STUDY THE USE OF RECYCLED AGGREGATES IN THE CASTING SHALLOW FOUNDATIONS

[1]MAHMUD M. ABU ZEID, [2]M. A. ATTIA

[1](Civil Engineering Department, Faculty of Engineering, Qena , South Valley University, Egypt)
[2](Department Of Civil Engineering, Helwan University, Cairo, P.O. Box 1171
E-mail: eng_abuzeid@yahoo.com, Dmahmoud_75@yahoo.com

Abstract- Due to the shortage of space for land reclamation in Qena Governorate, it is difficult to dispose tons of construction, Adoption of recycled aggregate from concrete waste. Most of studies held in Qena Governorate on recycled aggregate produced from construction and demolition wastes, focused on using recycled aggregate as granular material for base coarse roads and for concrete mixes for concrete hollow blocks. The percent of fine recycled aggregate in the all recycled aggregate was about 9.0% so it was excluded from the study. 0 % and 40 % of coarse recycled aggregate was used in the experimental tests. Two kinds of natural fine aggregates were used, Qena sand and crushed stone. The experimental tests focused on, physical properties density and workability, and mechanical properties compressive strength, flexural strength and bond strength between concrete and steel in raft foundation for example. More than 70 concrete specimens were tested for the study. The tests showed that the workability of recycled aggregate is lower than the workability of natural aggregate concrete ,the slump test was about 1.0cm slump for 40 % coarse recycled aggregate concrete and increases as the percent of recycled aggregate decreases . The compressive strength of recycled aggregate concrete with 40 % recycled aggregate, is about 85% of natural aggregate concrete. The compressive strength increases as the Percent of recycle aggregate in concrete mixes decreases.

Keywords- Recycled Aggregate, Compressive Strength, Raft Foundation, Natural Aggregate

I. INTRODUCTION

The quality of concrete made from recycled aggregate is generally lower than that of Concrete made from natural aggregate. The main reason for this is that recycled aggregate with its higher water absorption capacity has a porous mortar matrix around the natural. aggregate and hence develops an inferior bond Concrete is the premier construction material across the world and the most widely used in all types of civil engineering works, including infrastructure, low and high-rise buildings, defense installations, environmental protection facilities . Since aggregate represents about 70-80 % of concrete components, recently the use of recycled concrete as a structural fill material, in lieu of natural aggregate, has recently been increasing. In some regions, recycled concrete aggregate may cost 30 % to 40 % less than natural aggregate. The disposal of construction and demolition wastes in Qena Governorate is one of the challenging problems; due to the scarcity of open lands and the limited size of municipal dumping sites to accommodate large quantities of debris and unprocessed construction wastes. Aggregate produced from recycled concrete is badly needed in Qena Governorate to reduce the import of natural aggregate materials, transportation cost, and improved profits and to improve the environment by reducing wastes. The environmental problems in Qena Governorate are immense; it is one of the places in the world where the exploitation level of resources exceeds the carrying capacity of the environment. This is especially true for the land resource, which are under high pressure of prone to serve over-exploitation. The disposal of construction and demolition wastes in Qena Governorate is one of the challenging problems; due to the scarcity of open lands and the limited size of municipal dumping sites to accommodate large quantities of debris and unprocessed construction wastes. The random and uncontrolled disposal of construction an demolition wastes creates several environmental impacts.

In this research, recycled aggregate has been investigated to be as concrete fillers instead of natural aggregates or combined with it to produce concrete mixes to be used in concrete structural elements. By recycling of construction and demolition wastes the environmental impact can be minimized to the lowest level and natural resource of aggregates will be saved, shown as Fig(1).



Figure (1): Random and uncontrolled disposal of construction and demolition wastes at Qena City

III. EXPERIMENTAL PROGRAM AND MATERIALS

In general, aggregates make up 50%-65% of the total concrete volume, so their selection is important, because they control concrete properties. Hence, the selection and proportioning of aggregate should be given careful attention. Since recycled aggregate has a larger amount of porosity and can potentially undergo higher degree of deformation and will be weaker than the cement paste, therefore, it can greatly affect the mechanical and physical properties of concrete

3.1 - Experimental program

Figure (2) summaries the experiments and steps carried out in this work to study the effect of recycled aggregate on concrete properties.

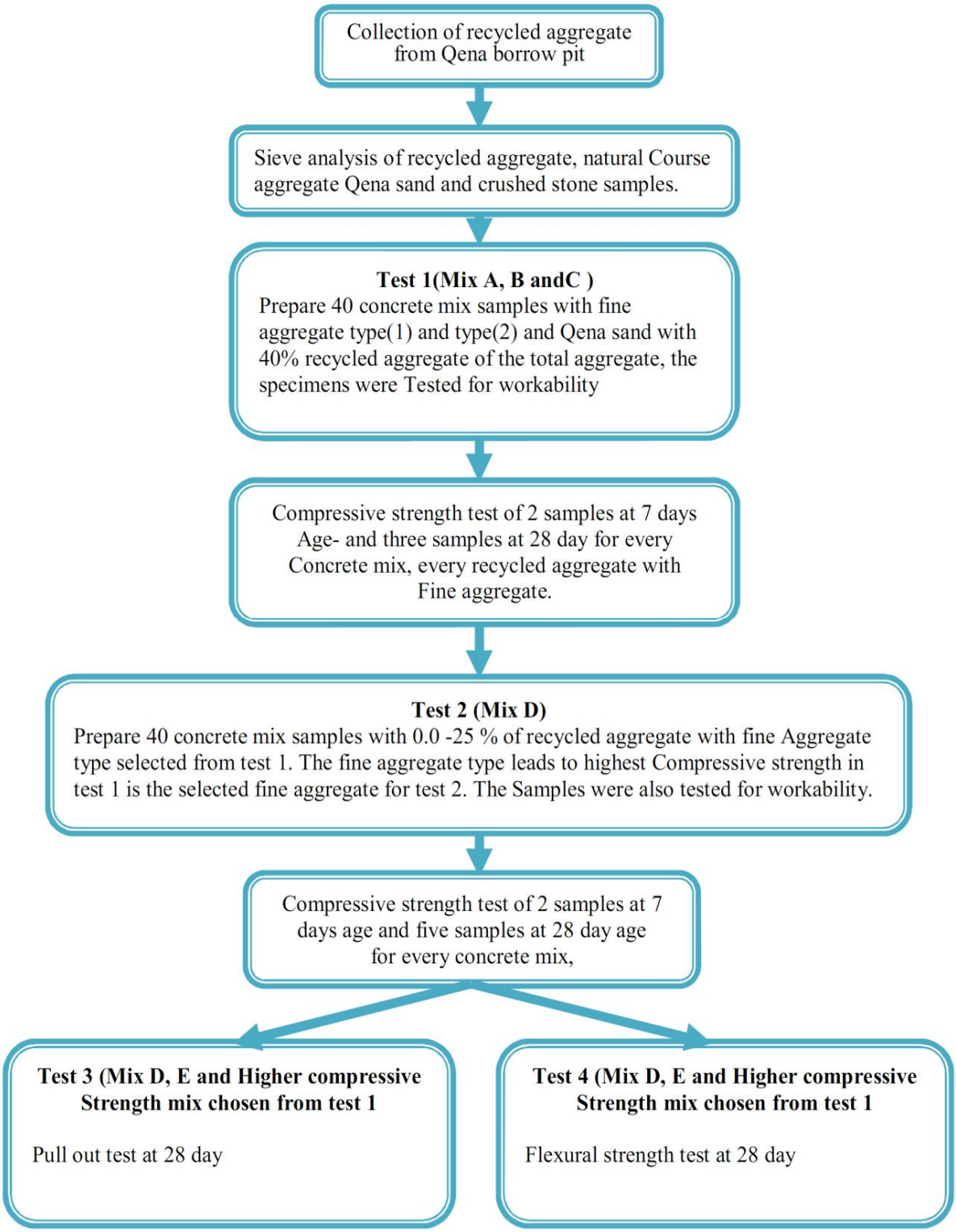


Fig (2): The chart of test program steps

. 3.2 Materials

Materials was used in the test program, ordinary Portland cement, natural course aggregate, recycled coarse aggregate , sand, natural crushed stone, water and super Plasticizer.

Material properties were as follows:

3.2.1Cement

Portland cement type used throughout the research, the cement is obtained from local concrete manufacture and reservation in dry site.

3.2.2Water

Natural water without any salts was used in the research. The water Source was the soil and material laboratory in faculty of engineering, South Valley University and Helwan University.

3.2.3Admixture:

In some concrete mixes, a workability admixture was used to study some variables the objective using admixture was only in order to improve workability by increasing slump value without changing the water-cement ratio.

.

3.2.4 Natural Aggregates:

Two major categories of aggregate were used, fine and coarse aggregates.

3.2.4.1 Natural Coarse aggregate:

The coarse aggregate in this research was crushed limestone, two sizes of course aggregate were used with maximum nominal size (20mm) and minimum size of 2.50mm.. The appearance of these aggregate are shown in Fig (3).



Fig (3): Aggregate used in mixtures preparation: (a) Aggregate with maximum size 20 mm -15mm. (b) Aggregate with maximum size 15 mm -5.5mm.

Many of the properties aggregate should be known to prepare one cubic meter of concrete.

The most of the properties aggregate which required preparing concrete mixes are:

. Specific Gravity:

The specific gravity was determined according to the American Standard AASHTO T100-70 using distilled water. For testes were carried out on the sample. The difference between the obtained values was very small, Shown in Table (1).

Table (1): Aggregate specific gravity

Aggregate type	G_s
Type (1)	2.66
Type (2)	2.67

- Water content:

The aggregate water content is the percentage of water present in a sample of aggregate either inside pores or in the surface. The water content was 0 .21% for all types.

. Density:

The bulk density of aggregate is the weight of aggregate per unit volume. The bulk density value is necessary to select concrete mixtures proportions.

Table (2) illustrates the aggregate density values.

Aggregate type	Dry density (Kg/cm^3)
Type (1)	1.555
Type (2)	1.652

- Aggregate absorption:

Absorption of aggregate is the weight of water present in aggregate pores expressed as percentage of aggregate dry weight. Table (3) illustrates the absorption percentages of all aggregates.

Table (3): Aggregate absorption

Aggregate type	Absorption (%)
Type (1)	1.09
Type (2)	2.33

- Grain Size Analysis:

Particles size analyses were conducted on the tow soil samples (coarse sand and fine sand).

The tests were performed in accordance to the (Standard Practice for dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants).show in figures (4, 5) respectively.

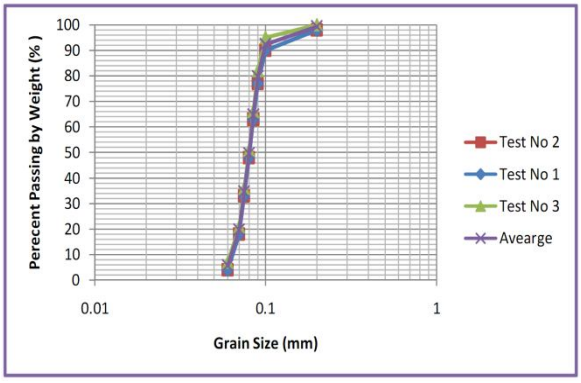


Figure (4): Particles Size Distribution Curve for Fine aggregate

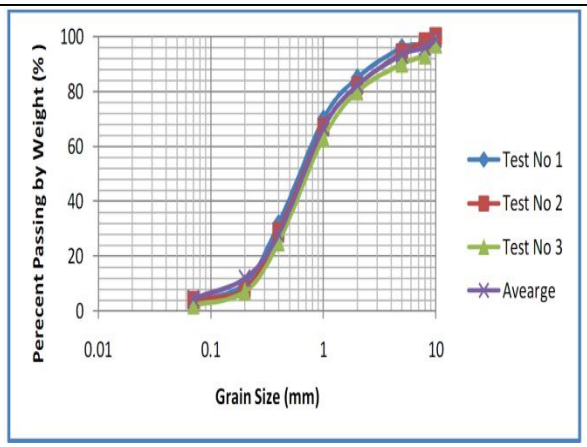


Figure (5): Particles Size Distribution Curve for coarse aggregate

- Fineness Modulus (F.M):

The use of a single parameter to describe the grading curve can be useful in checking the uniformity of grading. The fineness modulus is such a parameter that can be defined as:

F.M= ∑Cumulative percent retained on standard sieves (sieves No.4 to No.100)/100

The fineness modulus should be between 2.0 - 3.0.The fineness modulus of fine aggregate is required for mix proportioning. In this research two natural aggregates were used Qena sand and crushed stone:

. Sand:

Sand is a natural material, and it is available in Qena ..The appearance of Qena sand is shown in Fig (6).



Figure (6): Sand sample



Fig (7): a) Natural coarse aggregate b) Recycled coarse aggregate

3.3. Mix proportions

All the mixes was designed for slump 80-100 mm, and designed for the same air content of 0.015 per unit volume. The same water, cement and admixtures were used in all mixes; the variable material is the coarse and fine aggregate type, compressive strength of 250 Kg/cm^2 and 300 kg/cm^2

3.3.1-Mix A:

The proportions in this mix was designed using fine aggregates type (1), (F.M=2.0), and recycled aggregate as a coarse aggregate

3.3.2-Mix B:

The same mix design used in mix A is used in mix B, but all the quantity of fine aggregate is replaced by Qena sand , Concrete with compressive strength of 250 Kg/cm^2 and 300 kg/cm^2

3.3.3-Mix C:

The proportions of mixing in this set of testing was designed using fine aggregates fine type (2) with F.M=2.4 and recycled aggregate as a coarse aggregate.

3.3.4-Mix D

Mix D is used as a control mix, natural coarse aggregates and fine aggregate type 2 is used (coarse aggregate is saturated).

IV. RESULTS AND ANALYSIS

Results of the test program designed to study the properties of the various recycled aggregate concrete mixes as described in the test program. The density, slump test of fresh concrete (workability), compressive strength, flexural strength and check bond between concrete and steel of concrete specimens were discussed to investigate the influence of recycled aggregate on concrete properties. The two optimum compressive strength mixes of different percent of recycled aggregate in addition to the natural aggregate mix were used to investigate the flexural and bond strength properties. The physical and mechanical properties were discussed as follows:

4.1 Density:

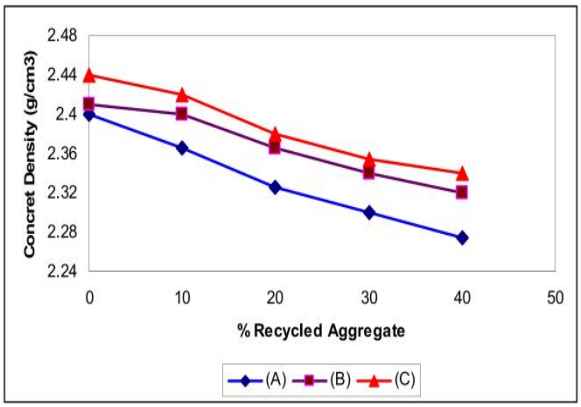


Fig (8): Average 28 day concrete density versus percentage of recycled aggregate

The decrease in concrete density when the percent of recycled aggregate in concrete increase can be explained as follows:

- The dry density of recycled aggregate is 1.35 g/cm^3; on the other hand the dry density of natural aggregate is 1.550 g/cm^3.

- Recycled aggregate has rough – textured, angular and elongated particles, which leads to less compacted concrete, where natural aggregate is smooth and rounded compact aggregate.

As shown in Figure (9), the density of concrete with 40% recycled aggregate increases when water cement ratio decreases, which is the same behavior of natural aggregate concrete.

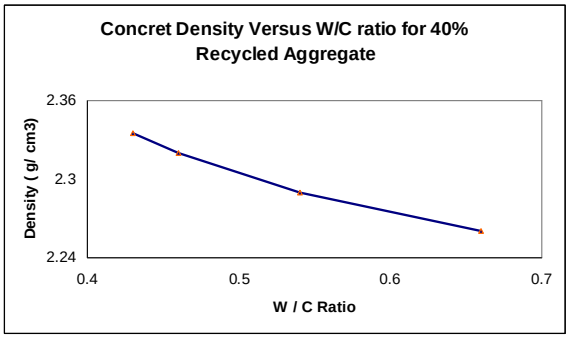


Figure (9): Average 28 day concrete density versus water/cement ratio for 40% recycled aggregate concrete

4.2 Workability

The slump value was used as indication of mix workability and all the mixes was designed for 80-100mm slump value, the percentage of recycled aggregate increases. The slump was about 1.0cm for recycled aggregate concrete without any admixtures and the slump was about 6.5 cm for natural aggregate concrete.

4.3 Compressive strength

The compressive strength of concrete is affected by both the aggregate properties, and the characteristics of the new cement paste that is developed during the maturing of concrete. The potential strength of concrete is partially a function of aspects related to mix proportioning such as cement content, water/cement ratio and choice of suitable aggregate but also a function of proper curing when chemical bonding develops. The w/c ratio, proper compaction and adequate curing, affect the development of concrete microstructure, and also affect the amount, distribution and size of pores, shown as Fig (10).

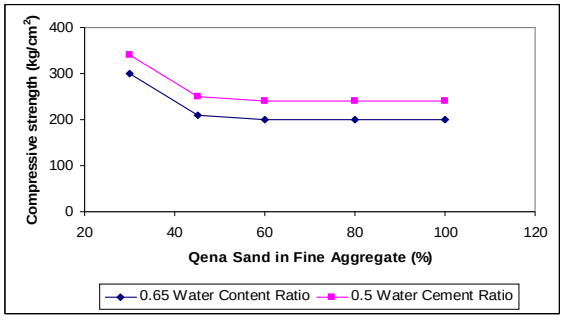


Fig (10): Average compressive strength versus % of Qena sand for the 40.0% of coarse recycled aggregate

The effect of Qena sand on recycled aggregate concrete is increase percent of sand increases the surface area of aggregate and consequently more absorption of water, taking in mind high water absorption of recycled aggregate.

4.4 Modulus of rupture _Flexural strength

Figure (11) show the relationship between recycled aggregate percent and flexural strength for theoretical and actual flexural strength .The flexural strength decreases as the percent of recycled aggregate increases and the flexural strength is well proportioned to compressive strength.

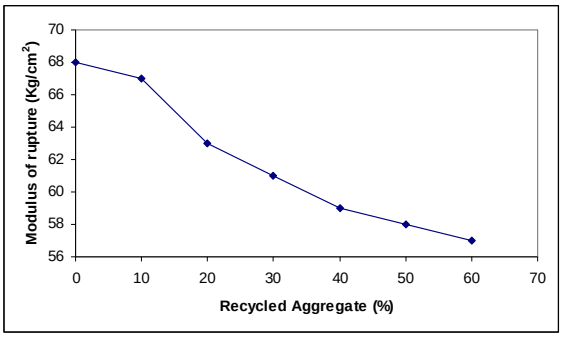


Fig (11): Average concrete modulus of rupture versus percentage of recycled aggregate

4.5 Bond strength:

The increase of bond strength between the deformed bars and recycled aggregate concrete is due to rough surface and angular edges of recycled aggregate increases the friction between deformed bars and recycled aggregate, Shown as Fig (12).

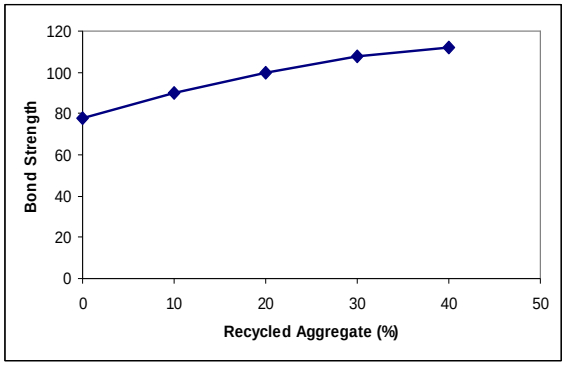


Figure (12): Bond strength versus percentage of recycled aggregate

CONCLUSIONS

Experimental works on the use of recycled aggregates have proven that good quality Concrete could be produced with recycled aggregates. The use of aggregates produced from recycled construction and demolition waste should be further promoted. Based on the experimental investigation reported in the work the following conclusions are drawn: The dry density of recycled aggregate is about .75 of the dry density of natural aggregate, the all density of recycled aggregate is about .85 of natural aggregate

concrete, which is not much lower than natural aggregate concrete density. The compressive strength of concrete increases as the percent of recycled aggregate decreases, on the average, the recycled aggregate concrete cube strength was 68.6% of that of the natural aggregate concrete. At the same time the increase of Qena sand (Qena sand is very fine, poorly graded and its fine modulus =1.4) for the same mix proportions of recycled aggregate concrete mix, The recycled aggregate concrete has a convenient compressive strength, flexural strength, and bond strength ,which means a convenient concrete for structural elements in concrete structures.

REFERENCES

[1] Adnan Enshassi and Ahmad Al-Riyati ,"CONSTRUCTION AND DEMOLITION WASTE MINIMIZATION, REUSE & RECYCLING", Civil Engineering Department, IUG, Palestine1 United Nation Development Programming, Qena, Palestine2, 2005

[2] Ayed .A. Zuhud Studies on Performance of Recycled Aggregate Concrete, main reference.

[3] Building Research Establishment. 1998. “Digest 433 – Recycled Aggregates”. BRE, Garston, Watford WD2 7JR

[4] DEPARTMENT OF THE ARMY U.S. Army Corps of Engineers 441 G Street, NW.Washington, DC 20314-1000\CEMP-CEPublic Works Technical Bulletin 14 September 2004No. 200-1-27

[5] Limbachiya,M.C.; Leelawat, T.; and Dhir, R.K. 1998. “RCA Concrete: A Study of Properties in the Fresh State, Strength Development and Durability”. Proceedings of the International Conference on the Use of Recycled Concrete Aggregates. Edited by: R.K. Dhir, N.A. Henderson and M.C. Limbachiya, Thomas Telford, UK., pp. 227-238.

[6] Major Rakshvir, Sudhirkumar V. Barai- Studies on recycled aggregates-based concrete-Waste Management & Research, Vol. 24, No. 3, 225-233,2006

[7] Nelson and Shing Chai NGO Research Project "High-Strength Structural Concrete with Recycled Aggregates", submitted November 2004, University of Southern Queensland Faculty of Engineering.

[8] Pilar Alaejos Gutiérrez , Marta Sánchez de Juan Utilization of Recycled Concrete Aggregate for Structural Concrete

[9] Recycling Concrete Saves Resources, Eliminates dumping www.ecco.org20/3/2007.

★★★