EXPERIMENTAL STUDY ON STRENGTH BEHAVIOR OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME AND COARSE AGGREGATES WITH WASTE TYRE RUBBER

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ABSTRACT *A very large amount of waste rubber tire are being generated each year all around the world. Being non biodegradable in nature their recycling is not easy. On burning they produce very toxic and harmful smoke. So the only option is to dump them to landfills. It is also not a proper solution as it takes a lot of space and stockpiles of waste rubber leads to soil pollution and contaminate water bodies along with ground water. Statistics show that every year more than 500 million tires are discarded to landfills, and the estimation is about 5000 million tires would be discarded by 2030. Many research studies has shown that the waste rubber tires could be used in concrete. Concrete with rubber tire has shown reduction in compressive and flexural tensile strength but they do possess some positive aspects as they have better toughness, impact resistance, thermal and sound properties.*

The main objectives of this study is to investigate the strength properties of M30 grade concrete by replacing cement with silica fume and rubber tyre aggregates (RTA). 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.

1. INTRODUCTION

The recent growth of automobile industry and use of vehicles has increased the production of tires all through the world. This has lead to large accumulation of used tires. The major problem of these tires is their disposal. Million of tires are discarded each year causing environmental risk to pollution. It is estimated that each year about 1000 million tires end their service life and more than 500 million among them are discarded to landfills. A future estimation is that the number of waste tire discarded yearly would reach 1200 million. And there could be as many as 5000 million of stockpiled discarded tire throughout the world. In 2008, the global production of waste tire was about one billion and production of new tires was about 1.5 billion. Rubber Manufacturer's Association in one of their statement say that every year about 75 million of waste tires are stockpiled in US itself and more than 230 million are produced. In India also there would be about 112 million of discarded tire per year after retreading twice. These waste tires are non-biodegradable in nature and on burning produces very harmful and toxic gases dangerous to health. So, a maximum amount of these waste tires are thrown to landfills causing very adverse effect on environment.

A very small amount of rubber from the tire gets abraded after its whole service life, this means that a whole of rubber is discarded. Their disposal in landfill also has some adverse effect on nature. Along with occupying a very large space in a landfill their decomposition also creates a variety of issues making it unfeasible to decompose. Waste tire rubber own shape allows it to store water for a long period causing a breeding place for mosquitoes and other insects.

It also causes contamination of underground water and above ground water and also spoils the fertility of soil by destroying many beneficial bacteria present in soil. Research in the past has shown that these waste tire rubbers could be used in concrete. In literatures, the term "Rubberized Concrete" or "Rubber Modified Concrete" is used for concrete made with mixing waste tire rubber particles into plain concrete. A lot of properties gets enhanced by replacing some components of concrete with waste tire rubber particles making it suitable for use in a particular work.

Rubber tyre aggregates (RTA)

Rubber from discarded tyres use in, floor mats, belts, gaskets, shoe soles, dock bumpers, seal, muffler hangers, shims and washers. 3 to 5% Rubber crumbs and upto 10% reclaimed rubber is particularly used in automobile tyres. Tyre pieces is used as fuel in cement and brick kilin. However, various local authorities are now banning the tyre burning due to atmosphere pollution. Whole tyres also used as highway crash barriers, furniture, boat bumpers on marine docks, etc. Land filling or burning tyres for energy have limited prospects as environmental authorities are acknowledging the need for its greener alternatives.

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 REVIEWS

T. SenthilVadivel& R. Thenmozhi (2012) In this Study, our present study aims to investigate the optimal use of waste tyre rubber crumbs as fine aggregate in concrete composite. A total of 90 cubes, cylinders and beam specimens were cast with the replacement of fine aggregate by shredded rubber crumbs with the proportion of 2, 4, 6, 8, and 10% by weight and compared with 18 conventional specimens. Fresh and hardened properties of concrete such as workability, compressive strength, tensile strength and flexural strength were identified and finally it is recommended that 6% replacement of waste tyre rubber aggregate with fine aggregate will gives optimal and safest replacement in concrete composites. Compressive strength decreases when the percentage of replacement of shredded fine rubber crumbs increases. Split tensile strength decreases at the maximum of 25% when rubber crumbs replaces up to 10% in fine aggregate. Flexural strength of concrete increases when rubber crumbs increases up to 6%.

Deepika Rana1, Dr. G. P. Khare2, Mr. Dushyant Kumar Sahu3 This paper studied about Concrete is the most commonly used in construction material. Concrete is the material of choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required. The hunger for the higher strength leads to other materials to achieve the desired results and thus emerged the contribution of Cementitious material for the strength of concrete. The Characteristic Compressive Strength of concrete at 7 days and 28 days was found in N/mm2. For Batch A the result shows a slight decrease in the strength with addition of Nano silica at first. Further with addition of Nano silica more than 0.5 %, there was an increase in the strength up to 2.0 % after which the strength again decreased. This led us to conclude that 2.0% is the ideal silica dosage. For batch A and B the percentage increase in the compressive strength with addition of Nanosilica with 0.5% replacement of cement workability percentage in increased and compressive strength of specimen is decreased at 3.032 and 3.284.The percentage increase in the compressive strength for 2.5% replacement of cement is decreased for both batches after that 2% replacement of cement is increased up to 15.911 and 18.666.

P Jaishankar[1] and C Karthikeyan[2] This paper describes Concrete can be nano-engineered by incorporating nano sized building blocks or objects (e.g., nano particles and nano tubes) to control material behaviour and add novel properties. In this work an attempt has been made to study the effect of nano alumina on the properties of concrete composite. From this study it was concluded that The accompanying were the conclusions touched base from the analyses directed on specimens in Standard condition: Based on the outcome, it was found that for the expansion in rate of nano alumina, mechanical properties demonstrated reliably enhanced results. The compressive strength expanded significantly, the split tensile strength increased marginally.

3. MATERIALS USED

Cement

In this study Ordinary Portland cement of 53 grade (ACC cement) has been procured and has been used.

Fig 1: OPC 53 Grade cement

Coarse aggregates

Coarse aggregates are particles greater that 4.75mm but generally range between 9.5mm to 37.5mm in diameter. They can either be from primary ,secondary or recycled sources. Primary or virgin aggregates are either land or marine-won. Gravel is a coarse marine-won aggregate, land-won coarse aggregates include gravel and crushed rock. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

Fig 2: Coarse aggregates

Fine aggregates

Fine aggregate are basically sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 4.75mm sieve.

Fine aggregates

Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, in the quantity and quality of water is required to be looked into very carefully. C_3S requires 24% of water by weight and C_2S requires 21%. It has also been estimated that on an average 23% of water by weight of cement is required for chemical reaction with Portland cement compounds.

Silicafume

Silica fume, also referred to as microsilica or condensed silica fume, is another material that is used as an artificial pozzolanic admixture. Condensed silica fume is essencially silicon dioxide in noncrystalline form. It has spherical shape. It is extremely fine with particle size less than 1 micron and with an average diameter of about 0.1 micron, about 100 times smaller than average cement particles. Silica fume has specific surface area of about 20,000 m^2/kg, as against 230 to 300 m^2/kg.

Silica fume

Rubber tyre aggregates

The scrap tyre rubbers are cut into aggregates with help of cutting machine and cutting to maximum nominal sizes equal to 20mm. The replacement of natural aggregates with rubber aggregates tends to reduce the density of the concrete. This reduction is attributable to the lower unit weight of rubber aggregate compared to ordinary aggregate. The unit weight unit weight of rubberized concrete mixtures decreases as the percentage of rubber aggregate increases. Reclaimed rubber has been obtained from karnool district and cut into small 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

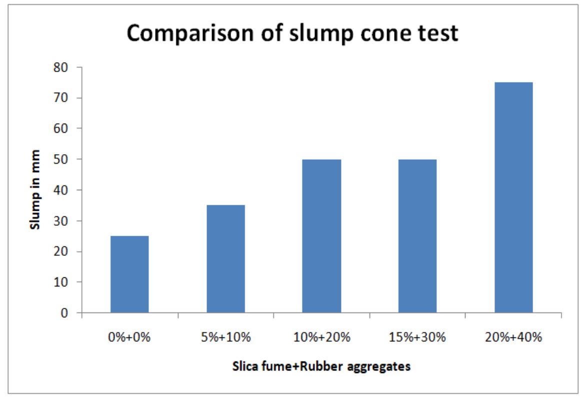
a. Compressive strength

b. Split tensile strength

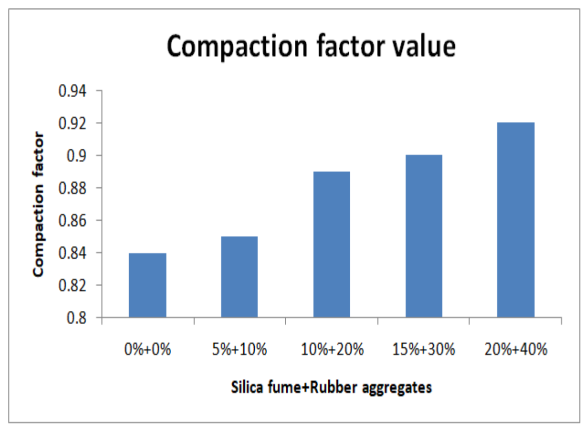
c. Flexural strength

4. RESULTS AND ANALYSIS

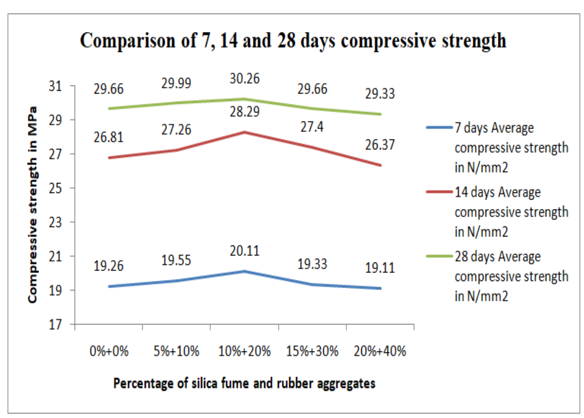
Slump cone test results



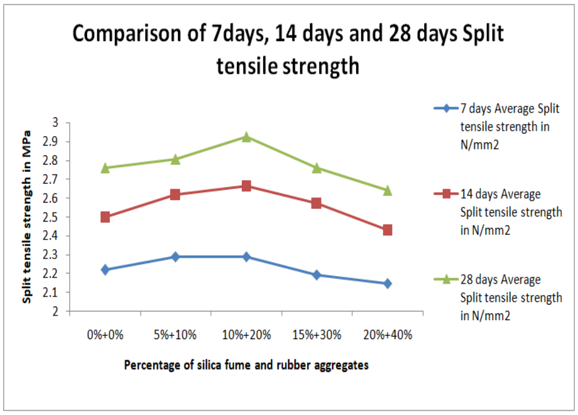
Compaction factor test results



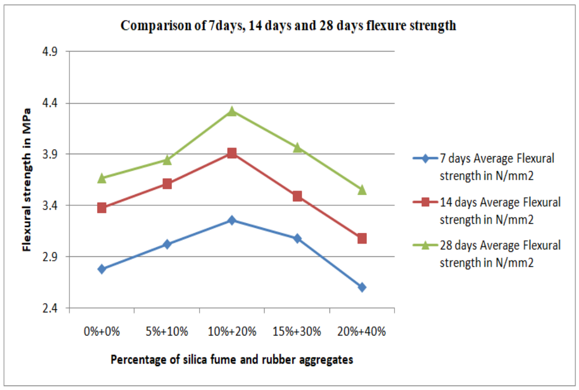
Compressive strength of concrete



Split tensile strength of concrete



Flexural strength of concrete



5. CONCLUSIONS

Eco friendly, Green Concrete has been promoted worldwide to encourage Sustainable Development in the field of Construction where huge amount of concreting works are carried out. Utilizing silica fume and rubber waste as a partial replacement for Cement and coarse aggregates provides a significant role in its disposal due to its adversarial effects. When investigated for partial replacement the following highlights were noted:

1. From the observations, it is noted that unit weight of beam and cylindrical specimen's has been reduced upto increasing the percentage of chipped rubber into concrete. From this test it has to be concluded that rubberized concrete is used in the light weight structures and restricted to the structural application.
2. Silica fume and rubber aggregates concrete has been highly effective in increasing the workability of the fresh concrete easing the placement of concrete.
3. A gradual increase in the workability was promisingly observed in Slump Cone and Compaction Factor Test.
4. For Compressive strength the optimum replacement of cement were observed for 10%silica fume+20% rubber aggregates. Further increase in Silica fume and rubber aggregates reduced the Compressive Strength.
5. For Split Tensile strength and Flexural Strength the optimum replacement of cement were observed for 5%silica fume+20% rubber aggregates mix. Further increase in Silica fume and rubber aggregates showed a gradual drop.

Upon careful examination, a suitable proportion where optimum results in strength characteristics were obtained at 5%silica fume+20% rubber aggregates mix. Further investigation over Silica fume and rubber aggregates with extensive chemical characteristics could be tested for replacement in cement with higher proportion.

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