

Experimental Investigation on Strength Improvement of Rubcrete

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ABSTRACT: Rubcrete is a type of concrete in which aggregates are replaced with waste rubber particles. The uses of Rubcrete are limited because of its reduced strength. By improving the mechanical properties of Rubcrete it can be used for advanced construction works. In this paper, the technique presented is for improving the mechanical properties of Rubcrete. The poor mechanical properties are due to the poor bonding between rubber particles and cement. Certain chemicals can make bond between cement and rubber powder by improving bond between them. It is possible to improve the mechanical properties of Rubcrete. PVA (Polyvinyl Alcohol) is one of the chemical that can make bonding between rubber powder and cement. The addition of PVA can make a considerable change in the mechanical properties of Rubcrete.

KEYWORDS: Rubcrete, Aggregate replacement, Improving mechanical properties, PVA (Polyvinyl Alcohol).

I. INTRODUCTION

Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space between the aggregate particles and glues them together. Aggregates can be obtained from different kinds of materials. In this study, crumb tires are used as filler in concrete by partial replacement of common natural aggregates. Polyvinyl alcohol (PVA) is used for increasing the bond between rubber and cement particle.

The objective of the study is to improve the performance of rubber- modified cement composites, especially the reduced strength due to the addition of crumb rubber. A good bond between rubber and cement can be achieved by OH or C-S-H bond. To achieve this goal, a new approach –addition of polyvinyl alcohol (PVA) – was proposed to treat the crumb rubber particles before they were added into cement composite. The OH bond present in the PVA increases the bond between rubber and cement particles.

The concept of strength improvement was studied by Rivas-Vazquez.et.al.[1].This study evaluated the effect of the pretreatment of recycled rubber from used tires. Different solvents like ethanol, methanol and acetone were used to generate surface changes in the structure of the rubber, creating more hydrophilic surface, which adheres to the different phases of the concrete. Hanbing Liu.et.al. [2].Conducted experiments with different modifiers like unsaturated resins, amino-acrylate, chloroprene adhesive, emulsion, epoxy line resin. The compressive strength, splitting tensile strength and axial compressive strength of crumb rubber concrete prepared with pretreated rubber using synthetic resin increased 12%, 40% and 5%, respectively. Neela Deshpandset.al [3], reported that a greater advantage is observed when shredded rubber is treated with NaOH. This can be an encouraging study which can lead to use of SR for higher structural applications. Baoshan Huang.et.al [4] presented a new approach – two staged surface treatment – to treat rubber particles for improving the performance of rubber-modified cement composites. In the first stage, silane coupling agent was used to modify rubber particle surface and develop chemical bonds between rubber particles and

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Vol. 6, Issue 4, April 2017

cement paste. Liang-Hisng Chou.et.al [5] conducted an experiment where crumb tyres are used as additive to concrete. Here crumb tyres were treated with waste organic sulphur compounds from a petroleum refining factory in order to modify their surface properties. Organic sulphur compounds with amphiphilic properties can enhance the hydrophilic properties of the rubber and increase the intermolecular interaction forces between rubber and C-S-H. Experimental results showed that rubber particles treated with waste organic sulphur compounds became more hydrophilic. From all these study's it is clear that a good bond between rubber and cement can be achieved by OH or C-S-H bond. And the bond can be achieved by the addition of PVA.

II. RELATED WORK

The ingredients of concrete i.e. cement, fine aggregate, coarse aggregate, rubber powder are tested As per Indian standard codes for finding out the property's for the mix proportion. The mix chosen was M40 and the mix was done using IS 10262:2009. The quantity of materials for trail mixes were found out from mix design. The fine aggregate was replaced by percentage of volume (8%, 10%, 12%, 14%, and 16%) and the PVA was added with percentage of weight of water (0%, 2%, 2.25% and 2.5%). The quantities of materials for each batch of specimen (for 1 m³) is given below in Table 1, 2 and 3 .Table 1 shows the details about the quantities of cement, coarse aggregates, water and admixture, which will be same for all the mixes of Rubcrete. Table 2 gives the details of quantity of PVA which varies from 0 % to 2.5 %. The ingredients are mixed using a pan mixer and the compactions of specimens are done using a needle vibrator.

Materials	Quantity(kg)
Cement	350
Coarse aggregate	1148
Water	140
Admixture	7

Table 1. Materials common in all batches of mixes

% of chemical	Quantity of PVA (Kg)
0	0
2	2.8
2.25	3.15
2.5	3.5

Table 2. Quantity of PVA in each batch of specimen

The quantity of fine aggregate and the rubber particles were varied as 8%, 10%, 12%, 14% and 16% of fine aggregates were replaced with corresponding volume of rubber powder. The details of the quantities of fine aggregate and rubber powder in each batch is given in Table 3.

Materials	Quantity (Kg)				
	8% Rubcrete	10% Rubcrete	12% Rubcrete	14% Rubcrete	16% Rubcrete
Fine Aggregate	802.24	784.8	767.36	749.92	732.48
Rubber Powder	15.347	19.184	23.021	26.858	30.694

Table 3. Quantities of fine aggregates and rubber powder in each batch

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Vol. 6, Issue 4, April 2017

For each batch of these Rubcrete mixes, cubes, cylinders and beam specimens were prepared. The specimens used are of standard dimensions. The details of the dimensions of the specimens and the number of specimens prepared for each batch is given in Table 4.

Specification of specimen	Number of specimens
Cube (150mm x 150mm x 150mm)	3
Cylinder (150mm diameter and 300mm height)	3
Beam (500mm x 100mm x 100mm)	2

Table 4. No. of specimens in each batch

Testing of the specimens are done after 28 days of complete immersed curing and the testing of the specimens are done according to IS 516 (compressive strength test, splitting tensile strength test, flexural strength test).

III. EXPERIMENTAL RESULTS

The results of the compressive strength obtained after 28 days of curing is given in the Fig.1. The compressive strength of the specimen is calculated by dividing the maximum load attained during the test by the cross-sectional area of the specimen. The compressive strength obtained is in an increasing trend. The maximum value of compressive strength obtained is for maximum PVA content in all the Rubcrete batches except for 14 % Rubcrete.

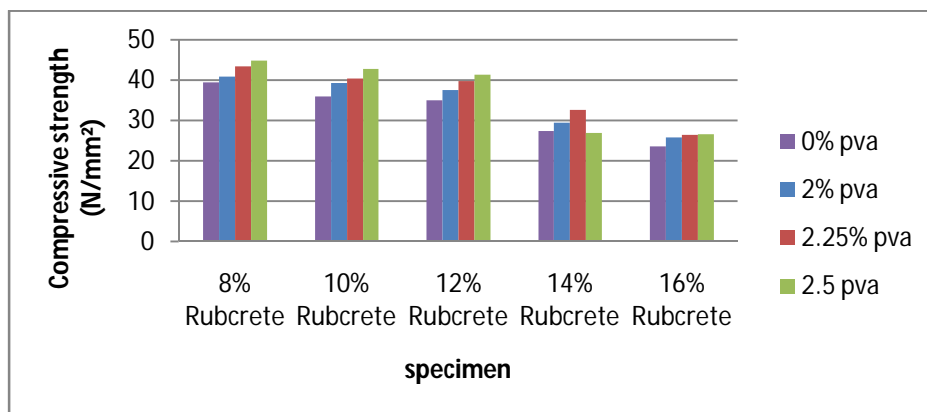


Fig.1: Comparison of compressive strength

The test method covers the determination of the splitting tensile strength of cylindrical concrete specimens. This method consists of applying a diametral compressive force along the length of a cylindrical specimen. The splitting tensile strength of each Rubcrete batch follows the same pattern as that of compressive strength. The only variation in the result is obtained in 14 % Rubcrete. The results are shown in Fig.2.

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Vol. 6, Issue 4, April 2017

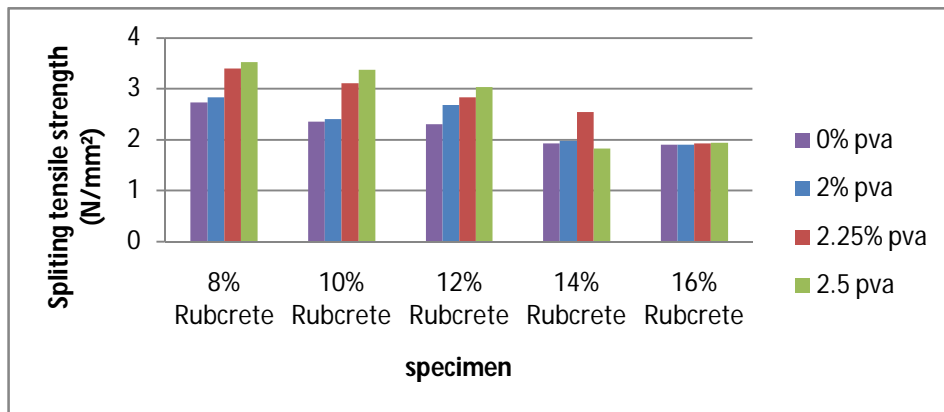


Fig.2 Comparison of values of Split Tensile strength

This test method covers the determination of the flexural strength of concrete using a simple beam with third-point loading. The results are calculated and reported as the modulus of rupture. Load was applied until the specimen fails and the load applied to the specimen during the test was recorded. The variation Flexural strength obtained for different batches of Rubcrete is given in Fig.3. The Flexural strength also increases as the percentage of PVA increases except for 14 % Rubcrete.

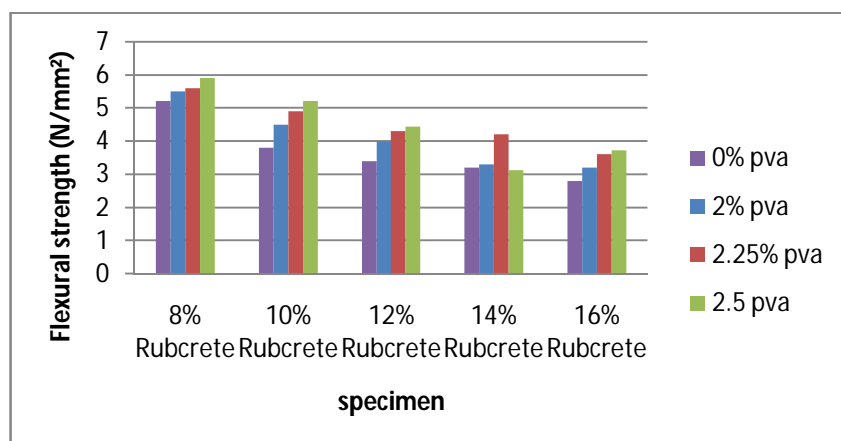


Fig.3 Comparison of values of Flexural strength

IV. CONCLUSION

1. The strength of the concrete decreases with the increase in the percentage of rubber content.
2. The mechanical properties of Rubcrete were improved by the addition of PVA in Rubcrete.
3. The compressive strength of Rubcrete was increased with the increase in the amount of PVA. The maximum value of compressive strength was obtained when 2.5% of PVA was added.

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4. The maximum increase in compressive strength was obtained for 10 % replacement of fine aggregate with rubber powder. The increase in the strength was about 19.16%.
5. The Flexural strength follows the similar pattern of the compressive strength. The maximum value of Flexural strength was obtained for 2.5% addition of PVA except for 14 % rubber replacement. The average increase in Flexural strength was about 28.424 %.
6. The Tensile properties of Rubcrete also increase with the increase in percentage of PVA.
7. The maximum value of Split Tensile strength was obtained for 2.5 % addition of PVA. The average increase in Split Tensile strength obtained was about 30.29 %.

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