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An Experimental Study on Basalt Fiber Reinforced Concrete

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Abstract: The art of knowledge of basalt fiber, it is relatively new material. Basalt fiber is a high performance non-metallic fiber made from basalt rock melted at high temperature. Basalt fiber reinforced concrete is more characteristics such as good fire resistance, light weight, brown in color and strength. In this study trial test for concrete with basalt fiber and without basalt fiber are conducted to show the difference between in compressive strength and split tensile strength by using concrete cubes of size 150mmx150mmx150mm and concrete cylinders of size 150mm diameter and 300mm height. .In this study the basalt fiber having length 12mm are used. Adding basalt fiber in concrete with different percentages of coarse aggregate (0%, 1%, 2%, and 3%) and partially replacement of cement with silica fume with different percentages (0%, 2%, 4%, and 6%).

Keywords: Concrete, Portland cement, Basalt fiber, Silica fume, Mechanical properties.

I. INTRODUCTION

Industry benefits greatly from the continuously searching for new better & more affordable materials used to make new products. The production of composite materials has seen a major increase recently. With this in mind, it is essential to take energy conservation, corrosion risk, sustainability, and the environment into account when a product is upgraded or a new one is developed. High quality non-metallic basalt fiber is produced by melting basalt rock at higher temperatures. Additionally, Basalt fabrics, continuous filament wire, and chopped basalt fiber can all be made from basalt rock.

Basalt fiber comes from volcanic lava and volcanoes, which is an extremely hot fluid or semi-fluid material that solidified outside. A range of volcanic rocks that are grey and dark in color are referred to as basalt. The molten rock is then forced out of a smaller nozzle to produce long strands of basalt fiber. The basalt fiber is produced without the need of any extra additives, which results in an additional cost benefit. Basalt rock fibers are non-combustible, explosion-proof, and do not react toxically with air or water. They don't cause any chemical reactions when in touch with other substance that can harmful to the environment or human health.

The mechanical qualities and toughness of basalt fiber concrete, basalt fiber polymers & basalt fiber rebar has been the subject of more research over the last five years. Research on basalt fiber & its composites was first conducted in the early 1980s (BR). Basalt fibres have been found to exhibit a moderate level of resistance to acid corrosion, reasonably great resistance to water and salt corrosive and extreme disintegration in an alkaline environment.

II. MATERIALS AND METHODOLOGY

A. MATERIALS

Basalt Fiber: In the current experimental research Fiber from basalt is a green industrial material. With a melting point between 1500° C and 1700° C, basalt is a volcanic rock that develops from frozen lava. Fibers made of basalt are completely natural and inert. By Nickunj Enterprises Pvt Ltd T.T.C Industrial area Rabale Naka District Thane, Mumbai Maharashtra India, basalt fibres were provided.

Cement: OPC of 43grade, conforming to IS: 1229-1987 is used. The Cement used in this study is Ordinary Portland Cement of 43 grades which founds to be finer material and is considered to be Paste that binds well for the given non-homogeneity materials. The Properties of cement are studied as per the Indian Standards. In this study, Specific gravity of cement is determined by density bottle method (IS-2720, part-iii, 1988).

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Fine aggregates: M-sand is an alternative composition of the natural river sand. Natural resource scarcity occurs from the dredging of rivers that contain naturally occurring sand. M-sand, which is easily accessible locally, in this experiment, is used as fine aggregate (FA).

Coarse aggregates: Natural Coarse aggregate is an important constituent in the concrete. This gives the confined shape and reduces the consumption of cement, water content and Shrinkage for a structure. Coarse aggregate of 20mm nominal size is used.

Silica Fumes: To improve the mechanical and durability properties of concrete, silica fume, a highly pozzolanic material, is used. It can be mixed with silica fume & Portland cement, or it can be put directly as a component to concrete. The primary purpose of silica fume's initial use in concrete was to replace cement.

Water: Potable water was used for this experimental study

B. METHODOLOGY

Experimental investigation is carried out to evaluating the behaviour characteristics of basalt fiber reinforce concrete. By using mix of concrete is casting 24 cubes of size 150mmx150mm×150mm and casting 24 cylinders of size 150mm diameter and 300mm height by adding basalt fiber with partially replacement of CA with different percentages (0%, 1%, 2%, and 3%) and also partially replacing of cement with SilicaFume with different percentages (0%, 2%, 4%, & 6%). Once casting is over then after 24 hrs concrete cubes & cylinders are immersing in water for curing.

After seven and twenty-eight days of curing, respectively, compression & tensile strength tests are performed. The compressive Testing Machine, which is a capacity of 3000kN, was used to test the compression and split tension strengths of concrete cubes, in accordance with IS: 516, & the UTM was used to test the tensile strength of all mixes using concrete cylinders loaded along a diameter plane.

III. RESULTS AND DISCUSSIONS

A. COMPRESSIVE STRENGTH TEST

By using results of (Table1), Compressive strength v/s % replacement as shown in (Fig 1 and Fig 2).The compressive & tensile strength of concrete goes on decrease with increasing % of basalt fibre in the concrete mix. The strength obtained by partially replacing of cement with SF of 2% & coarse aggregate with basalt fiber partially replacement by 1% varying strength is 31.40 N/mm2.The compression strength of conventional concrete is 25.85N/mm^2 for 7days. It was indicated that 21.47% of compression strength has increase for basalt fiber concrete over the conventional concrete. The strength is 25.47 N/mm^2 for 7 days by partially replacing of cement with the SF of 4% and coarse aggregate partially replacement of basalt fiber of 2% varying.

It was observed that 18.88% decrease in compression strength as compare to 2% of SF & 1% of basalt fiber replaced. At the 6% replacing of SF with cement and 3% replacement of basalt fiber with coarse aggregate the strength will be decreased by 51.19% from compare to 4% of silica fume and 2% of basalt fiber replaced.The decrease strength of partially replacing of cement with SF and partially replacing of CA with basalt fiber. The compression strength of conventional concrete is 32.55 N/mm^2 for 28days. Silica fume varying 2%, 4%, 6% and basalt fiber varying 1%, 2%, and 3% respectively the strength is 27.03 N/mm^2 (16.95%), 21.14 N/mm^2 (10.70%) and 20.96 N/mm^2 (13.17%).

Table No 1 Compressive strength at 7 days & 28 days

SL NO	% OF Basalt Fiber	%OF Silica Fume	AVERAGE COMPRESSIVE STRENGTH (N/MM^2)	
			7 DAYS	28 Days
1	0	0	25.85	32.55
2	1	2	31.40	27.03
3	2	4	25.47	21.14
4	3	6	12.43	20.96

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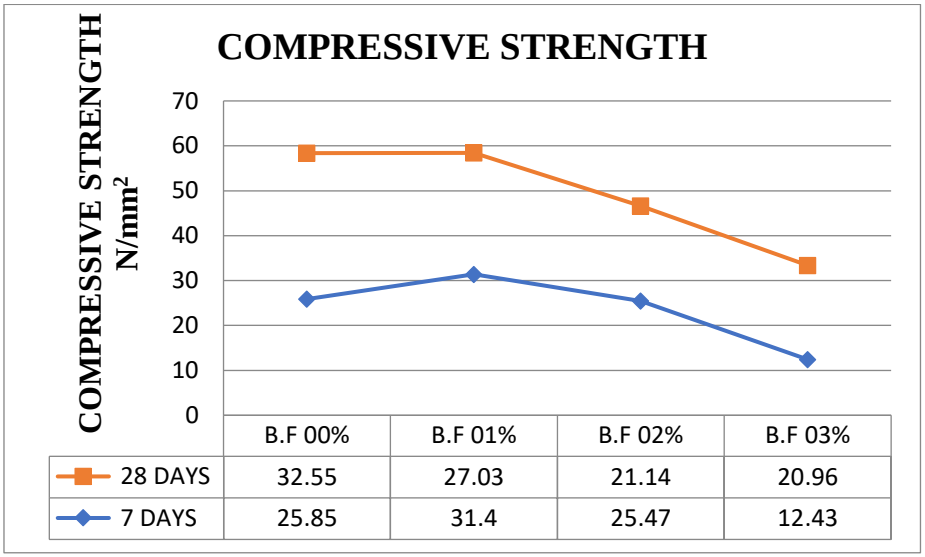

Figure1. Variation of 7 & 28 days Compression Strength

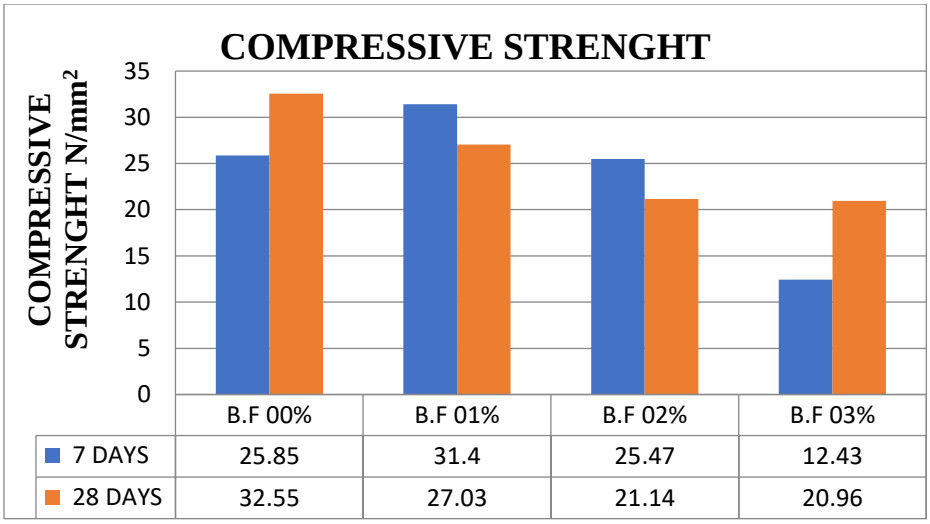

Figure2. Variation in Compressive Strength

B SPLIT TENSILE STRENGTH TEST

By using results (Table 2) tensile strength v/s % replacement as showing in (Fig 3 and Fig 4). It was observe that 7.89% of splite tensile strength has decrease for basalt fiber concrete over the normal concrete. At the 4% of silica fume, 2% of basalt fiber and 6% of silica fume, 3 % of basalt fiber partially replace the strength is increased 14.44% and 39.11% for 7days.

The Tensile strength of conventional concrete is 3.04 N/mm^2 for 7 days and partially replacing of cement with the SF of 2% and partially replacing of CA with basalt fiber of 1% varying is 2.77N/mm^2 for 7days. The decrease in strength partially replacing of cement with the SF & partially replacing of CA with basalt fiber varying by SF is a 2%, 4% 6% and basalt fiber is varying by 1%, 2%, 3% respectively. The strength is 3.79 N/mm^2 (3.26%), 2.65 N/mm^2 (30.07%) and 1.98 N/mm^2 (25.28%). The Tensile strength of conventional concrete is 3.67 N/mm^2 for 28days.

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Table No 2 Split Tensile Strength at 7 days & 28 days

SL NO	% OF Basalt Fiber	%OF Silica Fume	AVERAGE SPLIT TENSILE STRENGTH (N/MM^2)	
			7 DAYS	28 DAYS
1	0	0	3.04	3.67
2	1	2	2.77	3.79
3	2	4	3.17	2.65
4	3	6	1.93	1.98

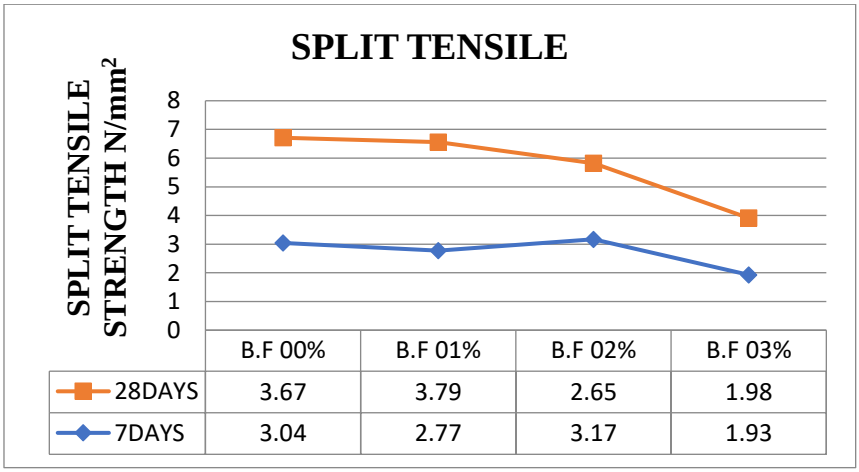

Figure3. Variation of 7 & 28 days Split Tensile Strength

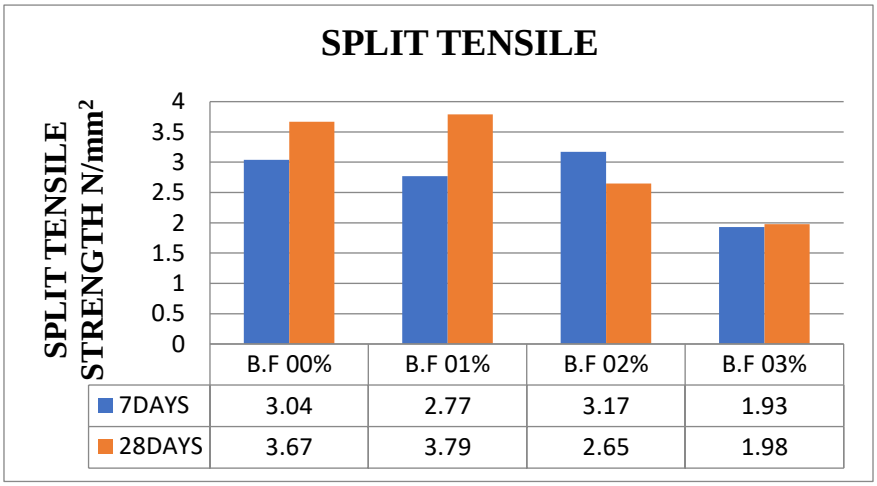

Figure4. Variation in Split Tensile Strength

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IV. CONCLUSION

1) The compression & tensile strengths of concrete goes on decrease with increasing % of B Fiber in the concrete mix.
2) The strength obtained by partially replacing of cement with SF of 2% & coarse aggregate with basalt fiber partially replacement by 1% varying strength is 31.40 N/mm^2 .The comp strength of normal concrete is 25.85 N/mm^2 for 7 days. It was observe that 21.47% of comp strength has increase for basalt fiber concrete over the normal concrete.
3) The strength is 25.47 N/mm^2 for 7days by partially replacement of cement with the silica fume of 4% and coarse aggregate partially replacement of basalt fiber of 2% varying. It was observed that 18.88% decrease in compression strength as compared to 2% of silica fume and 1% of basalt fiber replaced. At the 6% replacement of silica fume with cement and 3% replacement of B fiber with coarse aggregate the strength decreased by 51.19% from compare to 4% of silica fume and 2% of basalt fiber replacement.
4) The decrease strength of partially replacing of cement with the silica fume & partially replacement of coarse aggregate with basalt fiber. The comp strength of normal concrete is 32.55 N/mm2 for 28days. Silica fume varying 2%, 4%, 6% and basalt fiber varying 1%, 2%, and 3% respectively the strength is 27.03 N/mm^2 (16.95%), 24.14 N/mm^2 (10.70%) and 20.96 N/mm^2 (13.17%).
5) It was observed that 7.89% of splite tensil strength has decrease for basalt fiber concrete over the normal concrete. At the 4% of silica fume, 2% of basalt fiber and 6% of silica fume, 3 % of basalt fiber partially replacement the strength is increased 14.44% and 39.11% for 7days. The splite tensile strength of conventional concrete is 3.04 N/mm^2 for 7days and partially replacement of cement with the silica fume of 2% & partially replacing of coarse aggregate with basalt fiber of 1% varying is 2.77N/mm^2 for 7 days.
6) The decrease in strength partially replacing of cement with the silica fume and partially replacement of CA with basalt fiber varying by silica fume is a 2%, 4% 6% and basalt fiber is varying by 1%, 2%, 3% respectively. The strength is 3.79 N/mm^2 (3.26%), 2.65 N/mm^2 (30.07%) and 1.98 N/mm^2 (25.28%). Tensile strength of conventional concrete is 3.67 N/mm^2 for 28 days
7) However, it has been found concrete produced by partially replacement of silica fume and basalt fiber for a portion of the cement in one of three possible ratios also met the desired target strength requirements, although having less compressive & tensile strength than conventional concrete.

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