SPECIFIC ASSESSMENT OF FINE AGGREGATES FROM DIBDIBBA FORMATION AT TAR AL-SAYED IN KARBALA (MIDDLE OF IRAQ) AS CONSTRUCTION MATERIALS

¹Khaled Ahmed Abdullah Alhadad* and ¹Humam Thair Saeed Alrawee

¹Department of Applied Geology, College of Science, University of Tikrit, Iraq

*E-mail: KhaledAlhadad@yahoo.com

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ABSTRACT

This research deals with assessing fine aggregate (sand) properties as construction materials, that were collected from the Dibdibba Formation at Tar AL-Sayed, Karbala, Iraq, in mortar, concrete, tiles, thermo-stone, solid, hollow masonry blocks and cement paste. Physical tests were carried out on five samples, the moisture content, specific gravity, density of both bulk, dry and porosity were almost varied. The tested samples show that they are unsuitable for all types of concrete, tiles types, thermo-stone and cement masonry block in terms of grain size in all fractions except that of 4.75 mm and 2.36 mm. Later all samples were treated by washing using fresh water, fine clean sand was added in an attempt to form a convenient type for all construction works. The total dissolved solids (1.67 – 4.53%), gypsum content (0.64 – 2.13%), organic matters (0.71 – 2.01%), Cl⁻ (0.11 – 0.81%) and pH (7.51 – 7.91) are ranged within the global standards (ASTM, USCS, BS, and IQS). Quartz is predominated mineral, albite and gypsum are of moderate abundance, whereas mica and calcite occurred as traces.

Keywords: Injana Formation; Tiles; Masonry block; Thermo-stone; Clean sand

INTRODUCTION

Iraq is one of many countries which it has a wide desert, it consists of plenty amounts of sand, particularly distributed in the Mesopotamian plain, the Tigris and Euphrates riverbanks, and its branches, geological formations such as the Dibdibba Formation which is exposed in the middle and south of Iraq. The study area is characterized by dry weather, high temperature (35C° as average) in summer, wind speed (3.9m/s). In winter, low temperature (10C°), rainfall average (16mm) and wind speed average (1.9 m/s) (IMO, 2014). Tar Al-Sayed is located about 30 km to

the west of Karbala between longitude 43°52'30" - 43°55'30" E, and Latitude 32°37'30" - 32°39'10" N (Fig. 1.).

Fig. 1. The location map of the study area

The research aims to determine the suitability of the fine aggregate occurred in the Dibdibba Formation. Several previous studies were carried out on fine aggregate in the Dibdibba Formation. The clastic of the Dibdibba Formation are originated from the Arabian Shield deposited in a fluvial environment (Sadik, 1977; Awadh and Al-Ankaz, 2016). Bulgur-Gunmen (1980) has assessed the Dibdibba Formation for the construction materials. Al-Hadad and Al-Jwaynee (2010) mentioned that the fine aggregate from selected sites in the middle of Iraq at each of Tuz, Alalam, Senyah, Anbar, and Karbala Alekaydeer are suitable to be used as construction materials like concrete, tiles and mortar, but after removing gypsum, and soft materials.

GEOLOGICAL SETTING

Dibdibba Formation (Pliocene - Pleistocene)

Macfadyen (1938) described the Dibdibba Formation for the first time in an ideal section in Al-Bargesiya area in the south desert of Iraq. Hassan (2007) described the Dibdibba Formation in Karbala, Najaf and middle of Iraq, upper part is exposed in Tar Al-Sayed and Tar Najaf, which formed main plateau, with a thickness ranges 1–18 m. It is formed from, sand and pebbly sand, sand colors are brown, gray, yellow, white, and yellowish brown (Fig. 2). The Quaternary sediments are overburden deposits formed from aeolian deposits, which are sand sheets, and sand dunes present in Karbala and Najaf Plateau. Most sand dunes type in the study area is Nabkah sand dune which is characterized by fine gains (Al-Tawash, 1966). Valleys fill sediments product from activity of seasonal rivers, which cross Razzaza Lake, it is a base sorted mixture of silt, sand, and pebbles (Al-Shamari, 2018). Alluvial sediments existed as a long-restricted zone at the lower part of Tar AL-Sayed, derived from erosion of the Injana and Dibdibba formations (Awadh et al., 2013). The study area is located on the unstable shelf between Mesopotamian and Salman zone, at the Abu Jir fault, Euphrates zone represents the boundary between stable zone and unstable zone (Awadh et al., 2018). Henson (1951) and Al- Amiri, (1979) indicated presence linear structure toward NW-SE. Geomorphology of the study area according to, Al-Khateeb, and Hassan (2005) exposed many features like Najaf- Karbala Plateau, Razzaza depression, and rock cliffs slope.

MATERIALS AND METHODS

Field Work

First step included many tours in the study area that are started on 8 March 2018, by which sampling sites were determined. Second step, five samples (1, 2, 3,4,5) or (RZ1-A, RZ1-B, RZ2, RZ3-A, RZ3-B) were collected. Many field works were also documented by photographs (Plate 1). The coordinates of the study area were determined by GPS.

Petrographic and X-Ray Diffraction Tests

Samples were tested by using the polarized microscope and XRD that were prepared in the Department of Geology, College of Science, University of Baghdad, and Iraqi Geological Survey.

Chemical Analysis

Total dissolved solids (TDS), gypsum content, organic matter content, chloride (Cl⁻), and pH according to Nu et al. (2020) and Shekel et al. (1999) were carried out in Chemical Engineering Department, Engineering Faculty, Tikrit University.

Fig. 2. Iraqi lithological map (Sissakian and Bader, 2012)

Plate 1. Field work

Physical Tests

Moisture content, density, grain size, specific gravity, and porosity were done according to ASTM-C-33-02 (2004) and carried out in laboratory of Applied Geology Department, College of Sciences, Tikrit University.

The physical tests include:

Moisture content (mc)

Moisture content was determined according to ASTM D2216-98 (2004) using equation 1

$$m_c = \frac{w_w}{w_d} * 100\% \quad (1)$$

Where: m_c = moisture content, W_w = weight of water, W_d = weight of dry sample

Specific gravity Gs

The Gs was computed according to ASTM D854-02 (2004) using equation 2.

$$G_s \text{ at } C^\circ = W_3 / (W_1 + W_3) - W_2 \quad (2)$$

W_1 = Weight of distilled water + Weight of Volumetric flask, Where: W_2 = Weight of mixture

W_2 = sample (water + soil) + Weight of Vol. flask

W_3 = Weight of dry sample

Gs at $t^\circ C$ corrected according equation 3.

$$G_s T_{20} = G_s T_1 \quad (3)$$

GsT1 = Specific gravity at Initial temperature $(18 - 30) \pm 1$.

GsT20 = Specific gravity at standard (20) temperature.

A = Heat correction coefficient.

Bulk and dry densities (dry Unite Weight) γ_B and γ_d

Bulk and dry densities was computed according to ASTM C788-7 (2017). (Wilun, and Starzewski, 1975) using equation 4.

$$\gamma_B = (\text{BulkWeight gm}) / (\text{Volume cm}^3), \gamma_d = \text{dry (Weight gm.)} / (\text{Volumecm}^3) \quad (4)$$

Porosity n%

Porosity was calculated mathematically according to equation 5.

$$n\% = (1 - \gamma_d/G_s) * 100 \quad (5)$$

Grain Size Analysis

The graded ratio of sand was measured by sieving mechanically. Sand classification depends on its grading (ASTM-D, 422-63, 2004) sand do not presence individual material, it mixed with pebbles, and fine soil. Grains were separated from each other using sieve analysis in order to determine sands ratios (ASTM D 2487-06, 2014; Lambe and Whitman., 1969). Data represent the American standard (Fig. 3).

RESULTS AND DISSCUSSION

Results are presented in Table 1. Values m_c , G_s , γ_B and γ_d , are low-moderate based on results of mineralogical composition. Porosity values (28.677- 40.008%) increase with friable and exposed sand. The climate parameters (evaporate, temperature, and rainfall) affect on some physical properties. Grain size results pointed to unsuitability of the raw material based on the standard of construction works, unless treatments take place. Chemical analysis results showed fitting with standards, only gypsum values appear unaccepted (>0.5%). XRD in Fig.5 clarifies that quartz is dominant to very dominant, albite and gypsum are moderate, and calcite is rare. Thin sections under plane polarized microscope shows same mineralogical composition that are identified by XRD (Plates 2 and 3). Treatment of the fine aggregate by washing with a tape water to remove or reduce gypsum and soft materials, then added clean fine graded sand according to fineness equation, so this treatment is recommended.

Treatments

Samples are classified coarse sand according to standards (Table1, and Fig.3.) Unsuitable, so treatment be necessary. Washed raw material by fresh tape water to remove gypsum and added fine clean sand, to balanced grading ratios, equations 6 and 7. (ASTM C 33/C33- M13, 2003) (Fine ness modules).

$$FM = R_1 FM_1 + R_2 FM_2 \quad (6)$$

$$R_1 + R_2 = 1 \quad (7)$$

Where: FM= fineness equation, R_1FM_1 = Coarse Sample fineness, R_2FM_2 = Fineness of fine sand, R_1 = ratio of coarse sample and R_2 = ratio of fine sand. Noticed Table 2 and Fig. 6 showed samples curve after treatment, it be suitable for construction works.

Fig. 3. American standard of fine aggregate grading

Table 1. Results of some physical and chemical properties

Samples	RZ1-A	RZ1-B	RZ2	RZ3-A	RZ3-B
Mc	5.329	1.791	2.944	1.132	3.092
Gs	2.227	2.069	2.070	2.229	2.070
γ_d	1.366	1.455	1.477	1.455	1.355
γ_B	1.644	1.666	1.622	1.688	1.655
n%	40.008	29.677	28.648	34.725	34.542
4.75mm	100	99.36	99.55	99.55	99.47
2.38mm	99	96.26	94.12	94.66	95.71
1.18mm	93.1	84.34	82.41	78.49	82.5
0.600mm	78.99	66.59	67.42	58.7	64.55
0.300mm	36.11	40.49	35.42	32.58	44.06
0.150mm	16.89	6.48	15.55	11.2	11.99
0.075mm	4.31	2.31	4.15	4.43	3.38
T.D. S	2.31	1.67	3.15	4.53	2.03
Gypsum	1.23	0.92	2.13	0.60	1.21
o.m.c	1.88	2.01	0.96	1.97	0.71
Cl ⁻	0.61	0.11	0.81	0.20	0.42
pH	7.76	7.83	7.51	7.91	7.62

mc=moisture content, Gs= Specific gravity, γ_d , γ_B = Dry, Bulk density, n%= Porosity
 4.75mm - 0.075mm Grain diameters, T.D.S.= Total soluble salts, Gyp. %= Gypsum
 content%, o.m.c.= Organic material content, Cl⁻ = Chloride Ion, and pH= Acidic index

Fig. 4. Grain size curves of samples

Fig. 5. X-ray diffraction of samples

Plate 2. A, B; Mono, poly crystalline Quartz, C, D, F; Feldspar crystals, and E; carbonate

Plate 3. A; Chert rock, B; Igneous rock, C, D; Mudstone, metamorphic fragments, gypsum, quartz, and carbonate

Table 2. F. M. upper, lower limits, R_1FM_1 , R_2FM_2 , ratios of sample and fine sand

Samples	RZ1-A or 1	RZ1-B or 2	RZ-2 or 3	RZ3-A or 4	RZ3-B or 5
F.M.L L.	3.38	3.38	3.38	3.38	3.38
F.M. Up. L.	2.18	2.15	2.15	2.15	2.15
R_1FM_1	3.41	3.89	3.99	3.77	3.91
R_2FM_2	1.7-1.7 R_1	1.73-1.73 R_1	1.81-1.81 R_1	1.76-1.76 R_1	1.64-1.64 R
R1	42.5%	49.5%	36%	51.75%	51%
R2	57.5%	50.5%	64%	48.25%	49%
F.M.L.	-	2.80	2.80	2.80	2.80

F. M. L. L=Cumulative sum% Lower limit =3.38%, F. M. Up. L=Cumulative sum% upper limit= 2.15%
 R_1FM_1 =Coarse sand (sample) ratio, R_2FM_2 = Fine sand ratio and F. M. L. =Mean of sum lower, upper limits
 curves of standers

Fig. 6. Grain size curves of samples after treatments

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Friable sand appears of low moisture content, and high - medium porosity.
2. Samples 1, 2, 3, 4, and 5 represented fine aggregates contain gypsum more than 0.5%, it is not acceptable values, and need to remove gypsum.
3. Mineralogically, quartz is dominate to very dominate in all samples. Albite and gypsum are of moderate distribution, calcite in sample 5 is rare, therefore removed gypsum is important.
4. The TDS%, omc%, Cl⁻ % and pH value, are acceptable ratios and coincide with the standard. Gypsum content % is unacceptable.
5. Grain size results for all samples are unsuitable as raw materials.
6. Raw materials must be mixed with fine cleaned sand with a certain grading ratios added according to equations 6, 7 (ASTM, Fineness equation).

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