PROPERTIES OF CONCRETE USING CRUSHED BRICK AS COARSE AGGREGATE

SALAHALDEIN ALSADEY

Faculty of Engineering, Department of Civil Engineering, Bani Waleed University, Libya
E-mail: salahalsadey@yahoo.com

Abstract - Sustainability and material use have been becoming increasingly important in industry and academia in recent years. The investigation reported in this paper is carried out to study the feasibility of using crushed brick to substitute the coarse aggregate in concrete, replacing stone aggregate (partly) by crashed brick. the target compressive strength of stone aggregate concrete was 34 MPa remaining concretes were made by replacing the stone aggregate (partly) by equal volume of brick aggregate while everything else was kept unchanged. The only variable considered in this study was the volumetric replacement (0%, 25%, 50, and 75%) of stone aggregate by brick aggregate. Crashed Brick materials are a great prospective material for aggregate replacement due to their desirable mechanical properties and availability in waste streams worldwide. A total of 4 numbers of concrete mixes specimens are casted with and without crushed bricks and tested under compression relevant to British standard specifications. Test results indicated that using crushed bricks reduces the strength of concrete. Also, the percentage of water to cement ratio increases for constant slump when the percentage of crushed bricks increased.

Index terms - Recycled, Coarse aggregate, crushed bricks, concrete, waste.

I. INTRODUCTION

During the last decades, it has been recognized with growing concern that wastes from a construction are of large volume and that this volume is increasing year by year. The problem of waste accumulation exists worldwide. Most of waste materials are left as a landfill material or illegally dumped. Environmental impact can be reduced by making more sustainable use of this waste [1]. From the last few decades there is a major problem dispose of waste material. Dispose of waste in land filling is economically high due to transport charges & tipping fees. This waste material can be used as aggregate in concrete to reduce the cost of concrete and environment impact. Building bricks, roofing tiles and clay chips are some the example of clay products.

Concrete can be successfully produced using recycled materials. The use of recycled aggregate concrete (RAC) has steadily increased during the last two decades and its current field of applications includes: lightweight concrete, lightweight aggregate, asphalt concrete, concrete exposure to high temperatures and road construction. The use of crushed waste as aggregate in concrete has began in Europe since the Second world War [2]. In Japan, after the Second World War, many buildings are constructed from crushed waste because of the need for low-cost and rapidly constructed buildings. These buildings remained functionally good up to date. In Bangladesh, brick aggregates are easily available and much cheaper than crashed stone aggregate. Also concrete with compressive strength of around 20 MPa are easily achieved by using crushed normal strength brick and following the usual practice of concrete-making. Besides the unit weight of brick aggregate concrete has been reported to be much less than that of stone aggregate concrete [3]. And the use of brick aggregate instead of stone aggregate in various components of a building structure can result in a significant reduction of dead load on column as well as foundation. Hence, the replacement (partly or fully) of stone aggregate by brick aggregate may yield cost-effectiveness in making concrete.

Concrete is a material that is often seen as a potential place for wastes, because of its composite nature (a binder, water and aggregates) and because it is widely used, which means that if a waste could be used in concrete, then certainly large quantities of the waste material are recycled. Regardless of several studies in this field, such as those from [5, 6, 7], there are some questions regarding the behaviour of concrete produced with ceramic wastes as aggregate. This uncertainty is basically related with heterogeneity of wastes, different compositions, reduced strength of crushed brick aggregates, lamellar shape of aggregates and so on. Environmental protection concrete is to be able to reduce environment load while improving the ecological environment in harmony with nature, and to contribute to environmental protection of concrete [8].

II. TEST PROGRAM

In order to study the effect of replacing natural coarse aggregate by crushed bricks on the properties of concretes, several tests on the properties of coarse aggregates as well as those of concrete made with such aggregate were conducted. The volumetric replacement of stone aggregate with brick aggregate considered in this study were 0%, 25%, and 75% while everything else were left unchanged. The test specimens were divided into four series and the corresponding concrete mixes were identified as M_0, M_{25}, M_{50}, and M_{75}. Here 'M' stands for 'concrete mix' and the subscript indicates the 'percentage of

stone aggregate replaced by brick aggregate from the total coarse aggregate'. In each series a total of twenty four (150×150×150 mm) concrete cubes were cast and tested for compressive strength.

III. MATERIALS USED IN THIS WORK

Concrete mixes containing ordinary Portland cement, sea sand, crushed coarse aggregate, water, and different percentage of crashed brick replacement aggregate. The used ordinary Portland cement satisfies the ASTM requirements. Locally sea sand was used, which had specific gravity of 2.66 and its grading fell within ASTM. Crushed coarse aggregate had specific gravity of 2.70. The sieve analysis of coarse aggregate is carried out according to ASTM. Waste brick were collected and then crushed in the laboratory for making brick aggregates. The bricks were crushed manually and then sieved into various size fractions, and the flaky particles were separated for rejection. Both types of coarse aggregates were size-screened to a maximum of 19mm.



Figure1: Crushed bricks

IV. EXPERIMENTAL WORK

The experimental investigation was carried out in the Construction Materials Laboratory of the Faculty of Engineering at Bani Waleed University Libya. Twenty four concrete specimens are casted with and without using of crushed bricks. The specimens considered in this study consist of 24 numbers of 150 mm side cubes with the compressive strength 34 Mpa. The nominal mixing proportion used for casting the specimens (cement: sand: coarse aggregate) by weight with slump of (100 ±5) mm as a base to get constant workability for all specimens when designed. The crushed bricks are submerging in water for 24 hours and then dried to get saturated surface dry conditions. Cement, sand, and coarse aggregate (or crushed bricks) are mixed in dry state then the required quantity of water (0.6%) is added and mixed thoroughly. Before casting, machine oil is smeared on the inner surfaces of the cast iron mould. Concrete is poured into the mould in three layers and compacted thoroughly using a standard compact metal rod diameter 16 mm and 600 mm long. The number of compact beats is 25 times for all cubes for each concrete layers. The top surface is finished by means of a trowel. The specimens are removed from the mould after 24 hours and then cured under water for a period of 7 and 28 days. The specimens are taken out from the curing tank just prior to the test. The test of compressive strengths is conducted using a 3000 kN compression testing machine. This test is conducted as per the relevant standard specifications.

V. RESULTS AND DISCUSSION

Several tests were performed on fresh and hardened concrete. Fresh concrete tests were workability (slump) and flow. Hardened concrete properties measured were compressive strength. Concrete curing was carried out with specimens immersed in water.

Table 1. Mechanical Properties Test Results

Concrete Mix	Aggregate Replacement Ratio (%)	Slump mm	Flow mm	Compressive Strength MPa	
				7 Days	28 Days
M_0	0	200	600	25.97	34.03
M_{25}	25	190	580	24.73	30.3
M_{50}	50	100	500	20	24.6
M_{75}	75	90	500	14.9	21.73

The result for slump of crashed brick concrete is shown in Table 1. The data are recorded and being shown to observe the relation between percentages of crashed brick replacement of normal aggregate and slump. The values of slump for different percentages of crashed brick concrete are then plotted as a graph as shown in Figure 2. Graphs show slump for different percentages of crashed brick concrete. From the graph, it is clear that slump reduces with increase the percentages of aggregate replacement. However, the result for flow of different percentages of crashed brick concrete is shown in Table 1. The data are recorded and being shown in the manner of increasing percentages of different percentages of crashed brick aggregate. The values of flow table for different percentages of crashed brick concrete are then plotted as a graph as shown in Figure 3. Flow table is used to check the workability and cohesiveness of the concrete. From the graphs obtained, diameter of spread of concrete reduces with

increase of percentages of crashed brick aggregate replacement.

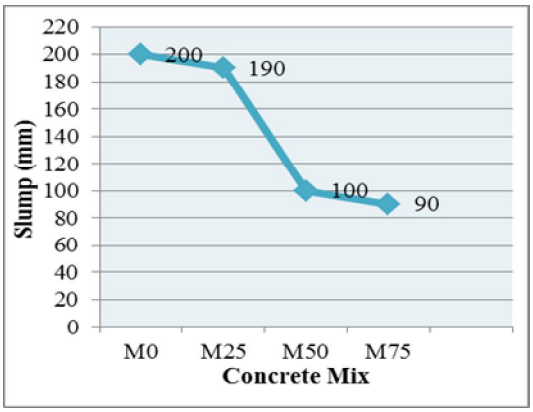


Figure 2: Slump Results for Different Percentage of Crashed Brick

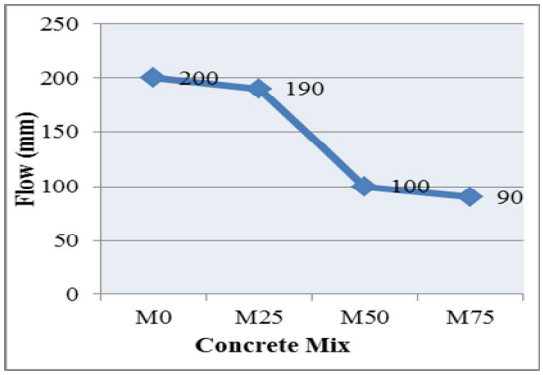


Figure 3: Flow Results for Different Percentage of Crashed Brick

Figure 4 show the test results obtained from concrete cube specimens with and without crushed bricks. The results reported are average of 3 specimens at age of 7 and 28 days and satisfies BS: 1881: part 3: 1970, 1881: part 4: 1970. From this Figure, it is clear that using of crushed bricks in concrete reduces its strength in compression strength. The reduction in strength may be attributed to three reasons:

(i) The crushed bricks failed to develop proper / adequate bond with concrete and cement matrix.
(ii) Because of high porosity of the surfaces of the crushed bricks, the mixture need more water to get the required slump.
(iii) The crushed bricks made the mixture unworkable because of roughness of the surfaces of crushed bricks aggregates affecting the compaction distribution upon the concrete layers.

It can be seen from this figure that compressive strength is reduced when the crushed bricks to coarse normal aggregate ratio increased. However, it is observed that the compressive strength of cubes (aggregate replaced by crashed brick) M2, M3 and M4 mixes decrease strength at 7 days 24.73,20 and 14.9 MPa respectively, compared to reference concrete with normal aggregate 25.97 MPa. The concrete mixes at 28 days curing decrease the compressive strength 30.3, 24.6 and 21.73 MPa as M_{25}, M_{50} and M_{75} respectively, compared to M_0 control mix.

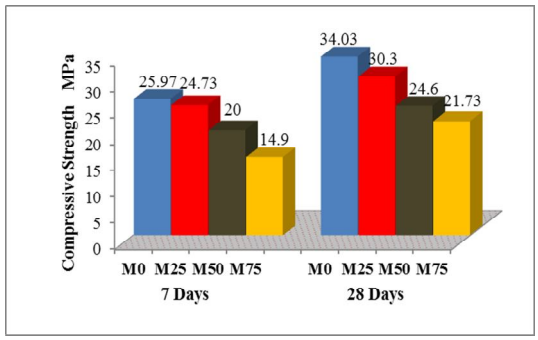


Figure 4: Compressive Strength for Different Percentage of Crashed Brick

CONCLUSION

This study has found that crushed bricks can be used satisfactory as coarse aggregate for making concrete of acceptable strength characteristics as can offer benefits associated with both economy and sustainability:

1. The use of crushed bricks as coarse aggregate decreases the compressive strength of concrete at age of 7 and 28 days according to the ratio of crushed bricks that used.
2. Use of crushed bricks as coarse aggregate in concrete increases the water to cement ratio as it increases the absorption of concrete to the water
3. The workability of the crushed bricks concrete is lower than that of normal concrete.

ACKNOWLEDGEMENT

The author would like to express gratitude to the engineering students those who had kindly offered help and useful to the project. The author would like to thank the Bani Waleed University, Libya for financial support.

REFERENCES

[1] [1] Batayneh, M.; Marie, I.; Asi, I. Use of selected waste materials in concrete mixes. //Waste Management. 27(2007), pp 1870-1876.
[2] Swamy, R.N., "New Concrete Materials", London, PP. 149-157, 1983.
[3] M. A. Rashid, T. Hossain, and M. A. Islam, “Higher Strength Concrete Using Crushed Brick as Coarse Aggregate”, Indian Concrete Journal, Vol. 82, No. 10, pp.18-23, 2008.
[4] Poon, C.S., Kou, S.C. & L. Lam (2002). Use of recycled aggregates in molded concrete bricks and blocks. Construction and Building Materials, Elsevier 16, 281–289, 2002.
[5] Khalafand, F.M., Devenny, A.S. (2004a). Performance of Brick Aggregate Concrete at High Temperatures. Journal of Materials in Civil Engineering, November/December, 556-565.
[6] Khalafand, F.M., Devenny, A.S. (2004b) Recycling of Demolished Masonry Rubble as Coarse Aggregate in

Concrete: Review. Journal of Materials in Civil Engineering, July/Augiust, 331-340.

[7] Brito, J., Pereira, A.S. & Correia, J.R. (2005). Mechanical behaviour of non-structural concrete made with recycled ceramic aggregates. Cement and Concrete Composites, 27, 429–433, Elsevier.

[8] X. Wang, "Experimental study of the preparation of ecological concrete using waste fly ash," Master's thesis, School of Civil Engineering of Shandong Jianzhu University, 2012.

[9] ASTM C 192/C 192M. 2002. ―Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory‖. ASTM International.

[10] British Standard Institution, BS 1881: Part 102 (1983). "Methods for Determination of Slump".

[11] British Standard Institution, BS 1881: Part 116 (1983). "Methods for Determination of Compressive Strength of Concrete Cube".

★★★