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Experimental Analysis on Basalt Fiber Reinforced Concrete

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Abstract - *Basalt fiber is a type of natural fiber which shows a recent demand in research field due to better chemical resistance, better environment friendliness and recyclability. Concrete were cast and designed for M40 grade and incorporated a basalt fiber in various proportion such as 0, 0.1, 0.25, 0.4, 0.5. The main extent of the research is to discover the optimum content of basalt fiber which enhances the mechanical strength of concrete. Strength of compression of basalt fiber reinforced concrete was tested and compared with the control concrete. Test result specify the significant improvement in strength of compression and high magnitude improvement in flexural and split tensile strength were obtained by using basalt fiber even at low contents.*

Key Words: Low content of Basalt fiber, compressive strength, split tensile strength, flexural strength and optimum content, Basalt Fibre Reinforced Concrete, Ceramic fibre, Stiffness.

1.INTRODUCTION

The micro reinforcement depends on the dimensions of the fiber such as its length and diameter, its aspect ratio (diameter/length), percentage proportioning of fibers to be added on to the concrete, the direction at which the fiber to be placed and condition of mixing, etc., The major role of fibers in FRC is that they delay and arrest the crack propagation to certain extent than the conventional concrete. It was a composite obtained by adding thread-like structures that are long, thin and flexible which is classified based on their source such as natural and synthetic fiber. Basalt fiber shown in figure 1 is one of the natural fibers because it will be extracted from the basalt rock. The only crushed rock to be used in the manufacturing of a fiber is the basalt fiber. The fiber is obtained by melting the igneous basalt rock for about 2,700° F. Basalt fiber has high modulus of elasticity than glass fiber so it acts as better replacement of glass rebar in the concrete beam. It is good resistance to salt, alkalies, impact load and fire. so, it enhances the mechanical and impact strength than the carbon fiber concrete.[3][5]

Thermal resistance and high corrosion character of basalt fiber improved the strength and strain capacity of concrete. The length and volume of fiber is increased for the enhancing the mechanical properties of concrete. Research stated that the basalt fiber of 0 -0.5% in the volume fraction of concrete, improved the compressive, flexural and tensile strength. M40 grade of standard concrete were analysed with incorporating basalt fiber in volume fraction and determine its optimum range. The dispersion of basalt fiber is based on the fiber aspect ratio and this aspect ratio is also play a significant role in strength of concrete.[9][10]

To investigate the performance of Basalt fiber concrete over Ordinary Portland cement, a comparative study has been carried out for different proportion of mixes in terms of compressive strength and split tensile strength Investigations were carried by us to find out the following:

The properties of fresh concrete with & without basalt fibres.

The properties of hardened concrete such as compressive strength & tensile strength. It includes making 5 mixes and amounts of basalt fibres added to the concrete were 0.1, 0.25, 0.4, 0.5 by volume.

2. Collection of materials and their properties

To carry out the experimental work the following list of materials have been used.

i. Fibres: The fibres used in this investigation were basalt fibres, which were supplied by Muktagiri Corporation, Mumbai. The specifications about the fibres, as provided by the manufacturer is as follows:

ii. Diameter of fibre: 6 microns

iii. Length of fibre (Average): 6 mm

iv. Cement: M40 grade ordinary portland cement was used.

v. Coarse Aggregate: The coarse aggregate used was obtained from a local source. The maximum size of the aggregate used was 20mm.

vi. Fine Aggregate: The fine aggregate used was natural sand passing through 4.75mm IS sieve and retained on 2.36mm IS sieve.

vii. Water: The water used was municipal tap water.

2.1 Mix Design Calculations

- Concrete mix design IS Code for Concrete mix design, we use, IS 456, and TS 10262
- Specific Gravity Details

  Type of cement - OPC M40 Grade

  Cement - 3.15

  Coarse Aggregate 20 mm - 2.885

  Coarse Aggregate 12.5 mm - 2.857

  Fine Aggregate - 2.723

- **Water Absorption Details**

  Coarse Aggregate 20 mm - 0.42%

  Coarse Aggregate 12.5 mm - 0.47%

  Fine Aggregate - 1.38%

- **Concrete quantity required for mix**
  Volume of 1 cube mould = 0.150 x 0.150 x 0.150

  = 0·003375 m3

  concrete quantity for 1 cube = 0.003375 m3

- **Concrete quantity for 45 cubes**
  = 0.003375 x 45

  = 0.15 m3

- **Now we calculate the quantity of materials for a mix**
  Cement = 450 x 15 = 67.5 kg

  Water = 209 x 0.15 = 31.35 kg

  Coarse Aggregate 20mm = 562 x 0.15 = 84.3 kg

  Coarse Aggregate 12.5mm = 557 x 0:15 = 83.55 kg

  Sand = 690 x 0.15 =103.5 kg

- **We calculated quantity of materials for 45 cubes Now we to calculate quantity of materials for 1 cube**
  Cement = 67.5/45 = 1.5 kg

  water = 31.35/45 = 0.6966 kg

  Coarse Aggregate 20 mm = 584-3/45= 1.87 kg

  Coarse Aggregate 12.5mm = 83.55/45

  sand = 103.5/45 = 2.3 kg

- **Now We are casting 45 cubes and in them are adding basalt fibres in the % of 0, 0.5, 0.4, 0.25, 0.1.**
  For 0 % = 9x 0 = 0kg

0.5% = 9 x 0.41 = 3.69 kg

0.4% = 9 x 0.032 = 0.288 kg

0.25%= 9 x 0.0205 = 0·1845 kg

0.1 % =9 x 0.0082 = 0·0739 kg.

Total kg Basalt for 45 cubes = 4.42364 kg.

3. Process of Basalt Fibre

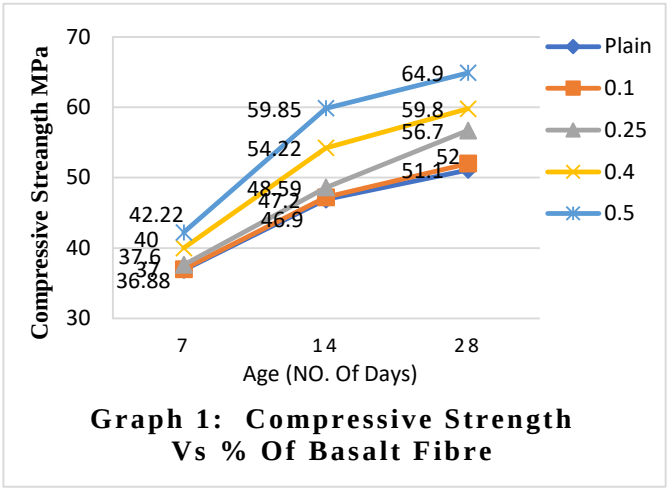
Basalt rocks are crushed in 5~20 mm fraction, Demolish raw material transported into the furnace melting by loader Into the furnace basalt is melted at 1400 – 1600 Basalt gives reaction with a platinum alloy set - holes of bushing Regularly filaments making with diameter 9~15 microns is lubricated by the lubricator and reeling up with the winding machine on bobbins. Reversing of primary string by machine, from bobbins on roving spool.[4]

Test & Results

Table 1: Compressive Strength (MPa) Vs % of Basalt Fibre

Mix Type	Percentage Of BFRC	Age (No. Of Days)		
		7	14	28
Plain	0	36.88	46.9	51.1
BFRC	0.1	37	47.2	52
BFRC	0.25	37.6	48.59	56.7
BFRC	0.4	40	54.22	59.8
BFRC	0.5	42.22	59.85	64.9

Graph showing comparison between Compressive Strength Vs % of Basalt Fibre for 7, 14 and 28 days:



Graph 1: Compressive Strength Vs % Of Basalt Fibre

Chart -1: Compressive Strength Vs % of Basalt Fibre

4. CONCLUSIONS

- The Compressive strength and split tensile strength of concrete goes on increasing with an increase in percentage of Basalt Fibre in the mix.

- Although using fibre will increase the cost of one cubic metre of concrete, when considering the improved properties of concrete with fibre and the extended working life, then its total cost is reduced.
- Basalt fibers are an ideal choice for applications such as marine structures, off-shore structures, parking structures, bridge decks, highway under extreme environments, and structures highly susceptible to corrosion (paper and chemical industries) and for pervious concrete pavements.

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