Replacement of Natural Sand in Mortar by River Sand Mechanical Properties

عداد/ Hayder Al Khazraji

(UTC+0200) **تاريخ الارسال:** 15-يناير-2021 09:42ص

معرف الارسال: 1487949827

اسم الملف: Natural_Sand_in_Mortar_by_River_Sand_Mechanical_Properties.docx (41.75K)

حساب الكلمات: 2510

عدد الرموز: 12479

Replacement of Natural Sand in Mortar by River Sand: Mechanical Properties

Abstract. The high cost of natural sand in some countries cause to the engineers and researchers to investigate the possibility and feasibility of using other materials to be used as a fine aggregate in concrete mixes. This work aims to provide a better understanding of the mechanical behavior of mortar under loading (compression, direct tension and flexural moment).

In Iraq, there are many cities placed along the Tigris and Euphrates, therefore can be obtained a lot of quantities of river sand that result from cree and clean these rivers which is considered a cheap prices material, it is used in agriculture only. The most of natural sand in Iraq contains high sulfur trioxide (SO_3) which is exceed the Iraqi Standard Specifications [IQS No. 45, 1984], it is (0.5 %).

This work explains the influence of river sand on the mechanical behavior of mortar which replacement of natural sand. Four groups of specimens have been realized within a water cement ratios of 0.48, 0.52, 0.58 and 0,6. One group is considered as reference: these specimens without river sand, natural sand only. Other groups have been river sand that replacement of natural sand of 25, 50 and 75 %. All manufactured specimens have the following dimensions for cubes (50 * 50 * 50 mm), prisms (40 * 40 * 160 mm) and bon dog (25 * 28 * 70 mm). In this work, some tests are used for materials and specimens for examples sieve analysis and flow test for materials. Compression test, flexural test and bon dog test have been designed for specimens.

Finally, the experimental results are presented in relationships, histogram and tables between mechanical properties and the replacement of river sand. The results show the effect river sand on the mechanical properties positively until 25 % but this this behavior becomes negatively when this value becomes higher than 25 %.

INTRODUCTION

The high cost of natural sand in some countries cause to the engineers and researchers to investigate the possibility and feasibility of using other materials to be used as a fine aggregate in concrete mixes. This work aims to provide a better understanding of the mechanical behavior of mortar under loading (compression, direct tension and flexural moment).

In Iraq, there are many cities placed along the Tigris and Euphrates, therefore can be obtained a lot of quantities of river sand that result from cree and clean these rivers which is considered a cheap prices materials, it is used in agriculture only. The most of natural sand in Iraq contains high sulfur trioxide (SO3) which is exceed the Iraqi Standard Specifications [1], it is (0.5 %). [2] pointed out this value. The sulfur content (SO3) in cement paste influence on behavior hardened cement paste, negatively.

The increasing of sulfur content (SO3) leads to delayed ettringite formation (DEF) can damage concrete. On the other hand, the sulfates reaction with the compound of cement caused to increase of volume hardened cement paste with internal stresses that caused to weak strength of cement [3] , [4]. We can explain this phenomena the reaction that accompanied with increasing in solid volume which is useful at early age of curing because this products fill the

pores and decrease the voids percentage and increase the strength. While the increasing in solid volume at later age, after concrete is harden is harmful that cause to increase the internal stresses and these stresses leads to cracking and deteriorates the concrete. For this problem, some of researchers are presented studies to use river sand which has a little of (SO3) (less than 0.5%) [Al-Salihi, 1994] [5], that presented the river sand is used as a fine aggregate because the proportion of sulfur trioxide (SO3) is not more than (0.1 %) and gives compressive strength is similar to compressive strength of concrete for the mixtures with the natural sand.

There is limited amount of previous work conducted on the use of river sands in concrete or mortar [6] have studied the effect of very fine sand dredged from river estuaries on concrete mixtures. It was found that as the sand content increases, the water required for a given workability increases. However, it was noticed that water contents required for normal workability are not higher than in concrete made with coarser sand. It was also found that strength development and elasticity are not different than conventional concrete.

[7] carried out an experiment which shows that sand concrete has almost equal strength to ordinary concrete, mainly in river sand concrete and increasing water/cement ratio increases the cube strength in dune sand concrete [7] therefore established the fact that the use of additives causes an increase in the strength up to 40% in dune sand concrete while this increase is almost negligible in river sand concrete.

This study is presented in this research through the use of river sand in mortar as an alternative to natural sand and different replacement ratios were (25, 50, 75 %) and indicating the impact of this substitution on the mechanical properties (compression, direct tensile test, flexural bending moment test) of the produced mortar compared to the results of references mixtures are tested with natural sand as fine aggregate only. Fig.1 shows the quantity river sand.

EXPERIMENTAL PROGRAM

This section presents the methodology of this study and materials composition with mix proportions, specimens preparation and curing method. In the following part of this section will be presented. The principles of mechanical device of the compression test, flexural test and bon dog test (direct tensile test) will be presented here.

Methodology

The experimental work highlights the effects of river sand on mortar mechanical behavior under loading. In additions, absorption test is presented for cubes specimens for each mixtures and sieve analysis and flow test are explained in this work. Fig.1 shows the specimens of mortar: cubes, prisms and eight shape (Bon dog).

Portland cement test

River sand is used as fine aggregate in mortar, three percentage of river sand are replacement of natural sand; 25, 50 and 75 %. On the other hand, four mixtures are used here will be presented in the next section.

Portland cement is used according to Iraqi Standard No. 5 of 1984. Physical properties of cement are given in **TABLE 1**.

Mix proportions

Four mix proportions used in this work are given in TABLE 2: Mix MR-00 corresponds to mortar without river sand, Mix MR-25 corresponds to the mortar with 25 % of river sand that replacement of natural sand, Mix MR-50 corresponds to mortar with 50 % of river sand that replacement of natural sand and Mix MR-75 corresponds to mortar with 75 % of river sand that replacement of natural sand. All four mixtures are used mix proportions 1:3 while the water cement ratios are used 0.48, 0.52, 0.57 and 0.60 respectively. Last two mixtures are used

superplasticizer 50 and 75 g respectively. TABLE 2 shows details of mix proportions for four mixtures. Superplasticizer is used to get as well workability, when have been used river sand will be needed more water for mixing that means more fine particles with river sand.

Tap water is used to prepare the mixtures for all the specimens. [3] pointed out that PH ranging between 6.0 and 8.0 had no significant effect on the compressive strength of concrete.

Sieve analysis

Iraqi Standard No. 45 of 1984 is depended in this work for sieve analysis to the fine aggregate. TABLES 3 and 4 show sieve analysis which resulted for fine aggregate (natural sand) and river sand, respectively. Fig.2 shows sieve analysis results for natural sand.

Specimens preparations and tests devices

Three cubes, prisms and bon dog specimens have been prepared for each age. All manufactured specimens have the following dimensions for cubes (50 * 50 * 50 mm), prisms (40 * 40 * 160 mm) and bon dog (25 * 28 * 70 mm). These specimens were cast in steel moulds, see Fig.3. After casting, these specimens were stored within moulds in a humidity room for 24 h at 20 °C with 98 % relative humidity. Then, the specimens were put without moulds for curing in water at 20 °C during 7, 14 and 28 days.

For studying the behavior of mortar under loading, three tests on mortar are classified in next sections compression, flexural and bon dog.

RESULTS AND DISCUSSION

This section presents the results of this study and discussion with explain the behavior mortar with river sand under loading, i.e. mechanical properties for compression test, flexural test and tensile test (bon dog). In addition, the relationships between replacement of river sand and mechanical behavior are offered in this section. Three percentages of replacement of river sand are used in this work 25, 50 and 75 %, all mixtures details are given in chapter two.

Compression test

The hydraulic ELE compressive machine was used with axial loading with capacity of 1000 kN. Each mixture is included three cubes were tested for each age 7, 14 and 28 days, respectively. This test is classified to the Iraqi Standard Specifications [1], British Standard [8] and [9].

Fig.4 shows the relationship between compression stress with replacement of river sand with natural sand for three ages of curing. The results show the compression stress of mortar with replacement of river sand 25 % higher than the corresponding reference mortar for all ages (7, 14 and 28 days) and this increasing is between 7 and 21 %. Herein, the river sand particles are considered filler materials in mixtures and that led to produce more bonding strength in mortar. In addition, the replacement river sand is led to improve the grading until 25 % i.e. the replacement of river sand is produced the correction of particle size distribution and improvement of rheological and mechanical properties. However, the silt and clay that are passing from sieve 150 µm in river sand is considered pozzolanic materials which reacts with the calcium hydroxide in mortar or cementitious materials with water, that is more bonding until 25 %. While, the compression stress seems to decrease as the river sand increases. However, the results show the particles size of river sand influence on the compression stress of mortar. But this effecting is considered negative when the river sand is more than 25 %.

To explain the decreasing in compression stress cause to increase the surface area of fine aggregate that lead to increase the water content to achieve the optimum workability. Increasing in water content that means increasing in avoid after hardening. In addition, the influence of gap grading in fine aggregate due to the river sand is one size particle (mono size). However, note that silt and clay in river sand reduces the mortar or concrete strength. Figs.4 and 5 show the relationship between compression stress and replacement of river sand we can see this behavior, clearly.

Flexural test (indirect tensile test)

The hydraulic ELE flexural machine was used with axial loading with capacity of 100 kN. Each mixture is included three prisms were tested for each age 7, 14 and 28 days, respectively. This test is classified to the [10] and [11] standards.

Three groups were presented in this test according to their ages of curing 7, 14 and 28 days. The flexural stress is increased for three ages, generally. When the replacement of river sand is increased until 50 % for two ages 7 and 14 days, while for the 28 days the increasing is until 25 % of river sand. The rate of increasing is between 48 and 88 % with replacement is reached to 50 % for two ages 7 and 14 days. However, this increasing of flexural stress is reached to 7 % for the 28 days. The flexural results are plotted in curve and histogram as shown in Figs.6 and 7, respectively. These figures show the relationship between the flexural stress and replacement of river sand for three ages. We can see the improvement of flexural behavior of specimens under loading, i.e. increases of flexural with increasing of river sand until 50 % for ages 7 and 14 days. While, the flexural stress is increased with the increasing of river sand until 25 % for 28 days.

The increasing in flexural stress due to the improvement the grading in fine aggregates (sand), i.e. is produced more density for the mortar when using river sand and more bonding between fine aggregates and cement paste.

Bon dog test (direct tensile test)

The eight shape (bon dog) test is one important test for mortar. From this test can be pointed out the real behavior material (mortar) under direct tensile test. The hydraulic ELE flexural machine was used with axial loading

with capacity of 100 kN. But the upper part was classified for bon dog specimens. Each mixture is included three bon dog specimens were tested for each age 7, 14 and 28 days, respectively.

The tensile behavior of mortar under loading (direct tensile loading) is negative, generally, that means the tensile stress decreases with increasing of the replacement river sand, it was starting from 25 to 75 % of natural sand. In addition, this behavior is similar for three ages, 7, 14 and 28 days. This test gave us real indication for the mortar under direct tensile force. The results show the tensile stress is less than flexural stress for the prisms specimens. Figs.8 and 9 show the results as a relationship between tensile stress and the replacement of river sand for three ages, we can see the decreasing of tensile stress with the increasing of river sand.

GERNERAL CONLOUSSIONS

To study and investigate the effects of replacement of river sand by natural sand on the mechanical properties were presented in this research. Three percentage were used herein, 25, 50 and 75 %. The first percentage is better than others i.e. the mechanical properties were a good agreement with some work in literature review.

Through the current study and the results obtained, the following conclusions can be noted:

1. Decreasing of workability with increasing of replacement of river sand with the same of water / cement ration, therefore a superplasticizer is used in this study.
2. The possibility of replacing natural sand (sand quarries) with river sand replaced the molecule and the replacement ratio which gave good results amounted to 25% of the weight of sand used.
3. The compressive stress of mortar is increased by increasing the percentage of sand substituted to a maximum of 25% higher than the compressive stress of the reference mixture when the replacement ratio is 25%. This increasing is considered for all ages 7, 14 and 28 days.
4. The compression stress of mortar starts to decrease when the replacement of river sand higher than 25%. This decreasing is pointed out for three ages 7, 14 and 28 days.
5. Increasing flexural stress of mortar when the replacement of river sand is 25%. While the flexural is decreased when the replacement of river sand higher than 25% for three ages 7, 14 and 28 days.

Replacement of Natural Sand in Mortar by River Sand Mechanical Properties

تقرير الاصالة

13%	6%	9%	2%
مؤشر التشابه	مصادر الانترنت	الاصدارات	مستندات الطالب

المصادر الرئيسية

1	A.S. Al-Harthy, M. Abdel Halim, R. Taha, K.S. Al-Jabri. "The properties of concrete made with fine dune sand", Construction and Building Materials, 2007 الاصدارات	3%
2	Haitham Al-Thairy. "Effect of Using River Sand on The Strength of Normal and High Strength Concrete", International Journal of Engineering & Technology, 2018 الاصدارات	3%
3	www.iosrjournals.org مصدر الانترنت	3%
4	www.uomisan.edu.iq مصدر الانترنت	2%
5	M. Iqbal Khan, Galal Fares, Shehab Mourad, Wasim Abbass. "Optimized Fresh and Hardened Properties of Strain-Hardening Cementitious Composites: Effect of Sand Size and Workability", Journal of Materials in Civil	1%

Engineering, 2016
الاصدارات

6	Anti-Corrosion Methods and Materials, Volume 61, Issue 3 (2014-09-16) الاصدارات	<1%
7	"Smart Technologies for Sustainable Development", Springer Science and Business Media LLC, 2021 الاصدارات	<1%
8	Ravindra K. Dhir, Jorge de Brito, Gurmel S. Ghataora, Chao Qun Lye. "Use of Glass Cullet as a Sand Component", Elsevier BV, 2018 الاصدارات	<1%
9	Alaa Rashad. "Cementitious materials and agricultural wastes as natural fine aggregate replacement in conventional mortar and concrete", Journal of Building Engineering, 2016 الاصدارات	<1%
10	Abhishek Srivastava, S.K. Singh. "Utilization of alternative sand for preparation of sustainable mortar: A review", Journal of Cleaner Production, 2020 الاصدارات	<1%

Replacement of Natural Sand in Mortar by River Sand Mechanical Properties

تقرير GRADEMARK

الدرجة النهائية

/0

تعليقات عامة

المدرس

صفحة 1

صفحة 2

صفحة 3

صفحة 4

صفحة 5

صفحة 6

صفحة 7