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INVESTIGATION OF SUITABILITY OF RECYCLE TRASH TRIES RUBBER CRUMBS CONCRETE PROPERTIES FOR CONSTRUCTION WORKS

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Abstract

The replacement of fine aggregates in concrete using rubber crumbs resulting from trash tires will minimize the consumption of the initial aggregates and result in high value use of waste. It will also assist to reduce the use of low value aggregates. This study aims to investigate the concrete properties with variable replacement ratio of rubber crumbs of trash tires. Fixed concrete blend was selected for all test specimens but with variable rubber crumbs content. Rubber crumbs were used with four weight contents of 5, 10, 15, 20, 30 and 40%, besides comparable specimens without rubber crumbs. The variables that were investigated using the rubber crumbs were the rubber crumbs content with compressive strength, unite weight and absorption as well as the appearance of concrete. The test results showed that the compressive strength of concrete with rubber tires crumbs is less than that of specimens without rubber crumbs. The unit weight enhanced as the rubber tires crumbs ratio increased. The test comes about moreover appeared that the unit weight decreased as the rubber tires crumbs ratio increased.

Keywords: Concrete properties, Rubber crumbs, Trash tires.

1. Introduction

The environmental pollution due to combustion or burring of the million tons of the car's tires causes dangerous problems [1, 2]. About one billion trash tires are cast down yearly and are estimated to increase by 20% by 2030 [3-5]. Many countries buried the trash tiers under the ground to avoid the pollution that result of burning of its and to avoid the chemical gasses that emitted as a result of tires combustion. Many research has been to reduce the environmental pollution by mixed it with asphalt to create composite material used in road paving because the high absorbance of the suddenly impacts [6]. Also, mixing rubber crumbs produced from trash tries with concrete and building materials [3, 7-9]. They were tried to use the great amount of trash rubbers of cars to decrease the impact of trash tire environmental issue. Trash tiers rubber properties such as high strength for air temperature and humidity and light weight in additional to high ability to be insulation represents the main reason of using it in building materials industry [10]. Furthermore, reduce the environmental pollution as a result of using rubber crumbs from trash tries in concrete and building materials, it will create light weight, waterproof and heat insulation concrete. This matter has economic advantages over the total cost of the building. The results of studies conducted over the years indicate the significant of rubberized concrete for different applications. Garbage tire fragments rubber performance was detected as a substitutional aggregate for concrete pedestrian blocks. It was aiming to locate the engineering properties of the crumb rubber concrete. Waste tire crumb rubber were demonstrating a good engineering property compare with plain concrete pedestrian blocks resistance [8]. An adjusted concrete is equipping by supplanting coarse aggregates in concrete with waste tire crumb rubber as a substitute development construction material. The comes about demonstrate that such sort of concrete cannot be utilized in structural elements where tall quality is required. It can be utilized in other development construction components like pavements, sidewalks, road barriers, partition walls, etc., which has tall request in development works [10].

The durability of concrete containing reused tires fine parts was evaluated. The results gotten appear that the substation of fine aggregate with 3% and 7% of rubber recorded a compressive strength of 50.8 MPa and 43.7 MPa respectively. That means that the strength and workability of concrete were decreased as the rubber substitution for fine aggregate increased. On the other hand, the water absorption test demonstrated that concrete which contains rubber superior water absorption capacity [11]. Also, concretes prepared with micro fibers, and waste tire crumb rubber was examined. The addendum of micro-reinforcement or waste tire crumb rubber helps to the raise the concrete resistance of wear grinding and hydro-abrasive [12-14]. Rubberized concrete with short steel fibers having lengths of 65 and 35 mm were included at 0.5 and 1.0% by volume were utilized within the deliver concrete pedestrian blocks. The steel fiber increments the density, absorption, flexural strength, abrasion resistance, and toughness of blocks marginally. In any case, the slip resistance did not influence due to fiber including [2]. The points of the consider is to investigate the effective weight percentage of the powder of trash tires to concrete on the properties of concrete to withstand the compression and the total absorption and density and its suitability for construction works which reflected on reducing the

amount of emitted danger gases that resulting of combustion of it, like CO_2, CO and SO_2.

2. Laboratory Work and Materials

2.1. Laboratory work

The test work of this investigate was coordinated to scrutinize the properties of mixing trash tries with concrete. Except for reference specimen, five different weight percentages of 0.15, 0.30 and 0.60 were deemed of rubber crumbs are utilized to supplement fine aggregates in concrete specimen's production. The concrete appearance as well resistance to compressibility, total absorption, and dry density were examined.

2.2. Material and mixing

Rubber crumbs which are produced by grinding the assembled tires by the rubber reclamation plants in Najaf, Iraq, local fine and coarse aggregate were used in preparing the concrete mix. The grain size distribution of rubber crumbs, sand and gravel were presented in Fig. 1. Portland cement characteristics listed in Table 1. The relative values of concrete mix components which be done by using proven ratios of empirical experience to use existing materials. The materials gravel, sand, cement, and rubber crumbs of trash tires mixed together with mix proportion (cement: sand: gravel) of 1: 2: 3. Water/cement ratio was of 0.5 [8]. The characteristics of the reference mix are shown in Table 2. The physical properties of fine and coarse aggregates used in all tests shown in Table 3. The fine and coarse aggregate, cement and rubber crumbs are mixed together then water is added to mixture. The mixing process continues five minutes to get homogenous mixture. The mixture poured in lubricated molds fixed on vibration device. The concrete specimens were kept in lab for 24 hours. Then the molds have weighted before and after curing by submerging in water. Compressive strength, water absorption and concrete density as well as concrete appearance were tested at age 28 days.

3. Results and Discussion

The most factors that are looked in this section are compressive strength, water absorption and concrete density at age 28 days.

3.1. Compressive strength

Figure 2 shows the compressive strength at age of 28 days of specimens having divers' contents of rubber crumbs of trash tires. It is evident from Fig. 2 that compressive strength decreases as rubber crumbs increases, whose is an anticipated result. Figure 2 also displays that the difference between the compressive strength of the specimens with the diver's rubber crumbs ratios is clearer after 5%. The compressive strength of the 28 days age specimens with rubber crumbs ratios of 5, 10, 15, 20, 30 and 40% were 29.50, 23.68, 19.0, 12.72, 9.82 and 4.85 MPa, respectively. While the compressive strength for corresponding specimen without rubber crumbs (0%) was 45.68 MPa.

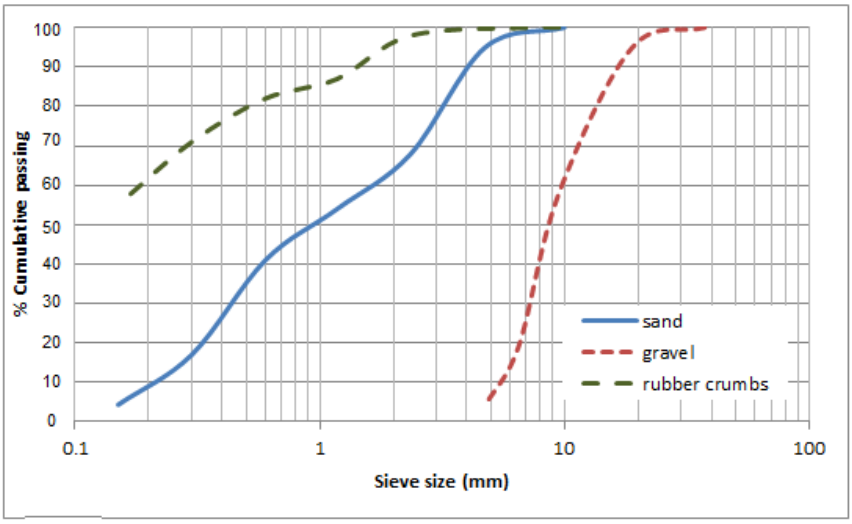

Fig. 1. Grain size distribution of rubber crumbs, sand and gravel.

Table 1. Portland cement characteristics.

SiO_2	Fe_2O_3	Al_2O_3	CaO	SO_3	f-CaO	Loss on ignition (%)	Specific surface (m^2/kg)	Specific gravity
21.03	5.47	2.98	63.49	2.0	0.76	1.36	364	3.15

Table 2. Reference mix characteristics.

Cement (kg/m^3)	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)	Rubber crumbs (kg/m^3)	Water (kg/m^3)	Maximum aggregate size (mm)	Cement type
315	630	645	0	158	19	Type I

Table 3. Aggregate physical properties.

Aggregate classification	Apparent Specific Gravity	Bulk Specific Gravity	Absorption	Moisture Content	Fineness Modulus
Coarse	2.71	2.11	1.43	0.48	
Fine	2.68	2.62	1.36	0.35	2.4

Figure 2 displays that for all cases, compressive strength values diminish with rubber crumbs content raise. According to ACI 318 section 5.1.1, the minimum compressive strength for concrete is 17 MPa (2500 psi). For the 15% rubber crumbs content specimen, compressive strength values after were approximately 19 MPa which acceptable for some construction works.

So, this kind of concrete can be used in a precast concrete which are not under high bearing loads or moments such as: fences, barriers, parapet walls, Decoration pieces, interlocking stones, etc. It can be use also in cast institute concrete for the sport yards, car parks, walkways, bicycle paths, etc. Also, due to low water absorption we can use this kind of concrete mix as waterproof in roofing or other similar locations. These results are agreed with [9]. Another notice is that the rubber

crumbs content specimen more than 15% showed a compressive strength less than 12.5 MPa. From environmental point of view, the replacement 15% of sand with rubber crumbs means an 80 kg rubber per each one cubic meter of concrete with accepted compressive strength. These results mean a recycling of thousands of tons of trash tires. In addition to decreases carbon dioxide emission resulted during aggregate manufacturing.

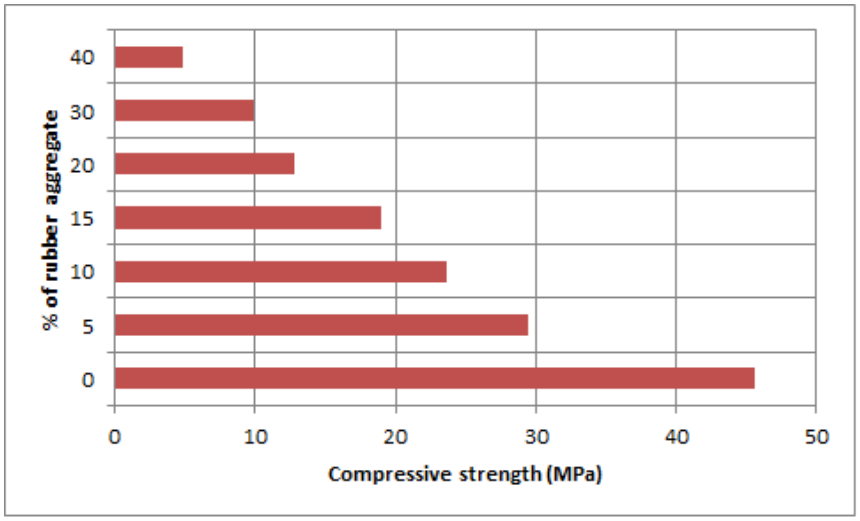

Fig. 2. Compressive strength verses the percentage of rubber crumbs.

3.2. Enhancement of light weight concrete property

It is familiars that the unit weight of all sorts of concrete decreases with decreases of aggregate unit weight and that the difference is more pronounced due to differ material. In this research, it was found that unite weight diminishes as rubber crumbs ratio raise because rubber crumbs specific gravity of 46% less than the specific gravity of sand [15], which reflects the development of light weight property of concrete specimen. Figure 3 shows the unit weight for the specimens with different rubber crumbs contents. It is obvious in Fig. 3 that for 5 to 20% of fine aggregate replacement with rubber crumbs specimen suffered the highest decreases in unit weight value, while at more than 20% fine aggregate replacement with rubber crumbs specimen display the lowest unit weight. Below 20% fine aggregate replacement with rubber crumbs, the unit weight of the concrete specimens was range from 21 to 25 kN/m^3, while these values approximately about 20 kN/m^3 for concrete specimens with more than 20% fine aggregate replacement with rubber crumbs.

3.3. Water absorption

The influence of fine aggregate substitution with rubber crumbs on water absorption was investigated using rubber crumbs from trash tries concrete specimens. To running this investigation, six rubber crumbs contents of 5, 10, 15, 20, 30 and 40% were adopted. Figure 4 demonstrates the leverage of rubber crumbs content on concrete absorption. Figure 4 clearly shows that the rubber crumb content has coordinate impact on the amount of water absorption. It is appeared within Fig. 4 that for the most part as the elastic pieces increments the water assimilation diminish.

Typically, an anticipated result because absorption properties of rubber. For the 0 to 20% rubber crumbs content specimen, water absorption values were approximately 4.9% to 4.5%, respectively. Another notice is that the less than 20% rubber crumbs content specimens showed mostly close water absorption vales.

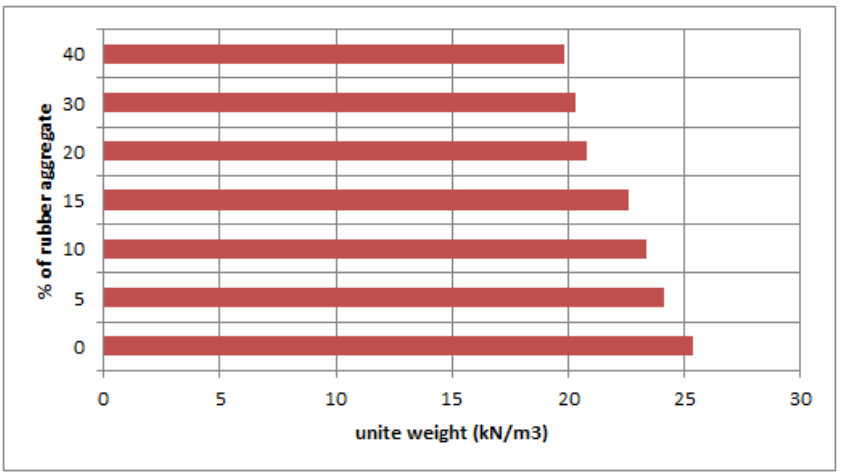

Fig. 3. Concrete unit weight verses the percentage of rubber crumbs.

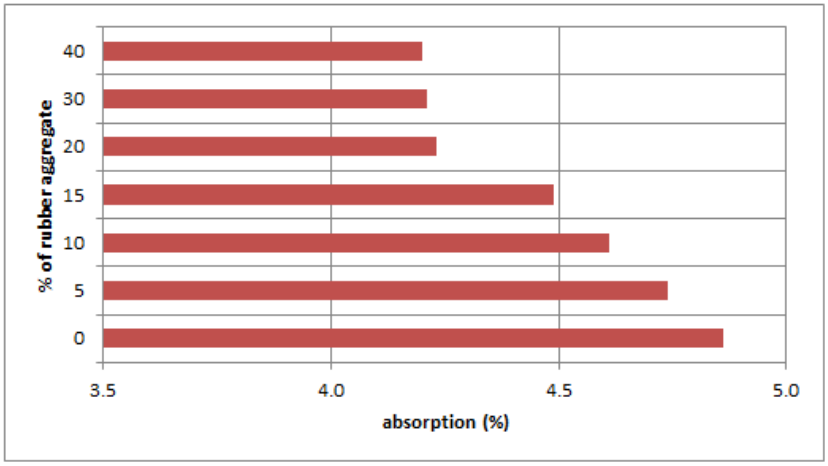

Fig. 4. Water absorption verses percentage of rubber crumbs.

3.4. Test the appearance results

Figure 5 shows that the final exterior manifestation does not differ much from the 0% rubber content specimens, which means that both the 0% rubber crumbs content and fine aggregate replacement with rubber crumbs have same quality of the fresh concrete. On the other hand, the rubber crumb content was effective on colour of concrete specimen which showed good aesthetic qualities for some construction works.

Fig. 5. The appearance of fine aggregate replacement with rubber crumbs concrete specimens.

4. Conclusions

The outcome from the current laboratory work for the studied variables can be summarizing as,

- The compressive strength of concrete at the age of 28 days with rubber tires crumbs proportional inversely with percentage of rubber content. The favourable ratio of rubber crumbs can be up to 15%.
- The test results showed that the specimens having the rubber crumbs (specific weight of 0.95 which is less than the specific weight of aggregate 2.68) light than the reference specimens. This reduces the weight of the dead loads and thus the quality of the foundations.

Comparing specimens having ages of 0, 5, 10, 15, 20, 30 and 40%, it was evident that the increase in the total absorption ratio with the increase of the proportion of rubber tires crumbs.

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