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Conventional Concrete by Using Basalt Fiber

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Abstract - *Basalt fiber has recently gained popularity in concrete applications due to its environmentally friendly manufacturing process and excellent mechanical properties. Basalt fibers are relatively cheaper and new fibers for concrete recently investigated by a few researchers. Fiber concrete is a most widely used for improving compressive and flexural strength of concrete. Various types of fibers such as steel, polypropylene, carbon, glass and polyester are generally used in concrete. In this study, the effect of inclusion of basalt fibers on the compressive strength, flexural and splitting tensile strength of fiber concrete was studied. The influence of addition of 0.1, 0.2, 0.3, 0.4, and 0.5% Basalt Fiber volume fraction in five different mixes of total volume of concrete is investigated and compared it with conventional concrete. Experimental results showed that the addition of basalt fiber up to 0.3% Basalt fiber volume together with concrete improved the compressive strength and flexural strength. In the corresponding to maximum compressive and Flexural strength results was observed at all fiber volumes, whereas there is a negligible influence of the fiber addition on the splitting tensile strength. The overall test results shows that Basalt Fiber could be utilized in concrete which improves the mechanical properties of concrete.*

Key Words*: 1) Concrete 2) *Basalt fibre, 3) Compressive strength, 4) flexural strength, 5) split tensile strength

1. INTRODUCTION

Concrete is one of the world's most used construction material due to its availability, durability and economy. India uses about 7.25 million cubic meters of ready-mixed concrete every year. It finds applications in highways, tunnels, bridges, high-rise buildings, dams etc. Basalt fiber is a high performance non-metallic fiber made from basalt rock melted at high temperature. Basalt Fiber originates from volcanic magma and volcanoes, a very hot fluid or semi fluid material under the earth crust, solidified in the open air. Basalt is a common term used for a variety of volcanic rock, which are grey dark in colour. Basalt rock fibers have no toxic reaction with air or water, are non-combustible and explosion proof. Basalt fiber has good hardness and thermal properties.

The Basalt fiber and material on their basis have the most preferable parameter a ratio of quality and the price in comparison with glass fiber, steel fiber, carbon fiber and other type fiber. In this study, influence of addition of 0.1, 0.2, 0.3, 0.4, and 0.5% Basalt Fiber volume fraction in five different mixes of total volume of concrete is investigated and compared it with conventional concrete**.** Concrete mixtures were prepared for different proportions of Basalt Fiber ranging from 0.1 to 0.5% with an increment of 0.1% of each and tested for compressive strength, Tensile, and Flexural strength after 3,7, and 28 days of curing.

1.1 OBJECTIVES OF INVESTIGATION

Experiment was conducted on concrete prepared by conventional concrete by using basalt fiber to changing the volume of basalt fiber in concrete by ranging from 0.1 to 0.5% with an increment of 0.1%. The main objective of this investigation was to find out the effect of Basalt fiber on the compressive strength, tensile strength and flexural strength.

Following are the main objectives of the investigation:

1) To check the strength of concrete by changing the volume of basalt fiber.
2) To check mechanical properties of conventional concrete by using basalt fiber.

1.2 MIX MATERIALS

The material details are as follows:

A. Cement

For this research, locally available cement which is of the ordinary Portland cement type (53 grade) was used throughout the work. Specific gravity of cement was 3.15.

B. Fine Aggregate

Locally available fine aggregate used was 4.75 mm size confirming to zone II with specific gravity 2.70. The testing of sand was conducted as per IS: 383-1970.Water absorption and fineness modulus of fine aggregate was 1.0 % and 4.375 respectively.

C. *Coarse Aggregate*

Coarse aggregate used was 20 mm and less size with specific gravity 2.59. Testing of coarse aggregate was conducted as per IS: 383-1970. Water absorption and fineness modulus of coarse aggregate was 0.5% and 3.39 respectively.

D. *Water*

The water used was potable, colour less and odour less that is free from organic impurities of any type.

E. *Basalt Fiber*

In this experiments basalt fiber having Length 18 mm and diameter is 13 micron size was used. Physical and Chemical properties of Basalt Fiber are tabulated as follows:

TABLE I

PHYSICAL PROPERTIES OF BASALT FIBER:

Sr. No.	Physical Property of Waste Glass Powder	Value
1	Specific Gravity	2.70
2	pH	13-14
3	Coefficient of friction	0.42-0.50
4	Moisture Content	0.1%

TABLE II

CHEMICAL COMPOSITION OF BASALT FIBER:

Sr. No.	Composition	Basalt Fiber (%)
1	Silicon dioxide (Sio2)	52.8
2	Aluminium Oxide (Al2O3)	17.5
3	Iron oxide (Fe2O3)	10.3
4	Magnesium oxide (Mgo)	4.63
5	Calcium oxide (Cao)	8.59
6	Sodium oxide (Na2O)	3.34
7	Titanium (Tio2)	1.38

2. EXPERIMENTAL WORK AND TEST

A. *Mix Design*

Mix design carried out for M30 grade of concrete by IS 10262:2009, having mix proportion of 1:1.74:2.13 with water cement ratio of 0.45. The Basalt fiber can be used total volume of concrete by 0.1 % to 0.5 % at an increment of 0.1% each. Chemical admixtures are not used in the work.

B. *Compressive, Flexural and Split Tensile Strength:*

Concrete prepared with different percentage of total volume of concrete by 0.1 % to 0.5 % at an increment of 0.1% each was cured under normal condition as per recommendations of IS and were tested at 3 days, 7 days and 28 days for determining the compressive, flexural and split tensile strength compared with the test results of conventional concrete.

3. TEST RESULTS

A. *Compressive Strength:*

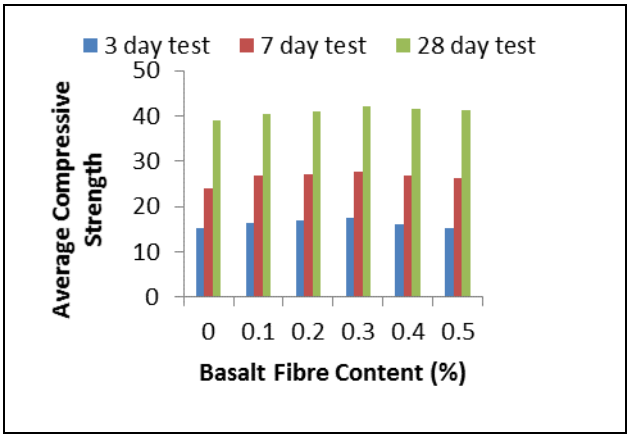
Three cubes of size 150 mm x150 mm x150 mm were casted to work out the 3rd, 7th and 28th day's compressive strength of all the proportions. The table III gives the results of test conducted on hardened concrete with 0 - 0.5 % Basalt Fiber for 3 days, 7days and 28 days.

TABLE III

EXPERIMENTAL TEST RESULTS FOR COMPRESSIVE SRENGTH

Mix Notation	% of Basalt Fiber	Compressive Strength in MPA (3 Days)	Compressive Strength in MPA (7 Days)	Compressive Strength in MPA (28 Days)
C1	0 %	15.26	24.01	40.17
C2	0.1%	16.296	26.87	40.94
C3	0.2%	17.03	27.05	42.17
C4	0.3%	17.41	27.58	42.63
C5	0.4%	16.07	26.93	41.38
C6	0.5%	15.89	26.41	41.15

It is clear from table III compressive strength obtained for concrete with 0.3 % basalt fiber by total volume of concrete showed a higher value by 12.34 % compared to conventional concrete for 3 days, 12.94 % compared to conventional con. For7 days and 5.77 % compared to conventional con. for 28 days.



B. *Flexural Strength*

Three beam section of size 100 mm x 100 mm x 500 mm were casted and cured for 28 days. The flexural strength is determined by the

Formula:

$$fcr = P_f L / bd^2 \quad or \quad 3P_f a / bd^2$$

Where,
fcr = Flexural strength, MPa
P_f = Central load through two point loading system, N
L = Span of beam, mm
b = Width of beam, mm
d = Depth of beam, mm
a = distance between line of fracture to the nearest support, mm.

The table IV gives the results of test conducted on hardened concrete with 0 - 0.5 % Basalt Fiber for 28 days.

TABLE IV

EXPERIMENTAL TEST RESULTS FOR FLEXURAL STRENGTH

Mix Notation	% of Basalt Fiber	Flexural Strength in MPA (28 Days)
B1	0 %	7.32
B2	0.1%	8.96
B3	0.2%	10.51
B4	0.3%	11.50
B5	0.4%	11.16
B6	0.5%	10.96

It is clear from table IV Flexural strength obtained for concrete with 0.3 % Basalt fiber by total volume of concrete showed a higher value by 36.34 % compared to conventional concrete for 28 days.

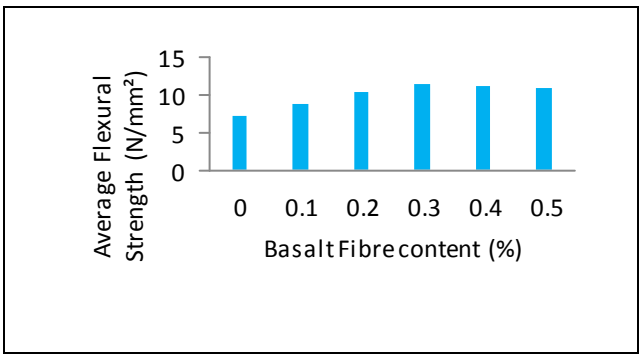


Fig.2.Comparative Flexural strength of concrete with basalt fiber.

C. Spilt Tensile Strength

Three cylindrical sections of diameter 150 mm and length 300 mm were casted and cured for 28 days. The split tensile strength of cylinder is calculate by the following formula:

$$fcys = 2P_{sp} / \pi D L$$

Where,
fcys = split Tensile strength, Mpa
P_{sp} = Load at failure, N
L = Length of cylinder, mm
D = Dia. Of cylinder, mm

The table VI gives the results of test conducted on hardened concrete with 0 - 0.5 % Basalt Fiber for 28 days.

TABLE V

EXPERIMENTAL TEST RESULTS FOR SPLIT TENSILEL STRENGTH

Mix Notation	% of Basalt Fiber	Split tensile Strength in MPA (28 Days)
B1	0 %	3.96
B2	0.1%	4.10
B3	0.2%	4.28
B4	0.3%	4.09
B5	0.4%	4.05
B6	0.5%	4.03

It is clear from table VI Flexural strength obtained for concrete with 0.2 % Basalt fiber by total volume of concrete showed a higher value by 7.48 % compared to conventional concrete for 28 days.

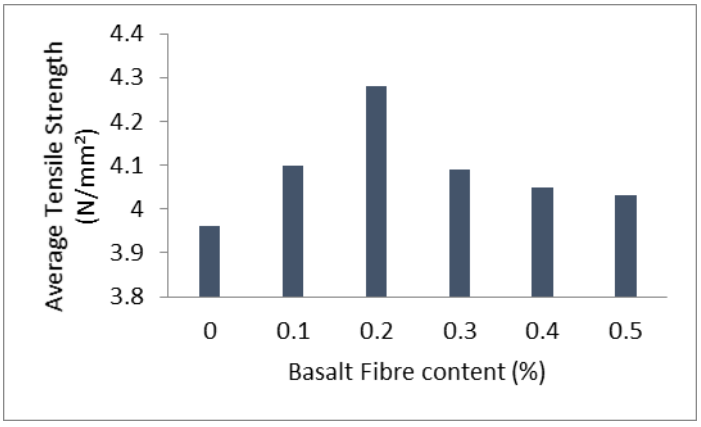


Fig. 3.Comparative Split Tensile strength of concrete with basalt fiber for 28 days.

D. Workability Test

Slump Cone test was conducted for investigation of workability of fresh concrete. Following table shows the slump value for all proportions.

TABLE VI

SLUMP VALUE FOR ALL PROPORTIONS

Sr. No.	Mix Notation	% of Basalt Fiber	Slump Value
1	S1	0 %	95
2	S2	0.1 %	82
3	S3	0.2 %	72
4	S4	0.3 %	57
5	S5	0.4 %	46
6	S6	0.5%	42

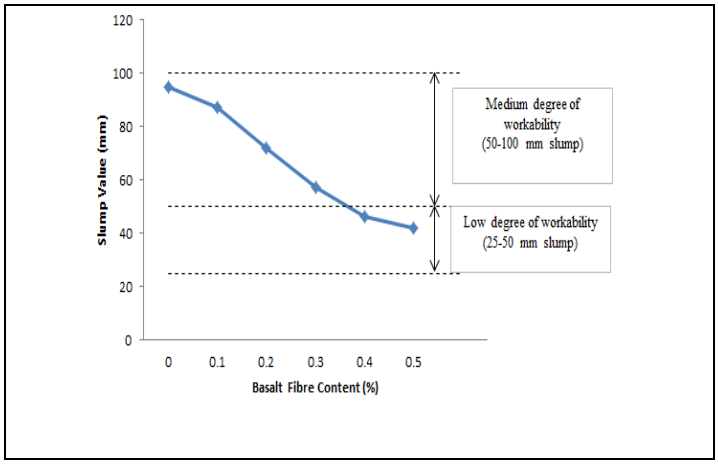


Fig. 5.Comparative Slump test of concrete with basalt fiber for 28 days.

4. CONCLUSIONS

Based on experimental observations, following conclusions can be established:

1) Basalt Fiber concrete increases the compressive strength, flexural and tensile strength as compared with the conventional concrete.
2) As the Percentage of Basalt Fiber in concrete increase's workability of concrete decreases.
3) From strength point of view, Conventional concrete by using basalt fiber shows positive results.
4) 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 concrete.

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