PARTIAL REPLACEMENT OF FINE AGGREGATES BY CRUMB RUBBER IN CONCRETE

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Abstract -The trend in sustainable development, environmental friendly, low cost construction materials in construction industry has led us to investigate the need of using waste materials to benefit the environment. Rapid increase in automobile industry has led to production of a huge amount of waste tires in the entire world. The disposal of waste tires continues to pose a severe threat to environmental protection and health. Waste scrap tires in landfills have direct effect on human health, contaminating soil and ground water due to the leaching effect of toxic metals present in tires. The utilization and reuse of waste tire rubber in concrete can reduce the consumption of raw materials, which leads to economic efficiency and sustainable development of the construction industry. This study involves the utilization of waste tires rubber material as partial replacement for fine aggregates in M30 grade of concrete. The mix proportions for different percentages (0%, 5%, 10%, and 15%) of crumb rubber replacement were proposed. Surface treatment of crumb rubber was done by soaking the rubber in 25% sulphuric acid (H2SO4) solution to increase the surface area of rubber particles. And also the treated crumb rubber was coated with polyacrylamide hydrogel to improve the hydrophilic property of rubber which would enhance the bonding between rubber particles and cement matrix .However the strength properties of the concrete were reduced. The strength reduction rate on further addition of rubber in concrete was found to be relatively decreased

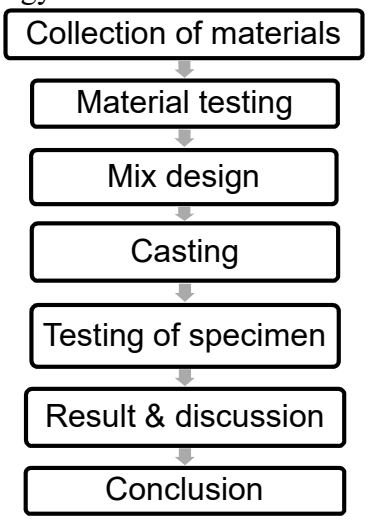
Key words: To concern environmental problems, low cost construction, eco-friendly.

1. INTRODUCTION

The trend in sustainable development, environment friendly, low cost construction materials in construction industry has led us to investigate the need of using waste materials to benefit the environment. Concrete is a material which is primarily used in construction and directly competes with all other major construction materials including timber, steel, asphalt and stone. However, concrete is a composite material, and its properties can differ considerably depending on the choice of materials and the proportions for specific application.

2. METHODOLOGY

The following flow chart explains the methodology for the study.



3. MATERIALS AND TESTING

3.1CEMENT

Cement is preferred as the binding material for this experiment. The type of cement used is Portland pozzolana cement (PPC) 43 grade

.The physical properties of the cement are shown in table.1

Table.1

Specific gravity	3.15
Initial setting time	32 mins
Final setting time	610 mins
Compressive strength	33MPa

3.2FINE AGGREGATE:

Fine aggregates consist of natural sand or any crushed stone particles that are ¼" or smaller. The type of fine aggregate used in the experiment is natural sand obtained from a local source. Fine aggregates passing through 4.75 mm sieve are taken and their physical characteristics are provided in table.2

Table.2

Specific gravity	2.65
Water absorption	0.5%
Fineness modulus	2.75

3.3COURSE AGGREGATE:

Coarse aggregates refer to irregular and granular materials such as sand, gravel, or crushed stone, and are used for making concrete. Coarse is naturally occurring and can be obtained by blasting quarries or crushing them by crushers. Crushed angular type of aggregates are preferred for the experimental work. The nominal maximum size of aggregates is 20mm. The properties of the coarse aggregates are given in the table.3

Table.3

Specific gravity	2.74
Water absorption	1%
Fineness modulus	7.2
Abrasion resistance	Less than 5%

3.4WATER

The amount of water in concrete controls many fresh and hardened properties in concrete. Water contributes about 10 to 20 percentage of total volume of concrete. The used in the experiment is completely tap water. The PH value of water is found to be less than 6. The water was completely free of impurities.

3.5CRUMB RUBBER:

3.5.1Introduction to crumb rubber

Crumb rubber is a term usually applied to recycled rubber from automotive and truck scrap tires. There are two major technologies for producing crumb rubber – ambient mechanical grinding and cryogenic grinding. In ambient mechanical grinding process, the breaking up of a scrap tire happens at or above normal room temperature. Ambient grinding is a multi-step technology and uses whole or pre-treated car or truck tires in the form of shred or chips, or sidewalls or treads. The rubbers, metals and textiles are sequentially separated out. Tires are passed through a shredder, which breaks the tires into chips.

Rubber crumb is sold for chemical devulcanization or pyrolysis processes, added to asphalt for highway paving and pavement sealers, or used for the production of a large number of recycled rubber-containing products.

In Sport Surfaces for Kindergarten Playgrounds and Recreation Areas, ,Athletic Tracks, Tennis and Basketball Courts Automotive Industry for Bumpers ,Floor Mats for Cars and Trucks, Floor Liners for Trucks and Vans Construction uses in Hospital, Industrial, and Bathroom Flooring, Floor Tile, Foundation Waterproofing, Dam, Silo, and Roof Liners Geotechnical/Asphalt Applications like Rubberized Asphalt for Roads and Driveways, Drainage Pipes, Soil Conditioner, Porous Irrigation Pipes, Road Building and Repair.

Adhesives and Sealants used for Roof Coating and Waterproofing Shock Absorbing Pads for Rails and Machinery Sound Barriers for Highways Rubber and Plastic Products including Pipe Insulation and Lining, Garbage Cans, Shoe Soles and Heels, Wire and Cable Insulation.

Fig.1 Showing crumb rubber

Crumb rubber is recycled rubber produced from automotive and truck scrap tires. Crumb rubber Crumb rubber aggregates of size 20 mesh is used as partial replacement of fine aggregates. The crumb rubber was bought from Balaji Rubber Industries Pvt Ltd, Athanur, and Salem. The characteristics of crumb rubber are shown in table.4

Table.4

Specific gravity	0.6
Water absorption	NIL
Fineness modulus	2.2

3.6POLYACRYLAMIDE:

Polyacrylamide is a hydrophilic gel obtained by the polymerization of acrylamide molecules or combination of acrylamide and acrylic acid. It is a colorless hydrogel material with cohesive, viscoelastic, hydrophilic, and biocompatible properties. PAM is also stable, no absorbable, and nontoxic and so it has a wide range of applications in wastewater treatment, agriculture, food processing and mining. The general properties of polyacrylamide are given in table.5

Table.5

IUPAC name	poly(2-propenamide)
Chemical formula	$(C_3H_5NO)_n$
Molecular weight	71.08
Density	1.122 g/ml
Melting point	84 °C

3.6 SULPHURIC ACID:

Sulphuric acid, also known as oil of vitriol, is a mineral acid composed of the elements Sulphur, oxygen and hydrogen. It is a colorless, odorless and viscous liquid that is miscible with water sulphuric acid is used for the surface modification of crumb rubber to enhance its bonding with cement and also increase the surface area of the rubber particles. The physiochemical properties of sulphuric acid is tabulated.

Table.6

IUPAC name	Sulfuric acid
Chemical formula	H_2SO_4
Molecular weight	98.08
Density	1.83g\cm^3
Melting point	10°C

4. TESTING

4.1WORKABILITY TEST

Workability is describe as how easily fresh concrete can be mixed, placed and finished without loss of homogeneous property. In this experiment slump test method is preferred for measuring workability of concrete. The apparatus used consist of a frustum of a cone made in steel. Workability test for different mix proportions are determined.

4.2COMPRESSIVE STRENGTH TEST

Compressive strength is widely accepted measure to access the performance of a given concrete mixture. It is a primary measure determining how well the concrete can withstand load. Compressive strength was

measured on a compression testing machine (1000 KN capacity).

4.3SPLIT TENSILE TEST

Tensile strength concrete is its capacity to resist failure under tension. Failure in a concrete arises when tensile force exist the tensile strength. Concrete is weak in tension due to its brittle nature and cannot resist direct tension. Hence it is important to find out the split tensile strength of concrete. It is measured by using compression testing machine.

4.4FLEXURAL STRENGTH TEST

Flexural strength represents the ability of concrete to withstand bending without any reinforcement. It is an indirect measure of tensile strength. Two point load is applied using universal testing machine to determine the flexural strength.

5.RESULT AND DISCUSSIONS:

The results obtained from testing the specimens prepared as per the mix proportions for different percent of fine aggregate replacements are as follows.

5.1 WORKABILITY

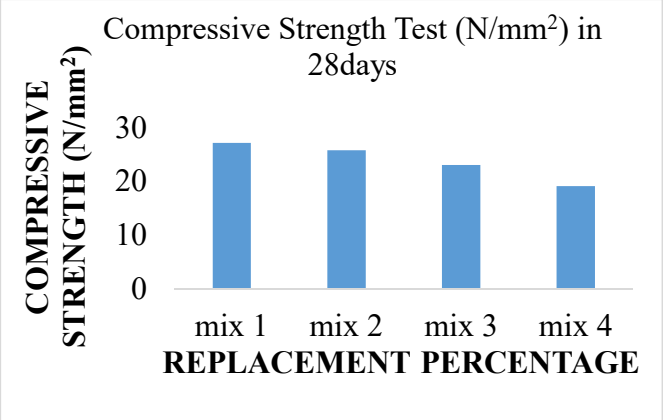
The values for diverse fresh concrete combination were determined and tabulated in table 7. The workability of concrete will increase with growth in rubber content.

Table .7

Type of concrete	Slump value (mm)	Inference
Conventional concrete	48	Low workability
Replacement by 5% crumb rubber	50	Low workability
Replacement by 10% crumb rubber	54	Low workability
Replacement by 15% crumb rubber	60	Medium workability

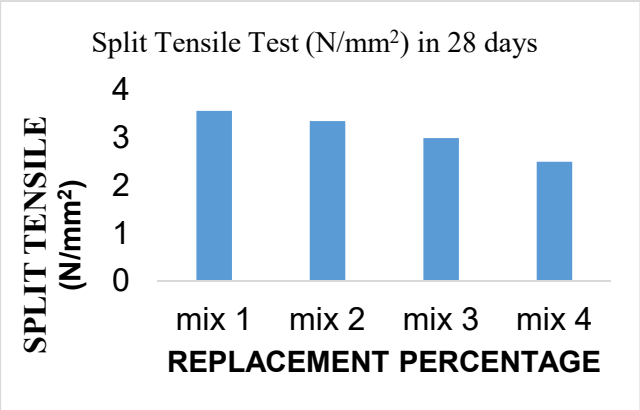
5.2 COMPRESSIVE STRENGTH

The compressive power of diverse concrete specimen are measured. The electricity of concrete is determined to be lowering on further addition of crumb rubber.



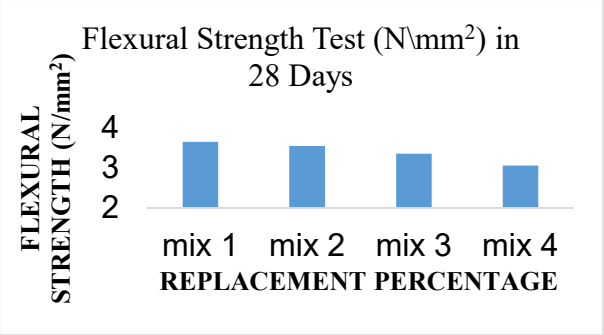
5.3 SPLIT TENSILE STRENGTH

The specimens had been tested for split tensile electricity. The tensile power of concrete was decreased with increasing rubber content.



5.4 FLEXURAL STRENGTH

The Flexural strength of the specimen prepared were measured. It was discovered that the flexural strength of concrete turned into decreased with admire to accelerated rubber content.



CONCLUSION:

Observation and evaluation are crafted from the tests carried out on the concrete prepared with the aid of replacing the high-quality mixture with crumb rubber for various percentages (0%, 5%, 10%, and 15%). Further the rubber debris were surface dealt with H2SO4 solution and covered with polyacrylamide gel.

Strength characteristics including compressive, cut up tensile and additionally flexural strength are calculated which are discovered to be reducing with the growing percent of crumb rubber. But the reduction fee of electricity changed into decreased while in comparison to preceding researches carried out by pupils. The weight of the concrete decreased which in turn proves that addition of crumb rubber reduces the density of the concrete with respect to the manage mix.

The surface amendment of crumb rubber has improved the bonding of rubber debris to the cement matrix. Thus our experimental take a look at on concrete with replacement of fine aggregates by using surface changed crumb rubber has provided the predicted outcomes.

FUTURE SCOPE

Further studies must be executed to decorate the binding traits of rubber with cement together with providing higher designs to limit the energy reduction factors on including crumb rubber to concrete. Other cementitious materials like silica fume, GGBS are not added to the concrete for the improvement of strength characteristics of the concrete. This can be studied by experimental work.

It is said that rubber would enhance certain concrete properties like thermal resistance, impact strength ,sound insulation, etc. these properties of the concrete containing crumb rubber are to be analyzed on further tests and observations.

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