Using of Waste material from aggregate crushers as fine aggregate in Concrete

Abdelhamed Ganaw*, Osama Arhuma , Tariq Daw
Civil Engineering, Faculty of Engineering, Elmergib University, Alkhums, Libya
*engnaw@gmail.com

ملخص

نظرا للحاجة المستمرة للبحث عن مواد بناء لإنتاج الخرسانة ادي ذلك لدراسة امكانية استعمال مخلفات كسارات انتاج الركام الخشن كركام ناعم في الخرسانة . تهدف الورقة لدراسة امكانية استعمال مخلفات الركام من كسارتين مختلفتين وركام ناعم معلوم جيد التدرج من محاجر منطقة زليتن لإنتاج الخرسانة. تمت دراسة خواص الركام المورد من الثلاثة مصادر وتم انتاج خرسانة بنسب ماء للإسمنت 0.50 ،0.55 و 0.60 بعدها قيست قابلية التشغيل للخرسانة الطرية ومقاومة الضغط للخرسانة الصلبة عند 28 يوم. من خلال النتائج وجد ان خواص الخرسانة الطرية كانت ضمن المواصفات القياسية. علي الرغم من ان مقاومة الضغط للخرسانة الناتجة كانت جيدة حتي مع الركام الناعم سيء التدرج فقد كانت افضل النتائج للخلطة المرجعية المستعمل فيها ركام جيد التدرج. الجدير بالذكر انه بعد تحسين تدرج ركام المخلفات بخلطها بركام اخر اعطت خلطاتها مقاومة ضغط مساوية للخلطات المرجعية مما يؤكد امكانية الاستفادة من مخلفات ركام الكسارات كركام ناعم في الخرسانة من جهة والحفاظ علي البيئة بعدم رميها في المكبات من جهة اخري.

ABSTRACT

Due to the need to find new sources of building materials, this need led to investigate the use of waste material resulting from the manufacture of coarse aggregate as fine aggregate. This paper investigates using of waste material from two different rock crushers and known well graded sand from Zliten quarry as a reference in concrete. The three fine aggregate properties from the three sources were studied and concrete was produced. Concrete was produced using w/c ratios 0.5, 0.55 and 0.6. Fresh concrete workability and compressive strength at 28 days were tested. From the test

results fresh concrete was within the range of specifications and concrete strength was also good at 28 days. However the best results were achieved by using Zliten sand the other waste sands results in good result and another trial was done by mixing Zliten sand and waste sand and gave a very good result This proves that waste sand in crushing aggregate plants can be used in the production of concrete and this will protect the environment and find new sources of fine aggregate.

Keywords: aggregate crushers, concrete, fine aggregate, compressive strength, slump.

Introduction

Due to the high consumption for building materials especially in concrete production like houses, bridges, dams etc., it was necessary to search for new sources of local materials to achieve these needs, and because the aggregate occupies more than 75% of concrete weight Neville and Brooks (2010), that will help in minimizing concrete cost if the appropriate source is found locally. Fine aggregate from natural sources in Libya is decreasing annually especially that meets the specifications and its price is increasing gradually. In recent years many investigations have come and started using waste materials in concrete production because of many advantages like environmental protection and minimize concrete cost in general. Elazhary et al (2013) and Alamin et. Al.(2018) have investigated using the damaged buildings as an aggregate in concrete production, and they proved its advantages in getting good strength. Ganaw et. al. (2019) also investigated the use of waste floor tiles from local factories as coarse aggregate and resulted in good properties of concrete. In specific to the use of waste material from aggregate crushers, Mansour et. al. (2004) were investigated the use of material as fine aggregate in concrete production and proved that fines can be used up to 20% but should not be a clay. Fareed (2010) was replaced part of cement up to 15 % with fine material from waste crushed aggregate and concluded that good setting times were get and designed concrete strength was

resulted in the desired range. It is obviously that using waste materials from aggregate crushing plants in concrete will be one of the best solutions to help in both, finding new sources of aggregate and protecting the environment as that will minimize packing these waste materials in open land.

1. Strategy of the research.

As mentioned above, the paper investigates using of waste material from two different rock crushers and known well graded sand from Zliten quarry, also Alhera sand was mixed with Zliten sand and used as fourth sand. The four fine aggregate properties from the three sources were studied and concrete was produced. Concrete was produced using w/c ratios 0.5, 0.55 and 0.6. Fresh concrete workability and compressive strength at 28 days were tested. All ingredients; fine aggregate, water, cement and coarse aggregate were mixed in a normal concrete mixer. Slump test was carried out immediately after mixing. After that, concrete casted in five cubes of 150mm for 24 hours, after that put in water and compressive strength was tested at 28 days.

2 - Materials and Methods

The used cement in the study was imported from Elethad Alaraby factory with setting times, soundness, compressive strength at 28 days all are satisfying the specifications. Water used was also suitable for concrete mixing, it was collected from the Alkhums engineering faculty network.

All coarse aggregate used in the project was imported from local quarry near Alkhums, its gradation was valid to be used in concrete production as shown in figure 1 and satisfying to the British standards BS 882-1992

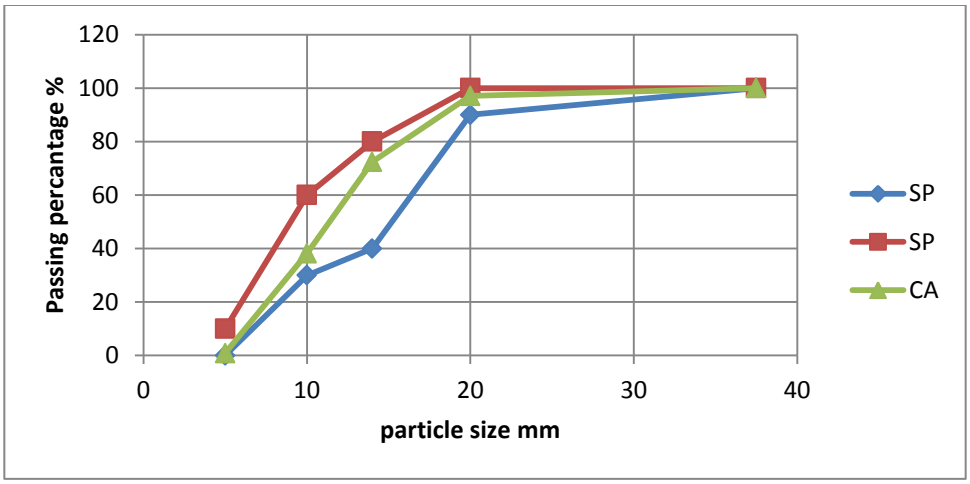

Figure1. Gradation of coarse aggregate

The used fine aggregate was collected from three sources: the first one was well graded sand from Zliten quarries as shown in figure 2, (Zl), the second one was waste material from the aggregate crusher plant from Alhera plant (Hi) and the third one was also waste material from aggregate crusher at Alkhums (Kh). Finally Alhera sand was mixed with Zliten (M Zl-Hi) and used in concrete production. The gradation of all aggregates is compared with specifications and shown in Figure (2) and compared with the British standards BS 882-1992.

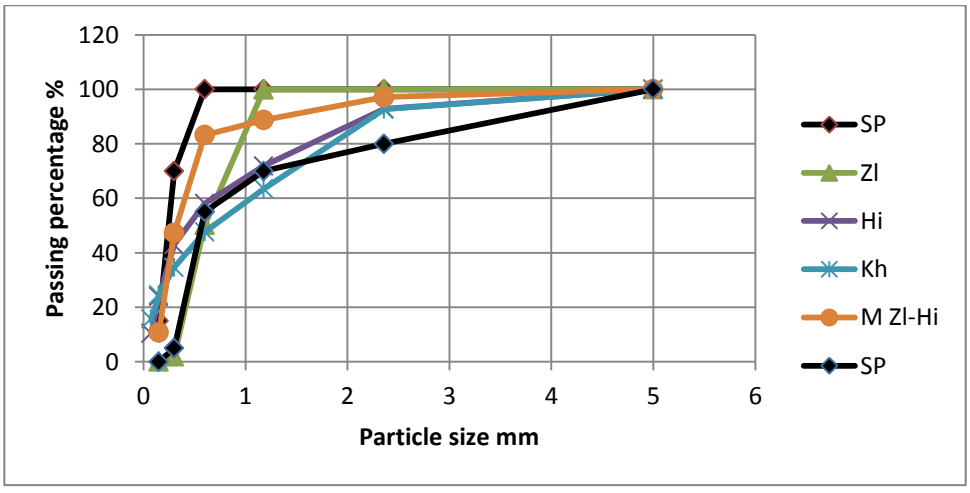

Figure 2. Gradation of used fine aggregates

3- Results and Discussion

3.1Fresh concrete test results The relation between a slump and water cement ratio is showingin figure 3, it is clear that as the w/c ratio increases the slump increases for all samples, It is clear that the well graded S1(Zl) gave the highest slump followed by the improved mixed sand S4(M Zl-Hi). However waste sand gave the lowest values but still the concrete workable to be filled and compacted in their forms. Notice that, S3is (Kh) and S4 is (Hi).

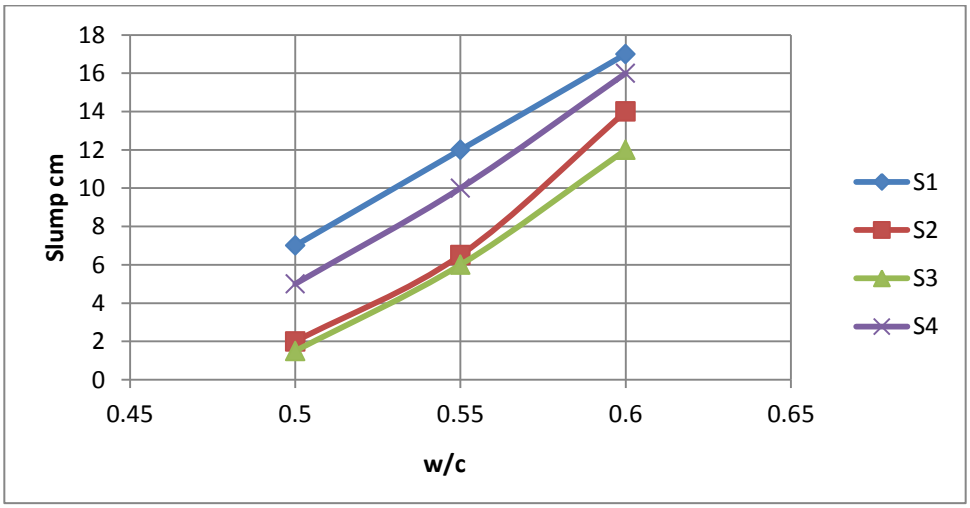

Figure 3- Fresh concrete slump vs the w/c ratio

3.2 Compressive strength test results: The relation between compressive strength and w/c ratio is shown in figure 4. The classic relation is visible as the strength at 28 days decreases with the increase of w/c ratio for all samples, It is obvious that S1(Zl) is the best one and gave the highest strength with nearly 35MPa as well as the improved S4(M Zl-Hi). The lowest values of strength were found by S3(Kh) with the lowest strength but still higher than 20MPa. Notice that, S1is (Zl), S2is (Hi), S3is (Hi) and S4is (M Zl-Hi).

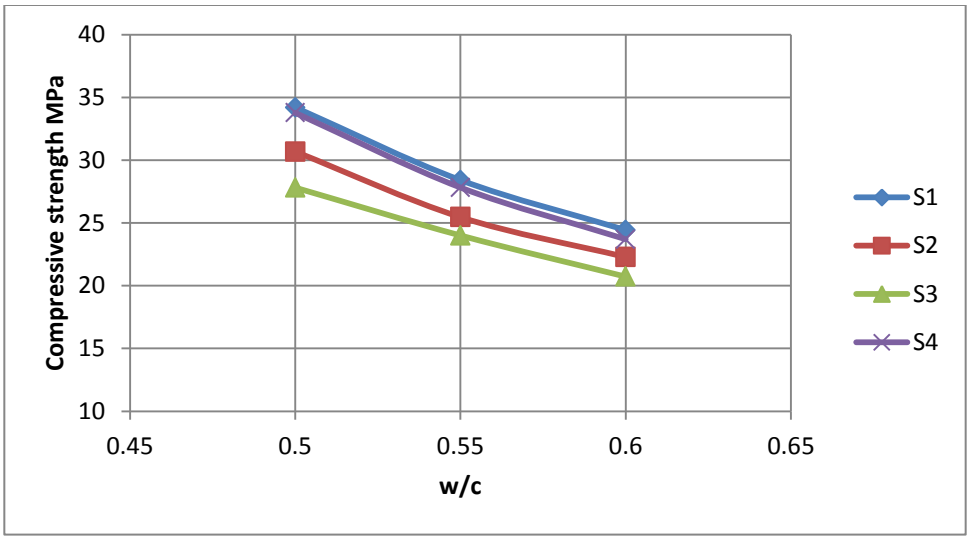

Figure 4 Compressive strength vs the w /c ratio at 28 days

4 Conclusions

From the investigation on using waste material aggregate plants as fine aggregate in concrete production, it can be concluded that;

1. Waste material from aggregate crushing plants is not satisfying the needs of fine aggregate gradation in concrete but their concrete compressive strength is above 20MPa and this is a promising result even without any sand improvement. On the other hand, when waste sand mixed with well graded one strength jumped to nearly 35MPa.
2. Although the material is out of gradation from Alhera and Alkhums plants, fresh concrete is within the needs of setting times and slump. The best results were come from using Zliten sand followed by mixed one.

It is important to suggest the use of this material in concrete technology with some care and needs to be investigated for durability purposes instead of throwing it in open land, to protect the environment and help to fine alternative materials in local market.

References

[1]A. M. Neville, J.J Brooks, "Concrte Technology," *Hand Book,* Pearson Education Limited, England, 2010.

[2]S.A.Elazhri, E Ben Zara, H. Ghrooda, "Recycled material of the damaged buildings," *Twelfth arabic engineering conference* , Tripoli, 11, 2013.

[3] F. R. Alamin, E. A. Atbwli, "Using of damaged buildings in Sirt as a recycled aggregate," *The seventh national conference for building materials and structural engineering*, Albayda, Libya, *2018*

[4] A.I. Ganaw, M. Ben Othman, A. Abosnina, "Influence of floor tiles as coarse aggregate on concrete properties," *The second conference for engineering science and technology*, Sabratha**,** Libya**,** 2019

[5] A. Masour, A. Masoud, A. Abdussalam, N. almassa "Using of waste crushed materials from aggregate in concrete production," *The second national conference for building materials and structural engineering*, Alkhums, 2004

[6] B. J. Fareed, "Replacing partial of cement in concrete by fine material from aggregate crusher," *The fifth national conference for building materials and structural engineering*, Tripoli, 2010.

[7] BS 882:1992 "Specification for aggregate from natural sources for concrete – Aggregate gradation for concret," London,1992

[8] BS EN 12350-3:2000 "Testing of fresh concrete, Part 3: vebe test, slump test," London, 2000.

[9] BS EN 12390-3:2002 "Testing hardened concrete, Part 3: compressive strength of test specimens," London.

[10] BS 812 – 109:1990, "Testing aggregate, Part 109: Methods of determination of moisture content," London