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Advantages of Concrete Mixing with Tyre Rubber

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ABSTRACT
Strong waste administration is one of the major natural concerns everywhere throughout the world. Tire-rubber particles made out of tire chips, piece elastic, and a mix of tire chips and scrap elastic, where utilized to supplant mineral totals in cement. These particles were utilized to supplant 10% , 15% , 20%, and 25% of the aggregate mineral totals volume in cement.Using rubber aggregates in such applications can help to prevent pollution and overcome the problem of storing used tyres. Advantages if using rubber aggregates to replace and coarse aggregates is that waste rubber that is expensive to store and is a hazard, can be reused.

I. INTRODUCTION

Since the past few decades, concrete is used in asphalt for road paving works to replace aggregates. About 20% by volume of shredded rubber or 'rubber crumb' is used in several highway surfacing works [1]. This practice has several advantages and these include safe disposal of scrap rubber types that are non-biodegradable, increase in the water resistance of roads, and considerable savings in use of aggregates [2]. However, the use of shredded rubber as a replacement for aggregates and sand in concrete is not widely practised. Considering that construction uses very large amount of sand and aggregates, successful use of rubber in concrete can not only save the environment but also reduce construction costs [3]. This paper examines the research for using shredded rubber as a partial replacement for aggregates in concrete and the advantages from using rubber.

II. EXPERIMENTAL PROGRAM

Several researchers have conducted studies in the use of rubber in concrete mix. While full replacement of aggregates with shredded rubber is not possible since it critically reduces the concrete strength, up to 20% replacement is suggested [4]. Use of this combination helps to reduce drying shrinkage, along with brittleness, while increasing the elastic module, thereby improving the service life of such mixes [5]. Rubber mix concrete should not be used for loading members such as column, bean since strength is critical, and any reduction in the compressive strength can be disastrous. Rather, rubber mix concrete can be used in other areas such as slab work, flooring, parking and driveways, compound construction, etc [6]. It is important to distinguish between various types of tyres since car and truck tyres have different composition. Car tyres have 48% elastomers than trucks that have 43%. Textile components in car tyres are 5% while truck tyres do not have any textile components. However, truck tyres have 27% more steel fibres than cars that have 15%. Depending on the size of shredded tyres, three categories are available, chipped rubber has aggregate size of 30 mm and it is used to replace aggregates in concrete. Crumb rubber is in the 3-10 mm size range and it is used to replace sand. Ash rubber has particles of 1 mm and it is used as filler concrete.

The shredding of rubber into small particles is very important since larger pieces have less bonding with cement paste, causing the mix to have less strength [7].Albano et al. [8] present reports from a study where rubber aggregate was used with Portland cement, coarse and fine aggregates, sand and water, super plasticizers and admixtures. These additives have differences in the viscous component, increases the period of workability when heated to 50 degrees centigrade. The mix was cast into eight blocks of 15 x 15 cm with different percentages of rubber and admixtures, and tested for workability, mass density, and compression. Tests were conducted using Abrams slump test and volumetric mass was estimated. Results indicate that the mix has good consistency while the compressive strength decreased when more rubber was added. The report concludes that lower mix of rubber with higher compressive strength can be used for structural applications while mixes with lower compressive strength and volume can be used for non-structural applications.Eldin and Senouci[9] conducted tests on compressive and tensile strength of concrete mix with rubber replacing 25, 50, 75, and 100 of sand and coarse aggregates. Test specimens were subjected to compression and tensile stress. Specimens with 25% rubber had a compressive strength of 19.2 Mega Pascal (MPa) while 40% rubber had 11.6 MPs, 75% had 9.2 MPa and 100 % had 6 MPa. Similarly, results for tensile strength showed that 25% had 2.2 MPa, 50% had 1.5 MPa, 75% had 0.8MPA, and 100% ad 0.8 MPa. The test results indicate that up to 25% of rubber can be used for non-structural construction work. In another set of experiments, Eldin and Senouci [10] repeated the experiment to test the strength of concrete for toughness, dynamic modulus of elasticity, freeze and thaw characteristics, and the compressive and tensile strength of concrete mix with rubber aggregates. Rubber was mixed as 25%, 50%, 75%, and 100% to replace sand and coarse aggregates. The results indicate that use of larger rubber chips reduces dynamic modulus, and specimens showed higher toughness and were less brittle since the energy generated is plastic. In addition, specimens showed a gradual failure of splitting and shearing and sudden, abrupt failure was not seen.Fedroff et al. [11] conducted a series of tests to examine rubber concrete mixes in various proportions. Test was conducted for split cylinder strength, compressive strength, modulus of elasticity, flexural strength, and stress-strain.

The results indicate that when compared to standard concrete, strengths of all parameters were reduced, and specimens shrunk in volume. The authors suggest that 'rubcrete' mixes can be used for non-loading work while use for structural loading is not recommended. In another related research, Ghaly and Cahill [12] conducted tests with 5%, 10%, and 15% by volume of rubber aggregates in concrete with water and cement ratios of 0.47, 0.54, and 0.61. Around 180 samples were tested for compressive strength. Test results indicate that compressive strength reduces in rubber mix concrete by 10-30%. The author suggests that such rubber mix concrete cannot be used in critical building components. However, this can be used in non-load bearing structures and in road paving works. Concrete used for residential construction needs to have a minimum MPs of 17 MPa [13].

Hernandez-Olivares et al.[14] conducted a series of tests on concrete mixes with 3.5%-5% of rubber by volume along with other ingredients and plastomers. Test results indicate that the compressive strength of rubber plastic was 23 MPa. Other samples without rubber aggregates had a compressive strength of 36 MPa. Using a four point-bending strength and three-point static bending load method, it was seen that rubber filled samples showed a drop in compressive strength, density, and modulus of elasticity. However, rubber concrete did not allow cracks to propagate immediately while plain concrete allowed cracks to progress very quickly. The authors recommend that small proportions of rubber can be used on highways for sound damping and reduction of noise since the mix dampens sound.

III. PROPERTIES OF MATERIALS

The previous sections have reported tests where sand and coarse aggregates were replaced with varying proportions of rubber aggregates. Important properties of material are observed and these are discussed as follows. None of the specimens showed any brittle failure under loading and the failure was gradual with splitting and shearing. Rubber has a very low modulus of elasticity and it functions as weak inclusions in the hardened concrete mix, creating higher internal tensile stress that acts perpendicular to the direction of load [15]. Voids are elliptical shape and the internal stresses formed are equal to the nominal compressive stress. Cement is weak under tensile load than under compressive load. As a result, material is subjected to tensile loads before the compression load limit is reached. These results in tension cracks on the surface, Cracks travel rapidly in the specimen until they reach the rubber aggregate. Since rubber can withstand much larger tensile forces, it acts as a spring and absorbs the load. This reduces crack formation and widening and as a result, rubber specimens can withstand much larger tensile loads. Rubber continues to resist loads until the bond between the cement and rubber chips is overcome. The specimen fails completely at this stage. Overall, the time required for complete failure is much less for rubber concrete than for conventional concrete. Some problems are mentioned in the use of rubber aggregates. Once problem is that old and discarded tyres have impregnated oils, dirt, chemicals, cement and other slag embedded in the surface. Long periods of storage can break down the chemicals, making them to react with other material. While the properties of rubber are not changed, extra efforts must be taken to remove all the dirt and embedded particles. In some cases, shredded tyre aggregates must be washed in special chemicals and with water to remove the impurities. If this precaution is not taken, then quality of cast concrete will degrade.

IV. CONCLUSIONS

The paper examines the properties of rubber aggregates mixed in concrete where sand and coarse aggregate are replaced by rubber chips. Test results indicate that while the tensile strength is increased, compressive strength is reduced when proportion of rubber aggregates is increased beyond 50%. These findings indicate that it is not advisable to use rubber aggregates in concrete mixes for high strength and load bearing applications. However, rubber aggregate can be used in other applications for non-load bearing components such as road paving, flooring, terrace and other auxiliary construction activities. Using rubber aggregates in such applications can help to prevent pollution and overcome the problem of storing used tyres. Advantages if using rubber aggregates to replace and coarse aggregates is that waste rubber that is expensive to store and is a hazard, can be reused. Rubber tyres storage requires large areas since about 80% of a tyre is made of voids.

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