IJEIT
The International Journal of Engineering and Information Technology
journal homepage:www.ijeit.misuratau.edu.ly
IECMU 2021 International Engineering conference-Misurata University

Effect of Waste Brick Clay Powder on Self Compacted Concrete

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Abstract— **This research investigates the effect of waste clay bricks powder in producing self-compacting concrete by partial replacement of cement. Bricks were crushed to particle sizes smaller than 75 microns. Percentages of cement of 5, 10 and 12.5 % by weight were replaced by the power at w/c ratios of 0.4, 0.425 and 0.45. Fresh concrete workability then measured and hard concrete properties were determined at 28 days. The results show that waste bricks powder can be utilized partially instead of cement to produce concrete with self leveling fresh properties and good hard properties. Consequently, this proves that waste bricks can be recycled to minimize both the effect of waste material on the environment and the heat needed for cement production.**

Index Terms: **clay bricks powder, super plasticizer, self-compacted concrete, workability, compressive strength.**

I. INTRODUCTION

Self-compacting concrete (SCC) is produced by employing super plasticizer in concrete and sometimes called flow able concrete[1]. Due to the wide use of SCC in construction led to the need to produce high quantity of cement, that also effects on the surrounding environment by gas evolution and heat needed for cement production. Replacement of cement by other materials like marble powder, bricks powder and glass powder is beneficial in minimizing the waste materials in an open land and useful in decreasing the evolution gases during cement production. [2] [3] [4]. Clay bricks powder was replaced the cement up to 20% and found that concrete compressive strength was increased by 25%. [4] Waste clay bricks was also used up to 50% as fine aggregate and produced light weight concrete and that was useful environmentally and economically [5]. In another study, cement was replaced by wasted clay powder at 5% of cement weight and the result was an increase in concrete compressive strength as well as fresh concrete workability [6].It is obviously from this presentation that using of waste clay bricks powder in concrete is useful and the shortage of such investigations] leading to the importance of this investigation.

Received 31 Oct , 2021; revised 7 Nov, 2021; accepted 7 Nov, 2021.

Available online 19 Nov, 2021.

II. USED MATERIALS

Portland cement was imported from Elmergib factory which located in Alkhums, cement fineness is 2977cm square/gram and its initial and final settings were within the limits of British standards [7]. The used water to produce concrete was drinkable and valid for this work.

Coarse aggregate was imported from aggregate quarry near Alkhums, its maximum size was 14 mm and its gradation was satisfied with Britsh specification for self-compacting concrete [8]. Coarse aggregate specific gravity and absorption were 2.58 and 0.023 respectively. Fine aggregate was taken from Zliten quarries with good gradation with respect the specifications [8]. Finally Visco-crete super plasticizer from Sika was used in the study [9].

Waste brick was collected from local brick factory , cleaned from dust and mud, dried and crushed to fine powder using Los Angelos drum .After that, the powder was sieved on 75 micron sieve, the remained sample crushed and sieved again. The whole powder was collected and mixed in concrete mixer to become homogeneous and stored in sealed containers.

III. RESEARCH STRATEGY

Concrete was produced first without brick powder with water/cement (w/c) ratio of 0.4, 0.425 and 0.45, after that concrete was produced by replacing part of cement by brick powder, the replacement ratios were 5%, 10% and 12.5% by weight. All mixes contain the same amount of fine and coarse aggregates. Super-plasticizer of 1% was also used in all mixes to give the required workability. Fresh concrete workability was measured by Flow diameter test, (J) ring and (L) box according to the specification required to SCC [10]. Finally concrete was poured in cubic forms of 150mm for 24 hours then demoded and put in water until 28 days. After 28 days concrete compressive strength and pulse speed results were measured.

IV. RESULTS

A Fresh Concrete Workability

A.1 L-Box Workability Test

The relation between fresh concrete L box reading and w/c ratio at different powder percentages is shown in Figure.1, it is clear that the best workability was measured at 5% replacement even when compared with the reference mix, on the other hand the lowest one was observed at 12.5 replacement. The common relation between workability and w/c ration also observed, as the w/c increases the workability increases for all mixes.

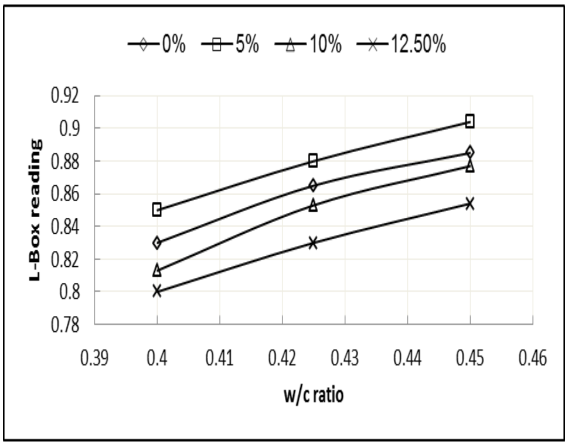

Figure 1 L box reading vs w/c ratio

4.3 Flow Meter Test

Figure. 2 shows the relation between flow diameter of fresh SCC and w/c ratio, it is clear that as the brick powder replacement increases the diameter decreases for the same water content mixes, and that could be related to the increase of surface area. Although the lower diameter was found by using 0.4 of w/c and 12.5% powder replacement in the mix the diameter is still in the range required for SCC according to the specifications which is (650-800) mm [10].The best flow was measured by employing 5% replacement, and this is agree with Zein et al (2013) which is presented in the introduction.

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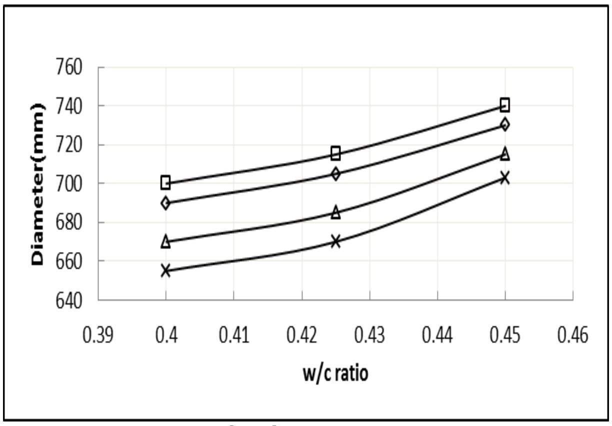

Figure2. Flow diameter vs w/c ratio

A.2 J-Ring Workability Test

Figure.3 presents the relation between J ring SCC workability and w/c at different powder replacements. As happened by the L box test, it is the highest reading of workability was measured by replacing 5% powder in the mix where the lowest workability reading is measured for the mix of 12.5% replacement, and that is attributed to the change in surface area and particle packing when compared with the reference mix with no brick powder.

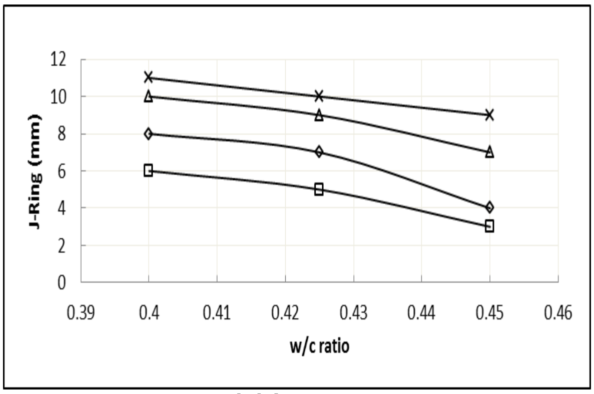

Figure.3.J-ring workability measurement vs w/c ratio

B Hardened SCC Test Results

B.1 Compressive Strength

The relation between concrete compressive strength and w/c ratio at 28 days for all mixes is shown in Figure.4. It is obvious that as the w/c ratio increases the strength of concrete strength decreases. The highest concrete compressive strength is obtained by the reference mixes and then, as the powder increases the strength decreases. Although of that, it was possible to produce SCC with 45MPa with high replacement percentage of 12.5%, and this concrete is useful for most of concrete purposes.

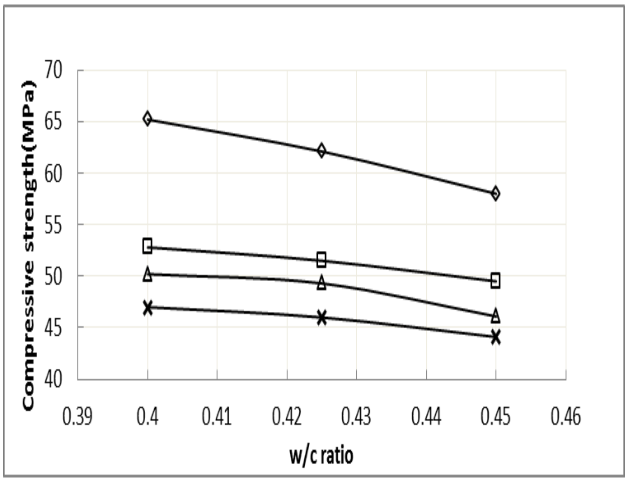

Figure.4 Compressive strength vs w/c ratio.

B.2 Ultra-sound wave speed test results

The relation between pulse velocity and w/c ratio for all mixes is presented in figure.5, It is revealed that as the quantity of powder increases the velocity decreases where the highest one is obtained by the reference mixes, that is agree by the compressive strength results as shown in the in the previous section.

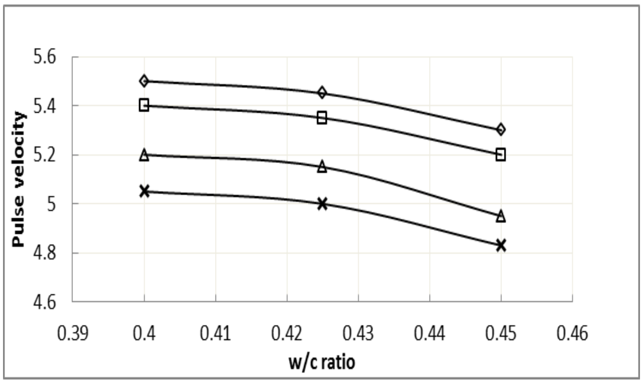

Figure.5. Ultrasonic velocity vs w/c ratio.

V. CONCLUSIONS

From the investigation the following remarks can be concluded:

- SCC can be produced with good fresh properties by replacement of cement by brick powder as low as 5%.
- Replacement of cement by waste brick powder as high as 12.5% with 1% super-plasticizer can give SCC with more than 40MPa, and this is enough strength for most concrete structures.

Generally speaking, It is recommended to utilize the waste clay bricks powder as a replacement material instead of cement to produce self-compacted concrete with good fresh and hard properties. This will results in minimizing the waste material which helps the environment and results in decreasing the power needed for the cement manufacture, and that will affect certainly on the global warming.

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