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Suitability of the Lower Zab River Sediments for Concrete Works / Southwest of Kirkuk - Northern Iraq

Ibrahim Mustafa Hassan, Mohammed Rashid Abood , Lafta Salman Kadhim
Applied Geology Department College of Science , Tikrit University , Tikrit , Iraq
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Corresponding Author:
Name: Ibrahim Mustafa Hassan
E-mail: ibraheem.mustafa100@gmail.com
Tel:

ABSTRACT

An Engineering study was carried out for five stations in the Lower Zab basin, southwest of Kirkuk, to determine the viability of the Quaternary age sediments for concrete works. The geotechnical evaluation results included that the coarse aggregate's grain size analysis is identical to the gradient class (63.0 mm) according to the [1] classification. As for the gradation of fine aggregate for the sediments of the study area, the results of the granular gradient of the samples after matching them with the limits of AASHTO specification showed that they are identical to the specification with slight differences on some sieves. The elongation and flatness tests showed that the highest percentage of the longitudinal shape is (19.2%) and flat-shaped particles is (28.8%), within permissible limits according to British standard [2], the specific gravity for coarse aggregate was between (2.60 - 2.64) and saturated specific gravity (2.61 - 2.65), and the values of specific weight for fine soil ranged from (2.72 - 2.64) which is suitable for use in concrete works. The results of the laboratory test of the durability tests - The Los Angeles test for the samples showed that the highest percentage for weight loss was (20%), which is suitable for use in the concrete according to the Iraqi standard [3], the results of the laboratory test for stability showed that the percentage of weight loss for coarse aggregate (gravel) by the effect of sodium sulfate solution and for the number of 5 cycles of the samples ranged between (8.3% - 4.1%), which is valid for use in concrete works according to the American specification [4]. The results of the resistance tests - the point load test for stations (S1, S3, S4) within the classification range of very strong - extremely strong, and the two stations (S2, S5) within the class strong - very strong - extremely strong compared to the classification of [5], and they are good for concrete works. It was found from the results of the chemical tests the gypsum content, organic matter content, Total soluble salts, and the sulfate content of the samples of the study area are suitable to for concrete works according to British Standard [6], which is suitable for concrete works, testing the compressive strength of concrete cubes ranged between (24.93 - 18.22 MPa) for age seven days and ranged between (33.02 - 29.76 MPa) for 28 days for reference mixture, Which is (4:2:1 by weight). According to the Iraqi standard specification [7], the compressive strength values of the samples are suitable for regular unreinforced concrete, and in comparison with [8] classification, it was apparent that the concrete produced is of moderate endurance. And suitable for concrete works According to [9].

1- Introduction

Concrete is a heterogeneous mixture of aggregates (coarse and fine), cement and water with some voids, and it is possible to add some other materials called additives to obtain specific properties, as the proportions of materials for this mixture includes according to the type of work required and the available materials. By mixing these materials, concrete is obtained, which begins to harden gradually over time until it becomes solid and robust, and its strength varies according to the essential components, as well as the method of shaking during pouring and treatment method [10]. Aggregate (coarse and fine) is the main material for concrete works, as it occupies the most significant part of the concrete volume, about 70-75% of the total volume of the concrete block. Therefore, being familiar with the study of the quality of aggregates in terms of their physical and mechanical properties is directly responsible for the strength of the engineering performance of the concrete produced and affecting its behavior and durability (Pereira et al., 2009). Administratively, the study area has located south-west of Kirkuk governorate and includes the sediments of the lower Zab river down to the proposed Makhul dam on the Tigris river and about 68 km away from the centre of Kirkuk governorate, the study area is determined to the UTM square coordinates between the northing lines (3918000) and (3892000), and the easting lines (384000) and (354000), figure no. (1).

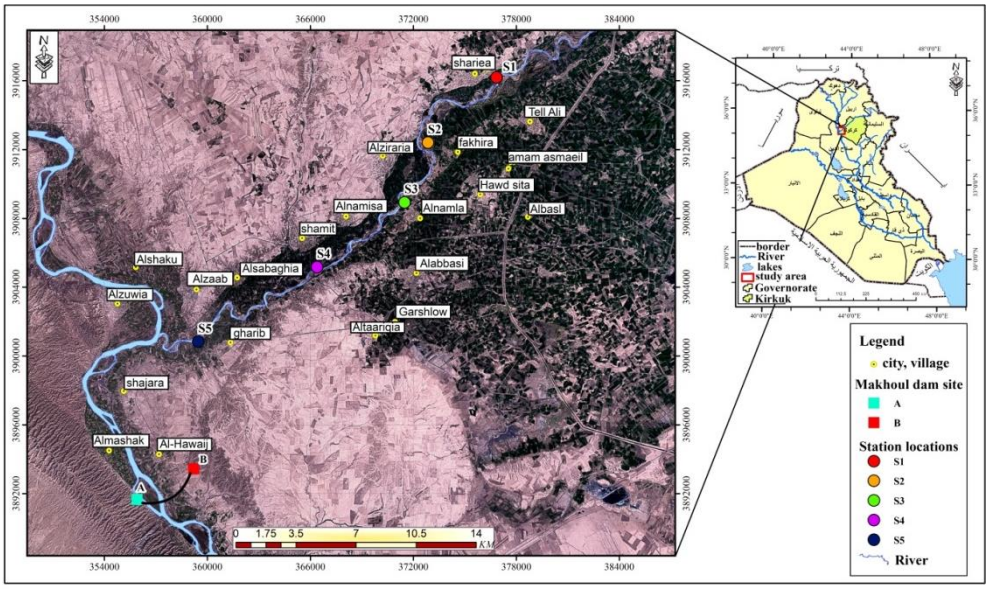

Fig. 1: location map of the study area

There are previous studies related to the topic for research including:-

- [12] conducted a study to show the effect of cement fixation and its durability for the base layer taken from selected quarries of the city of Erbil, and he evaluated these materials based on their physical and chemical properties, resistance, and durability tests, and concluded that the materials have good resistance to the California endurance test, but they are highly effective. Low strength ability to test for unconfined compression, but the test values for unconfined compressive strength increase by fixing materials with cement for all studied samples.
- [13] explained the effect of variables in the gradient of aggregates on concrete performance, as it is considered one of the basic requirements for designing asphalt concrete in all tests. To find aggregates, and among the conclusions is that using a joint gradient with a maximum size of (12.5 mm) with (10%) fillers and a ratio (1.8 / 1) of the ratio of coarse to fine aggregates in the concrete mix gives a higher resistance to elastic deformation. Finally, statistical samples have been prepared to evaluate the effect of the combined gradient on the behavior of concrete mixtures.
- [14] studied the effect of discontinuous aggregate and gradually failed aggregates on the compressive strength of concrete. The results showed a decrease in the compressive strength of concrete mixtures with sequential aggregates compared to concrete mixtures with sequential aggregates by (6%) for a lifespan of (28) days, while it was the compressive strength of concrete mixes with gradual failure aggregates is (3%) higher than that containing sequential aggregates.
- [15] studied the viability of aggregates in the Daquq and Laylan regions, south and southeast of Kirkuk / northern Iraq for concrete works, and thus the results showed the suitability of aggregates for use in cement concrete works. Iraqi standard and British standard.

2-Geology and stratigraphy of the study area

The study area consists of the following formations, the Fatha formation, the Injana formation, and Muqdadiyah formation, in addition to Quaternary deposits, figure (2).

2-1. Fatha formation (Middle Miocene)

This formation are exposed on the south-western side for the proposed Makhul dam reservoir within the Makhul fold flank and in the north-eastern flank from the Khanukah fold, Figure No. (2).

2-2. Injana formation(Upper Miocene)

This formation appears on the right bank of the zab river in the Sabbaghiyah village, west and south-west of the Zab sub-district. It is also exposed on the left bank of the Tigris river east of the proposed Makhul dam. This formation appears on the northern side of the proposed Makhul dam reservoir within the Khanukah fold and the western and south-western sides of the Makhul dam reservoir site.

2-3. Mukdadia formation - Pliocene

This formation of Muqdadiya has exposed in form strip along the right bank of the Lower Zab river from the village of Shari'a and Al-Zarariah, Al-Namisa, and Shamit. The distance of the formation from the flow of the Zab river is variable ranging from 2.6km to 1 km in some areas.

2-4. Quaternary deposits: These sediments have located on both sides of the Lower Zab river and the Tigris river. These sediments extend over large areas. The sediments of the Quaternary period in the study area are represented by sediments (river terraces, slopes, runoff, floodplains, and sediments of multiple origins). Figure (2), these sediments consist of loose, incoherent, or semi-cohesive materials such as clay, silt, sand, and gravel in an overlapping or successive manner and varying.

3-Tectonic - Structure for study area

The studied area is tectonically located within the Hamrin-Makhul belt, which belongs to the unstable shelf, within the low folded zone, according to the tectonic divisions for Iraq [16]. The topography for the study area differs from one place to another place the topographical heights in the study area range between (115 m) in the course of the Lower Zab river and the Tigris river and (482 m above sea level on the southwestern side of Makhul fold.

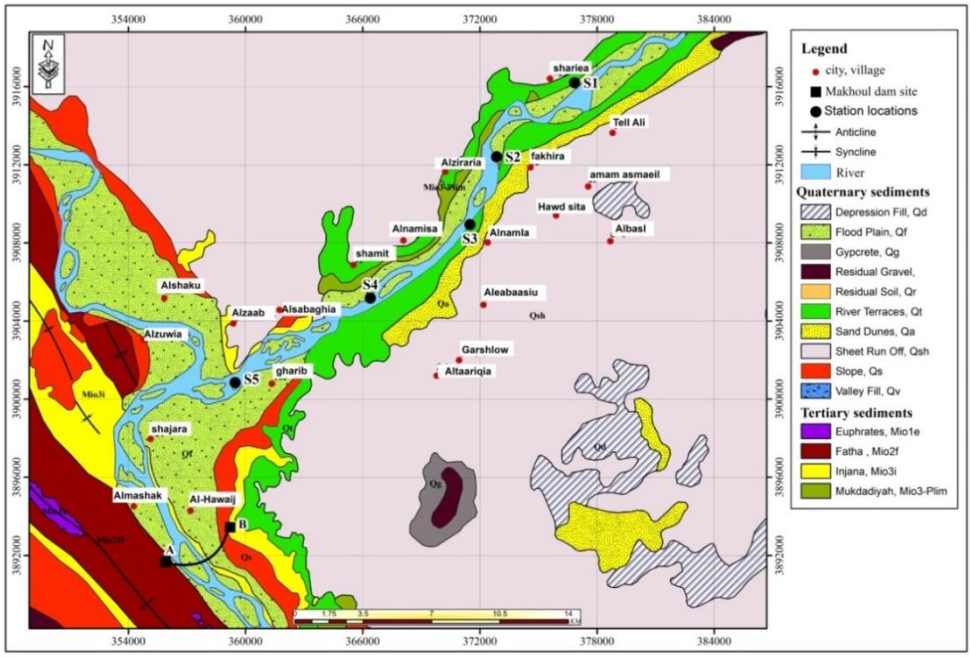

Fig. 2: a geological map for the study area

4- Aims of study

The aims of this study is to know for suitability of the study area sediments for concrete works.

5- Field Work

- Five stations are selected to collect samples from the study area and along the Lower Zab river, the length of the study area was more than 45 km, and all equipment was prepared and field tools, Including a GPS device, bags for storing samples, a record of notes, the geological hammer, a tape measure for calculating thickness, drilling tools for taking samples, and unique bags for chemical tests. All samples were collected and numbered, the coordinates and recorded of each station. Soil samples were collected, which consisted of a mixture of clay, silt, sand, and gravel, weighing (250 kg) from each station to ensure their adequacy for laboratory tests, Plat No (1).
- The samples are transferred to (The National Center for Laboratories and Construction Research, in Kirkuk Governorate). In addition to the laboratories of the university of Kirkuk, to initiate laboratory work and complete all required laboratory tests.

Plat 1: collecting samples during fieldwork

6- Laboratory Works

The laboratory work started after the completion of the fieldwork. After that, the samples had prepared for the analysis and various tests. The test sample is taken from the original laboratory sample, the sample are divided into four identical sections using manual division to quarters, and then the two opposite parts are chosen from the sample for ensuring the completeness of the sample in the laboratory test. The suitability of the sediments for concrete works use is evaluated through laboratory tests and geotechnical evaluation of the sediments. The laboratory tests included all the tests required to evaluate the aggregates for concrete works . and It includes the following tests (sieve analysis test, grain shape test, specific gravity and absorption rate, loss angeles test, soundness test , point load test, chemical analysis, compressive strength test of concrete)

7- Results and discussions

7-1 Sieve analysis test.

The grain size analysis for of the aggregate was tested according to the specification [1] in the laboratory, plate (2).

A- Grain Size of coarse aggregate

The results of the granular gradation of all samples of stations in the study area for coarse aggregates, depending on the specification [1], showed their conformity to the gradient class (63 mm) [1], Table (1).

Table 1: Results of the grain size analysis of coarse aggregate for concrete works, according to the specification [1]

Sieve size (mm)	**Percentage of materials passing through the sieves**					
	Grain Size distribution, sample S1	Grain Size distribution, sample S2	Grain Size distribution, sample S3	Grain Size distribution, sample S4	Grain Size distribution, sample S5	**Specification limits [1] for class 63 m.m**
75	100	100	100	100	100	**100**
63	100	99	99	100	100	**100-95**
37.5	83	82	84	83	84	**90-60**
19.5	42	46	52	44	40	**55-25**
9.5	11	16	19	14	12	**25-10**
4.75	0	0	0	0	0	**5-0**

B- Fine Aggregate

The results of the granular gradation of the samples of the five stations of the study area for fine aggregates, and after matching them with the limits of the specification [1] showed, The first station, S1: conforms to the presence of a slight deviation in the sieve (0.3 mm), and the second station, S2: conforms to the specification, and the third station, S3: does not match the sieves (1.18) and (0.3) mm, the fourth station, S4: conforms to the specification with a deviation in the sieve (0.3) mm, and the fifth station, S5: conforms to the specification with a deviation on the sieve (1.18) mm, table (2).

Table 2: Results of the grain size analysis of fine aggregate for concrete works, according to the specification [1]

Sieve size (mm)	**Percentage of materials passing through the sieves**	**Grain Size distribution sample S1**	**Grain Size distribution sample S2**	**Grain Size distribution sample S3**	**Grain Size distribution sample S4**	**Grain Size distribution sample S5**
9.5	100	100	100	100	100	**100**
4.75	95-100	100	100	100	100	**100**
1.18	45-80	78	70	91	67	**84**
0.30	10-30	34	29	48	37	**26**
0.15	**2-10**	**3**	**3**	**2**	**2**	**3**

Plat 2: grain size analysis test process for coarse and fine aggregates

Grain Shape Test7 - 2

The concrete mixture consists mainly of fine aggregates and coarse aggregates. The shape of the coarse aggregate plays an essential role in influencing the behavior of concrete in terms of its strength, durability, and lifespan. The flatness and elongation factors were tested in the (National Center for Laboratories and Construction Research, in Kirkuk Governorate), using the Iraqi standard [17]. The results of the flatness test shown in table (3) showed that the highest value of the flatness coefficient for the samples of was (28.8%), thus it meets, the requirements that must be met according to the British standard [2], whose value should not exceed 50% for natural aggregates and 40% for crushed aggregates the elongation coefficient reached the highest value of the study area samples (19.2%), thus meeting the requirements that must be met for use in all concrete works, the rest of the results represent the round grains and the remaining ones from the study area sample for each station after identifying the ratio of the elongation factor and flattening factor.

Table 3: results of the elongation and flatness factor tests for samples.

No.	Elongation factor %	flattening factor %	Rotation (round, semi-round, irregular) %
S 1	17	25	58
S 2	18.2	28	54
S 3	17.3	24	59
S 4	19.2	28.8	52
S 5	10.2	15.3	74

7-3 Specific gravity and Absorption rate

It also means the weight of a specific volume of a substance at a specific temperature to the weight of the same volume of distilled water at the same temperature (20 C°), [18]. The specific gravity of coarse and fine aggregates was measured as follows:

Calculated according to the American standard [19], the results of the tests for the stations sampled in the study area showed that the dry specific weight values ranged between (2.60 - 2.64), the values of saturated specific weight ranged (2.61 - 2.65), and absorption ratio (0.25, 0.37%), table (4).

- **Specific Gravity of coarse aggregate**

Table 4: Results of dry and saturated specific gravity and absorption ratio of coarse aggregate for samples of the study area

No	dry specific gravity	saturated specific Gravity	**Absorption %**
S1	2.63	2.64	**0.32**
S2	2.60	2.61	**0.36**
S3	2.62	2.62	**0.28**
S4	2.64	2.65	**0.37**
S5	2.61	2.62	**0.25**

- **Specific Gravity of fine aggregate**

The specific weight of passing soils was determined from a sieve (No.4) according to the American standard [20], where the values of the specific weight of the fine soil ranged between (2.72-2.64), the highest value of the specific weight was reached in sample S5 and the lowest value in S2, table (5).

Table 5: shows the results of the specific gravity of fine soil in the study area

No	dry specific gravity	saturated specific Gravity	**Absorption %**
S1	2.71	2.75	**1.41**
S2	2.67	2.70	**1.21**
S3	2.64	2.69	**1.72**
S4	2.69	2.71	**1.01**
S5	2.72	2.76	**1.41**

7-4 Loss Angeles Test

This test was carried out at (the National Center for Laboratories and Construction Research, in Kirkuk Governorate), using the specification [21], the corrosion of the sample in this test gives evidence that the aggregates resistance. In contrast, the sample with little erosion shows that the sample is of high corrosion resistance, the results of the laboratory test

of the samples showed that the highest percentage of weight loss was (20.06%), as shown in table (6), as the maximum allowable weight loss for concrete works is (40%) according to the specification [3], thus, all samples are suitable for concrete work, in comparison with [22] specification, it should not exceed 35%, and thus it is suitable for concrete works according to [22] specification, table (6).

Table 6: results of the mechanical loss

No	The mechanical loss %	Limits of [22]	Limits of [3]
S 1	14	35% Max	40% Max
S 2	16.7		
S 3	14.7		
S 4	20.0		
S 5	16.2		

Plate 3: Los Angeles test process

7-5 Soundness test

According to the American standard [4], this test was carried out at the National Center for Laboratories and Construction Research, in Kirkuk governorate. The loss percentage was calculated for each sample and then compared with the loss percentage according to the specification [4]. And then, to indicate its suitability for engineering works, the laboratory test results proved that the percentage of weight loss for coarse aggregate (gravel) by the effect of sodium sulfate solution and for the number of 5 cycles of the sample ranged between (4.1% - 8.3%). Thus, it conforms to the requirements of the American standard [4].which states that the loss percentage does not exceed 12%, Table No. (7) shows the tests' results for the study area samples.

Table 7: Percentage loss of coarse aggregate according to the American standard

No	total weight of sample (gm)	weight of the sample after test (gm)	**Chemical abrasion ratio %**
S1	1000	937	**6.3%**
S2	1000	921	**7.9%**
S3	1000	924	**7.6%**
S4	1000	952	**4.8%**
S5	1000	959	**4.1%**

7-6 Point Load Test

The point load test is one of the important tests in rock mechanics. It is considered an indirect test for obtaining the unconfined compressive strength (UCS). It was considered a standard test by the international society of rock mechanics in 1973 [23], The test was carried out in the department of applied geology / college of science / university of Kirkuk, based on the specification [24], six samples of gravel, which are irregular in shape, were taken for each sample with different dimensions. Each sample was placed between the two loading points, then the device is managed manually until the collapse and failure of the sample.

The study area samples' unconfined compressive strength (UCS) was classified according to the classification [5]. The test was carried out by selecting six samples of aggregates depending on the different colour characteristics of each station and based on the classification [5]. The results showed that each of the stations (S1, S3, S4) falls within the classification range of (very strong - extremely strong), while the remaining two stations (S2, S5) fall within the (strong - very strong - extremely strong). Table (8) shows the point load check results for all station samples.

Table 8: The results of unconfined classification strength of samples and classification according to [5]

No	Number of samples per station	The highest and lowest value of the unconfined compressive strength (UCS) MPa	Classification of samples according to classification [5]
S1	6	135.12 - 234.54	Very Strong - Extremely Strong
S2	6	74.98 – 339.50	Strong - Very Strong - Extremely Strong
S3	6	138.57 – 277.73	Very Strong - Extremely Strong
S4	6	114.71 – 263.86	Very Strong - Extremely Strong
S5	6	68.01- 325.25	Strong - Very Strong - Extremely Strong

Plat 4: Point Load Test for samples of the study area

7-7 Chemical Analysis

The chemical properties of the soil are an essential factor in knowing the chemical behavior of the soil and the extent of the soil's tolerance of external factors affecting it, such as erosion and weathering processes [25], chemical analyses of soil samples for the study area were carried out at the (National Center for Laboratories and Construction Research in Kirkuk Governorate), according to British standard [6], to test the organic content, gypsum and sulfates, and according to the American standard, the percentage of soluble salts in water was found [26] The results are shown in table (9) were obtained, and the analysis results can be reduced to lower levels by washing during sifting and before using them in concrete since the results of the analyses for the samples are in their natural state without any washing or treatment. The results showed that they conform to the terms of British standard No [6].

Table 9: Results of chemical analyzes and their comparison with the British standard [6]

No.	TDS	percentage of organic content	SO3%	CaSO4.2H2O%	pH
S1	1.525	1.407	0.26	0.56	8.23
S2	1.322	1.534	0.177	0.381	8.02
S3	1.953	0.562	0.51	1.096	8.11
S4	1.681	1.548	0.385	0.828	8.09
S5	0.907	1.401	0.044	0.09	7.98
Limit of (B.S1337–T5, 1990)	10 Max	2% Max	5% Max	10.75% Max	-

7-8 Compressive strength test of Concrete

The compressive strength of concrete is defined as the resistance of the concrete cube sample to the pressure applied on it until the failure point is reached and the concrete is destroyed. The compressive strength test was conducted for cube-shaped concrete samples with dimensions (15 cm X 15 cm X 15 cm) at a rate of three cubes for sample at period of (7 days) and five cubes for each sample in a period of (28 days). The basic materials for the components of the concrete mixture (gravel, sand) were prepared from the stations of the study area in the laboratory of the (National Center for Laboratories and Construction Research, in Kirkuk Governorate).

7-9 Materials used

1- Coarse Aggregate: Coarse aggregate was used, passing from the sieve (19.5 mm) and retained on the sieve (4.75 mm).

2- Fine Aggregate: Passing sand was selected from sieve number (4.75) mm.

3- Mixing water used in concrete: Ordinary drinking water was used for the purpose of preparing the concrete cubes, and the water was used after checking the percentage of total dissolved salts in the laboratory because the increase in the percentage of total dissolved salts above the standard limit negatively affects the durability and life of the concrete.

4- Cement : Iraqi Almas-type cement was used, which is ordinary portland cement, conforming to the Iraqi standard [27]. The chemical, physical and mechanical properties of this cement were measured at the company's headquarters - laboratory department, on 05/20/2021 before the design of the concrete mixture, Table (10).

Table 10: The chemical, physical and mechanical properties of the cement used in the mixture, according to Iraqi standard [27]

Chemical Requirements		Testing Method	Limitation	Test Result
Loss on Ignition (as LOI)	%	IQ 472/1993	≤ 4.0	3.43
Non Soluble Substances	%		≤ 1.5	0.73
Sulfate Content (as SO_3)	%		2.5 if $C_3A \leq 3.5$	2.23
			2.5 if $C_3A \geq 3.5$	
Tricalcium Aluminates (C_3A)	%		≤ 3.5	3.33
Magnesium Oxide (as MgO)	%		≤ 5.0	3.66
Chloride Content [a]	%	BS EN 196-2/2013	≤ 0.1	0.01
Physical & Mechanical Requirements			**Limitation**	**Test Result**
Finesse (Blaine)	m^2/kg	IQ 198/1990	≥ 300	360
- Initial Setting Time	minute	BS EN 196-3/2016	≥ 45	160
- Final Setting Time	hours		≤ 10	3:32
Soundness (expansion) - Le Chatle	mm		≤ 10	0.0
Compressive Strength is not less than (mN/m^2) [b]	2d	BS EN 196-1/2016	≥ 20.0	24.3
	28d		≥ 42.5	48.0

7-10 Concrete Practical Program

A- Concrete mix design

The process of designing the concrete mix depends on a critical factor:

percentage of constituents of the mixture concrete

The aim for make concrete with a compressive strength of more than (30) MPa after 28 days of mixing, pouring and curing, the weight method was used to determine the proportion of the materials constituting the concrete mixture according to the weighted mixture (1:2:4 by weight) for the materials (cement, sand, gravel) respectively, according to the British standard [28].

B- Casting and Curing

- Mixing materials (cement, sand, gravel, water) and pouring the samples using special strong plastic moulds designed for this purpose, and the stages of casting and processing were as follows:
- The molds are cleaned well from the previous casting works. The mold is lubricated with a light layer of oil before the casting stage to ensure that the concrete does not stick after solidification with the mold's inner surface.
- All the molds were filled with a layer of thickness of 5 cm according to the British standard, which stipulates that the molds should be filled in three layers. The thickness of one layer is 5 cm.
- This layer was stacked using a metal rod 600 mm in length and 22 mm in diameter with a rounded shape from one end and with a number of strokes of up to 25 strokes per layer distributed evenly on the surface of the mixture.
- The second layer is added and stacked as in the first layer.
- The stacking process is repeated with the third layer until the mold is filled, and then it is well leveled with the upper edges of the mold.
- All molds are covered for up to 24 hours with a layer of nylon in the laboratory atmosphere to prevent water evaporation and avoid shrinkage cracks.
- The molds are opened, and the hardened concrete is extracted using an air pressure device to ensure no disturbance in the concrete cube after 24 hours of mixing and pouring.
- After casting, the concrete cubes were immersed in a water basin for seven days and 28 days.
- In the current study, the cubes were cast and prepared to check their compressive strength in two stages.

- In the first stage, three cubes of each sample were poured with several up to (15) cubes of all samples in preparation for testing their compressive strength after seven days of immersion in the treatment ponds.
- In the second stage, another 25 cubes of the same materials and concrete mix were poured at five cubes per station to check their compressive strength after 28 days of immersion in the treatment basins. Then the compressive strength of cubes poured from the same materials after seven days of treatment was compared to find out Which gives more resistance.

The sum of the cubes poured in the first and second stages is the pouring and checking of the unlimited compressive strength of 45 cubes of concrete after an immersion period of 7 days and 28 days.

C- Measure compressive strength

Compressive strength is the main criterion in determining the quality of concrete. For each type of concrete, there is a limited compressive strength that shows the purpose of its use [29].The compressive strength test was carried out at the (National Center for Laboratories and Construction Research, in Kirkuk Governorate) according to the British standard [30] for concrete cubes with dimensions (15cm x 15cm x 15cm). After the end of the treatment period, which included immersion in water for seven days and 28 days, the compressive strength

of each cube was calculated using the following equation No. (1).

F_{cu}= P / A ……(1) , F_{cu} = Compressive strength of a cube in units (MPa) , A= Concrete Cubic Area (mm2) , P= Maximum load (N)

The average compressive strength values of the concrete cubes ranged between (18.22 - 24.93 MPa) for seven days after the production of the concrete mixture, it ranged between (33.02 - 29.76 MPa) for 28 days after casting, depending on the reference mixture used in all stations, which is (1:2:4 by weight) and according to the Iraqi standard specification [7], the compressive strength values of concrete cubes are suitable for ordinary unreinforced concrete, in comparison with [8] classification shown in table (11) for the compressive strength of concrete cubes, it was found that the concrete produced is of the moderately endurable type. And According to [9], the minimum allowable compressive strength is 17 MPa. According to this specification, the concrete produced is suitable for use in concrete, building and construction works.

Table 11: shows the average compressive strength values of concrete cubes in 7 days and 28 days and their comparison with the classification [8] and [9].

No.	Average values of compressive strength of cubes in 7 days	Average values of compressive strength of cubes after 28 days	Type of Concrete by Classification [8]	According to [9]
S1	24.93	33.02.	moderate tolerance	Suitable for concrete works
S2	21.60	30.12	moderate tolerance	Suitable for concrete works
S3	18.22	29.76	moderate tolerance	Suitable for concrete works
S4	21.89	31.07	moderate tolerance	Suitable for concrete works
S5	23.49	32.66	moderate tolerance	Suitable for concrete works

Plat 5: The process of checking the compressive strength of concrete cubes

8- Interpretation and Conclusions

the following conclusions have been resulted

1- The results of the grain size for coarse aggregates showed their conformity with the gradient class (63 mm) according to the classification [1]. the results showed that the first station S1 conforms to a slight deviation in the sieve (0.3) mm. The second station, S2, conforms to the specification. The third station, S3, does not conform to the sieves (1.18) and (0.3) mm, and the fourth station, S4, conforms to the presence of The deviation in the sieve is (0.3) mm, and the fifth station S5: conforms to the specification with a deviation on the sieve (1.18) mm.

2- The highest percentage of flat-shaped granules in the study area samples was (29%). The highest percentage of longitudinally shaped granules reached to (19%). Thus it conforms to the requirements that must be provided according to the British standard, whose value should not exceed 50% for aggregates. Natural and less than 40% for crushed aggregate, thus meeting the requirements that must be provided for use in all concrete works

3- The results of the tests for samples of stations in the study area for coarse aggregates showed that the dry specific gravity values ranged between (2.60 - 2.64). While the saturated specific gravity values ranged (2.61 - 2.65), the specific gravity of fine soil ranged between (2.64-2.72). Thus it is suitable for use. in concrete works.

4- From (Los Angeles) test of the samples, the highest percentage of weight loss is (20.06%). And that the maximum permissible weight loss for cement

concrete works reaches (40%) according to the specification [3]. Thus all samples are suitable for concrete works.

5- The ratio of chemical abrasion is ranged between (4.1% - 8.3%). And thus, it conforms to the requirements of American standard [4], which stipulates that the loss percentage does not exceed 12%. Hence, all samples of stations in the study area are suitable for concrete works.

6- The resistance tests (compressive test deduced from the point load test) showed that each of the stations (S1, S3, S4) falls within the classification range of very strong - extremely strong. In contrast, the results of both stations (S2, S5) fall within the category - strong - very strong - extremely strong, based on the classification of [8], and thus they are all suitable for concrete works.

7- The results of the chemical analyzes represented by the tests (gypsum content, organic matter content, total soluble salts, sulfate content) of the sedimentation samples of the study area showed that they within the conditions that must be met for the aggregates used in concrete works, according to the terms of British Standard [6]. Thus, all samples of stations in the study area are suitable for concrete works.

8- The age compressive strength of concrete cubes ranged between (24.93 - 18.22 MPa) for seven days after the production of the concrete mixture and ranged between (33.02 - 29.76 MPa) for 28 days after pouring. Based on the reference mixture used in all stations (4:2:1 by weight) and according to the Iraqi standard Specification [7], the compressive strength values of the study stations samples are suitable for ordinary unreinforced concrete. In comparison with [8] classification of the compressive strength of concrete cubes, it was found that the concrete produced is moderate endurance. And suitable for concrete works According to [9].

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صلاحية ترسبات نهر الزاب الاسفل للأعمال الخرسانية – جنوب غرب كركوك/ شمال العراق

ابراهيم مصطفى حسن سليمان ، محمد راشد عبود ، لفتة سلمان كاظم

قسم علوم الأرض التطبيقية ، كلية العلوم ، جامعة تكريت ، تكريت ، العراق

الملخص

تم دراسة 5 محطات في حوض الزاب الاسفل جنوب غرب كركوك لتحديد صلاحية ترسبات العصر الرباعي للأعمال الخرسانية، وشملت نتائج التقييم الجيوتكنيكي ان التدرج الحجمي للركام الخشن مطابق لصنف التدرج (63 ملم) بحسب تصنيف [1]، اما تدرج الركام الناعم لترسبات منطقة الدراسة فقد أظهرت نتائج التدرج الحبيبي للنماذج بعد مطابقتها مع حدود المواصـــفة (AASHTO) انها مطابقة للمواصفة مع وجود اختلافات بسيطة على بعض المناخل، وتبين من نتائج فحصي عاملي التسطح والاستطالة ان اعلى نسبة للحبيبات ذات الشكل المسطح هي (29%) والشكل الطولاني هي (18%) وهي ضمن الحدود المسموح بها حسب المواصفة البريطانية [2]، وتم اجراء فحص الوزن النوعي وتراوحت قيمته للركام الخشن بين (2.60 – 2.64) و الوزن النوعي المشبع (2.61 – 2.65)، وقيم الوزن النوعي للتربة الناعمة بين (2.64-2.72) وهو ملائم للاستخدام في الاعمال الخرسانية، وأظهرت نتائج الفحص المختبري لفحوصات الديمومة – فحص لوس انجلوس لنماذج منطقة الدراسة ان اعلى نسبة فقدان في الوزن بلغت (20.06%) وهي ملائمة للاستخدام في الخرسانة حسب المواصفة القياسية العراقية [3]، وان نتائج الفحص المختبري للثبات ان نسبة الفقدان في الوزن للركام الخشن (الحصى) بتأثير محلول كبريتات الصوديوم ولعدد 5 دورات للنموذج تتراوح بين (4.1% –8.3%)، وهي صالحة للاستخدام في الاعمال الخرسانية حسب المواصفة الامريكية [4] ، واظهرت نتائج فحوصات المقاومة – فحص حمل النقطة ان نتائج الفحص للمحطات (S1, S3, S4) تقع ضمن مدى التصنيف Very Strong - Extremely Strong والمحطتين (S2, S5) تقع ضمن الصنف Strong - Very Strong - Extremely Strong بالمقارنة مع تصنيف [5] فهي تصلح لأعمال الخرسانة، وتبين من نتائج الفحوصات الكيميائية المتمثلة بمحتوى الجبس، محتوى المواد العضوية، مجموع الاملاح الكلية القابلة للذوبان، محتوى الكبريتات لنماذج ترسبات منطقة الدراسة مطابقتها للشروط الواجب توفرها للركام المستخدم في الأعمال الخرسانية الاسمنتية، حسب شروط المواصفة البريطانية [6] وهي تصلح لأعمال الخرسانة، واظهرت نتائج فحص المقاومة الانضغاطية للمكعبات الخرسانية بين (24.93 – 18.22 MPa) بالنسبة لفترة 7 ايام بعد انتاج الخلطة الخرسانية، وتراوحت بين (33.02 – 29.76 MPa) بالنسبة لفترة 28 يوم بعد الصب واعتماداً على الخلطة المرجعية المستخدمة لكل المحطات وهي (4:2:1 وزنية) وحسب المواصفة القياسية العراقية [7] فأن قيم مقاومة الانضغاط لنماذج محطات الدراسة تعد جيدة بالنسبة للخرسانة العادية غير المسلحة، وبالمقارنة مع تصنيف [8] فقد تبين ان الخرسانة المنتجة من النوع ذات التحمل المعتدل. وصالحة للأعمال الخرسانية حسب مواصفة الكود الامريكي [9].