

# Experimental Study on Basalt Fibre Reinforced Concrete with Partial Replacement of Fine Aggregate by M.Sand

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**ABSTRACT:** Basalt fibre has gained popularity in concrete reinforcing applications due to its excellent mechanical properties and an environmentally friendly manufacturing process. In developing countries where concrete is widely used, the high and steadily increasing cost of concrete has made construction is very expensive. This project is experimented to reduce the cost construction and increase strength & durability. The environment has led to studies on various materials which could be used as partially replacement for fine aggregate. In this project, fine aggregate is partially replaced with manufacture sand and basalt fiber used to improve the both compression, tensile and flexural strength of concrete (1%,2%,3%,4%).

**KEYWORDS:** Basalt, fibre, , Compression, tensile strength test, flexure strength test.

## I. INTRODUCTION

Basalt is an igneous rock found in abundance throughout the world. Basalt rock is crushed, loaded into a furnace and liquefied. Next, basalt filaments are drawn through platinum-rhodium bushings. As the filaments cool, they are coated with a sizing agent. The sizing agent is necessary to prevent abrasion during transportation; however, it also provides manufacturers with a way to differentiate their fiber from their competitor's. For example, the performance of E-glass fibre depends on parameters such as fibre volume and aspect ratio, but the fibre itself differs little from manufacturer to manufacturer. In regards to interfacial properties (e.g. bond strength and alkaline resistance), sizing is the primary variable.

Basalt fibres can be manufactured directly from a single raw material (basalt rock) without the need for additives, making the process simpler than that of glass fibre. As a result, the fibres can be manufactured with conventional processes and equipment, and less energy, which offers an economic advantage. Moreover, the fibres are considered 100% natural, have no toxic reaction with air or water, and the fiberization process is said to be more environmentally friendly than that of glass fibre. In terms of mechanical and physical properties, basalt fibre has gathered attention due to its high elastic modulus, high strength, corrosion resistance, high temperature resistance, and light-weight. In general, research into using basalt fibre as a concrete reinforcing material has grown in popularity because of its potential to replace glass fibre. Basalt fibre is often reported to offer better mechanical properties and a more economical, environmental friendly manufacturing process.

## II. CONSTITUENT MATERIALS AND ITS PROPERTIES

- 1. Fine aggregate:** The particles of granular materials are so fine that they pass through a 4.75mm sieve. It is essential material in concrete consist of natural sand. The purpose of fine aggregate is to fill the voids, on coarse aggregate and to act as workability agent. It was screened to remove deleterious materials and tested as per procedure given in IS: 2386-1963. Specific gravity of fine aggregate is 2.34, Grading zone -Zone II, Water absorption-0.5%, Bulk density-1.60 g/cc, Moisture content-nil.
- 2. Coarse aggregate:** Aggregate, which retained in 4.75 mm sieve, is known to be coarse aggregate. Locally available coarse aggregate having the maximum size of 10mm were used in this experiment. Testing of coarse aggregate was done as per IS: 383-1970. Specific gravity of coarse aggregate is 2.77, water absorption-0.3%, Impact value-20%, crushing value-18%.

3. **Ordinary Portland cement:** cement in concrete acts as a binding material that addition of water. It plays an important role construction sector. In this study the Ordinary Portland Cement (OPC) of 53 grade conforming to IS : 12269-2013 is used .Various tests were performed on cement they are: Consistency 32% ,Specific gravity-3.12 , Initial and Final setting time 40 minutes & 360 Minutes .
4. **Basalt fiber :**  
Basalt rock is a volcanic rock and can be divided into small particles then formed into continues or chopped fibers. Basalt fiber has a higher working temperature and has a good resistance to chemical attack, impact load, and fire with less poisonous fumes.
  - a) **Physical Properties:** Color:- It is available in golden brown in color .Diameter:- It is available in different diameter like 5.8 micron .Length:- Available in 6mm,8mm,12mm etc. Density: - density of basalt fiber is 2.75 g/cm<sup>3</sup> .Coefficient of friction:- The coefficient of friction may be between 0.42 to 0.50.
  - b) **Chemical Properties:** Basalts are more stable in strong alkalis. Weight loss in boiling water, Alkali and Acid is also significantly lower. Possess resistance to UV- Light & biologic and fungal contamination. Are Compatible with phenolic resins. Absorption of humidity comes to less
5. **Water:** Potable tap water available in the laboratory with PH value 6 to 8 and conforming to the requirement of IS: 456-200 is used for mixing concrete and curing the specimens.

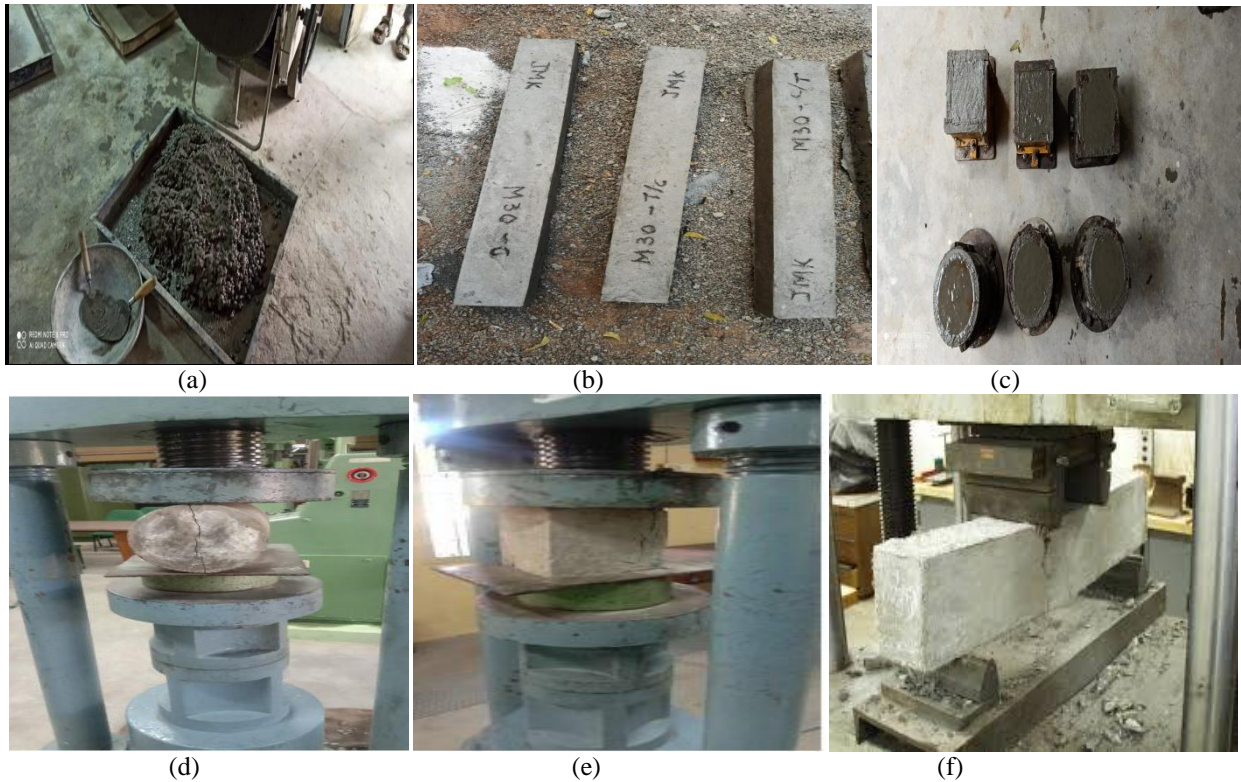


Fig 1. Basalt fiber

### III. EXPERIMENTAL INVESTIGATION

The experimental investigation is done to know its mechanical property, which is induced by its microstructure of Basalt fiber reinforced concrete. The following tests were conducted on the Basalt fiber reinforced concrete specimens are

1. **Compression test (conforming to IS 516):** This test was performed on 150 mm x 150 mm x 150 mm sized basalt fiber concrete cubes casted for M30 grade to determine the compressive strength of the mix.. The compression test on cube specimens was performed in the compression testing machine.
2. **Split tensile test (conforming to IS 5816-1999):** To determine the tensile strength of Basalt fiber reinforced concrete mix for M30 grade , split tensile test was done on the cylindrical test specimens of 150mm x 300mm using the compression testing machine. This method consists of applying a diametric compressive force along the length of a cylindrical specimen.
3. **Flexure test (conforming to IS 516):** Flexural strength of a concrete is a measure of its ability to resist bending. Flexural strength can be expressed in terms of “modulus of rupture’. Concrete specimens having 100 mm x 100 mm cross section and 1000 mm length are prepared for flexural test. They were supported on two rollers in the flexure testing machine.



**Fig 2.** Testing of mechanical properties and casting of specimens (a) Batching (b)BFRC beam specimen (c)BFRC cube and cylindrical specimens (d) Split tensile strength test (e) Compression strength test (f) Flexure strength test

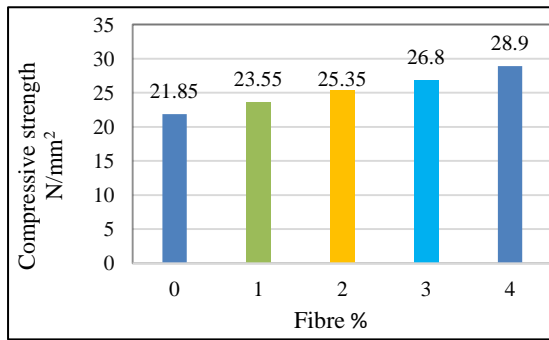
**IV. EXPERIMENTAL RESULTS**

**7.1 COMPRESSIVE TEST**

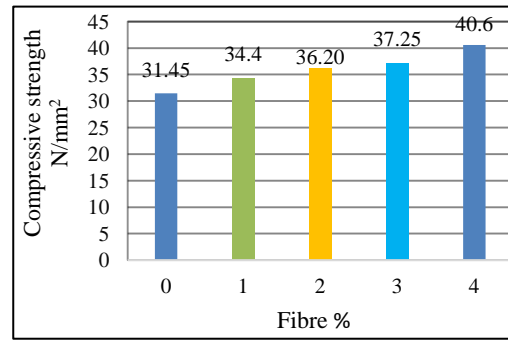
A test result is the average of at least three standard cured strength specimens made from the same concrete sample and tested at the same age. In most cases strength requirements for concrete are at an age of 28 days of curing. The concrete cubes, after 28 days were tested for their compressive strength in the following manner. After cleaning of bearing surface of compression testing machine, the axis of the specimen was carefully aligned with the center of thrust of the plate. No packing was used between faces of the test specimen and of testing machine. The load was applied without shock and increased continuously at a rate approximately 140 Kg/cm<sup>2</sup>/min until the resistance of the specimen to the increasing load broke down and no greater load could be sustained. The compressive stress calculated in N/mm<sup>2</sup> from the maximum load sustained by the cube before failure.

**Table 1 Compressive strength test of BFRC**

S.No	Grade	Basalt fiber %	Compressive strength N/mm <sup>2</sup>	
			7 days	28 days
1	M30	0	21.85	31.45
2	M30	1	23.55	34.40
3	M30	2	25.35	36.20
4	M30	3	26.80	37.25
5	M30	4	28.90	40.60



(a)



(b)

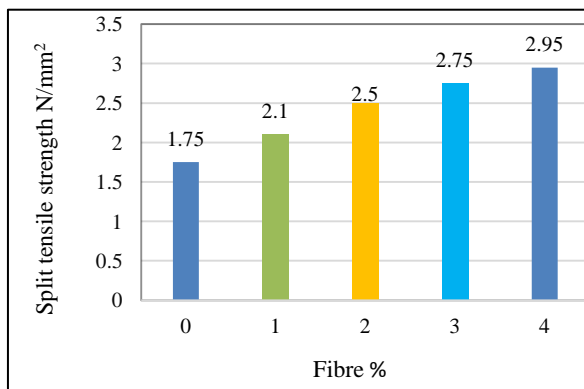
**Fig 3.** Graph of Compressive strength test of BFRC (a ) 7 days compressive strength (b) 28 days compressive strength

**SPLIT TENSILE TEST:**

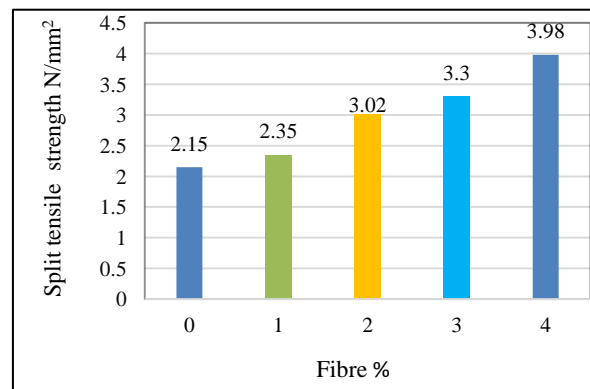
This method consists of applying a diametric compressive force along the strength of a cylindrical specimen. This loading induces tensile stresses on the plane containing the applied load. Tensile failure occurs rather than compressive failure. Plywood strips are used so that the load is applied uniformly along the length of the cylinder. The maximum load is divided by appropriate geometrical factors to obtain the splitting tensile strength. A diametric compressive load is applied along the length of the cylinder until it fails. The cylinder will typically fail due to horizontal tension and not vertical compression .

**Table 2 Split tensile strength test of BFRC**

S.No	Grade	Basalt fiber %	Tensile strength N/mm <sup>2</sup>	
			7 days	28 days
1	M30	0	1.75	2.15
2	M30	1	2.10	2.35
3	M30	2	2.50	3.02
4	M30	3	2.75	3.30
5	M30	4	2.95	3.98



(a)



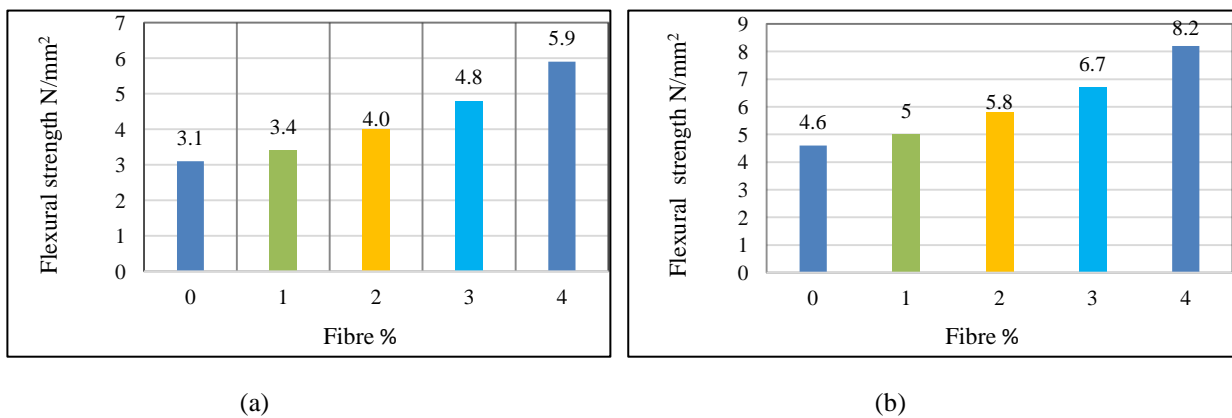
(b)

**Fig4.** Graph of Split tensile strength test of BFRC (a ) 7 days Split tensile strength (b) 28 days Split tensile strength

**FLEXURAL TEST:** The flexural Strength were tested at 7 and 28 day of testing for control mix and basalt fiber concrete mixes. The test results are presented in the table 3 below. In flexure strength test we followed two point load system because there is no shear in between the two point loading. So the failure takes place only due to bending .Basalt reinforced was not observed bridging the cracks during testing and the specimens failed in the same brittle manner as Plain concrete.

S.No	Grade	Basalt fiber %	Flexural strength N/mm <sup>2</sup>	
			7 days	28 days
1	M30	0	3.1	4.6
2	M30	1	3.4	5.0
3	M30	2	4.0	5.8
4	M30	3	4.8	6.7
5	M30	4	5.9	8.2

**Table 3 Flexure strength test of BFRC**



**Fig 5.** Graph of Flexure strength test of BFRC (a ) 7 days flexure strength (b) 28 days Flexure strength

**V. CONCLUSION**

Based in experimental investigation carried out in this work the following conclusion can be drawn:

- 1.The percentage increase of compressive strength of basalt fiber concrete mix compared with 28 days compressive strength of Plain Concrete is observed as 29.09% at 4% of fiber content.
- 2.The percentage increase of split tensile strength of basalt fiber concrete mix compared with 28 days compressive strength of Plain Concrete is observed as 85.12% at 4% of fiber content
- 3.The flexural strength of basalt fiber concrete is also found have a maximum increase of 78.26 % at 4% of fiber content at 4% of fiber content
- 4.Addition of more than 4% of basalt fiber to the concrete it leads to the decrease in workability .But this difficulty can be overcome by using plasticizers or super-plasticizers.
- 5.Also it was found from the failure pattern of the specimens, that the formation of cracks is more in the case of concrete without fibers than the basalt fiber reinforced concrete.
- 6.It shows that the presence of fibers in the concrete acts as the crack arrestors.

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