Experimental Investigation on Mechanical Properties of Basalt Fibre Concrete

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Abstract— The concrete properties can be enhanced in many ways as per the requirements of it. Mainly, concrete possesses enough compressive resisting capacity but has negligible tensile strength. Moreover, the low resistance to cracking leads concrete to failure by enlarging cracks and due to low ductility the sudden failure occurs, which are not the good signs for concrete. The fibre reinforced concrete is helpful for the enhancement in terms of strength and resulting in the exceptional concrete. This research work focuses on the consideration of the basalt fibre in various percentages in concrete having a specified range for the exploratory concrete work. This research work is done to examine the effect of basalt fibre incorporation with discrete percentages such as 0\%, 0.25\%, 0.40\% and 0.55\% by weight of cement for the grade of M-25 concrete. The optimum dosage of basalt fibre concrete is carried out amongst the taken various percentages. The compressive strength test, flexural strength test and split tensile strength test was done for this research work.

Key words: Basalt Fibre Concrete, Split Tensile, Basalt Fibre, Compression, Flexural Strength

I. INTRODUCTION

Concrete is the most extensively and preferred material for the construction world. The modern developments in the concrete field are like Fibre Reinforced Concrete (FRC), High Strength Concrete, Self Compacting Concrete, High Performance Concrete, Composite Concrete, etc.

The fibre inclusion in concrete concept is approach to achieve the increment in the tensile strength as possible in this era. The fibre enhance tensile strength of concrete in great manner and also enhance compressive strength in some manner depends on the type of fibre, dosage of fibre, strength of fibre, etc.

Fibre utilization in concrete having bridging mechanism while cracking propagation occurs from the intrinsic cracks. The inclusion of fibres provides the anchoring bondage of different points while cracking. The fibre improves the crack resistance strength and also it changes the behavior of post cracking. These fibres act as linkage in concrete member and prevent the cracks propagating in the member due to applied loads. These fibres are distributed randomly and uniformly in all directions throughout the member and hence it improves the behavior of concrete as like ductile.

Basalt fibre reinforced concrete (BFRC) introduced as a use of natural material. Basalt fibre addition to concrete enhances the mechanical properties of concrete. These fibres are made from the uniform virtues of basalt deposits. Crushed basalt rock is the source of basalt fibre. Fibres are made by the extrusion process from crushed basalt rocks. It has some excellent properties like thermal insulation and sound insulation, non-flammable, non-corrosive, etc. Basalt fibres have no toxic action with air and water. It sustains against chemicals and has better resisting property. It has lower density than steel. It is highly resistant to alkaline, acid attack, etc.

Basalt fibre concrete applications are such as concrete floors, runways in airports, industrial floors in shops, repair and reconstruction of buildings, fire retardant structures etc.

II. MATERIAL COLLECTION

A. Basalt Fibre:

It is chopped fibres from monofilament fibres. Monofilament fibres are made by extrusion process from basalt.

Specification:-

<table>
<thead>
<tr>
<th>Base Material</th>
<th>Basalt Rocks</th>
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<tbody>
<tr>
<td>Fibre type</td>
<td>Basalt chopped fibre strands</td>
</tr>
<tr>
<td>Length</td>
<td>18 mm</td>
</tr>
<tr>
<td>Diameter</td>
<td>13 (\mu)m</td>
</tr>
<tr>
<td>Density</td>
<td>2.7 g/cm(^3)</td>
</tr>
</tbody>
</table>

Fig. 1: Basalt Chopped Fibre Strands

B. Cement:

Cement is a binding material for concrete and mortar as well as plaster. The type of cement suitable for particular work is depend on the requirements of concrete properties like strength, durability, etc. Ordinary portland cement of 53 grade is used for the research work. This OPC-53 grade cement is easily available in market so use of it is worldwide. When Portland cement is mixed with water, a series of chemical reactions occur between water and cement which is responsible for hardening of concrete. Reactions between water and cement are known as hydration.

C. Coarse Aggregates

Hard and strong aggregates should be used for strength of concrete. Also, the coarse aggregate should not contain any undesirable impurities, and should be chemically non-reactive. Coarse aggregates were available from local material and used for the make concrete. The specific gravity of coarse aggregate having size 10 mm was 2.78. The specific gravity for the 20 mm coarse aggregate was 2.81.
D. Fine Aggregates
Generally used Fine aggregates are natural sand and crushed stone. Fine aggregates from locally available material used for the mix design. The sand falls in zone II. The specific gravity of sand taken in consideration was 2.67.

E. Water
An important ingredient for making concrete is Water. Tap water was used for the research work which was satisfying requirements of relevant standards. The water cement ratio was kept 0.5. For concrete of better quality, water should satisfy all criteria of drinking water.

III. EXPERIMENTAL WORK
A. Compressive Strength Test:
For compressive strength test, concrete cube specimens of size 150mm x 150mm x 150 mm were cast for M25 grade of concrete. The various percentages of basalt fibre content were taken as 0 %, 0.25 %, 0.40 % and 0.55 % respectively by weight of cement for this research work. For compression test, 9 cubes of concrete without fibre and 9 cubes of each proportion of basalt fibre concrete were casted. These cubes were tested at 7 days, 14 days and 28 days respectively as per IS 516-1959 and the failure load was noted. In each category 3 cubes were tested and their average value was reported.

B. Flexural Strength Test:
For flexural strength test, beam specimens of dimensions 150mm x 150mm x 700 mm were casted for M25 grade of concrete. The testing was done as per IS 516-1959. For Flexural strength test, 9 beams of concrete without fibre and 9 beams of each proportions of basalt fibre concrete were casted. These flexural strength specimens were tested on three point flexural testing machine at 7 days, 14 days and 28 days respectively and failure load was noted. In each category three beams were tested at 7 days, 14 days and 28 days and their average value is reported.

C. Split Tensile Strength Test:
For Split tensile strength test, cylinder specimens of size 150 mm diameter and 300 mm length were casted for M25 grade of concrete. The test was done on compressive testing machine. For Split tensile test, 9 cylinders of normal concrete and 9 cylinders of each proportions of basalt fibre concrete were casted. In each category three cylinders were tested at 7 days, 14 days and 28 days and their average value is reported.
C. Split Tensile Strength Test:
The test was done on compression testing machine. The test was done on concrete cylinders with and without the use of fibres. The results of the split tensile strength of concrete cylinders are given in the chart.

![Split Tensile Strength Test Results](chart)

V. CONCLUSION
The compressive strength for the concrete without fibre was lower than the concrete with fibre. The 0.4% of fibre addition shows the highest compressive strength at every age than the other fibre proportions amongst taken. The compressive strength of concrete having 0.55% fibre was lower than concrete without fibre at the age of 28 day. The flexural strength for the concrete with fibre shows good increment in the strength rather than the strength of concrete without the use of fibres. The compressive strength was increased for 0.25% dosage is 6.54%, 6.66% and 7.02%, for 0.40% dosage is 10.78%, 16.43% and 13.30% at 7 days, 14 days and 28 days respectively. For 0.55% dosage the 7 days and 14 days strength increased was 4.49% and 9.16% respectively. The 28 days strength for 0.55% fibre dosage decreased 5.48% at 28 days with compare to normal concrete. The flexural strength was increased for 0.25% dosage is 18.97%, 25.64% and 29.71%, for 0.40% dosage is 12.70%, 15.98% and 24.18%, for 0.55% dosage is 8.02%, 13.58% and 17.59% at 7 days, 14 days and 28 days respectively with compared to normal concrete. The split tensile strength was increased for 0.25% dosage is 10.21%, 16.05% and 21.89%, for 0.40% dosage is 12.70%, 25.92% and 33.86%, for 0.55% dosage is 13.67%, 22.22% and 29.48% at 7 days, 14 days and 28 days respectively with compared to normal concrete. As per the results, the flexural strength was increased as per the increased percentage of fibres. The split tensile strength of concrete without fibre was lower than the strength of concrete with fibre. The split tensile strength increases as per the increment of fibres. The addition of 0.55% fibres gives the highest tensile strength amongst the taken percentages.

REFERENCES