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A Brief Study on Shredded Scrap Rubber Tyre Replacement for Cement in Cement Concrete

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Abstract: ***Accumulation of scrap tyres is a major problem as degradation of such waste materials is very difficult because of the highly complex configuration. The available studies regarding utilization of waste rubber tyres in concrete provide a strong recommendation for the use of this waste as a partial replacement of fine aggregate or coarse aggregate in concrete production. This would facilitate the effective use of the solid waste, minimize the accumulation of the tyres and reduce the consumption of natural resources. In this study an attempt has been made to study the various properties necessary for the design of concrete mix replacing cement by weight with the shredded scrap rubber tyres in a systematic manner.***

Keywords: Shredded Scrap Tyre Rubber, Light weight Concrete, Compressive Strength, Admixture

1. Introduction

Modifications of construction materials have an important bearing on the building sector. Several attempts have been therefore made in the building material industry to put to use waste material products, e.g., scrap tyres, into useful and cost effective item. Scrap tyres have been classified as a part of municipal solid waste (MSW) resulted from the increase of vehicle ownership and traffic volume. This eventually will increase consumption of tyres over time. Current practices show that residents throw it randomly in different places such as valleys, road sides, open areas, and waste dump sites in improper ways taking the means of open fire, and without consideration of risk on human health and environment. Earlier many researches related to the use of waste rubber tyre has been done in concrete by replacing coarse and fine aggregate by the waste tyre rubber material. It has been observed that rubber tyre mixed concrete mixtures showed lower unit weight compared to plain concrete and good workability. Also results of compressive and flexural strength indicated larger reduction in rubberized concrete when replacing coarse and fine aggregate.

2. Literature Review

(a) **Naik TR, Singh SS. (1991)** [1] studied to determine constructive use options of discarded tyres. Various technologies concerning use of discarded tyres reviewed were retreading, splitting, reclaiming, combustion, pyrolysis, construction of breakwaters, erosion control structures, reefs, pavements, general construction material, etc. The experiment primarily describes the use of discarded tyres in rubberized pavements and materials. Tyre rubber can be used as an ingredient of construction materials, including impact absorbing materials. This includes use of tyres in several asphaltic application such as roofs, basements, water proofing, expansion joints, etc., elastic foundations, railroad ties, crash barriers, etc.

(b) **Eldin NN, Senouci AB (1994)** [2] The study focused on determining the strength characteristics of rubberized concrete and examined the relationship between the size, percentage, and shape of rubber aggregate and the strength measured. Rubberized concrete was found to possess good aesthetics, acceptable workability, and a smaller unit weight than plain concrete. However, it showed low compressive and tensile strengths and lower resistance to repeated freezing and thawing cycles than that of plain concrete.

(c) **Pelisser F, Zavarise N, Longo TA, Bernarin AM (2011)** [3] Utilization of waste vehicle tires in composite materials is an important way to consume these wastes. The strength reduction of rubberized concretes leads to prejudgment to this type of concrete. However, its lower unit weight with higher sound and heat insulation, higher impact resistance and toughness and increased ductility properties are the advantages when compared with the traditional concrete.

(d) **Thomas BS, Gupta RC, Mehra P, Kumar S. (2015)** [4] In this study, waste tyre rubber in the form of crumb rubber was used as a partial replacement for natural fine aggregates in high strength cement concrete. Crumb rubber was replaced for fine aggregates from 0% to 20% in multiples of 2.5%. Tests were done to determine the depth of carbonation, water absorption of acid attacked specimens, compressive strength of acid attacked specimen, variation in weight of acid attacked specimen and chloride penetration of these concrete samples. From the test results it could be concluded that the high strength rubberized concrete are highly resistant to the aggressive environments.

(e) **Bravo m, de Brito J. (2012)** [5] The aim of this paper is to explore the effect of rubber types and rubber content on mechanical properties of concrete. The compressive strength, tensile strength, flexural strength, modulus of elasticity, strain at maximum strength, and compressive stress–strain curves of RC are studied. Extensive databases used for evaluating the mechanical properties of RC include the measured compressive strength of 298 mixtures, measured tensile strength of 90 mixtures,

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measured flexural strength of 93 mixtures, measured modulus of elasticity of 156 mixtures, and compressive stress-strain curve of 15 mixtures. Three main rubber mixtures are replaced by fine and coarse aggregate in the collected experimental results that are crumb rubber (CR, with dimension of 0.5–5 mm), tire chips (TC, with dimension of 5–25 mm), and combination of crumb rubber and tire chips (CR+TC).

3. Shredded Scrap Rubber Tyres

3.1 Production and Collection

Tyre shreds are waste tyres that have been cut into pieces or smaller sizes by a shredder cutter. The product of shredding is referred as "tyre chips" when they are generally between 12 mm to 50 mm in size and are generally uniform in size and can bring down the sizes below 600 micron. The steel belting also gets cut in the process. Rubber is chopped up into granules of predetermined sizes; however, for this research project, rubber was shredded into fibres of lengths less than and equal to 1 cm with diameters of less than and equal to 0.1 cm respectively shown in the figure below and shredded tyre has been collected by tyre recycling factory situated in Bhanpuri, Raipur (C.G.)

Figure 1: Shredded Scrap Rubber Tyre

3.2 Properties of Rubber Tyres

1) **Composition -** All rubber tyres have a rubber and fabric composition, which is molded to the size needed to fit the various rim sizes on vehicles. Moreover, chemicals are added to the rubber to improve its life and performance. Steel wires also are present into the tyres, near their inner edge, to help them better stay on the metal rims.
2) **Bonding -** Rubber tyres, with their flexible qualities, bond to the minor irregularities in the surface of a road, providing higher friction that helps tyres grip the road better.
3) **Strength** - Rubber, in addition to being flexible, is highly durable, even more so after a tyre goes through the vulcanization process. Rubber tyres are strong, able to hold the air pressure needed for them to operate properly and to resist puncture from objects such as sharp stones in the road.
4) **Wear and Tear** - The chemical processing used in the manufacture of tyres makes an already tough product even better. Those chemicals make tyres more resistant to wear and tear. The chemicals also stop tyres from melting from excessive heat, or cracking in extreme cold. In addition, this treatment slows the aging process of the rubber tyres, making them last longer than they would untreated.

3.3 Role of Rubber Tyre Waste in Modern Construction

Construction is an industry where materials must be long-lasting and hard wearing to stand up to the rigours of the building process as well as the constant use after its completion. Rubber is one such material that can be used in multiple products in construction due its exemplary properties. While rubber does have a lower tensile strength than metal, it has a higher elasticity. Materials can work together to compliment strengths and minimize weaknesses.

1) Temperature Resistance
One benefit of rubber is that it holds up to extreme heat and cold. In some climates it will be exposed to both heat and cold, and will experience warming and cooling over the course of the day so rubber is an ideal choice as it does not expand and contract like metal does.

2) Flame Retardant and Low Smoke and Toxicity
Rubber is also flame retardant and also has low smoke and toxicity when it does burn. There is a big advantage as buildings now are held to strict fire codes that regulate materials. It is a material that does not catch fire easily, and if it does, it does not produce a large amount of smoke and toxins unlike other materials do.

3) Absorption
Rubber is considerably more absorptive and is able to absorb stress, movement and vibrations. This is particularly helpful in areas where buildings may be subject to high winds or ground movements. Rubber also protects the joints and promotes flexibility. It is also good at absorbing noise which makes it ideal for sound insulation.

4. Environmental Resistance

As buildings are exposed to the elements on a regular basis, it is important that materials used in construction can resist heat, sunlight, ozone, corrosion, moisture and pollution. All of these elements can limit the life span of materials and mean more frequent maintenance and repairs, so it is important to use materials that will resist degradation as much as possible.

Hazards of Rubber Tyre Wastes
1) Burning of waste tyres produces carbon.
2) As the number of tyres is very large, so it becomes very difficult to place it because of lack of space in our country.
3) Aside from the persistent annoyance, mosquitoes have been shown to spread various dangerous diseases.
4) Equally hazardous are tyre fires, which pollute the air with large quantities of carbon smoke, hydrocarbons and residue.
5) Also these fires are virtually impossible to extinguish once started.

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