Experimental Study on Strength Behavior of Concrete with Partial Replacement of Cement with Silica Fume and Coarse Aggregates with Tyre Rubber

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Abstract: - Rubber tire trash is produced in enormous quantities every year all around the world. Since they are non-biodegradable by nature, recycling them is difficult. They emit smoke that is extremely poisonous and dangerous. Therefore, the only choice is to dispose of them in landfills. It is also not a good answer because it consumes a lot of area and waste rubber stocks pollute the soil and groundwater in addition to contaminating water bodies. Statistics reveal that more than 500 million tires are dumped in landfills each year, and it is predicted that by 2030, around 5000 million tires would be dumped. The utilization of old rubber tires in concrete has been demonstrated by several investigations. Concrete and rubber tires have demonstrated. Although the compressive and flexural tensile strengths of concrete reinforced with rubber tires have decreased, they do offer certain advantages, including improved toughness, impact resistance, thermal characteristics, and acoustic qualities.

The primary goals of this study are to explore the strength characteristics of M30 grade concrete using rubber tyre aggregates (RTA) and silica fume in place of cement. The percentage of silica fume and rubber tyre used as 0%SF+0%RT, 5%SF+10%RTA,10%SF+20%RTA,15%SF+30%RTA,20%SF+40%RTA.

Keywords: *Concrete, Silica Fume, Rubber tyre, Strength Behavior, Compressive Strength*

1. Introduction

The usage of automobiles and the subsequent expansion of the automobile industry have expanded tire manufacturing globally. This has caused a significant buildup of old tires. The main issue with these tires is how to dispose of them. Each year, millions of tires are dumped, posing a danger of damage to the environment. More than 500 million tires, out of an estimated 1000 million that reach the end of their useful lives each year, are disposed of in landfills. In the future, it is predicted that 1200 million waste tires would be thrown away annually. And there may be up to 5000 million hoarded and abandoned tires worldwide. Around 1 billion used tires were produced worldwide in 2008, compared to 1.5 billion new tires. According to a statement made by the Rubber Manufacturers Association, more than 230 million tires are produced and over 75 million used tires are accumulated in the US alone each year. After being retread twice, around 112 million tires are wasted annually in India as well. These used tires are poisonous garbage that may be damaging to your health when burned because they are not biodegradable in nature. As a result, the majority of these used tires are dumped in landfills, having a tremendously negative impact on the environment.

After the tire's whole service life, a very little portion of rubber is abraded, which results in the entire amount of rubber being discarded. Their disposal in landfills also has a negative impact on the environment. In addition to taking up a lot of room in a landfill, the decomposition of these materials produces a number of problems that make it impossible for them to degrade. Waste tire rubber's ability to retain water due to its form makes it a favorable environment for mosquito hatching.

Additionally, it contaminates surface and groundwater and reduces soil fertility by eradicating a large number of beneficial microorganisms. Previous studies have suggested that these old tire rubbers might be used in concrete. When scrap tire rubber is mixed with normal concrete, the resultant concrete is referred to as "Rubberized Concrete" or "Rubber Modified Concrete" in literature. Concrete may be made more suited for use in a particular job by adding leftover tire rubber particles to certain of its constituent parts.

Rubber tyre aggregates (RTA)

Floor mats, belts, gaskets, shoe bottoms, dock bumpers, seals, muffler hangers, shims, and washers are all made of rubber from used tires. In particular, car tires employ up to 10% reused rubber and 3 to 5% rubber fragments. In the cement and brick kilns, tire fragments are utilized as fuel. However, due to air pollution, several municipal authorities have recently outlawed tire burning. Whole tires are also employed as furniture, boat bumpers on docks, and highway collision barriers. As environmental authorities recognize the need for more environmentally friendly options, burning or disposing of tires for energy has limited future possibilities.

Objectives of the study

For the current study the following conclusions were made

1. Determine the workability, strength of M30 grade concrete containing silica fume and rubber tyre aggregates.
2. To compare the test results with conventional mix concrete.
3. To determine the concrete strength values for different percentages of silica fume and rubber tyre aggregates.
4. Determine compressive strength, split tensile strength and flexural strength of concrete.

2. Literature review

T. Senthil Vadivel and R. Thenmozhi (2012) The point of this study is to decide the most ideal way to utilize scrap elastic from scrap tires as a fine total in composite cement. A sum of 90 shape, chamber and pillar tests were broken down and contrasted with 18 standard examples, with the fine total being supplanted by elastic chips in the extents of 2%, 4%, 6%, 8% and 10% by weight. The usefulness, compressive, elastic and flexural qualities of new and restored concrete have been assessed and it is inferred that a 6% supplanting of worn elastic total with fine total is awesome and most secure swap for elastic composites. Concrete. As the finely ground rubber shavings' exchange rate rises, their compressive strength decreases. Supplanting up to 10% of fine total with squashed elastic lessens rigidity by up to 25%. Concrete's flexural strength can be increased by up to 6% using rubber crumbs.

Deepika Rana1, Dr. G.P. Khare2, M. Dushyant Kumar Sahu3 The building material most frequently discussed in this paper is concrete. When strength, performance, durability, waterproofing, fire resistance and abrasion resistance are required, concrete is the material of choice. The need for higher strength is driving the development of additional materials and the result is the cementitious material's contribution to the strength of the concrete. This led us to believe that a silica dosage of 2.0% was optimal. By adding nano silica and substituting 0.5% of the workability of the cement, the compressive strength of the sample drops to 3.032 and 3.032.284 for batches A and B, respectively. After increasing the cement substitute by 2% to 15.911 and 18.666, respectively, for both batches, the percent increase in compressive strength decreases at 2.5% cement substitute.

P Jaishankar1 & C Karthikeyan2 This paper explains: By integrating nano scale components or objects (such as nano particles and nano tubes), concrete can be nano engineered to adjust material behavior and add new functionalities. The aim of this effort is to investigate the effect of nano corundum on the properties of composite concrete. This study produced the following results, derived from analysis of samples stored under standard conditions: Based on the results, the mechanical properties ofconsistently showed superior results in terms of nanoalumina expansion rate. While the tensile strength of the gap increased only slightly, the compressive strength increased dramatically.

3. Materials used

Cement

Ordinary Portland cement of grade 53 (ACC cement) was obtained and utilized in this investigation.

Fig 1: OPC 53 Grade cement

Coarse aggregates

Particles larger than 4.75 mm in diameter, but often between 9.5 mm and 37.5 mm in diameter, are considered coarse aggregates. They can come from new, secondary or recycled materials. New or new aggregates come from onshore or offshore. Gravel is a coarse earth aggregate that is mined from the sea. Gravel and aggregate are examples of coarse aggregate. Most of the coarse aggregate used in concrete is gravel, while most of the remaining material is crushed stone.

Fig 2: Coarse aggregates

Fine aggregates

Sands collected from the land or the sea make up fine aggregate. The majority of the particles in fine aggregates pass through a 4.75mm screen and are typically made of natural sand or broken stone.

Fine aggregates

Water

Water is an essential component of concrete because it actively participates in chemical interactions with cement. Because it contributes to the formation of the concrete gel that gives the concrete its strength, the quantity and quality of the water must be carefully considered. Contrasted with C2S, C3S requires 24% more water by weight. Additionally, it has been determined that 23% of the cement weight of water is required to chemically react with Portland cement compounds.

Silicafume

One more substance utilized as a manufactured pozzolana previous is silica rage, likewise called miniature silica or dense silica smolder. Seethed silica is basically non-translucent silica. Its shape is round. It is tiny, with a molecule size of under 1 micron and a typical breadth of around 0.1 micron - multiple times less than normal concrete particles. Contrasted with 230-300 m2/kg, silica smolder has a particular surface area of around 20,000 m2/kg.

Silica fume

Rubber tyre aggregates

With the aid of a cutting machine, the leftover rubber from tires is divided into aggregates with a minimal size limit of 20mm. Concrete's density tends to decrease when rubber aggregates are used in place of natural aggregates. This decrease is due to the rubber aggregate's reduced unit weight when compared to regular aggregate. As the proportion of rubber aggregate rises, the unit weight of rubberized concrete mixes falls. The Karnool area has provided reclaimed rubber that has been chopped into little pieces.

Rubber aggregates

Mix design of concrete

Concrete Mix proportions for Trial

Cement = 394 kg/m3

Water = 197 kg/m3

Fine aggregates = 638.6 kg/m3

Coarse aggregate = 1071.16 kg/m3

Water-cement ratio = 0.50

Final trial mix for M30 grade concrete is 1:1.62:2.7186 at w/c of 0.50

Tests to be conducted

Workability of concrete

a. Slump cone test

b. Compaction factor test

Strength of concrete

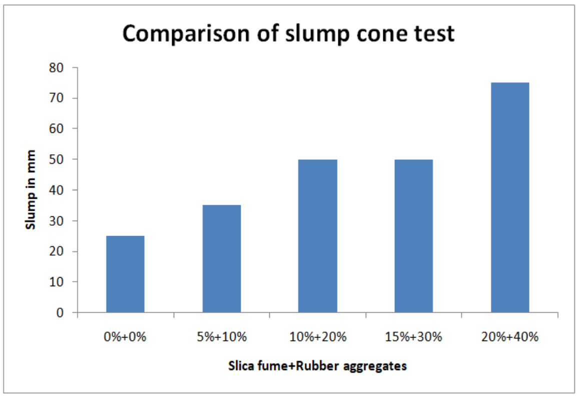
a. Compressive strength

b. Split tensile strength

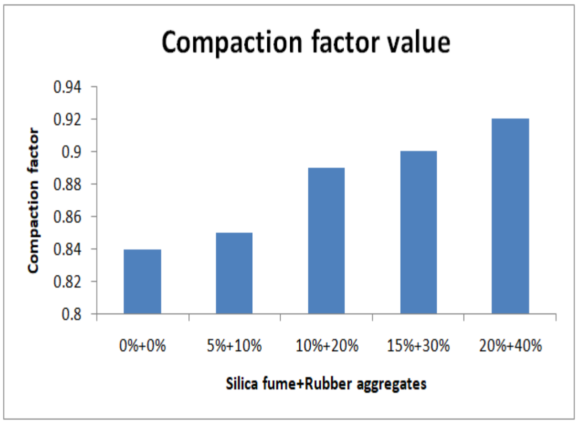
c. Flexural strength

4. Results and Analysis

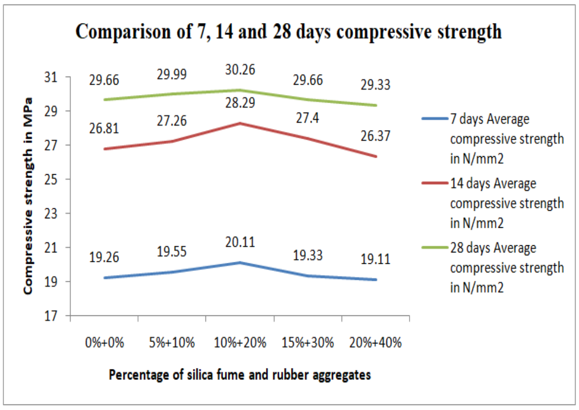
Slump cone test results



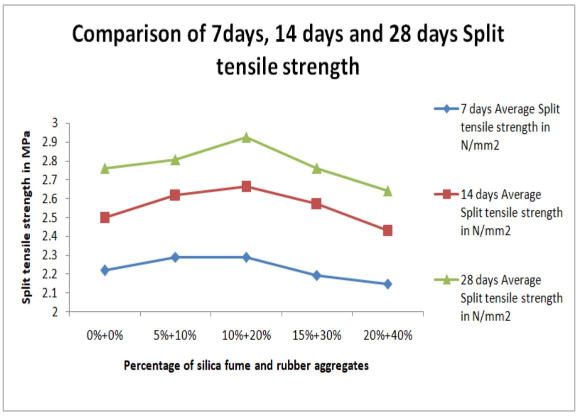
Compaction factor test results



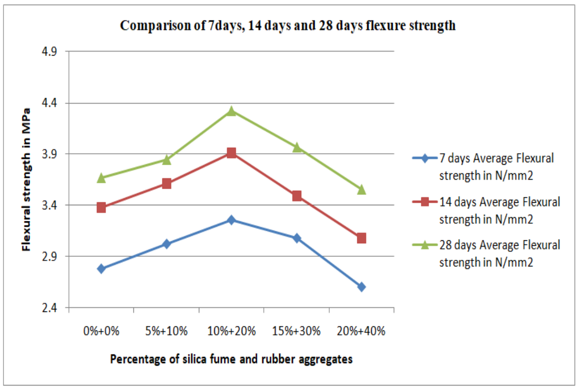
Compressive strength of concrete



Split tensile strength of concrete



Flexural strength of concrete



5. Conclusions

Globally, eco-friendly, green concrete has been advocated to support sustainable development in the construction industry, where a significant amount of concreting work is done. Due to its adverse consequences, using silica fume and rubber waste as a partial replacement for cement and coarse aggregates plays a crucial role in its disposal. The following key points were discovered during the investigation for partial replacement:

1. Based on the findings, it is evident that the unit weight of cylindrical and beam specimens has decreased while the proportion of chipped rubber in concrete has increased. This test must lead to the conclusion that rubberized concrete is only employed in structural applications and light weight buildings.
2. Silica fume and rubber aggregate concrete has shown to be very successful in improving the workability of new concrete and simplifying concrete placing.

3. The Slump Cone and Compaction Factor Tests showed encouragingly rising workability.
4. For compressive strength, 10% silica fume and 20% rubber granules were found to be the best cement substitute. The Compressive Strength gradually decreased as Silica fume and rubber granules were added.
5. A blend of 5% silica fume and 20% rubber aggregates was found to be the best cement substitute for split tensile strength and flexural strength. Rubber aggregates exhibited a progressive decrease and further increase in Silica fume.

After careful consideration, it was determined that a blend of 5% silica fume and 20% rubber aggregates produced the best results in terms of strength properties. Additional research into rubber aggregates with wide chemical properties and silica fume might be investigated as replacements in cement with larger proportions.

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