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Research Article

The Influence of Shredded Tyres on The Strength of Concrete

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Abstract: This research focuses on the influence of shredded tyres on concrete compressive and pulling tensile strength. 5%, 10% and 15% of the tyre shreds in volume from the waste tyres were used to replace the 20mm coarse mineral aggregates in the concrete. Series of strength test of the rubberized concrete were conducted and compared with the control mixture without rubber particles. The experimental results show a reduction of the compressive strength as the percentage of rubber particles increases. Also the pulling tensile test conducted shows a reduction in the tensile strength of concrete as the rubber content increases.
Keywords: Shredded tyres, Rubberized concrete, compressive strength, pulling tensile strength

INTRODUCTION

The massive turn out of waste tyres from car users is of great concern, especially in the developed countries. This is because stockpiling of these waste tyres causes a lot of negative environmental impact to the occupants. For instance, these scrab tyres when stockpiled in fields becomes a source of fire hazards and breeding ground to mosquitoes, rats, reptiles etc.[1-2]. The above issues call for the need to devise means of recycling these waste tyres. A small percentage of these scrap tyres are currently been reused for different purposes but still have not remedy the issue associated with their disposal. They are used for light weight fills for embankments, break waters, crumb rubber asphalt pavement etc. The above mention issues calls for the need to extensively research on rubberized concrete in order to save guard our environment from dangers associated with waste tyres from vehicles.

Over the years researchers have shown great interest in the use of shredded tyres from vehicles in concrete mix. From all studies, the shape, surface texture and the percentage of the shredded tyres incorporated in concrete have great influence on the performance of the concrete mix. The waste tyres used by researchers are usually from motor vehicles and trucks because of their massive production by the automobile industries. Considering the expected performance of the final product, the rubber is used “as it is” while in some instances, the textile component is removed from the steel fibres. In most case the rubber particles are pre treated before incorporating them into the concrete in order to improve its performance. Some previous studies have shown that the workability of the rubberized concrete decreases as the percentage of the rubber particles increases. The fine rubber particles have shown good workability compared to the conventional concrete when the concentration of the rubber particles in volume is not more than 15% of the coarse mineral aggregates[3-4]. The unit weight, compressive and the flexural strength of the rubberized concrete as shown by most researcher’s decreases as the percentage of rubber particles increases in the concrete mix. The size and surface texture of the rubber particles also have influence on the strength of the concrete. These outcomes were attributed to the fact that high density mineral aggregates replaced with lower density rubber particles will definitely reduce the unit weight and the compressive strength of concrete and also the low bonding that exists between the rubber particles and the concrete mix[1,2, 5-12].

The rubberized concrete generally exhibits high deformability, high toughness and damping properties[2, 3,9].

The purpose of this research is to study the influence of the rubber particles from waste tyres on the concrete strength. Some detailed tests were conducted to ascertain the strength of the hardened concrete.

EXPERIMENTAL PROCEDURE

Raw Materials

The constituent materials used for the concrete mix includes the Portland cement of class 42.5 complying with the type CEM 1, BS EN 197-1:2000, the Thames Valley flint gravels of less than 20mm maximum size were used as the coarse aggregates, uncrushed river sand of less than 5mm maximum size as fine aggregates. The absorption to the saturated surface dry condition of Thames Valley aggregates are as follows; 1.2% for 20mm aggregate size, 3.6% for 10mm aggregate size and 1.8% for sand.

The scrap tyres were shredded into different sizes ranging from 10-20mm and without wire strings. For the purpose of this research, the shredded particles were not pre treated before incorporating into the concrete mix.

Mix proportion, Curing and specimen preparation

For this research, 5%, 10% and 15% in volume of the 20mm coarse mineral aggregates were replaced with the shredded rubber particles from scrap tyres in concrete while maintaining the proportion of every other constituent material. The control mix or conventional concrete is without rubber particles.

The surfaces of these shredded tyres are rough and damaged due to the splitting process. The apparent density of the shredded tyres is 468kg/m^3 and is free of steel wires. All samples were cured in a fog room at a temperature of 20 ±1 ^{o}c and a relative humidity more than 95% for 28 days prior to testing in a controlled environment. The fresh concrete mix was well place in the moulds and compacted by means of a vibrating table. The samples were cured for a minimum of I day before de-moulding for the curing process.

The table 1 and 2 shows the composition of concrete mixtures and the required number of samples for each test to be conducted. The C mix stands for the control concrete without rubber particles while the T5, T10 and T15 are concrete with 5%, 10% and 15% replacement of the 20mm size coarse aggregate with the tyre shreds in volume.

Table 1: Composition of concrete mixture

Specimen designation	**Tyre shred aggregates (%)**	**20mm coarse aggregates (%)**	**10mm coarse aggregates (%)**	**Sand (%)**
C	0	100	100	100
T5	5	95	100	100
T10	10	90	100	100
T15	15	85	100	100

Table 2: Sample Specifications in millimetres and required number per test.

Specimen designation	Compressive strength test (100 x 100X 100)mm	Pulling tensile strength test.
C	6	6
T5	6	6
T10	6	6
T15	6	6

Test procedures

The compressive strength test of specimens was carried out based on the specifications made in BS 1881-116:1983. Specimen size 100mm X 100mm X 100mm for both the conventional concrete and rubcrete (rubber modified concrete) was used for this test in estimating strength after 28days of curing.

The dog bone pulling tensile strength test was conducted to ascertain the tensile strength of the control and rubberized concrete. The specimen configuration and dimension used for this test is presented in figure 1.

The cross section of the specimen varies along its length and failure of the specimen is expected to occur at the middle of specimen comprising of the smallest cross sectional area as shown in section B-B of figure 1.

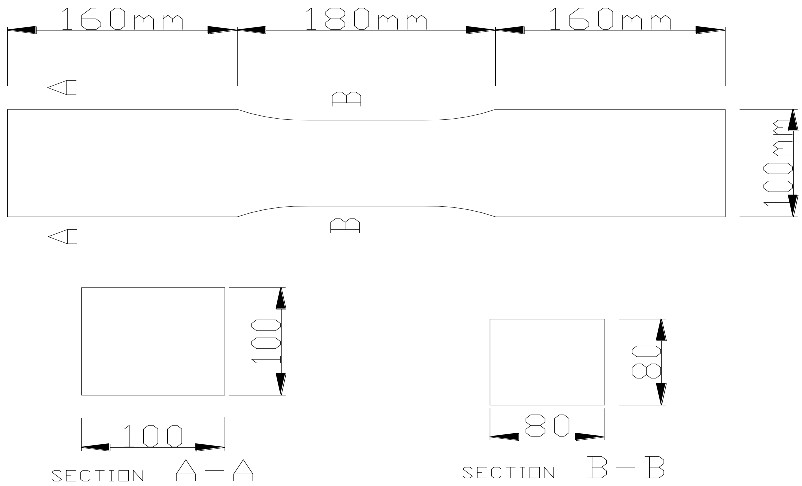

Fig- 1: Geometry for the tensile pulling test (dimensions in millimetre).

RESULTS AND DISCUSSION

Compressive Strength, Tensile pulling strength

The compressive strength of the concrete also decreases with an increase in the percentage of rubber particles in concrete. For T5, T10 and T15 specimens, the compressive strength is reduced by 21%, 32% and 38% respectively as shown in figure 2. This behaviour may be attributed to the fact that the rubber particles are weaker and more elastic than the cement paste surrounding it which propagates cracks from the contact zone of the rubber and cement matrix. Also a high density aggregates replaced with rubber particles of low density will definitely reduced the compressive strength of the concrete[2, 7, 9].

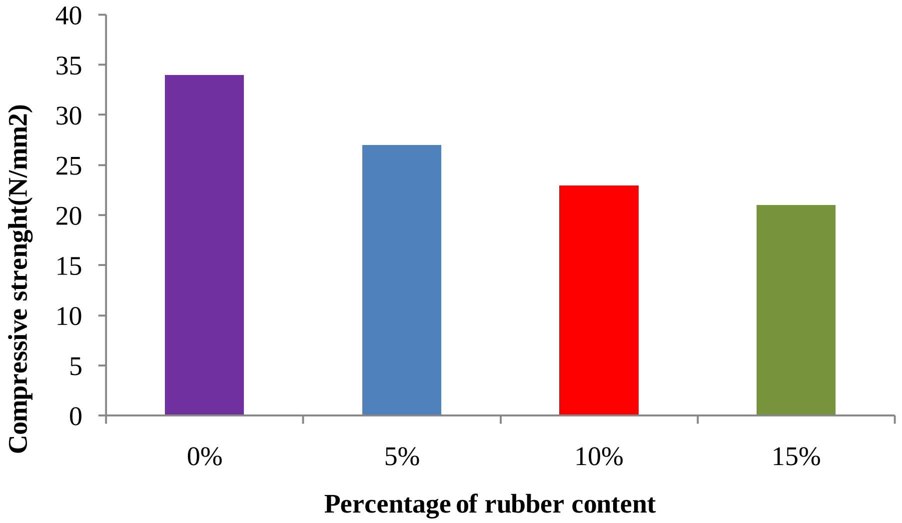

Fig-2: Compressive strength of hardened concrete as a function of rubber content.

Pulling Tensile Strength

The tensile capacity of concrete reduces with increase in rubber particles. The reduction of the pulling tensile strength of specimen T5, T10 and T15 compared to the plain concrete is 4.7%, 9.5% and 23.7% respectively. The reduction may be attributed to the low strength of the rubber particles compared to the 20mm coarse mineral aggregates. Also the bonding of the rubber particles and the cement paste can also be a reason for the low tensile strength exhibited by the rubberized concrete. The figure 3 below shows tensile capacity against the rubber content in concrete.

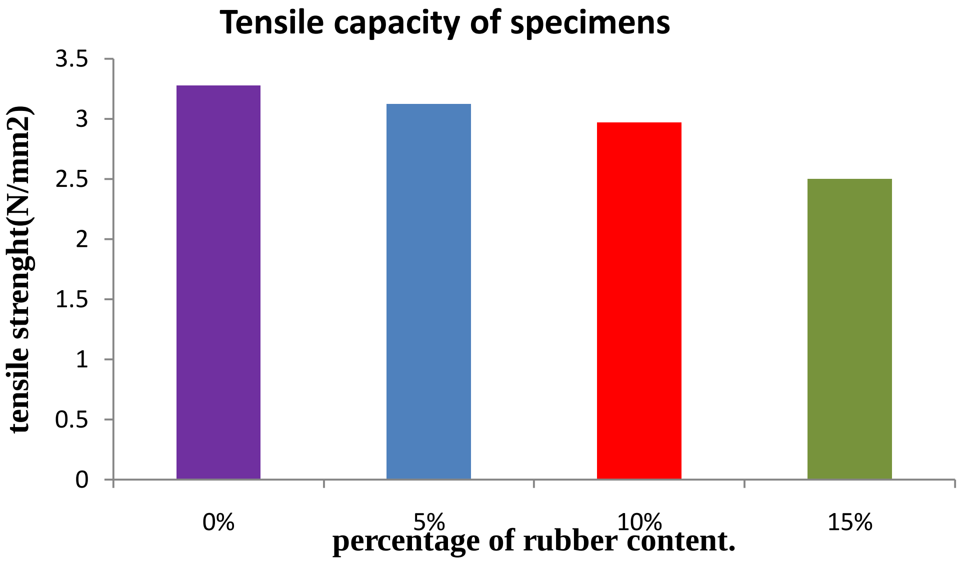

Fig-3: Reduction of the tensile strength as a function of rubber content.

It was also found that the reduction of the compressive strength is higher than that of the tensile strength. Though the reductions in both strengths are not linear as shown in figure 4 below.

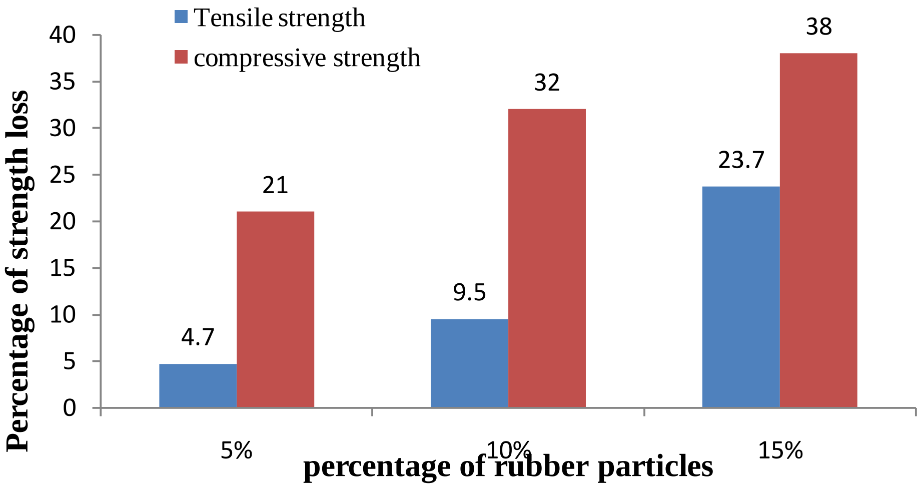

Fig-4: Loss of strength of hardened concrete as a function of rubber content.

CONCLUSIONS

The incorporation of shredded tyres in concrete reduces its compressive and tensile strength. Nevertheless, these reductions can be minimized by limiting the percentage of the shredded tyres of the coarse mineral aggregate volume in concrete in order to be employed in the Civil engineering construction industry.

1. There was a decrease in the compressive and tensile strength of the concrete by 38% and 23.7% respectively when 15% by volume of rubber particles of the total coarse aggregates are incorporated into the concrete mix. The reduction in strength is attributed to the low strength of the rubber particles compared to the replaced coarse mineral aggregates, weak bonding between the rubber particles and the cement paste.
2. For 15% replacement of coarse mineral aggregates with rubber particles in concrete, the reduction in compressive strength is 37.6% more than the pulling tensile strength.
3. To retain the mechanical properties of concrete, rubber particles used in replacing coarse aggregates should not exceed 15%.

FUTURE RESEARCH

1. The durability of rubber modified concrete under adverse weather conditions.
2. A large scale experimental validation of the rubberized concrete material should be conducted in order to be employable in most civil engineering construction requiring low concrete strength.

REFERENCES

1. Khatib ZK, Bayomy FM; Rubberized Portland cement concrete. Journal of Materials in Civil Engineering ASCE, 1999; 11(3): 206–213.
2. Toutanji HA; The Use of Rubber Tire Particles in Concrete to Replace Mineral Aggregates. Cement & Concrete Composites, 1996; 18 :135-139.
3. Ali AO, Yücel AO; Crumb rubber in concrete: Static and dynamic evaluation. Construction and Building Materials, 2012; 36:617–622.
4. Long G, Ma K, Li Z, Xie Y; Self-Compacting Concrete Reinforced by Waste Tyre Rubber Particle and Emulsified Asphalt. Bridges, 2012;10: 9780784412671-0008.
5. Ghaly AM, Cahill JD; Correlation of strength, rubber content and water: cement ration in rubberized concrete.Can.J.CivilEng, 2005; 32:1–7.
6. Silvestravičiūtė I, Šleinotaitė-Budrienė L; Possibility to Use Scrap Tires as an Alternative Fuel in Cement Industry .Environmental Research, Engineering and Management, 2002; 3(21):38-48 (in Lithuanian).
7. Eldin NN, Senouci AB; Rubber-tire particles as concrete aggregates. ASCE Journal of Materials in Civil Engineering, 1993; 5(4):478–496.
8. Stankevičius V, Skripkiūnas G, Grinys A, Miškinis K; Acoustical characteristics and physical – mechanical properties of plaster with rubber waste additives, Materials Science (Medžiagotyra), 2007; 13(4): 304–309.
9. Khaloo AR, Dehestani M, Rahmatabadi P; Mechanical properties of concrete containing a high volume of tire–rubber particles. Waste Management,2008;28(12):2472-2482.
10. Batayneh MK, Iqbal M, Ibrahim A; Promoting the use of crumb rubber concrete in developing countries. Waste Management, 2008; 28:2171–2176.
11. Papakonstantinou CG, Tobolski MJ; Use of Waste Tire Steel Beads in Portland Cement Concrete. Cement and Concrete Research, 2006; 36 (9):1686-1691.
12. Ganjian E, Khorami M, Maghsoudi AA; Scrap-tyre-rubber replacement for aggregate and filler in concrete. Construction and Building Materials, 2009; 23(5):1828-1836.