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Experimental Study on Behaviour of Steel Fiber and Glass Fiber for M-30 Grade of Concrete

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ABSTRACT— concrete is the prime material used for cement concrete road and can exhibits very high compressive strength but lower tensile strength due to internal minor cracks in concrete. Tensile forces are transferred only through the un-cracked concrete. That is the reason why concrete is weak in tension. The present work describes the experimental research on fiber reinforced concrete with M-30 grade in addition of Steel fiber and glass fiber with different percentages, to over-come the internal minor cracks in concrete. The main objective of this thesis work is to investigate the optimum percentage of Steel fiber and glass fiber on M-30 grade concrete and develop a high performance concrete. The research focused on an experimental study to determine and compare compressive strength, split tensile strength, slump value of concrete grade M-30 having different percentage of iron fiber chip and glass fiber (0%, 0.25%, 0.5%, 0.75%, 1.0%, 1.25%, 1.5%, 1.75%, 2.0%, and 2.25%). Compressive strength, increases up to 1.75% addition of Steel fiber and glass fiber then it were decreased in case of 2.0% and 2.25% were used but split tensile strength increases up to addition of 2.25% Steel fiber and glass fiber. In addition of fiber the workability of concrete was decreased. The chemical admixture is used to increase the workability of concrete.

Key words- Slump value, Steel fiber, glass fiber, Compressive streng, Split tensile strength.

1. INTRODUCTION

The Plain cement concrete has a very low tensile strength, and high compressive strength, low ductility, and less resistance to cracking. Internal cracks are inherently occur in the concrete and its poor tensile strength is due to the propagation of such internal cracks, eventually leading to measure failure of the cement concrete road. The most commonly way to eliminate this failure of concrete is to provide with high strength steel in concrete . Although these methods provide tensile strength to members of building and any other comparatively small scale structure, they however do not increase the inherent tensile strength of concrete itself. Also the reinforcement placing and efficient compaction of RCC is very difficult if the concrete is of low workable, especially in the case of mass concreting (M 30) and also to the cost becomes too high if excessive steel is used in concrete to increase the tensile strength of slabs of road. In plain concrete, structural cracks (micro-cracks) develop even before loading, particularly due to drying shrinkage or other causes of volume change like change in temperature. The width of these cracks seldom exceeds a few microns, but their two dimensions may be of higher magnitude.

When loaded, the micro cracks propagate and open up, and owing to the effects of stress concentration, additional cracks form in places of minor defects. The cracks in structure proceed slowly because they are retarded by various obstacles, changes of direction in bypassing the more resistant grains in the matrix. The development of such micro crack is the main cause deformation in concrete. It observed that the fibers in concrete will act as crack arrestors and would substantially improve its static and dynamic properties. Concrete with fiber is called fiber reinforced concrete. Glass fibers do the same effect and perform better than any other fibers. Glass Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, concrete and uniformly dispersed fibers and admixtures for concrete of grade M30 and above.

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1.1 FIBER REINFORCED CONCRETE

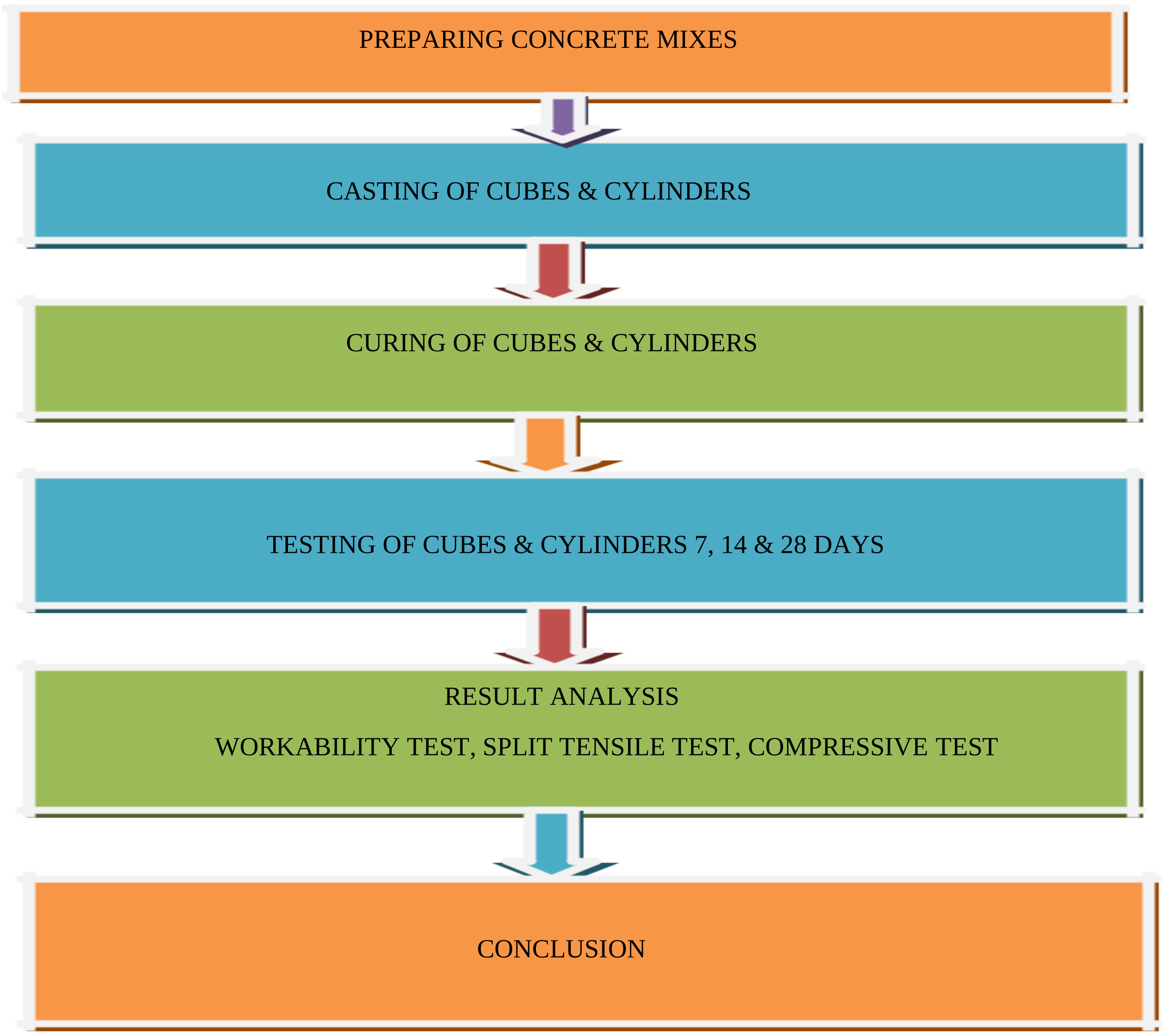
There are many way to increase the tensile strength of concrete. Many of the methods are able to make the concrete members resistant to tension, but no one increased the inherent tensile properties of plain concrete. The dispersion of fibers in concrete matrix to improve its tensile properties has been practiced worldwide over 3 past decades. The addition of small closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its tensile strength. Fiber reinforced concrete is defined as a mixture of cement, mortar, or concrete and fibers.

1.2 FIBERS USED

Every type of fiber has been mixed with cement and concrete, not all of them can be effectively and economically used. All types of fibers have some characteristic properties and limitations. Some of these can be used are steel fibers, polypropylene, nylons, asbestos.

2. EXPERIMENTAL SETUP

To achieve the stated objectives, this study was carried out in some stages. On the initial stage, all the materials and equipments needed must be gathered or checked for availability. Then, the concrete mixes are prepared according to the predefined ratio. Concrete cubes were tested through concrete tests such as cube test. Finally, the results obtained were analyzed to draw out conclusion



2.1 EXPERIMENTAL PROGRAM

MIX PROPORTION

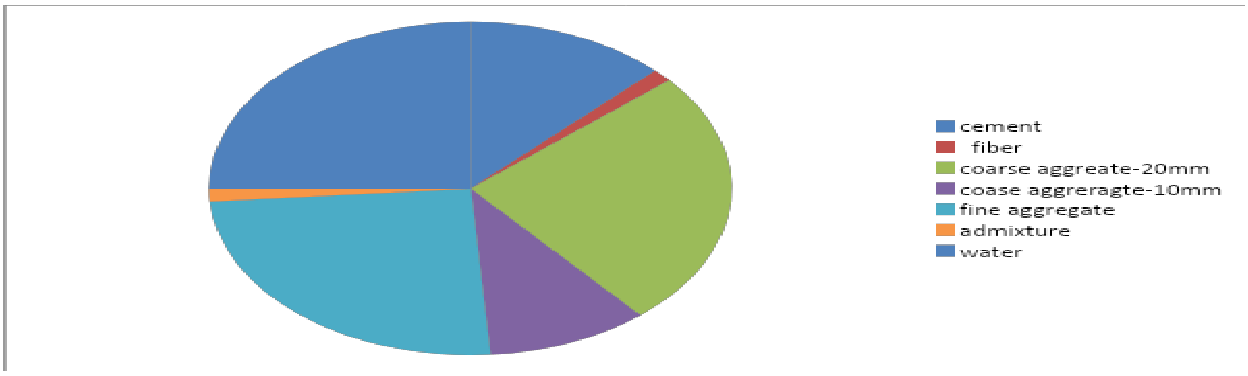


Fig 2.1 Mix proportion

Mix proportion

Mix Calculation	M-30(%in volume)
Mass of cement	12
Mass of water	16
Mass of admixture	0.16
Mass of coarse aggregate-20mm	32.04
Mass of coarse aggregate-10mm	12.50
Mass of fine aggregate	27.3
Total	100

In order to study the interaction of Steel fibers chips (chip formed) & glass fiber with concrete under compression, flexure, split tension 162 cubes, 18 beams and 18cylinders were casted respectively. The experimental program was divided into 18 groups. Each group consists of 9 cubes, one cylinders and one beams, of 15x15x15cm, 15(dia) x30cm and 15x15x70cm respectively, For concrete grade of grade M 30 with different dosages of steel fiber chips & glass fiber (0%, 0.25%, 0.5%, 1.0%, 1.25%, 1.5%,1.75%, 2.0%, 2.25%)

Fig 2.2 Dry Mixing

2.3 CASTING OF SPECIMENS:

For casting the cubes, beam specimens, standard cast iron metal moulds of size150x150 cubes, 150x150x70 mm beam moulds are used. The moulds have been cleaned of dust particles and applied with mineral oil on all sides, before the concrete is poured into the moulds. Properly mixed concrete has filled into the mould in three layers of equal heights followed by tamping to achieve compaction. After that the moulds are placed on the table vibration table for some time. With the help of trowel excess concrete is removed and top surface is finished to smooth level.

Fig 2.3 casting of cubes and cylinder

2.4 CURING:

Curing is the way of preventing the loss of water from concrete while maintaining a required temperature. After casting the cubes are stored in the laboratory and at a room temperature for 24 hours from the time at addition of water to dry ingredients. After this period the specimens are removed from the moulds immediately submerged in clean and fresh water. The specimens are cured for 28days in the present work.

2.5 CUBE COMPRESION TEST

This test was conducted as per IS 516-1959. The cubes of dimension size15 cm x15 cm x15 cm were used to find the compressive strength of concrete. Cubes were placed on the bearing surface of compression testing machine, of capacity 2000 KN and a uniform rate of loading of 5.2 KN/s was applied till the first crack in the cube. The maximum load has been noted and the compressive strength was calculated.

Fig 2.4 Compressive Strength Testing Machine

The results are tabulated. Cube compressive strength in MPa = P/A Where,

P= cube compression load

A= 150 x 150= 22500 mm^2)

2.6 SPLIT TENSILE TEST

Cylinders of size 15cm (diameter) x 30cm (height) are casted. Test is done by placing a cylindrical specimen horizontally between the loading surface of a CTM and the load is applied until the failure of the cylinder occures, along the vertical diameter. When the load is applied, an element on the vertical diameter of the cylinder is subjected to a horizontal stress of 2P/πLD.

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Fig. 2.5 Split Tensile Test machine

Here, P is the compressive load on the cylinder

L is the length of the cylinder

D is diameter of the cylinder. The main advantage of this method is that the same type of specimen and the same testing machine as used for the compression test can be employed for this test. This is why this test is gaining popularity. The splitting test is simple toper form and gives more uniform results than the other tension tests. Strength obtained in the split tensile test is assumed to be closer to the actual tensile strength of concrete, than the modulus of rupture.

2.7 Slump test

For each prepared mixes the slump cone test is performed and slump value of concrete is calculated and recorded. The various possibility of slump obtained are mentioned below-

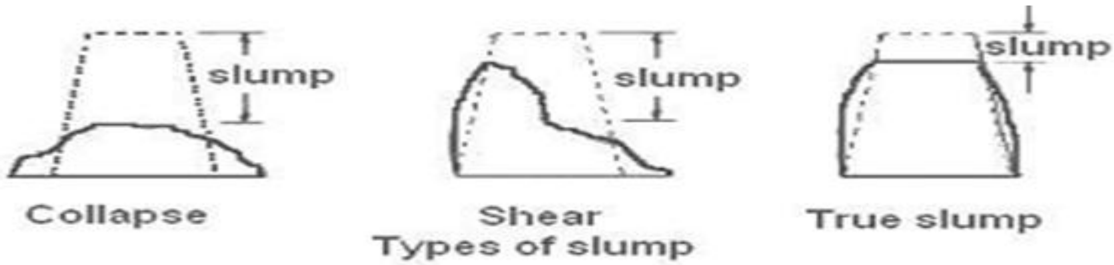
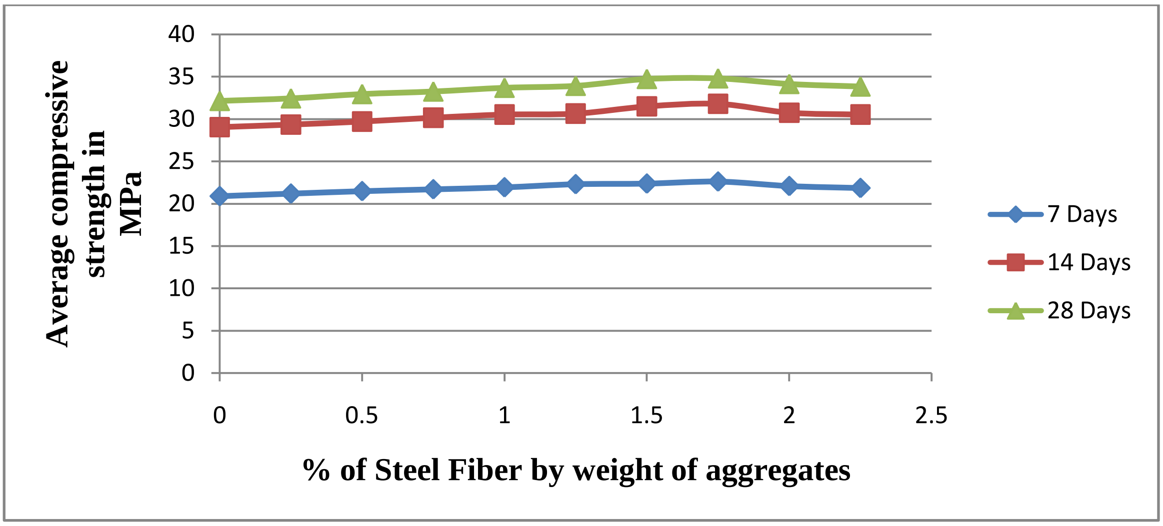


Fig. 2.6 various types of slumps

3. RESULT AND DISCUSSION

3.1 Result of cube (Grade M-30) compressive strength in MPa (Steel Fiber)

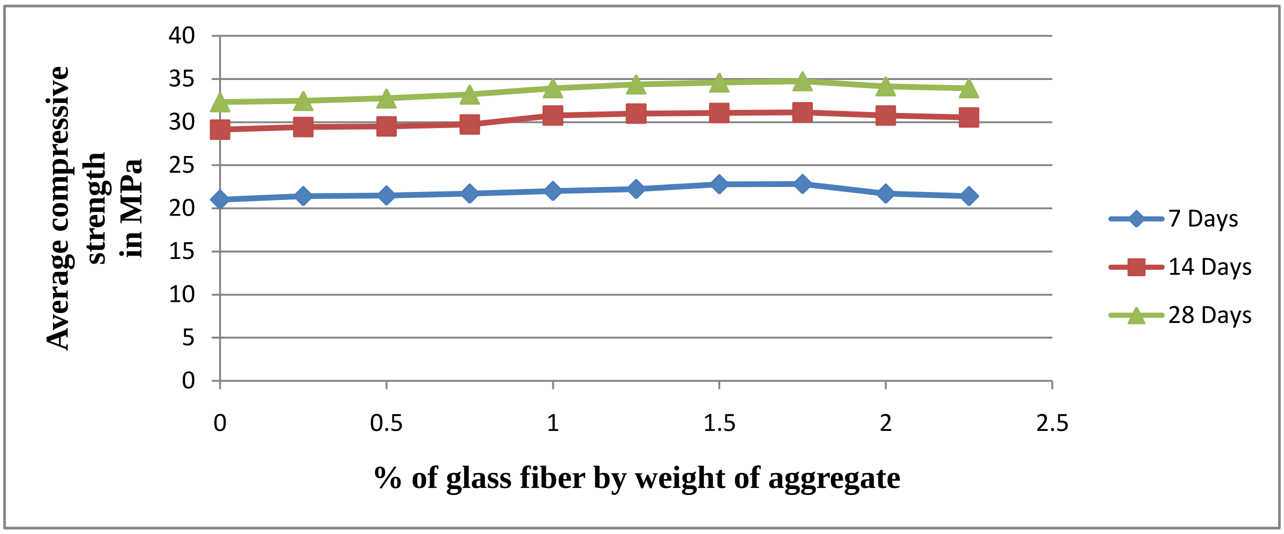
Result of compressive strength for M-30 grade of concrete on cube specimen with 0%, 0.25%, 0.5%, 0.75%, 1.0%, 1.25%, 1.50%, 1.75%, 2.0%, 2.25% steel fiber mixes are shown in table & graph below. Table-5.3 gives the compressive strength values of M-30 grade concrete and steel fiber concrete mixes and their values are observed to be varied from 20.88 to 32.14 MPa with 0% steel fiber, 21.18to 32.44 MPa with 0.25%, 21.47 to 32.95 MPa with 0.5%; 21.69 to 33.25 MPa with 0.75%, 21.92 to 33.69 MPa with 1.0%, 22.29 to 33.92 MPa with 1.25%, 22.36 to 33.76 MPa with 1.5%; 22.6 to 34.80 MPa with 1.75%, 22.07 to 34.14 MPa with 2.0%, 21.84 to 33.84 MPa with 2.25% of steel fiber of steel fiber. With addition of steel fiber compressive strength gradually increases up to 1.75% & again gradually downfall with 2.0% of steel fiber



variations in compressive strength according to % of steel fiber (Grade M-30)

3.2 Result of cube (Grade M-30) compressive strength in MPa (Glass Fiber)

Result of compressive strength for M-30 grade of concrete on cube specimen with 0%, 0.25%, 0.5%, 0.75%, 1.0%, 1.25%, 1.50%, 1.75%, 2.0%, 2.25% glass fiber mixes are shown in table & graph below. Table-5.4 shows the compressive strength values of M-30 grade concrete and glass fiber concrete mixes and their values are observed to be varied from 21.00 to 32.30 MPa with 0% glass fiber, 21.40 to 32.44 MPa with 0.25%, 21.47 to 32.73 MPa with 0.5%; 21.69 to 33.18 MPa with 0.75%, 21.99 to 33.92 MPa with 1.0%, 22.22 to 34.36 MPa with 1.25%, 22.77 to 34.98 MPa with 1.5%, 22.80 to 34.73 MPa with 1.75%, 21.69 to 34.14 MPa with 2.0% and 21.40 to 33.92 MPa with 2.25% of glass fiber. With addition of glass fiber compressive strength gradually increases up to 1.75% & again gradually downfall with 2.0% of glass fiber.



Variations in compressive strength according to % of glass fiber (Grade M-30)

Result of Cylinder (Grade M-30) split tensile strength in MPa (Steel Fiber)

Result of split tensile strength for M-30 grade of concrete on cylinder specimen with 0%, 0.25%, 0.5%, 0.75%, 1.0%, 1.25%, 1.50%, 1.75%, 2.0%, 2.25% steel fiber mixes are shown in table & graph below. Table-5.7 shows the split strength values of M-30 grade concrete and steel fiber concrete mixes and their values are observed to be varied from 3.2 MPa to 5.0 MPa from 0% up to 2.25% addition of steel fiber and this value increasing gradually up to 2.25 % of addition steel fiber.

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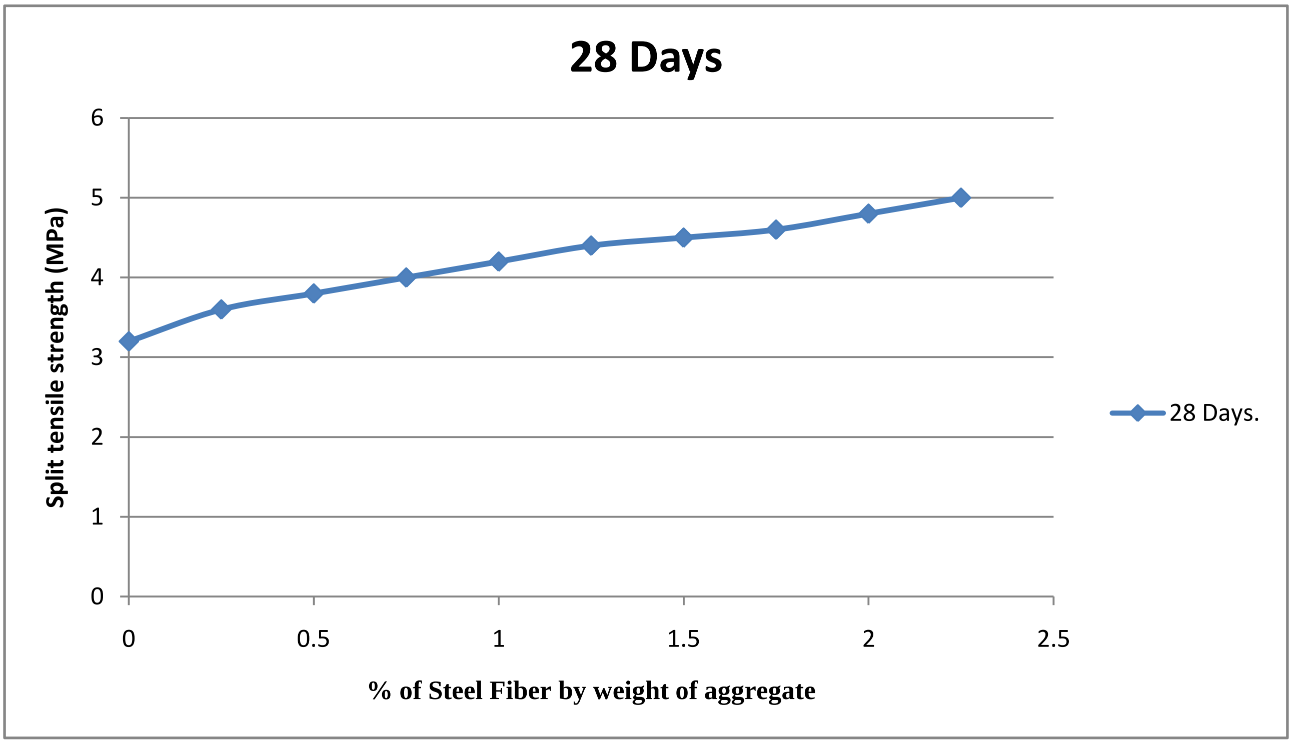
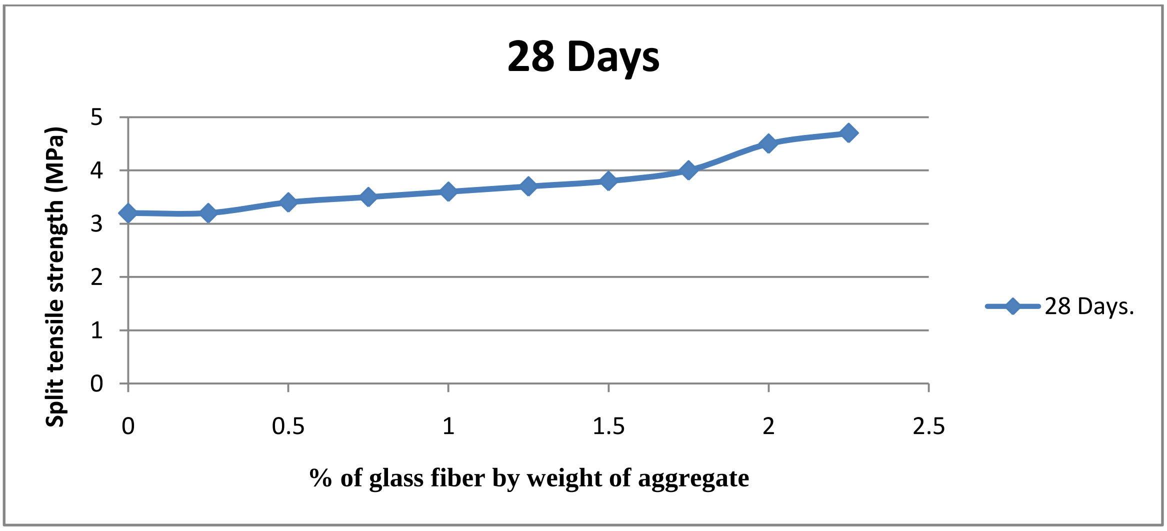


variation in split tensile strength according to % of steel fiber (Grade M-30)

3.3 Result of Cylinder (Grade M-30) split tensile strength in MPa (Glass Fiber)

Result of split tensile strength for M-30 grade of concrete on cylinder specimen with 0%, 0.25%, 0.5%, 0.75%, 1.0%, 1.25%, 1.50%, 1.75%, 2.0%, 2.25% glass fiber mixes are shown in table & graph below. Table-5.8 shows the split strength values of M-30 grade concrete and glass fiber concrete mixes and their values are observed to be varied from 3.2 MPa to 4.7 MPa from 0% to 2.25% addition of glass fiber and this value increasing gradually up to 2.25 % of addition glass fiber.



Variations in split tensile strength according to % of glass fiber (Grade M-30)

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4. CONCLUSION

Based on the experimental investigation the following conclusion is given within the limitation of the test result.

1. Addition of steel fiber and glass fiber resulted in significant improvement on the strength properties of concrete (M-30) grade.
2. Compared to plane concrete the fiber addition resulted in better strengthening (compressive and tensile) properties of concrete.
3. The reinforcing efficiency of fiber addition was dependent on the optimum dosages level of steel fiber up to 1.5% to 1.75% of fibers since increased fiber addition resulted in loss workability.
4. The reinforcing efficiency of fiber addition was dependent on the optimum dosages level of Glass Fibers up to 1.5% to 1.75% of fibers since increased fiber addition resulted in loss workability.
5. The maximum increase in compressive strength was observed of concrete grade M-30 at 1.75% of Steel fiber.
6. The maximum increase in compressive strength was observed of concrete grade M-30 at 1.75% of Glass Fibers.
7. Tensile strength is continuously increased with increasing the percentage of steel fiber and maximum tensile strength was achieved in the case of 2.25% Steel fiber for concrete of grade M-30.
8. Tensile strength is continuously increased with increasing the percentage of Glass Fibers and maximum tensile strength was achieved in the case of 2.25% Glass Fibers for grades of concrete M-30.
9. Compressive strength was decrease in case of 2% Glass Fibers and steel fiber.

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