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RESEARCH ARTICLE

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AN EXPERIMENTAL INVESTIGATION ON BEHAVIOR OF GLASS FIBER REINFORCED CONCRETE

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ABSTRACT

The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using fibres and other admixtures in concrete up to certain proportions. In the view of the global sustainable developments, it is imperative that fibres like glass, carbon, polypropylene and aramid fibres provide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitation, erosion resistance and serviceability of concrete.

INTRODUCTION

Concrete is the most widely used man-made construction material in the world. In the last fifty years, there has been significant progress in concrete technology, mainly owing to the revival of the interest in supplementary cementing materials, as well because of the advent of new generation chemical additives for concrete. The concrete without any fiber will develop the cracks due to plastic shrinkage, drying shrinkage and other reasons of changes in volume of concrete.

The development of these micro-cracks causes elastic deformation of concrete. Plain concrete is a brittle material and having the values of modulus of rapture and strain capacity is low. The addition of fibers in the plain concrete will control the cracking due shrinkage and also reduce the bleeding of water. Fibers help to improve the post peak ductility performance, prerace Tensile strength, fatigue strength, impact strength, and eliminate temperature.FRC are used in Civil structures where corrosion can be avoided at the maximum. Fiber reinforced concrete is better suited to minimize cavitations /erosion damage in structures such as sluice-ways, Navigational locks and bridge piers where high velocity flows are encountered. Glass fiber is Available in continuous or chopped lengths.

OBJECTIVES OF THE WORK

Main objective of this experiment investigation is found out the effect of addition of the glass fiber by volume fraction in different percentage addition of GF adopted in experiment are 0%, 0.5%, 1%, 1.5%, 2%. Workability testing operators like slump test, compaction factor operations to find slump and compaction factors. The strength characteristics like compression strength, tensile strength, flexural strength are found for different % addition of GF by volume fraction.

Mix proportion

Cement = 413.33 Kg/m3
Water = 186.00 Kg/m3
Fine aggregate = 581.23 Kg/m3
Coarse aggregate = 1118.75 Kg/m3
W/C = 0.45

M 20 was designed using IS method of mix design. The mix proportion for M 30 grade concrete
is given in the following Table

Mix proportion for M 20 Grade concrete

Sl. no	Grade of concrete	Cement	Fine aggregate	Coarse aggregate	W/C
1.	M 20	1.00	1.5	3	0.45

Mixing

Calculate the material required for 3 cubes, 3 cylinders, 3 beam and 3 shear specimen using the mix proportion by mass.

The mixing procedure was done according to following steps:

- Separately mix the cementitious materials.
- Dry mix the sand and cementitious materials and add glass fiber.
- Add coarse aggregate to it and mix it thoroughly to achieve cement particles on each and every coarse aggregate.
- Add the calculated quantity of water to the dry mix and mix thoroughly to get homogeneous mix.

Workability tests

After the mixing, following workability tests are conducted on fresh concrete.

- Slump cone test.
- Compaction factor test.

Slump cone test.

The following procedure is adopted to conduct the slump cone test.

-Place the mixed concrete in the cleaned slump cone mould in four layers. Each layers is 1/4th of the height of the mould.

-Tamp each layer with 25 blows spreading the blows uniformly over the entire surface.

-For second and subsequent layer tamping rod should penetrate to the under lying layer. Strike of the top with a trowel or tamping rod so that mould is exactly filled.

-Raise the handle of the slump cone instrument vertically and bring it on the top of the slump cone. Measure the height between the handle and top of the slump cone, note this as H1.

-Lower the handle to the sides of the slump cone and lift the cone gradually without disturbing the concrete. Concrete starts settling, as soon as the settlement stops. Raise the handle and bring it on the top of the unsupported concrete. Measure the vertical height between the handle and the top of concrete, call this as H2.

-Slump = (H2-H1) in mm.

Compaction factor test.

The following procedure is adopted to conduct the compaction factor test.

- Keep the compaction test set up on a level ground and applying grease on the inner surface of hopper and cylinder.
- Tighten the flap doors of hoppers.
- Take the empty weight of cylinder (W1).
- Fix the cylinder below the hoppers in such a way that center point of hoppers and cylinder should lie in the same vertical line.
- Fill the mixed concrete in upper hopper gently and carefully with hand without compacting.
- After two minutes release the flap door of the upper hopper so that concrete may fall in to the lower hopper bringing the concrete into standard compaction.
- As soon as concrete comes to rest in the second hopper, open the flap door of lower hopper and allow the concrete to fall in the cylinder, bringing the concrete into compaction under its free fall.
- Remove the excess concrete above the top of the cylinder by a trowel keeping the blades horizontal.
- Clear the cylinder from all the sides properly and then find the mass of partially compacted concrete, thus filled in the cylinder (W2).
- Take out all concrete from the cylinder and refill it in the cylinder in three layers. Each layer is

being compacted with a standard rod for 25 blows.

- Remove the excess concrete and level the top surface of cylinder. Take the weight of the cylinder filled with compacted concrete (W3).
- Compaction factor is obtained as follows.

$$\text{Compaction Factor} = \frac{(W2-W1)}{(W3-W1)}$$

Strength tests

Following strength tests were conducted on concrete specimens.

- Compressive strength test using 150mm X 150mm X 150mm cube.
- Tensile Strength test using 150mmϕ X 300mm cylinder.
- Flexural Strength test using 100mm X 100mm X 500mm beam.

Compressive strength test

The following procedure is adopted to conduct the Compressive strength test.

- Size of the test specimen is determined by averaging perpendicular dimensions at least at two places.
- Place the specimen centrally on the compression testing machine and load is applied continuously and uniformly on the surface perpendicular to the direction of tamping.
- The load is increased until the specimen fails and record the maximum load carried by each specimen during the test.
- Compressive stress was calculated as follows
  Compressive strength = P/A x 1000
  P = Load in KN
  A = Area of cube surface = 150 x 150 mm^2

Tensile Strength test

The following procedure is adopted to conduct the tensile strength test.

- Draw diametrical lines on two ends of the specimen so that they are in the same axial plane.
- Determine the diameter of specimen to the nearest 0.2 mm by averaging the diameters of the specimen lying in the plane of pre marked lines measured near the ends and the middle of the specimen. The length of specimen also shall be taken be nearest 0.2 mm by averaging the two lengths measured in the plane containing pre marked lines.
- Centre one of the plywood strips along the centre of the lower platen. Place the specimen on the plywood strip and align it so that the lines marked on the end of the specimen are vertical and centered over the plywood strip. The second plywood strip is placed length wise on the cylinder centered on the lines marked on the ends of the cylinder.
- Apply the load without shock and increase it continuously at the rate to produce a split tensile stress of approximately 1.4 to 2.1 $N/mm^{2/}min$, until no greater load can be sustained. Record the maximum load applied to specimen.
- Computation of the split tensile strength was as follows.

  Split tensile strength = 2P/ πdL x 1000

  Where,
  P = Load in KN
  π = 3.142
  d = Diameter of cylinder = 150 mm
  L = Length of cylinder = 300 mm

Flexural strength test

The following procedure is adopted to conduct the flexural strength test.

- Brush the beam clean. Turn the beam on its side, with respect to its position as molded, and place it in the breaking machine.
- Set the bearing plates square with the beam and adjust for distance by means of the guide plates furnished with the machine.
- Place a strip of leather or similar material under the upper bearing plate to assist in distributing the load.
- Bring the plunger of the jack into contact with the ball on the bearing bar by turning the screw in the end of the plunger.
- After contact is made and when only firm finger pressure has been applied, adjust the needle on the dial gauge to “0”.
- Here we are applying two point loading on the beam specimen, apply load till it breaks and note that as failure load.
- Computation of the flexural strength was as follows.
  Flexural strength = PL/bd^2 1000 Where,

P = Load in KN

L = Effective length of beam = 500 mm

b = Width of the beam = 100 mm

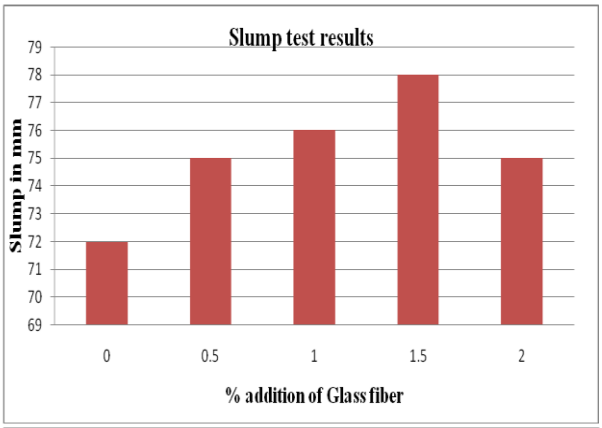
d = Depth of the beam = 100 mm

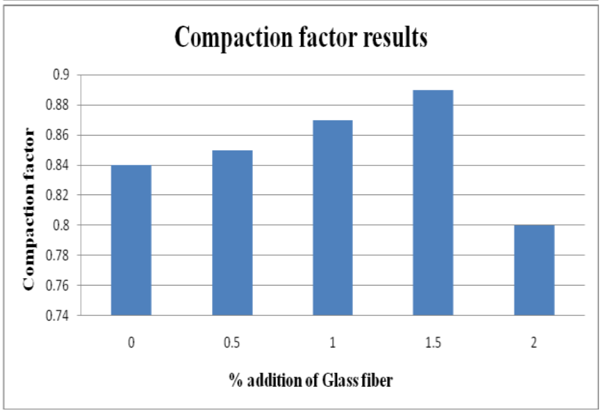
EXPERIMENTAL RESULTS

Workability test results:-Following table gives the workability test results of concrete produced by glass fiber. Variations of slump and compaction factor are depicted in the form of graph as shown in fig.

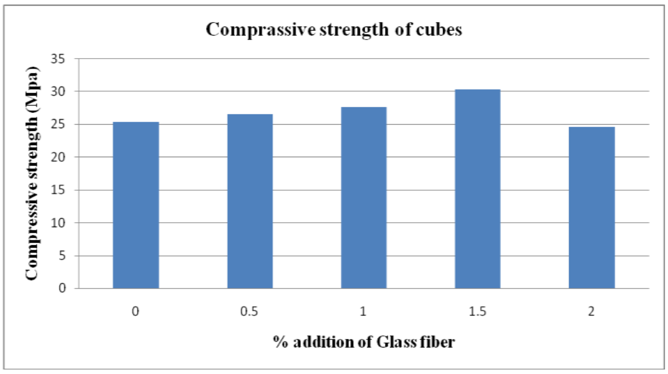
Workability test results

Percentage addition of glass fiber	Slump (mm)	Compaction factor
0%	72	0.84
0.5%	75	0.85
1%	76	0.87
1.5%	78	0.89
2%	75	0.80

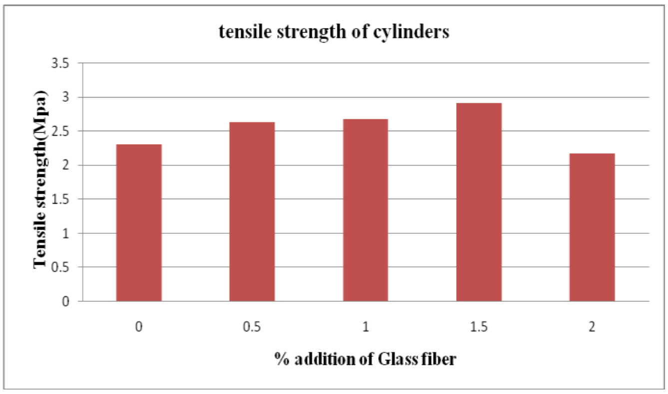




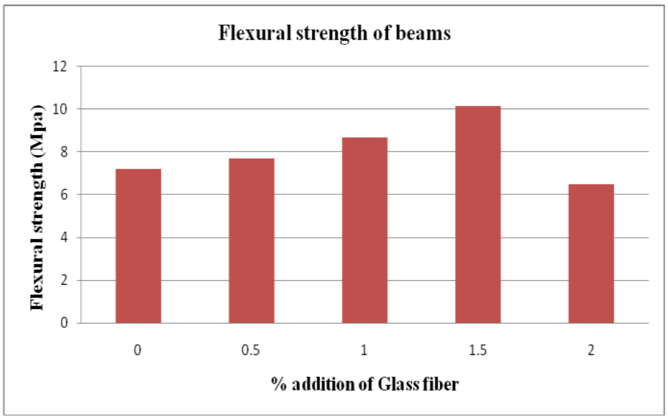
Compressive strength test results



Tensile strength test results



Flexural strength test results



CONCLUSIONS

- The workability of concrete is higher with the addition of 1.5% of glass fiber. Behind this addition level workability decreases drastically.
- The maximum compressive strength achieved is 30.22Mpa @ 1.5% glass fiber as compare to 25.57Mpa of strength of plane cement concrete.
- In general significant improvement in various strength is observed with the inclusion of glass fiber in the plane concrete.
- The maximum tensile strength achieved is 2.91Mpa @ 1.5% glass fiber as compare to
- 2.30Mpa of strength of plane cement concrete.

- The maximum flexure strength is achieved is 10.11Mpa @ 1.5% glass fiber as compare to 7.18Mpa of strength of plane cement concrete.

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