Experimental Investigation on Basalt Fiber in Concrete

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Abstract-- In recent past years, the use of alternative sources of aconstruction material is became higher than original material in order to reduce environmental impactwhich can be energy consumption, pollution, waste disposal, global warming, etc. The use of concrete deficiencies to certain extend like brittleness, poor tensile strength and poor resistant to impact low ductility, low durability andstrength fatigueis found in concrete structure. To overcome this, various types of admixtures and fibers like basalt, carbon and glass fibers are introduced in concrete. This study presents aexperimental investigation on the use of basalt fiber reinforced concrete and the comparison with conventional used concrete regarding their properties with varying percentage of basalt fiber. A total 16 cubes, 16 beams & 16 cylinders are casted and tested in this research. These 16 are casted as 4 of conventional concrete, 4 with 1.5% basalt fiber, other 4 are with 1.75% basalt fiber & remaining are with 2% basalt fiber. All are casted with same grade of concrete(M20). Tests performed in this study are workability, compressive strength, split tensile strength & flexural strength.

Keywords-Basalt Fiber, Compression Strength, Split Tensile Strength, Flexural Strength.

I.INTRODUCTION

Recently, there is need or requirement of having our own structural stability& durability.There is need of modification in traditional cement concrete has become mandatory. Fiber reinforced concrete is a most widely used solution for improving flexural strength and tensile strength of concrete. Many natural and synthetic Fiber are utilized in concrete obtained from carbon, glass, aramid, basalt rock and polypropylene. Fibers are used in concrete to improve its flexural strength, tensile strength, toughness, impact, fatigue resistance, abrasion resistance and ductility characteristics. We have casted cubes, beams and cylinders for compressive strength test, flexural strength test and split tensile test are to be conducted to obtain the necessary results against conventional method. Construction is an important component of developing countries development plans, particularly India's.Maintenance and life enhancement of structures are very important to meet the large demand for infrastructure development. Concrete is the most widely used man-made construction material. Very low tensile strength, limited ductility and little resistance to cracking are the disadvantages of plain concrete. Conventional concrete doesn't meet many functional requirements such as impermeability, resistance to frost adequately. Basalt fiber materials does not undergo any toxic reaction with water and air, also do not have any side effects on human health. Alkali resistance and acid resistance are two important characteristics of basalt fiber. It is electrically,thermally, and sound insulated. Basalt Fiberis made from basalt rock melted at high temperature which is a high-performance non-metallic fiber. In recent years, basalt Fiber in concrete is found to be cost effective having excellent properties than other Fibers. Basalt, an igneous, extrusive rock (volcanic magma which solidifies in open air), is generally found near East Asian countries among which Russia has abundant reserves. In India, these rocks are found near DeccanPlatea.

Fig.1 Chopped Basalt Fiber

Basalt Fiber is a material made from extremely fine Fibers of basalt. Manufacturing of basalt fiber is done by melting basalt rock. The molten rock is then extruded through small nozzles to produce continuous filaments of basalt Fiber. It do not contain any other additives in a single producing

process, resulting in lesser in cost. From the recentstudies it can be conclude that basalt Fibers have better tensile strength than E-glass Fibers, greaterfailure strain than carbon Fibers as well as good resistance to chemical attack, impact load and fire with less poisonous fumes.

II.EXPERIMENTAL WORK

Mixing

A)Material

I)Cement- Cement has a binding property with fine aggregate and coarse aggregate and hardens with the addition of water. Various properties of cement are determined according to IS 12269: 2013 and IS 4031: 1988.

II)Aggregates- The aggregate is a mixture of natural coarse and fine materials. The aggregates are mainly responsible for 70% of the strength gained by concrete. Aggregates are classified as fine and coarse aggregates, fine aggregates are the aggregates which pass through 4.75 mm sieve whereas coarse aggregates are retained on 4.75 mm sieve. Various specifications of aggregates are according to IS 383: 1970. Natural sand as per IS:383-1987 will be used.

III)Water- Water is responsible for hydration of cement and it is also responsible for workability, strength and durability of concrete. Water should be added in limited quantity whereas an excess of water added to the concrete leads to segregation. Water used work for mixing as per IS 10262: 2019 whose pH is around 7.

IV)Basalt Fiber- The fibers used were chopped basalt fibers which are uniformly and randomly distributed in the concrete matrix with percentage 1%, 1.75%, 2% in each mix.

B)Mix Proportion

Mix proportion was done by using IS:10262-1982. For conventional concrete the targeted strength is 20MPa. We have design concrete to M20 grade. The total material used is as follows

Sr. No.	Material	Quantity
1	Cement	394.92 kg/m3
2	Coarse aggregate	1258.6 kg/m3
3	Fine aggregate	658.8 kg/m3
4	Water	197.16 kg/m3
5	Basalt Fiber	2 kg

Table.1 Quantity Required

C) Casting

After calculating the required quantities of materials, manual casting of blocks (cubes, cylinders, beams) were done at MVR RMC plant Mahalunge, Pune. For compression test, cubes of size 150mm x 150mm x 150mm were casted. Similarly for split tensile test, cylinders of diameter 150mm and height 300mm & for flexural test, beams of size 150mm x 150mm x 700mm were casted.

III.TEST RESULTS

1) Workability

Workability is a property of raw or fresh concrete mixture. In simple words, workability means the ease of placement and workable concrete means the concrete which can be placed and can be compacted easily without any segregation. Workability is a vital property of concrete and related with compaction as well as strength. With increasing basalt fiber percentage workability of concrete mixture decreases.

% Basalt Fiber	Slump (mm)
0	118
1	106
1.75	100
2	96

Table.2 Slump Cone Test

2) COMPRESSIVE TEST

The compressive strength is the capacity of a material or structure to withstand loads. It can be measured by plotting applied force against deformation in a testing machine. First of all the specimen is placed inside the CTM and the loading is applied gradually. Then we wrote down the reading at which the specimen failsCompressive strength was measured at 7, 28 days of testing. The test results are shown in the following table

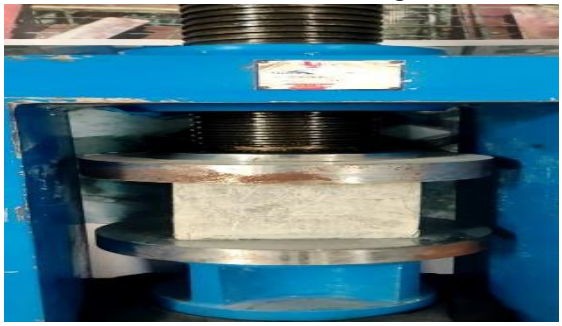

Fig.2 Test for CompressiveStrength

% Basalt Fiber	Compressive Strength (MPa)	
	7 Days	28 Days
0	16.80	27.90
1	18.00	30.70
1.75	19.00	32.00
2	18.60	30.50

Table.3 Test Result Compressive Strength Of Basalt Fiber Specimens

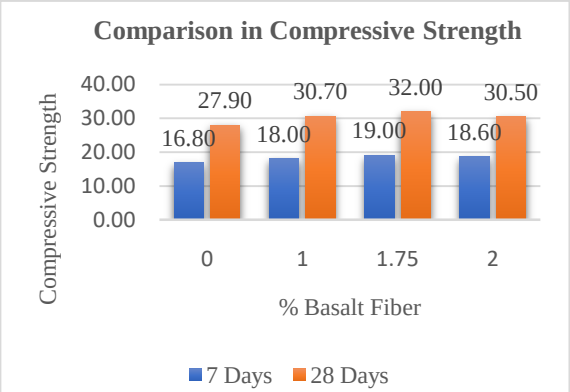

Fig.3 Compressive Strength of Basalt Fiber Specimens

Fig.3 indicates the comparison of results obtained on 7 & 28 days with varying percentage of basalt fiber. It shows the highest strength obtained at 1.75% of basalt fiber. Beyond 1.75% of basalt fiber compressive strength decreases

3) SPLIT TENSILE TEST

The split tensile strength test on conventional as well as fiber reinforced concrete can be performed conforming to IS 519-1959, at the age of 7 and 28 days. The cylinders can be tested using Fully Automatic Compression Machine. Is the ability of the concrete to survive under tension load. Expressed as minimum tensile stress needed to split the material apart.

Results obtained are shown in table

Fig.4Test for Splitting Tensile Strength

Table.4 Test Result Split Tensile strength of basalt fiber specimens

% Basalt Fiber	Split Tensile Strength	
	7 Days	28 Days
0	2.23	2.73
1	2.70	3.29
1.75	2.77	3.40
2	2.74	3.34

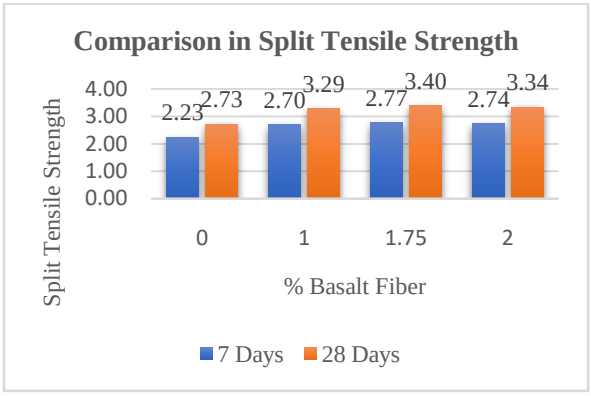

Fig.5 Split Tensile Strength Of Basalt Fiber Specimens

Fig.5 shows the result obtained by spliting tensile test performed on 7 & 28 days for different percentage of basalt fiber. Maximum strength obtained at 1.75% of basalt fiber i.e. 3.40 MPa. Further 1.75% strength decreased.

4) FLEXURAL TEST

Flexural Strength is one of the measures of the tensile strength of concrete. It is themeasureofconcretetoresistfailureinbending.Theflexuralstrengthisexpressedasmodulusof rupture in MPa. The flexural strength was tested at 7&28 days of testing. The test results areshowninthefollowing table.

% Basalt Fiber	Flexural Strength	
	7 Days	28 Days
0	2.28	3.48
1	2.63	4.11
1.75	2.71	4.16
2	2.66	4.06

Table.5Result Flexuralstrength of basalt fiber specimens

Fig. 6 Flexural Test

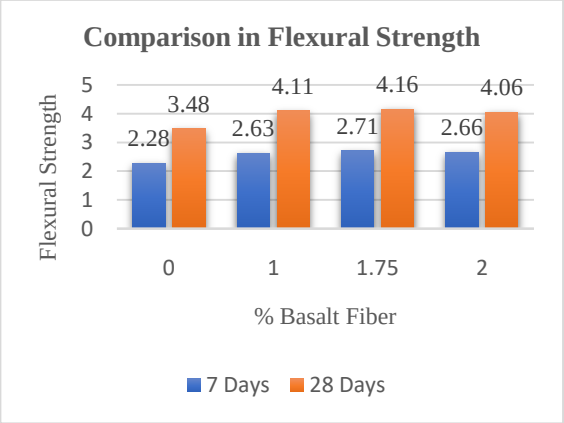

Fig.7Flexuralstrength of basalt fiber specimens

In the Fig. 7, results obtained are from flexural test performed on beams. Maximum strength obtained at 1.75% of basalt fiberi.e. 4.16 MPa. From the beginning strength increases gradually upto 1.75%. Further it goes on decrease.

IV.CONCLUSION

- With increase in the percentage of basalt fiber, it has been observed that the workability of concrete decreases.
- Compressive strength of a concrete with basalt fiber increases by 14.5 %. The compressive strength increases to the 1.75 % further it decreases.
- The percentage increase of split tensile strength of basalt fiber concrete mix is 24.7% , it shows maximum value at 1.75% of basalt fiber.
- Flexural strength of concrete has maximum value at 1.75 % of basalt fiber. Strength increases by 19.5 % compared to conventional concrete.

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