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Mechanical Properties of Basalt Fiber Reinforced Concrete

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ABSTRACT:In modern era, the handling of fiber reinforce polymer materials has been hastily rising up. The life span of reinforced concrete structure is decreases due to the various natural effects on steel and to reduce those effects maintenance are required. The cost of repairing, maintenance of steel RC structures can be high. New materials such as fiber reinforced, which is non-corrodible by nature can be used, which eliminates the corrosion problems. There are various types of commercially available fibers like steel fibers, glass fibers, polypropylene fibers, carbon fibers, and basalt fibers. This paper describes the fundamental mechanical properties of basalt fiber like compressive strength, split tensile strength and comparative experimental study of plain concrete and concrete with addition of basalt fiber.

KEYWORD:Basalt Fiber, Mechanical properties.

I. INTRODUCTION

As we know plain concrete is strong in compression and weak in tension because it involves several micro-cracks. Plain concrete member not sustain tensile stresses developed due to the applied forces without addition of reinforcing elements in the tensile zone. The producing of micro-cracks and macro-cracks, however, still cannot be arrested by the single use of continuous reinforcement. The addition of randomly spaced discontinues fibers helps in arresting the producing of micro-cracks and macro-cracks. Due to addition of fibers reduces the crack width and permeability of concrete. The service life of reinforced concrete is reduced due to the corrosion of steel reinforcement and deterioration. Periodic maintenance is required to counter durability related deterioration; cost of repairing, rehabilitating, or strengthening of steel structure can be high. FRP is non-corrodible is used in severe environment condition to leave out corrosion problems. FRP is non-corrosive nature, and lower specific weight as compare to conventional steel. Basalt fibers are increase in safety and reliability of structural system as compared to other fibers. Basalt fibers are use because of their cost effectiveness, high temperature resistance, freeze thaw performance and lack of difficulty in manufacturing. Basalt fibers are formed of volcanic rock called basalt. Basalt fiber is a material made from extremely fine fibers of basalt, which is composed of the minerals plagioclase, pyroxene, and olivine. It is similar to fiberglass, having better physical, mechanical properties than fiber glass, but being significantly cheaper than carbon fiber. The formulation of basalt fibers does not produce any environmental waste and it is non-toxic in handling. Basalt fiber is an exclusive construction material containing high tensile strength and good thermal endurance. It is not a new material, but its applications are surely innovative.

II. METHODOLOGY

A total 54 cube specimens are casted and tested. In each batch, 6 cubes are prepared for compression test (3 cubes each for 7 day and 28-day test), 6 cylinders are prepared for split tensile test. Plain concrete specimens are prepared using 1:1.86:3.29 (cement: fine aggregate: coarse aggregate) mix proportion (by weight). The water-cement ratio is kept constant at 0.42 for the mixes. All FRC specimens are prepared using the same mix proportion. BFRC cube and cylinder specimens are cast using basalt fibers (16 μm in diameter) of varying length (12 mm, 18 mm, and 24 mm) and varying fiber dosage (4 kg/m^3 , 8 kg/m^3 , 12 kg/m^3 of volume of concrete). Compressive strength and split tensile strength tests are conducted. The compressive strength of concrete cylinders is tested on the 7th day and 28th day. The

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split tensile strength is tested at the age of 28 days. The compressive strength and split tensile strength of cylinder specimens is determined according to IS code, respectively. The test results are then analyzed and statistical analyses are completed to draw conclusions.

III. MIX DESIGN

Mix design was carried out using ACI Committee 211.1 of 1991 method for M40 grade of concrete. Addition of basalt fiber is depending upon volume of concrete (4kg/m³, 8kg/m³, 12kg/m³). The table1 shows the mix proportion of concrete.

Table 1: Mix Design

Cement	Fine aggregate	Coarse aggregate	Water
400	742	1316	168
1	1.86	3.29	0.42

COMPARATIVE TEST RESULTS

Compare the 7 days and 28 days compressive strength and split tensile strength of basalt fiber concrete with the plain concrete specimen. The results obtained are shown in the table 2 and table 3 respectively.

Table 2: Compressive Strength of M40

M40 Grade Concrete Blocks										
	Plain	12 mm			18 mm			24 mm		
		4 kg/m ³	8 kg/m ³	12 kg/m ³	4 kg/m ³	8 kg/m ³	12 kg/m ³	4 kg/m ³	8 kg/m ³	12 kg/m ³
7 Days	28.87	47.81	46.02	43.21	47.89	46.48	42.80	48.85	44.59	45.83
28 Days	45.09	57.53	56.58	52.78	57.30	57.55	51.57	56.04	55.53	56.28

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The different dosage of Basalt fiber is used as represented in following graphs.

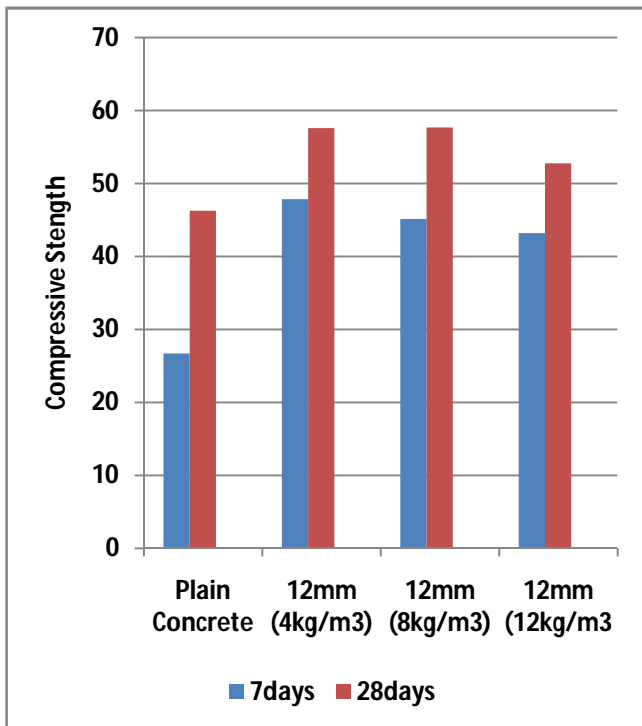


Figure 1: Compressive Strength of 12 mm Basalt Fiber

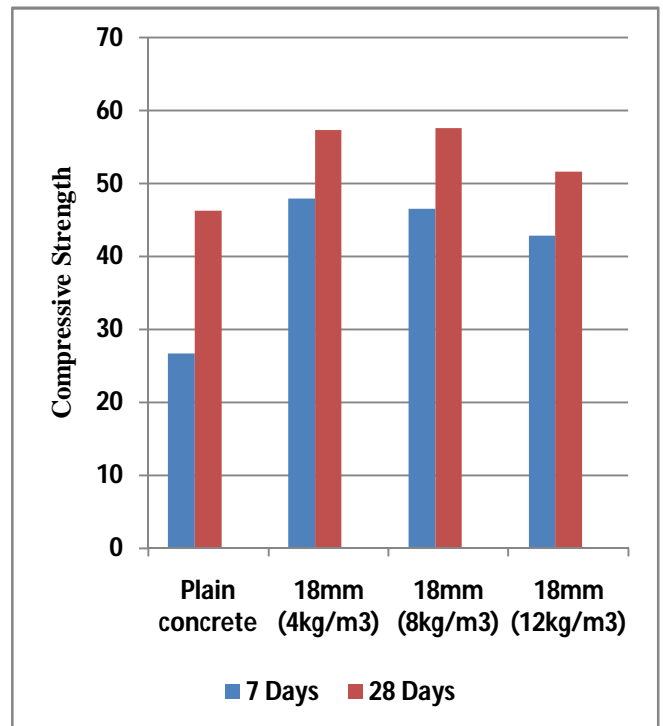


Figure 2: Compressive strength of 18mm Basalt Fiber

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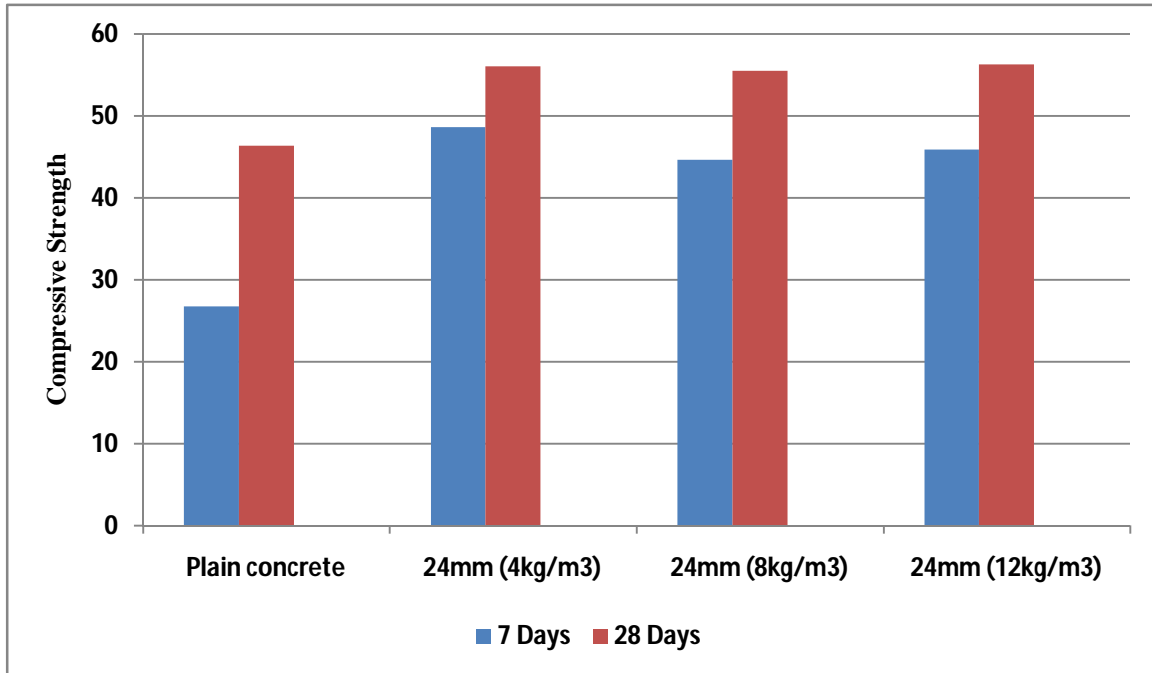


Figure 3: Compressive Strength of 24 mm Basalt Fiber

Table 3: Split Tensile Strength of M40

M40 Grade Concrete Cylinder										
	Plain	12 mm			18 mm			24 mm		
		4 kg/m ³	8 kg/m ³	12 kg/m ³	4 kg/m ³	8 kg/m ³	12 kg/m ³	4 kg/m ³	8 kg/m ³	12 kg/m ³
7 Days	3.11	3.29	3.38	3.68	3.19	3.32	3.33	3.65	3.71	3.75
28 Days	4.05	4.30	4.41	4.75	4.27	4.37	4.78	4.74	4.72	4.79

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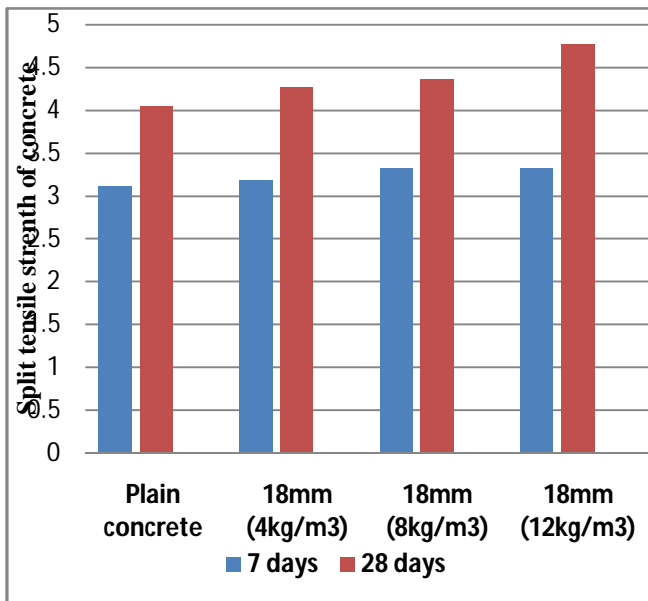


Figure 4: Split tensile Strength of 18 mm Basalt Fiber

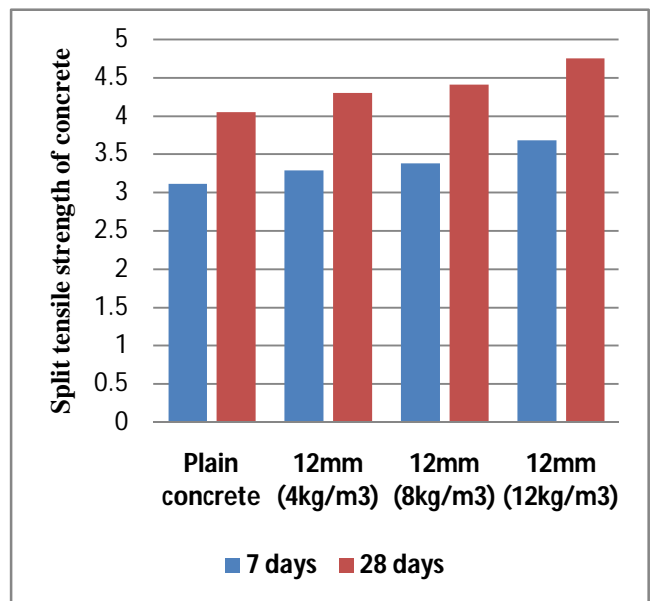


Figure 5: Split tensile Strength of 12 mm Basalt Fiber

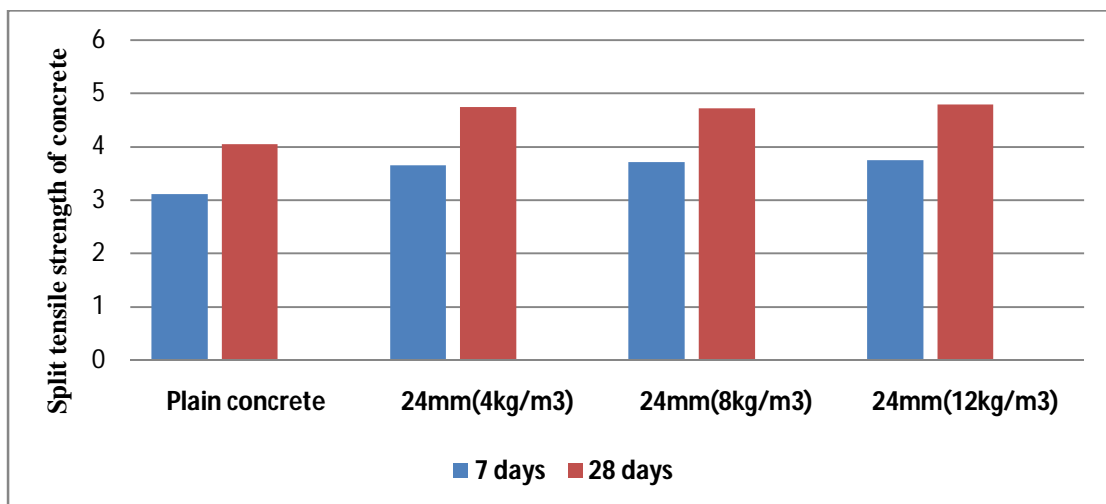


Figure 6: Split tensile Strength of 12 mm Basalt Fiber

IV. CONCLUSION

The result of present research work conclude that the compressive strength and split tensile strength of concrete is significantly improved by basalt fibers. This result has concentrate on the mechanical properties of the concrete with different dosage of basalt fibers as well as compressive and tensile behavior of cubes and cylinders respectively.

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Comparison is made of plain concrete and concrete with addition of basalt fiber with different dosage. It has been found that addition of basalt fiber increases the tensile strength and compressive strength of concrete as compare to the plain concrete. The 12mm, 18mm, 24mm length of basalt fibers are used with dosage of 4kg/m^3 , 8kg/m^3 , 12kg/m^3 for each length among of them. The optimum fiber length and dosage for basalt fiber which provided the best compressive strength for 7 and 28 days curing are 18mm basalt fiber at 8kg/m^3 , 24mm basalt fiber at 4kg/m^3 respectively. The optimum fiber length and dosage for basalt fiber which provided the best split tensile strength for 7 and 28 days curing are 24mm basalt fiber at 12kg/m^3 . It showed a 28% increase in compressive strength and 10.87% increase in split tensile strength compared to the plain concrete control specimen.

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