

Comparative study to investigate performance of Basalt Fiber Concrete (BFC) and Rubber fiber Concrete (RFC) with different dosage

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ABSTRACT

This study investigates the different properties of concrete added by the basalt fiber and rubber fiber as a strengthening material in concrete experimentally. Three different tests performed viz. Compressive, Split tensile test and Flexural test for all dosage of BFC and RFC. Basalt fibres are considered with having diameter of fibre: 6 micron, length of fibre: 6 mm, specific gravity 2.9. Rubber fiber size is 1 micron and length 3 mm, Specific gravity 0.95. Different proportions of fibre selected for making specimens (0 to 0.75%). Different samples were prepared with different dosage of the basalt fiber and rubber fiber manufactured according to the standard of the testing equipment. It concluded from study the addition of basalt fiber in concrete as the compressive strength of concrete enhances significantly where rubber fiber addition slightly lowers the compressive strength. Instead of it in flexural strength both shows good results.

Keywords:- Basalt fiber concrete, Rubber fiber concrete, Compressive strength, split tensile test, flexural test.

1. INTRODUCTION

Basalt fiber concrete (BFC) can be regarded as a composite of cement mortar, aggregate and basalt fiber. Basalt Fibre Reinforced Concrete is newly developed for application in civil infrastructure as structural reinforcement material, displaying approximately 20% higher strength and modulus, similar cost, and more chemical stability and a wider range of working temperatures [1, 2]. A fibre is a material made into a long filament with 50cm. The aspect ratio of length and diameter can be ranging from thousand to infinity in continuous fibres. It is do not undergo any toxic reaction with water and do not pollute air also. The main functions of the fibres are to carry the load and provide stiffness, strength, thermal stability and other structural properties in the Basalt Fibre Reinforced Composites. Rubber obtained from scrapped tyres is considered as the most recent waste materials that have been examined because of its vital use in the construction field. Worldwide, the production of rubber increases every year. This creates a major problem for the earth and their livings. For this issue, the easiest and cheapest way of decomposing of the rubber is by burning it. This creates smoke pollution and other toxic emission and it create global warming. Currently 75-80% of scrap tyres are buried in landfills. Burying scrap tyres in landfills is not only wasteful, but also costly. Investigations have shown that scrapped rubber tyres contain materials that do not decompose under environmental conditions and cause serious problems. Based on these problems, tyres can be used as aggregates in concrete. India's waste tyres account for about 6-7% of the global total. With the local tyre industry growing at 12% per annum, waste volumes are rising. India has been recycling and reusing waste tyres for four decades, although it is estimated that 60% are disposed of through illegal dumping. Sim et al. [2] studied the characteristics of basalt fiber based concrete for the application of different structures. They investigated the strengthening capacity of the basalt fiber based concrete material for structural concrete with acceptable durability and mechanical properties. A 30% carbon and 60% high strength glass fiber contains were used to manufacture the concrete. They found, the improved strengthening capacity of basalt fiber concrete of both the yielding and the ultimate strength of the beam specimen up to 27% depending of the number of layers applied. Li and Xu [3] did an experimental study on the basalt fiber based concrete under impact loading. A 100 mm- diameter split Hopkinson pressure bar system is used for analysis of deformation and compressive strength. They revealed that, the impact properties of the basalt fiber concrete has a good strain rate dependency and linear relation with strain rate. The influence of total length and different contain of BFRC were investigated by different numerical simulations. They concluded that, increase in fiber contains, the compressive and tensile strength were increased up to a certain values and then decreases, while a bending strengths keeps increasing in nature. They also predicted that, the size of the BFRC effects on the overall mechanical properties of the concrete.

Rubber recycling through fine aggregate replacement in a mortar or cementitious material. Concrete with rubber mixes causes to the workability, initial setting time, segregation, bleeding, and density [4,6,7,9]. Low-density

material impact on results of strength, toughness, and ductility. Shrinkage, abrasion of material shows the usefulness of the material. Major drawbacks related to fire, thermal, corrosion, carbonation will be minimized by some treatments. While working with rubber particles freeze-thaw, porosity, chloride ion penetration shows an adverse effect on environmental issues, sound absorption, electrical resistance and cracking resistance. [34] Microstructural behavior, fracture of rubber in concrete. Waste rubber problems to the environment like landfills and health issues associated with it. Chipped and crumbed tyre rubber particles used to replace Course and fine aggregates with different compositions. Increased value of rubber content decrease workability. Microstructural investigation of rubber decreases strength and reduces bonding between tire particles and cement paste. [8] shredded scrap truck tyre rubber to add it into cement-based materials resulted in reduced compressive strength and densities. Impact resistance of RCC slab containing rubber was comparable to ordinary concrete. Cracks appeared were wider than expected. The different crack pattern was observed. Rubber Reinforced concrete includes rubber and steel fibre which involved the use of rubber particles 0.178mm, 1.11mm, 2mm and steel fibre of 30mm in length and 0.5% in volume fraction. The static compressive strength of RRC with larger rubber size was higher at RRC with smaller rubber size. The dynamic compressive strength of RRC was higher than the static compressive strength of RRC. Strength RCC increased with an increasing rate of strain.[10]. waste tyre rubber to find out optimum content of rubber ash in concrete by testing of flexural strength. Rubber ash used more than 3% decreased flexural strength of concrete but improved by adding fly ash.[5]

In this paper, an experimental analysis is performed to evaluate the performance of BFC and RFC. The properties of concrete with basalt fibers and rubber fiber has been compared with plain concrete. The optimum dosage of basalt fiber and rubber fibre were analyzed experimentally with cost effectiveness. Both fibers was added in dosage as 0%, 0.25%, 0.50%, 0.75%. Three test has been performed viz. Compressive, Split tensile test and Flexural test.

2. EXPERIMENTAL METHODOLOGY

The basalt fibres material supplied by Muktagiri Corporation, Mumbai, India. The specifications about the fibres is having Diameter of fibre: 6 micron m (0.0005 in), Length of fibre (Average): 6 mm (0.52 in), Specific gravity 2.9. The rubber fibre were collected from crushed rubber is used in concrete mixes with having combinations of powdered rubber and rubber shredded rubber. The dimensions of shredded rubber 2mm to 3mm which satisfying the norms of fine aggregate and comes under the zone II for utilization in concrete mix. The material collected from Rohan Enterprises Pune. Specific gravity of Material is equals to 0.95. With water absorption value 0.2% and Fineness modulus is 4.508. The samples were prepared with four different proportions of the basalt fiber such as 0, 0.25, 0.50 and 0.75%. OPC of 53 grade cement was used which having specific gravity 3.15. Crushed sand is used as fine aggregate in concrete mix design. The crushed sand was passing through 4.75 mm sieve and retained on 60micron sieve, having specific gravity 2.81 and water absorption capacity 2.88%.Maximum size of 10 mm aggregate was selected for this mix design with a specific gravity of aggregate is 2.89 and water absorption 1.63%. BASF Rheobuild 821 IA admixture was used for this mix design with a ratio of 1.2% of admixture to volume of concrete. A potable water were selected with w/c ratio of 0.45 for mixing as per IS 456: 2000. Mix Design formulated for above testing is M45 grade to analyse use of above fibre in concrete road construction. So minimum design of PQC is get considered.

SEM Analysis of BF and RF

Scanning Electron Microscopy testing images were observed during the casting of specimens. The bonding behavior of BF and RF with concrete were studied. As per observation BF shown good results with respect to BF.

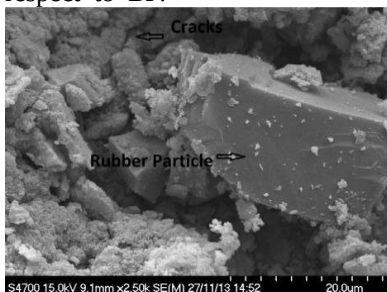


Fig- SCM analysis of Powdered rubber [12]

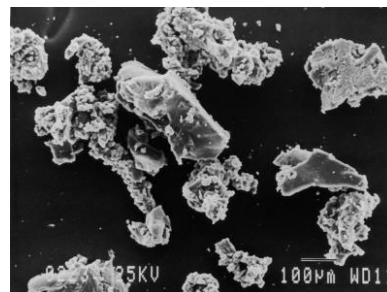
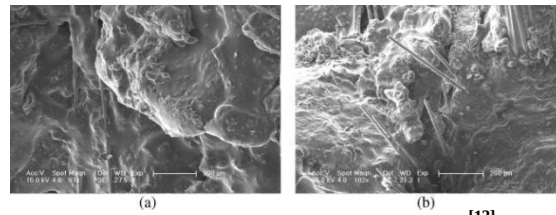


Fig- SCM analysis of Powdered rubber [11]

Fig- SCM analysis of Basalt Fiber ^[13]

3. RESULTS AND DISCUSSION

3.1 compression strength

The experimental study has been carried out for the analysis of BFC and RFC with different percentage of basalt fiber. Total 48 samples were tested for 28 days curing time with four different volume fraction of fibers material. Basalt shows their property to get enhancement in compressive strength.

Table 1- Compressive Strength of Concrete Cubes after 28 Days.

Volume fraction (%)	Age of Testing	Stress in MPa BFC	Stress in MPa for RFC	% Reduction in strength BFC to RFC
0	28 days	43.98	43.98	0
0.25	28 days	65.33	48.05	26.45
0.5	28 days	56.64	46.56	17.79
0.75	28 days	47.93	41.16	14.12
1.0	28 days	42.56	40.01	5.99

3.2 Flexural Strength-

The flexural test were carried out to find the modulus of rupture utilized for bending in specimen with concrete mix properties and fibre content for 28 days age of testing samples. Specimens were in controlled condition of axially loading by roller points.

Table 2- Flexural Strength of Concrete Beam

Volume fraction (%)	Age of Testing	Failure load in kN for BFC	Failure load in kN for RFC	% Reduction in strength BFC to RFC
0	28 days	43.14	43.14	0
0.25	28 days	30.4	29.5	2.9
0.5	28 days	32.6	28.1	13.88
0.75	28 days	24.5	26.4	-98.92
1.0	28 days	20.2	25.7	-98.73

3.3 split tensile strength

Split tensile test has been carried out to investigate the tensile strength of the fiber based concrete with different percentage of the basalt fiber and rubber fiber material. Total eight cylinder type specimens were prepared and tested in UTM machine. The load were applied gradually on the test specimens, until the specimen in failure. The specimens are kept for 28 days curing time and the average results were mentioned in table 3. Changes in size and cracking of specimen occur due to tensile forces applied on it.

Table 3- Split Tensile Strength of Cylinder

Volume fraction (%)	Age of Testing	Failure load in KN of BFC	Failure load in KN of RFC	% Reduction in strength BFC to RFC
0	28 days	322.5	322.5	0
0.25	28 days	403	298.8	25.86
0.5	28 days	398.5	277.4	30.39
0.75	28 days	368	271.2	26.30
1.0	28 days	351.2	266.3	24.17

5. CONCLUSION

An experimental investigation has been done to investigate the addition of the fibers material in concrete. Five different volume fraction of the fibers material compositions were considered for the analysis and three test viz. compressive strength, flexure strength and tensile strength were done for the analysis. The effect of curing time also been investigated and the following conclusions were drawn,

- With properties of basalt fibre, such as crack resistance, impact resistance, and freeze resistance, basalt fibre is beneficial for improving durability and increasing the working life of concrete as compare to rubber fiber.
- This shows effectiveness of basalt fibre when it used in varying percentage in concrete. Experimental evaluation shows that performance of concrete higher at 0.25% then it gets decreased slowly as compare to rubber fiber concrete.
- In overall behavior of basalt fiber is good as compare to rubber fiber in concrete elements.

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