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AN EXPERIMENTAL STUDY ON STEEL FIBRE REINFORCED RUBBER CONCRETE

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ABSTRACT

Accumulation of discarded scrap tires are non-biodegradable and have been a major concern. Even after a long period of land fill treatment, unmanaged waste tire poses environmental and health risk though fire hazard. Therefore, utilization of rubber from these scrap tires for the production of building materials in construction industry would help to preserve the natural resources and also maintain ecological balance. So, rubber used as replacement of aggregates with using fibers. Fiber reinforced concrete containing rubber particles have increased levels of toughness in comparison with conventional concrete. This experimental investigation focused on the material properties of fiber reinforced rubber concrete. Rubber particles were used at various concentrations to partially replacement with coarse aggregate 0, 5, 10, 15&20% with the addition of 0.85% steel fiber. This investigation includes an evaluation of standard fresh and hardens concrete properties. Results show that the fiber reinforcement counteracts the negative effects of using rubber particles to replace traditional aggregates.

Keywords: Composite Material, Concrete, Granite Powder, Waste Rubber, Fiber-Reinforced Concrete, Steel Fibers.

INTRODUCTION

1.1 Waste Rubber:

The use of recycled materials and sustainable design has gained more and more attention over the past two decades in an effort to reduce the amount of waste entering landfills. The construction industry often uses a wide variety of recycled materials.

Rubber aggregates from discarded tire rubber in sizes 20-10 mm, 10-4.75 mm and 4.75 mm down can be partially replaced natural aggregates in cement concrete construction. Rubber from discarded tires use in, floor mats, belts, gaskets, shoe soles, dock bumpers, seal, muffler hangers, shims and washers. 3 to 5% rubber crumbs and up to 10% reclaimed rubber is particularly used in automobile tires. Tire pieces are used as fuel in cement and brick kiln. However, various local authorities are now banning the tire burning due to atmosphere pollution. Whole tires also used as highway crash barriers, furniture, boat bumpers on marine docks, etc. Land filling or burning tires for energy have limited prospects as environmental authorities are acknowledging the need for its greener alternatives.

Concrete mixtures incorporating discarded tire rubber as aggregate and as cement replacements. The use of tire rubber particles as a replacement for coarse aggregate in concrete. The substitution of coarse aggregate with rubber particles in concrete results in large reductions in compressive strength and modulus of elasticity.

The flexural strength of concrete was reduced with increased levels of rubber particle content of coarse aggregate in concrete. And the rubber particles significantly improved the abrasion resistance of concrete. Substitution with rubber particles adversely affects the mechanical properties of concrete. But at the same time use of waste tire as aggregate replacement in concrete showing that a concrete with enhanced toughness, sound insulation, impact resistance, and reduced fatigue cracking properties can be achieved.

The greater difference in density for mixes with higher concentrations of rubber particles may be the result of the slight differences in air content. Rubber particles used to replace coarse and fine aggregates resulted in reduced 28-day compressive strengths for mixes with and without fiber reinforcement. However, unlike previous research, there was very little difference between mixes using coarse, fine, and a mixture of coarse and fine rubber particles to replace respective sizes of conventional aggregates.

Although rubber particles have the same effect on mixes with and without fiber reinforcement, the mixes with fibers consistently and had higher compressive strengths compared to mixes without fibers. Split tensile strength also decreased with an increase in rubber content, the effect was not a prevalent in comparison to 28-day compressive strengths. The addition of fibers resulted in a greater increase in split tensile strength than in compressive strengths.

Fig 1: Waste Rubber

1.2 Fiber-Reinforced Concrete:

Fiber-reinforced concrete (FRC) has grown in popularity in recent years and research efforts continue to investigate its behavior and potential applications. Common types of artificial fibers used in FRC today are made of steel, glass, carbon, polymers, and synthetics. These include ultra-high molecular weight polyethylene (Spectra) fibers, low-density polyethylene fibers, polypropylene fibers, polyvinyl alcohol (PVA) fibers, nylon fibers, hooked-end steel fibers, twisted steel fibers, straight steel needle fibers, and crimped steel fibers. Research shows that increasing the volume fraction of fibers in a concrete matrix enhances the toughness and post cracking behavior of the concrete by minimizing the growth of micro cracks. The performance of FRC depends on many factors including the type, amount, and geometry of fibers used and the composition of the cementation's matrix itself.

The addition of fibers has various effects on the hardened concrete properties. Conversely, adding fibers to conventional concrete increases the tensile strength significantly. The increase in tensile strength is a result of fiber bridging in cement matrix, which provides resistance against crack opening, thus leading to enhanced post-cracking behavior. This significant enhancement in post-cracking behavior ultimately leads to increases in ductility and toughness of the material.

1.3 Steel Fibers:

Steel fiber-reinforced concrete is basically a cheaper and easier to use form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are laid within the liquid cement, which requires a great deal of preparation work but make for a much stronger concrete. Steel fiber-reinforced concrete uses thin steel wires mixed in with the cement. This imparts the concrete with greater structural strength, reduces cracking and helps protect against extreme cold. Steel fiber is often used in conjunction with rebar or one of the other fiber types.

Fig:2: Steel Fibers

1.4 Objectives of the study

- To study the strength of the concrete with partial replacement of coarse aggregate with waste rubber
- To study the strength of the concrete with partial replacement of coarse aggregate with waste rubber and steel fibres
- Compensate the scarcity of natural coarse aggregates.
- To economize the cost of construction works.
- Deciding suitable percentage of waste rubber as an alternate for conventional coarse aggregates.
- Strength comparison of Conventional and Non-conventional concrete.

II. Materials

Cement:

Ordinary Portland cement of 53 grade conforming to both the requirements of IS: 12269 and ASTM C 642-82 type-I have been used. different types of tests had conducted on cement which include Normal Consistency, Initial and Final setting times, Compressive strength of cement, Specific Gravity and Fineness of cement. Finally, we have chosen M30 Grade (1: 1.48: 2.64) concrete for our experimental work.

Basic Composition:

Chemical compound	Weight %
caO	60-67
Sio_2	17-25
Al_2O_3	3-8
Fe_2O_3	0.5-6.0
MgO	0.5-4.0
Alkalis	0.3-1.2
SO_3	2.0-3.5

Fine Aggregate:

Well graded river sand that passing through 4.75 mm was used as fine aggregate. It Consists of Natural sand and other inert materials with similar characteristics by having hard, strong, durable particles. Specific Gravity of Fine Aggregate is 2.58

Coarse Aggregate:

Normal aggregate that is crushed blue granite of maximum size 20mm was used as coarse aggregate. We are conducting tests on coarse aggregate are Water Absorption Capacity, Specific Gravity and Fineness Modulus of coarse aggregate. Coarse aggregate opted for the present study is dark blue granite, conforming to IS 383-1970 requirements. Specific Gravity of Coarse Aggregate is 2.67.

Replaced Coarse Aggregate (Rubber):

Re cycling waste tires that are no longer suitable for use on vehicles due to wear (or) irreparable damage. The tires are highly durable and non-biodegradable. All through tires are usually burnt, not recycled, efforts are continuing to find value. Tires can be recycled into, among other things, the hot melt asphalt, typically as crumb rubber modifier recycled asphalt pavement and also been cut up used as aggregate in Portland cement concrete. Tires can also be recycled into other tires. Specific Gravity of rubber is 2.625.

Steel fibers

They can be reduced the plastic shrinkage cracking and also increase tensile strength and flexural strength. The shape of the fibers is adjusted in such a way that it increases the anchorage of fibers in concrete

Water:

Portable water conforming to IS 3025-1986 is taken for the present study.

Mix Proportions:

The proportions of the concrete mix for M30 grade is 1: 1.48: 2.64, with a water cement ratio of 0.45 obtained with the help of IS 10262-2019.

III. <u>METHODOLOGY</u>

Experimental Programme:

The major goal of this experiment is to determine the effect of replacing coarse aggregate with waste rubber in percentages of 0 %, 5%, 10% ,15% and 20% on the hardened qualities of cement concrete and also casting of specimens. The experiments are carried out for each percentage 0 %, 5%, 10% ,15% and 20% also with addition of steel fibre of 0.85% in each specimen like 5% +0.85%, 10%+0.85% ,15%+0.85%and 20%+0.85% the casting, curing, and testing of specimens are all part of the experimental effort.

The trials are all carried out at room temperature. The dry materials for concrete, namely cement, fine aggregate, and coarse aggregate, are combined first. Waste Rubber is used as a partial replacement for coarse aggregate, followed by the addition of a calculated amount of water and thorough mixing to achieve a uniform mix. Concrete cubes are compacted on table vibrator. Layers of concrete are utilized for compressive strength testing, Split Tensile strength testing and flexural strength testing and are cured in water as in Fig. for 28 days before being tested on a compressive testing machine (CTM)

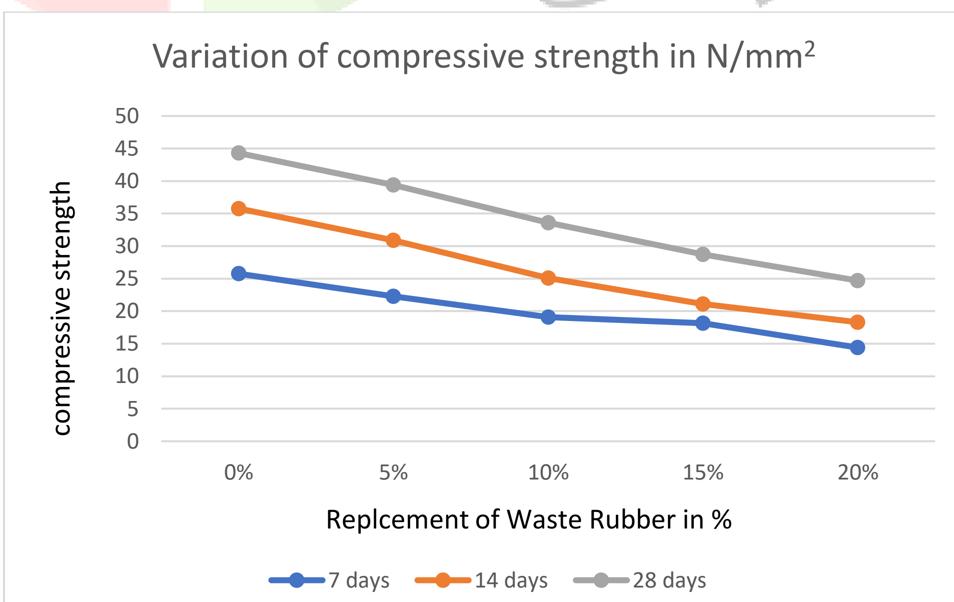
Fig 3.1: Compressive Strength Test

Fig: Split Tensile Strength Test

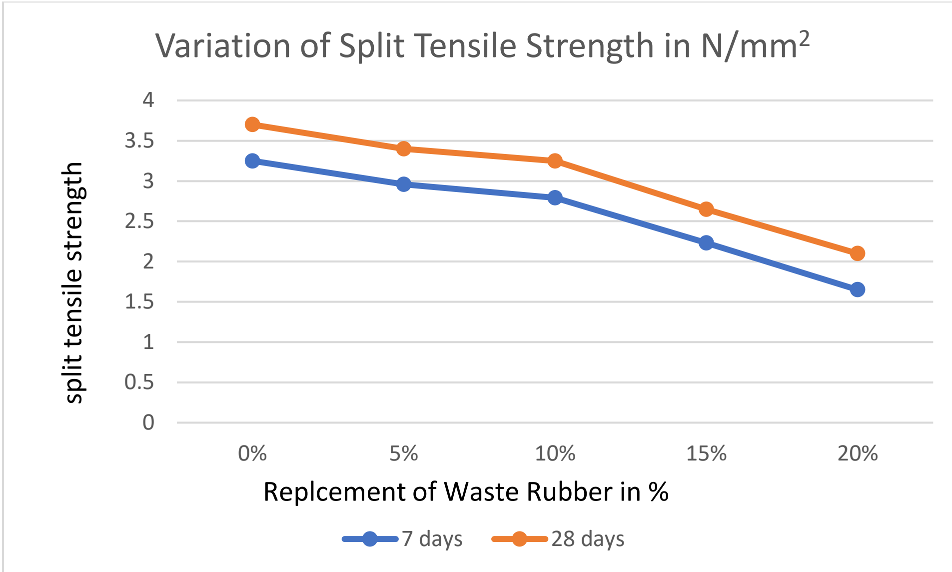
Fig: Flexural Strength Test

IV. Results and Discussions

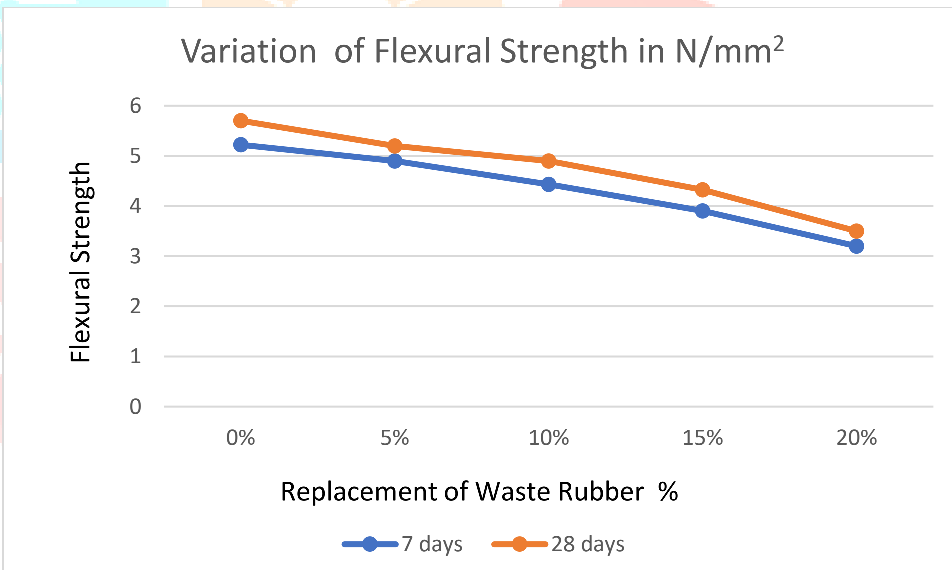
Mix- 1 Compressive strength study on 1: 1.48: 2.64 with Waste Rubber



Graph of compressive strength results



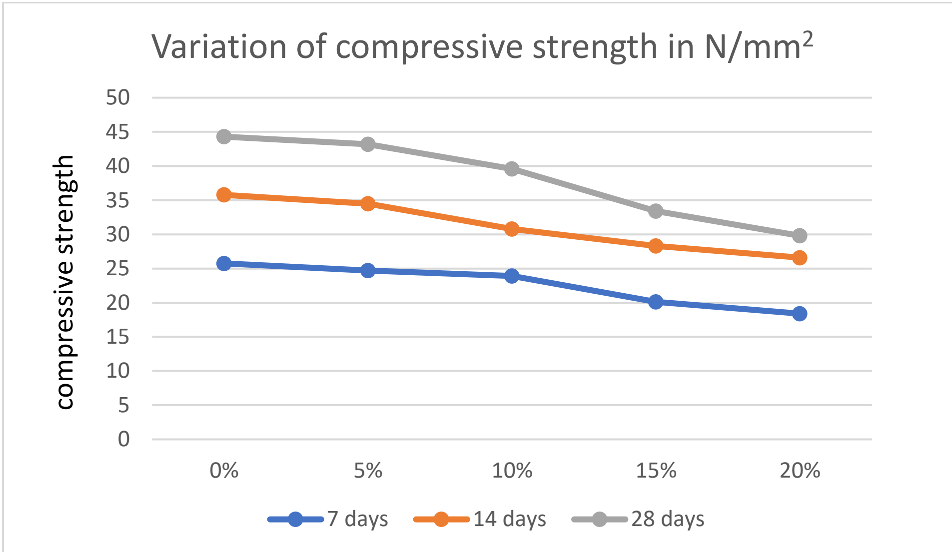
Graph of split tensile strength results



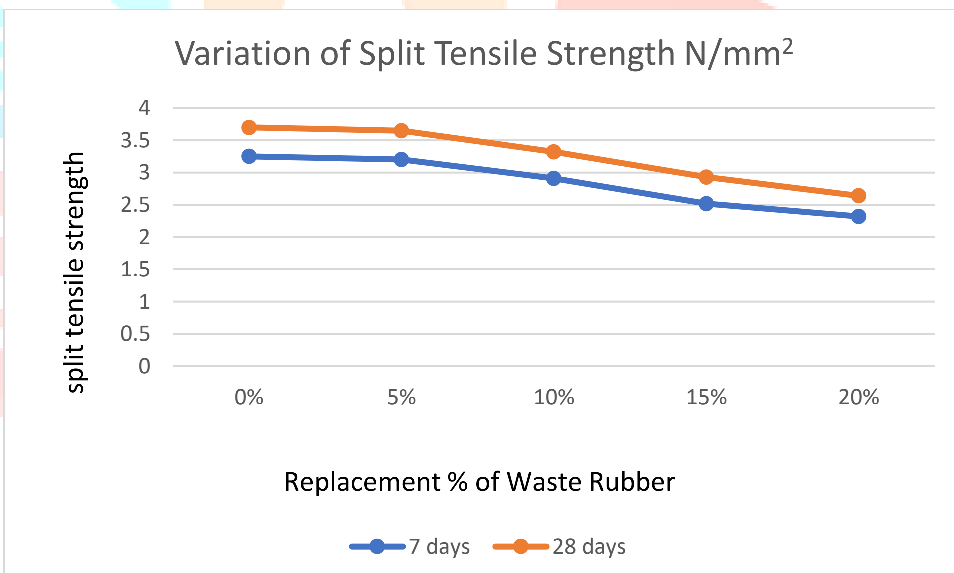
Graph of Flexural strength results

The test results obtained by performing the mix proportion 1: 1.48: 2.64 has achieved the less strength by taking the reference of previous journals and studies, but self-weight of the structure is reduced which is induces due to presence of rubber pieces used as a aggregate concrete. At present, our study is mainly based on strength property. So, by basing on that in order to improve strength the mix is designed in such a way that some amount of steel fibers is added to the mix proportion without the addition of super plasticizer and of any add mixtures. The comparison of results is done by improving the strength and impact resistance of structure.

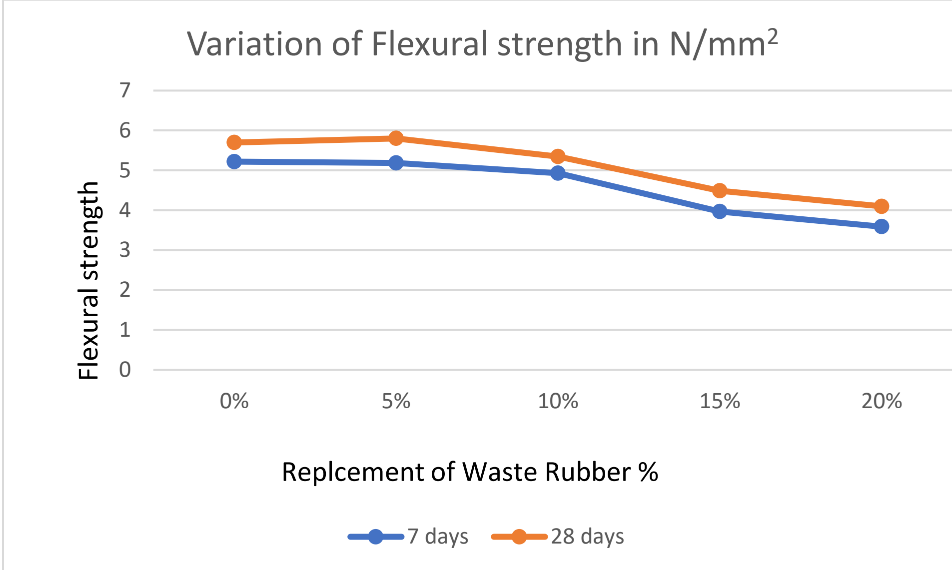
Mix- 2 Compressive strength study on 1: 1.48: 2.64 with addition of Waste Rubber and steel fibers



Graph of compressive strength results



Graph of split tensile strength results



Graph of Flexural strength results

CONCLUSIONS

- The increasing percentage of rubber pieces will show negative impact on strength of concrete (strength decreases).
- The compressive strength, split tensile strength &flexural strength of rubberized concrete decreased considerably with the increase of rubber content. The percentage reduction of the above properties can be reduced with the incorporation of hooked end steel fibers.
- The negative effects of the rubber on the flexural strength have a more significant effect than those on the compressive strength and split tensile strength.
- As in the first mix we can reach the target mean strength at 5% rubber content but by adding steel fibers the target mean strength reached at 10%rubber content

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