Influence of Waste Floor Tiles as coarse aggregate on Concrete Properties

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ABSTRACT

This research investigates the possibility of using waste floor tiles as coarse aggregate in the production of normal concrete. Waste tiles were crushed to particle sizes of coarse aggregate. Three types of coarse aggregate were used in the research, the first one was normal aggregate used for the reference concrete mix and the other two were imported from two different local tile factories. Concrete mixes were designed at water/cement (w/c) ratios of 0.45, 0.50 and 0.55 with normal fine aggregate. Fresh concrete workability then measured and concrete compressive and tensile strengths were determined at 28 days. The results show that waste tiles coarse aggregate can be utilized to produce concrete of required workability and good hard concrete strength properties. Consequently, this proves that waste floor tiles can be recycled to minimise the effect of waste material on the environment and can be considered as a new source of coarse aggregate.

Keywords: Floor tiles, coarse aggregate, concrete, workability, tensile strength and compressive strength.

1. Introduction

The need to find new sources of building materials and the negative effect of waste materials like demolished buildings [1,2], waste bricks, waste floor tile on the environment led to find new way to recycle them. Recycled concrete was used as coarse aggregate at 30 % and 100%, it was found that there is no significance difference strength with normal concrete but using 100% recycled aggregate there is a reduction in compressive strength, moreover from the three aggregate sources the lower absorption showed better compressive strength.[3]. In addition aggregate from demolished buildings was used in concrete production at 20% and the strength results were met the standard values [4]. In another study concrete was produced with recycled concrete aggregate, its compressive strength and indirect shear strength were equals to 90% of those resulted from normal aggregate concrete, and the average compressive strength was in the range of 25-30 MPa [5]. Due to the large quantity of waste floor tile in the local factories it was beneficial to reuse them in concrete production as coarse aggregate. From the physical properties resulted from recycled coarse aggregate it was clear that concrete can be successfully produced with good results. The literature show that waste tiles coarse aggregate can be utilized to produce concrete of required workability and good hard strength properties. Consequently, this proves that waste floor tiles can be recycled locally to minimise the effect of waste material on the environment and can be considered as a new source of coarse

aggregate.

2 . Used materials in the research

Ordinary Portland cement from local cement factory was used in concrete production with Blain fineness of 2977 cm2/gm, its setting times are satisfying to BS EN 196 – 3: 1995[6].

Fine aggregate used was imported from Zliten and its gradation satisfied the requirements of British standard BS 812:1992[7].

All used waste floor tiles in the research were collected from two different factories. Waste tiles were crushed in order to satisfy the requirements of coarse aggregate gradation. Normal aggregate was used also for the reference mixes; its gradation is satisfied to the requirements of British standard BS 812:1992. Specific gravity and absorption and crushing values of coarse aggregates are shown in table 1.

Table 1 *Coarse aggregate properties*

Sample	Specific weight	Absorption (%)	Crushing Value
Normal Aggregate	2.65	2.64	26.93
Factory1 aggregate	2.35	9.1	29.23
Factory 2 aggregate	2.31	9.3	29.45

3. Methodology

Concrete mixes were produced at w/c ratios of 0.4, 0.45 and 0.5 with normal coarse aggregate, then the same mixes were produced again two times by changing the normal aggregate (Nagg) by recycled aggregate from tile factory 1 (Fac1) and tile factory 2 (Fac2). Fresh concrete was mixed by normal mixer and its workability then measured by the slump test. After that, concrete was casted in 150 mm cubic moulds for compressive strength tests and in cylinders 150 mm diameter with 300 mm height for indirect tensile strength tests. At 24 hours concrete was removed from their forms and put in water for 28 days for hard concrete tests.

4. Results and Discussion

4.1 Fresh Concrete Workability

Figure 1 presents the relation between fresh concrete slump and w/c ratio. As the water content increases the slump increases for all mixes. It is clear that the reference mixes show higher slump than mixes of recycled aggregate, following that mixes of aggregate from factory1, and that could be attributed to the absorption of coarse aggregate shown in table 1, where normal aggregate shows the lowest absorption following that aggregate from factory 1.

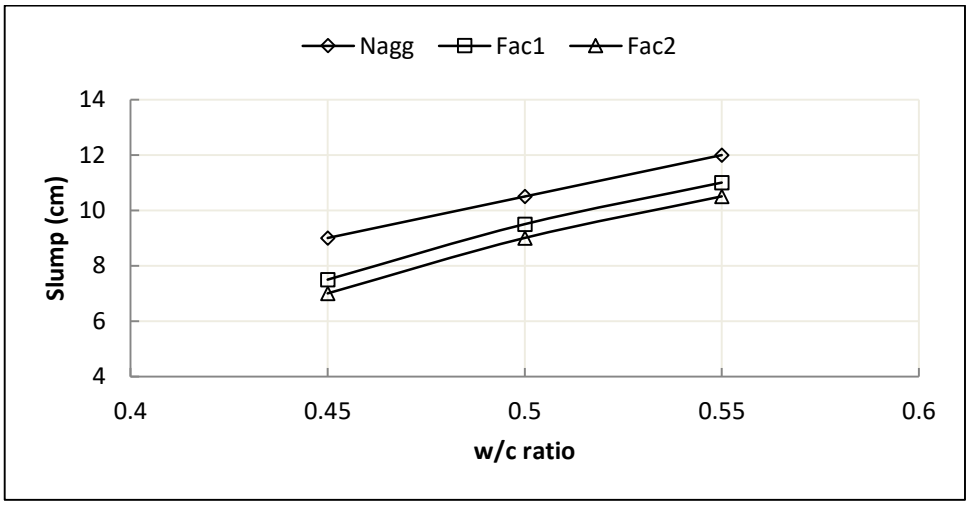

Figure 1 Relation between slump and w/c ratio

4.2 Concrete Compressive Strength

Figure 2 presents the relation between concrete compressive strength and w/c ratio. The common relation is available where the strength decreases by the increase in water content. The relations show that the highest compressive strength has resulted by using normal aggregate in concrete and the lowest results has obtained by using aggregate from factory2, this sequence can be noticed from the results of aggregate crushing values presented in table 1, this result agrees with that presented in the research of reference no 3. It is justified to state also that strength of concrete of aggregate factory 1 and factory 2 are very close especially at high w/c ratios. However concrete resulted from normal aggregate is higher than recycled aggregate concrete the strength is still enough for many purposes especially at low w/c ratios where the strength is higher than 20MPa.

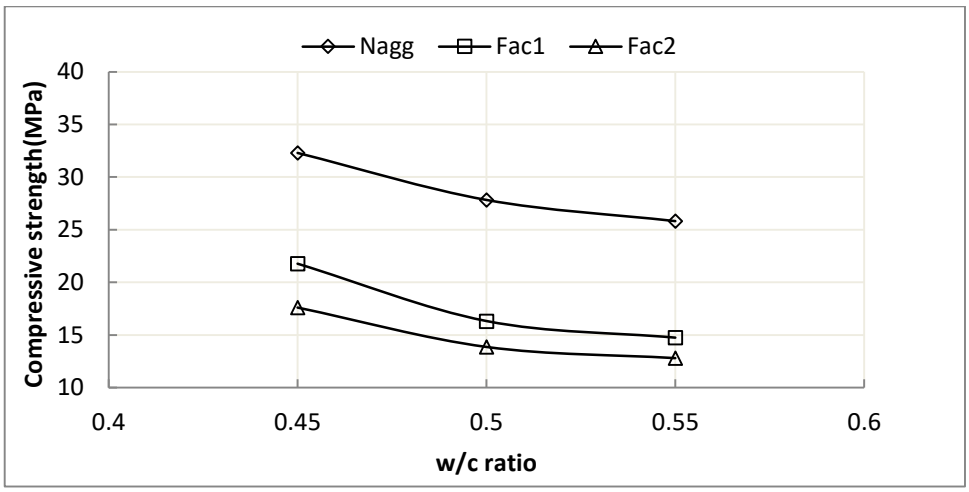

Figure 2 Relation compressive strength and w/c ratio

4.3 Concrete tensile strength

Figure 3 shows the relation between concrete indirect tensile strength and w/c ratio. As usual, the tensile strength decreases with the increase in water content. The relations present that the highest tensile strength has resulted by using normal aggregate and the lowest results have obtained by using aggregate from factory2. It is clear that at w/c ratio of 0.55 the strength of concrete is almost the same by using different aggregates, and that is attributed to the weakness of the bond between coarse aggregate and cement mortar.

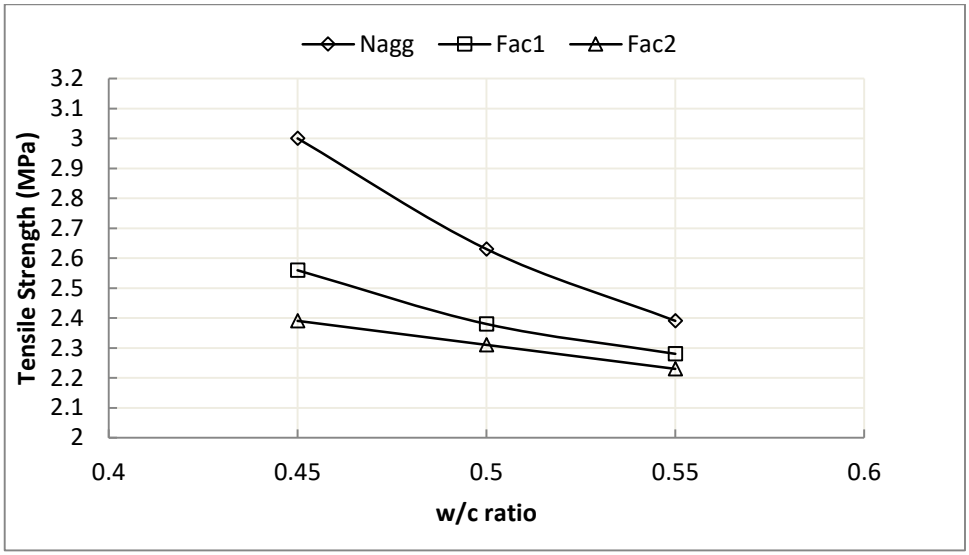

Figure 3. Relation between tensile strength and w/c ratio

5 Conclusions

The main outcome of this research is that concrete can be produced from 100% recycled coarse aggregate of waste floor tiles with good compressive and tensile strengths without using any admixtures. It is recommended that using of waste tiles is beneficial in concrete production as that will give another source of building materials and minimizes the land area required for the waste materials and of course it will protect our environment.

It is recommended for future work to study the durability of concrete contains waste coarse aggregate floor tiles, and it is preferred the concrete will be produced with high strength which can be obtained at low w/c ratios with the use of super plasticiser.

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