the soil particles together within the soil mass, and the source of this force is the electronic bonds present between the soil particles (Al-Samarrai, 2001)

The first person to link the relationship between the two workers was the scientist, Coulomb, it was known as Columb Law

He mentioned it (Scott, 1974) as in the equation, and it differs from it in sandy soils with cohesion resistance (C) equal to zero

$\tau = C + s_n \tan Ø$………………(5)

$\tau = n \tan Ø$ …………..(6)

Whereas:

(τ) Shear resistance

(C) Cohesion

(n)Vertical stress

(Ø) Angle of internal friction

The tests were conducted (1, 2, 4, 5, 7) according to the American standard (ASTM D3080-11, 2011), and the results are shown in the figures 10-14.

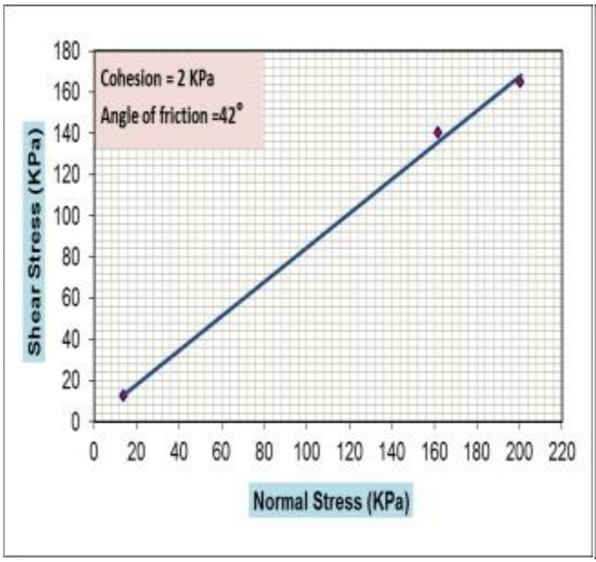


Fig. 10. Direct shear test for sample (1)

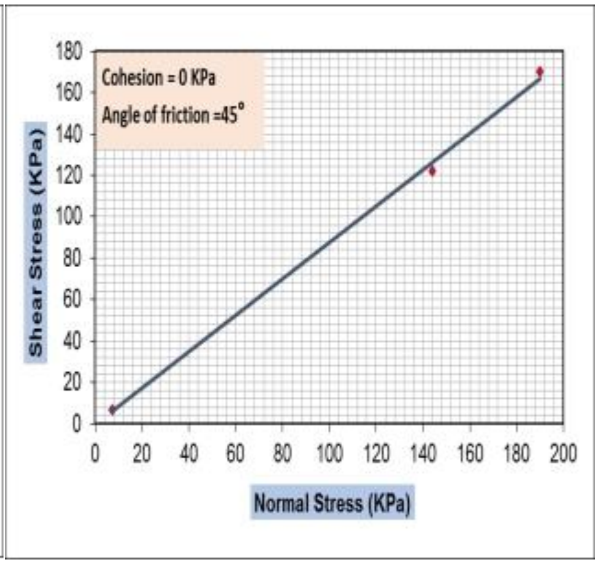
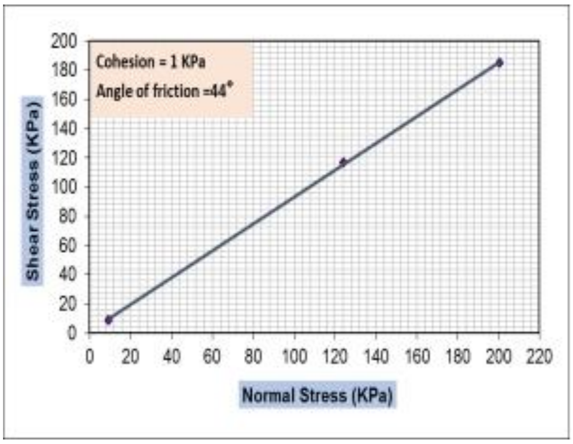


Fig. 11. Direct shear test for sample (2)



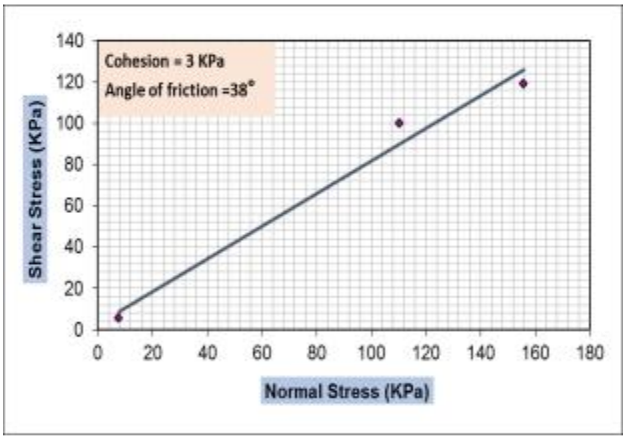


Fig. 12. Direct shear test for sample (4) **Fig. 13. Direct shear test for sample (5)**

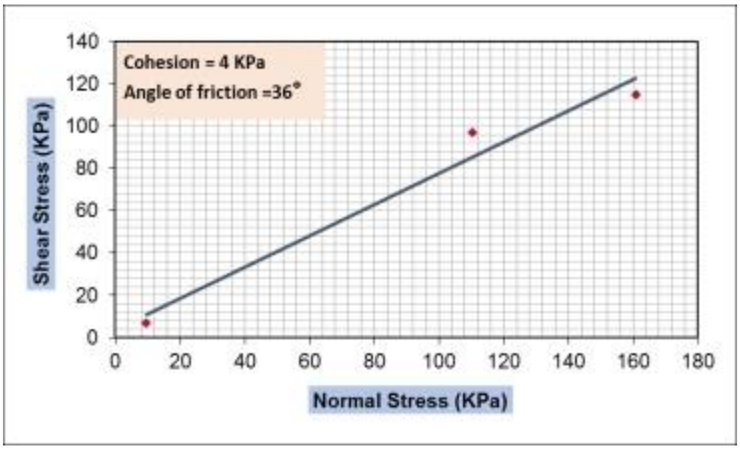


Fig. 14. Direct shear test for sample (7).

Table 9: The results of the direct shear test of the study area.

No.	Cohesion	Angle of friction
1	2	42
2	0	46
4	1	45
5	3	38
7	4	36

2. Standard Compaction Characteristics of Soil Test

It is a laboratory test to obtain the maximum dry density for a type of soil and to obtain the typical water or the optimal water for the recent dry density. The French scientist Proctor 1933 was able to experiment with the laboratory and obtained the recent dry density and its corresponding optimal water the test was conducted according to the American standard, ASTM D698-04 (2004).

Compaction is defined as the process in which soil particles are rearranged using some mechanical means to reduce the porosity of the soil and increase its dry density. The compaction process includes expelling air from the soil voids and adding water to the soil will bring the soil particles closer together and increase the compaction force. The recent dry density of the soil will be reached (Powrie,2014).

The dry density value for each attempt to increase water content is extracted from the equation 7 and 8.

$\gamma wet = m2 - m1/v$ …………………..…(7)

$\gamma dry = \frac{\gamma wet}{1+W}$…………………………(8)

Whereas:

(Ɣwet)The wet density of the soil (gm/cm^3)

(Ɣdry) The dry density of the soil (gm/cm^3)

(m1) Weight of the mold with its base (gm)

(m2) Weight of the mold with its base and soil inside (gm)

(v) sample size(cm3)

(W%) Percentage of soil water content

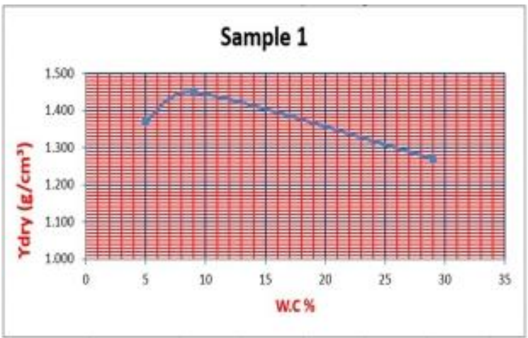


Fig. 15. Compaction test for sample (1)

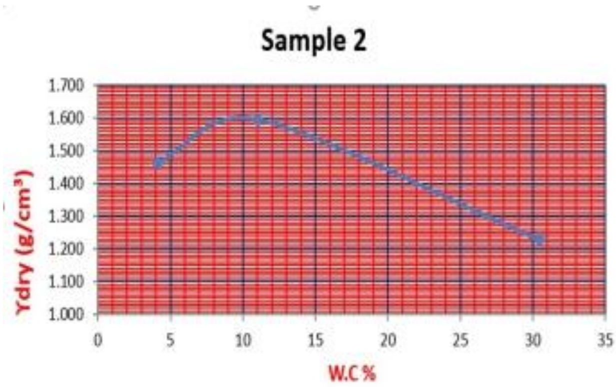


Fig. 16. Compaction test for sample (2)

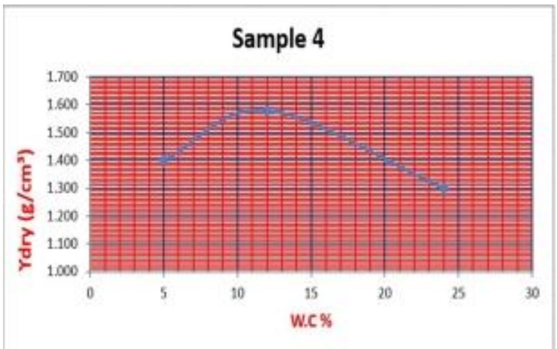


Fig. 17. Compaction test for sample (4)

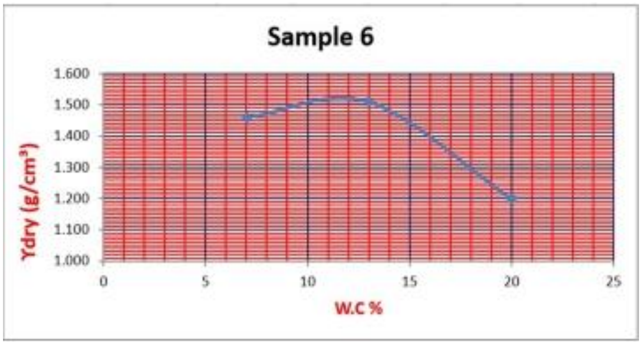


Fig. 18. Compaction test for sample (6)

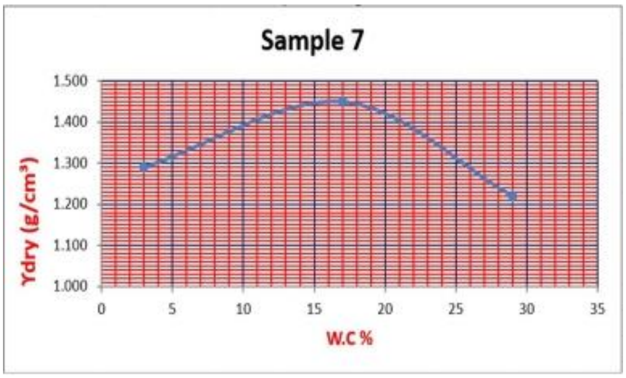


Fig. 19. Compaction test for sample (7)

Table 10: The results of the recent dry density and the optimal water content for the study area

No.	OMC	MDD(g/cm^3)
1	9 %	1.46
2	11 %	1.61
4	12 %	1.59
6	11.5%	1.54
7	17 %	1.46

3-Chemical and Mineralogical Tests

1-Deposit chemistry

The study of the chemical properties of soil is necessary to achieve sustainable development in various fields such as agriculture, engineering, and the manufacturing of building materials, as well as environmental protection in the engineering field. Understanding the chemical properties of soil is important for the design of foundations and structures because some soils can interact with building materials, which affects the stability and sustainability of engineering facilities.

The effect of the pH value on the behavior of the soil is considered one of the factors that affect the movement of elements directly or indirectly in the processes of precipitation, dissolution, complex formation, and oxidation-reduction reactions. When the pH value is acidic, all of the iron, manganese, and aluminum accelerate their ability to dissolve, and thus the soil becomes toxic. More, in return, leads to an increase in alkalinity, thus increasing the concentration of the elements and then precipitation due to the element's weakness in dissolving (Al-Saffawi., 2018).

Effect of salts the percentage of salts in their ability to dissolve varies depending on the chemical composition. Chloride salts in general are the highest among the salts.

The most important factors affecting solubility are temperature, pH, the percentage of dissolved carbon dioxide (CO2), the evaporation process, and humidity, where the solubility of salts is high due to the effect of water, as salts dissolve freely in water (Al-Rashidi, 2004).

(Baver, 1972) indicated that if the percentage of dissolved salts is less than 0.5%), it does not pose a threat to engineering buildings.

The effect of organic matter. The most important of these effects, according to (Sparks., 2003), are:

1. Increased compressibility due to reduced bearing capacity
2. A rapid and large decline caused by gases resulting from decomposition present in soil voids that affect the joining coefficient in engineering tests.
3. Its effect on shear coefficients because it contains voids, which gives unreal shear coefficients, so the shear strength is very low.
4. Increasing the moisture content leads to an increase in the occurrence of swelling and shrinkage
5. The amount of organic matter is related to the pH

The value of organic matter can be considered high if it exceeds (1%) because it causes problems with the strength of the soil if the soil is saturated and has a high percentage of clay (Al-Hashemi and Al-Shammari 2020)

Gypsum ratios: The effect of gypsum is negative on the soil because it can dissolve in water, so cracks and voids occur between soil particles that lead to a decrease in the strength of the soil. This increase in solubility leads to a decrease in the dry density of the soil and an increase in moisture content, which leads to a danger to the foundations of buildings. If its percentage exceeds (5%) (Aratynyan and Manukyan 1982)

According to the classification developed by (Barazanji,1973) for gypsum soils, the deposits of the study area are classified as non-gypsiferous soils.

The effect of the element chlorine (CL) when it reacts with hydrogen (H). The product of this reaction is hydrochloric acid (HCl), which hurts concrete due to the reaction of the acid with reinforcing steel (Salman, 1996).

If the percentage of chlorides is greater than (0.1%), its impact will be negative on the foundations of engineering facilities (Bowels, 1988).

The percentage of chlorides for the samples of the study area ranged between (0.81_0.96).

The engineering effect of sulfates: Increasing the percentage of sulfur salts requires an increase in salt-resistant cement in the concrete mix to reduce the effect of these salts, which leads to additional costs. Therefore, it is considered uneconomical and hurts the concrete. (Reyes et al., 2017)

Table 11: shows the results of chemical tests for the study area

No.	PH	TDS %	Organic %	Gypsum %	Cl %	SO_3%
1	8.01	5.11	0.17	0.208	0.96	0.24
2	8.08	5.14	0.16	0.208	0.93	0.20
3	8.03	5.10	0.17	0.21	0.90	0.26
4	8.02	5.2	0.20	0.22	0.88	0.34
5	7.77	4.88	0.16	0.26	0.84	0.35
6	7.69	4.92	0.30	0.25	0.83	0.33
7	7.89	4.7	0.32	0.26	0.81	0.36

2-Mineral deposits

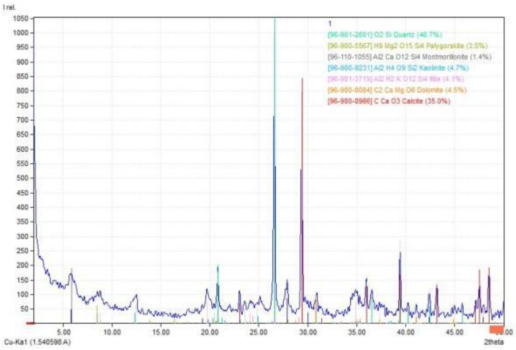


Fig. 20. (XRD) test for sample (1)

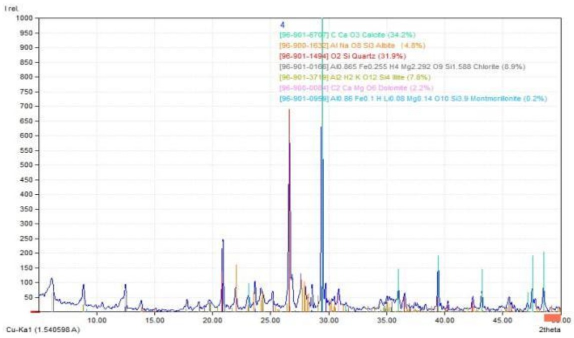


Fig. 21. (XRD) test for sample (4)

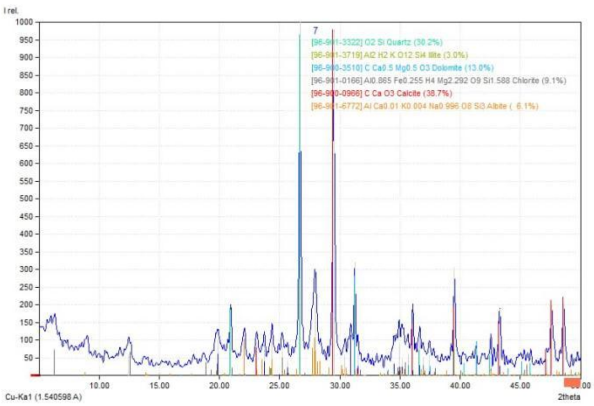


Fig. 22. (XRD) test for sample (7)

*Sample(1)

Quartz	Dolomite%	Calcite%	Kaolinite%	Illite%	Montmorillonite%	Palygorskite%
46.7	4.5	35	4.7	4.1	1.4	3.5

*Sample (4)

Quartz%	Dolomite%	Calcite%	Albit %	Illite%	Montmorillonite%	Chlorite %
31.9	2.2	34.2	4.8	7.8	0.2	8.9

*Sample (7)

Quartz%	Dolomite%	Calcite%	Albit %	Illite%	Chlorite %
30.2	13	38.7	6.1	3	9.1

Discussion

From the results of the current study, the following conclusions were drawn

•These are deposits that differ from the deposits found in the deposition area, and they are recent deposits resulting from water erosion.

• The sediments of the study area are soft, devoid of gravel, and are mostly fine sand deposits with silt and a little clay, which are mostly Quaternary sediments.

• The moisture content of these sediments depends mostly on the number of water releases, flood seasons, and increased rainfall, as well as the season during which the modeling was done, as the moisture content values during the drought were (11%_5.2%) and during the flood seasons were (40.4%_26.2%).

• The sediments are dominated by the size of sand in the deposits deposited in the tank and the front of the regulator, and the percentage of clay in the sediments is small, and the percentage of clay increases slightly at the last point in the study area, and this is one of the results of the sizing analyses

• The clays of the study area, in terms of Liquidity limit and plasticity, are characterized by having Low liquid limit, where the L.L value was (19.1_24.79)

Moderately Plasticity index where the P.I My value was (5.83_9.8)

• The deposits in the study area are characterized by having little cohesion because they are mostly sand deposits and have an internal friction angle between (460_360). From the compaction test, the results were

The optimum water content (9%_17%) and dry density values (1.46_1.61).

• Through chemical tests, it was found that the gypsum and organic content were low, and thus had little effect on the engineering properties of the soil. In general, the basic soil was scarce and the content of soluble salts and chlorides was, more than 1%, so its negative effect was represented by corrosion, cracking, and moderate sulfate, but one must be careful not to corrode and crack. The sediment content was low because the sediments were transported by water and were subject to alteration and loss. Many of its components.

• The mineralogical study showed that the sediments of the study area, especially in the Samarra Dam reservoir, have a high percentage of quartz and carbonate minerals and lack clay minerals. The reason for this is that the prevailing percentage of sediments is sand and gradually increases from the front of the Tharthar Nazim to the end of the Tharthar channel of clay minerals, but their percentage remains somewhat small.

Conclusions

Through the values obtained from the tests conducted for all samples of the study area, the difference in moisture content values according to the seasons of the year and climatic conditions.

In all study areas, the predominant percentage is sand and silt, which are not suitable for engineering purposes in the manufacture of building materials such as the manufacture of bricks, and are not suitable for uses in filling dams, but it is possible to use these deposits for agricultural purposes and concrete purposes.

Recommendations

Conduct a detailed study of the study area, as it is an area that contains an important hydraulic facility, and the amount of sediment is large that hinders the work of the system. Conduct treatments of the sediment by adding clay for use in the manufacture of bricks.

Conduct a new experiment and a new study of the sediments of the study area and find out the possibility of using them in the manufacture of sand bricks composed of 90% sand and 10% pure limestone.

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