COMPARATIVE STUDY OF EFFECT OF BASALT, GLASS AND STEEL FIBER ON COMPRESSIVE AND FLEXURAL STRENGTH OF CONCRETE

Ranjitsinh K. Patil[1], D. B. Kulkarni[2]

[1]*M. Tech (Structure) Student, Rajarambapu Institute of Technology, Rajaramnagar, Sakharale, Dist-Sangli (M. S.), India. 415414*

[2]*Asst. Prof, Civil Department, Rajarambapu Institute of Technology, Rajaramnagar, Sakharale, Dist-Sangli (M. S.), India. 415414*

Abstract

This paper presents the comparative study of effect basalt, glass and steel fiber on compressive and flexural strength of M40 grade concrete. For flexural and compressive strengthening of reinforced concrete, total thirty-nine cubes and thirty-nine beams were cast and beams were tested over an effective span of 900 mm up to failure of the beam under two-point loading. The beams were designed as balance-section. The fibers were placed in concrete randomly by (0.25%, 0.5%, 0.75%, 1%) of its total volume of concrete. For each percentage of fiber total three cubes and three beams were casted to take average results. Finally comparative results are shown for each percentage and for these three fibers.

Keywords: *Fiber Reinforced Concrete, Bending moment region, Control beam, strengthened beam, Strengthened cubes, Ultimate Load carrying capacity*

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1. INTRODUCTION

Plain concrete has two major deficiencies; a low tensile strength and a low strain at fracture. The tensile strength of concrete is very low because plain concrete normally contains numerous micro cracks. It is the rapid propagation of these micro cracks under applied stress that is responsible for the low tensile strength of the material. These deficiencies have lead to considerable research aimed at developing new approaches to modifying the brittle properties of concrete. Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers each of which lend varying properties to the concrete. In addition, the character of fiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation, and densities.

1.1 Basalt Fibers

Basalt is a natural material that is found in volcanic rocks. It is mainly used(as crushed rock) in construction, industrial and high way engineering. One can also melt basalt (1300-1700°C) and spin it into fine fibres. When used as (continuous) fibres, basalt can reinforce a new range of (plastic and concrete matrix) composites.

1.2 Glass Fibers

Steel fibers have been used in concrete since the early 1900's. Steel fibers are widely used applications of steel-fiber- reinforced concrete include highway pavement, airport runways, refractory concrete and shotcrete tunnel lining by spraying fiber- reinforced concrete

1.3 Steel Fibers

Glass fibers have been developed mainly in the production of thin sheet components, using glass as reinforcing bars, impregnated and saturated plastics. Glass fibers are produced in the process in which molten glass extracted by the form of filaments, at the bottom of a heated platinum tank

2. EXPERIMENTAL PROGRAM

The experimental programme consist of casting and testing of reinforced concrete beams and cubes with (0.25%, 0.5%, 0.75%, 1%) of its total volume.

2.1 Details of the Beam Specimen

The experimental work consisted of total thirty-nine rectangular beams under reinforced concrete and thirty nine cubes. All beams were of the same size 100 mm x 150 mm x 1200 mm, 2 -8 mm and 1-10mm diameter bars were used for flexural reinforcement at the bottom of each beam, 2-8 mm at the top of each beam and 6 mm diameter stirrups spaced 150 mm center-to-center for shear reinforcement. Typical beam reinforcement details are illustrated in the Figure 1.

The casting of beams was made as per IS code specification using M40 grade concrete with 20 mm maximum size of coarse aggregate, locally available sand and 53 grade ordinary Portland cement. These beams were cured for 28 days in pure.

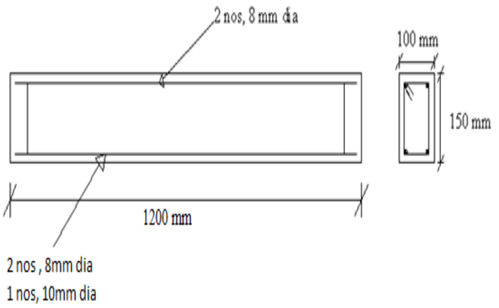

Fig. 1 reinforcement details of beam

2.2 Test Procedure and Instrumentation

All beam specimens were instrumented and loaded and supported simply as shown in figure 2. The load was applied through Universal Testing Machine of capacity 600 kN. All beams were tested under two point loading. They were statically tested for failure at equal 2 kN increment of load. During loading the mid span deflection was measured using dial gauge having a least count of 0.01 mm. Deflections and the applied load were recorded at every load increment.

2.3 Results and Discussions

The control beam had a load at yielding of 70 kN and an ultimate load of 88 kN. All strengthened specimens exhibited limited deformation and cracks before yielding of reinforcement. The initial cracks were initiated at a load of 40 kN and progressed towards upward direction from bottom as shown in Figure 7.

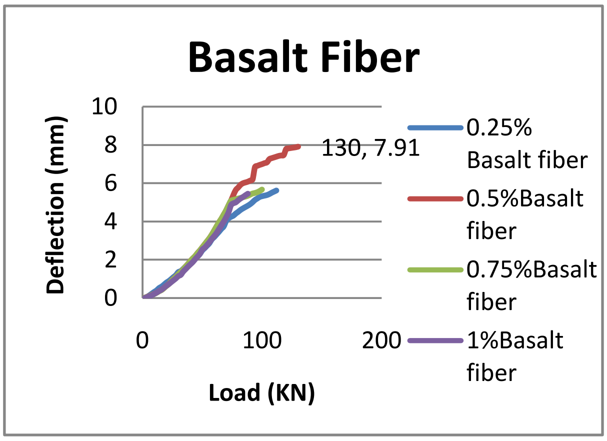

Fig 2 load vs deflection curve (Basalt fibers)

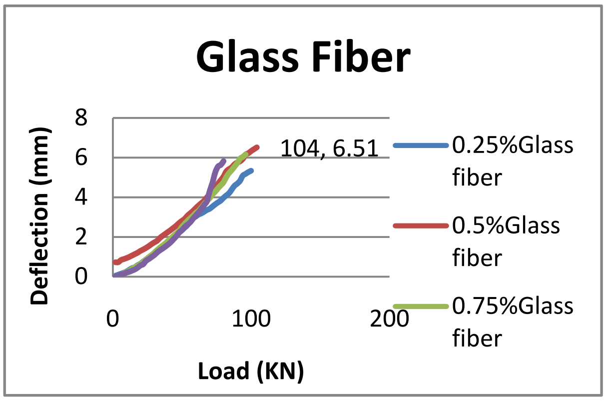

Fig. 3 load vs deflection curve (Glass fibers)

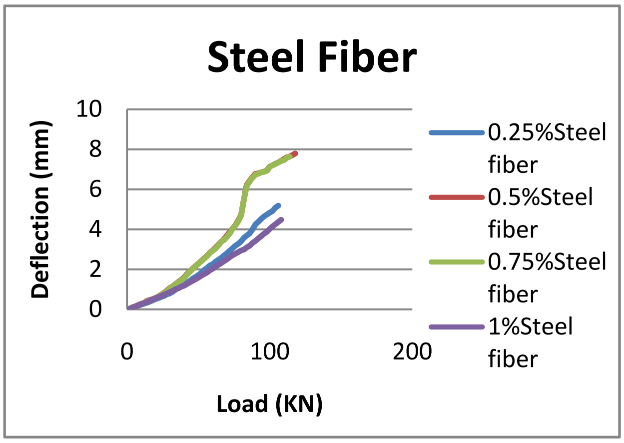

Fig. 4 load vs deflection curve (Steel fibers)

Fig. 5 cracking pattern for the control beam

2.4 Effect of Fiber on Beams

In fiber reinforced beams, first crack formed on beam surface slightly more than CB first crack load. A small crack formed on beam surface which was not propagated throughout the beam depth. The first crack was observed at a load of about 60% of total load carrying capacity.Beyond this point some cracks are formed in flexure zone of beam, but not propagated throughout the beam depth, when fiber come in their path crack direction was changed. Shear cracks are formed in shear zone of beam, at an angle of 45$^{o.}$ Observed cracks are less in number that CB, having small width up to failure of beam.

2.5 Effect of Fiber on Cubes

To check the effect of basalt, glass and steel fibers on compressive strength of M40 grade concrete three cubes were casted for each percentage of fibers i.e.(0.25%, 0.5%, 0.75%, 1%) by total volume of concrete.

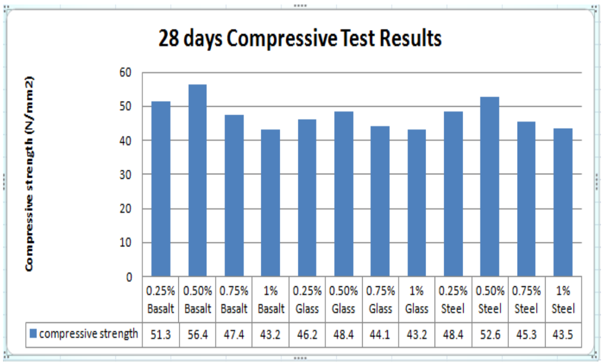

Fig. 6 testing of FRC cubes

3. CONCLUSIONS

From above test results we can conclude that for every percentage of basalt fiber i.e. 0.25%, 0.5%, 0.75%, 1% the compressive strength of basalt FRC is 51.3N/mm2, 56.4N/mm2, 47.4 N/mm2, 43.02 N/mm2 which are 16.3%,23.9%, 10.75%, 0.7% respectively more than control cube. Similarly the Flexural strength of basalt FRC is 58 N/mm2, 68N/mm2, 52N/mm2, 46.1 N/mm2 which are19.16%, 31%, 9.8%, 1%more than control beam. Similarly for every percentage of glass fiber i.e. 0.25%, 0.5%, 0.75%, 1% the compressive strength of glass FRC is 46.2 N/mm2, 48.4 N/mm2, 44.1 N/mm2, 43.2 N/mm2 which are 7.14 %, 11.36 %, 2.7%, 1% respectively more than control cube. Similarly the Flexural strength of glass FRC is 52 N/mm2, 57 N/mm2, 49N/mm2, 47 N/mm2 which are 9.08%, 17.1%, 4.24%, 0.2% more than control beam. Similarly for every percentage of steel fiber i.e. 0.25%, 0.5%, 0.75%, 1% the compressive strength of basalt FRC is 48.4 N/mm2, 52.6 N/mm2, 45.3 N/mm2, 43.5 N/mm2 which are 11.36%, 16.86%, 5.3%, 1.4% respectively more than control cube. Similarly the Flexural strength of steel FRC is 54 N/mm2, 62N/mm2, 51N/mm2, 48 N/mm2 which are 13.14%, 24.3%, 8.7%, 2.29% more than control beam.
AS per our results the maximum compressive strength is obtained for 0.5% for every fiber and among these three fibers Basalt fiber has got maximum compressive and flexural strength for 0.5%

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