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INVESTIGATION OF THE DISPOSITION OF BRASS LAYERED STEEL FIBER ON STRENGTH OF CONCRETE

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Abstract - The present research aims to investigate and perceive the comprehensive disposition of compressive strength of concrete reinforced with brass layered straight steel fibers with an aspect ratio of 75.Specimens were casted and tested in either case with and without fibers of 0.5% and 2%.SFRC cubes were chosen as the subject for test foe compressive strength. In all 24 SFRC cubes were casted with the standard dimension size of 150x150x150mm. For the research experiment, steel fibers were obtained for usage by tying reinforcement steel bars in the form of steel binding wires. Each wire was cut into pieces to get a proper length of 6cm; diameter of the steel fiber was 0.8mm and aspect ratio was 75.

Key Words: *Concrete, Mix Design, Fiber Reinforced Concrete, Compressive Strength,*

1. INTRODUCTION

"Concrete" is the second most broadly used material for construction after water in all over the world. The future of cement concrete application seems to be brighter not only because of its better engineering properties but also on account of its better ecology and environmental acceptance for some of the following reasons:

1. It is not only the cheapest but also the most freely available material.
2. It is plastic in nature when in the green state and can be moulded in desired shapes and sizes.
3. It has good resistance against water passage.
4. It has better ecological acceptance.

However, besides all the above merits, concrete is a combination of various micro-cracks as well as interfacial discontinuities subsequently in deficiencies such as low tensile strength, limited ductility and many more.

To overcome these deficiencies, continuous reinforcement and pre-stressing tendons have been used in concrete. The conventional reinforced concrete behaves as a two stage compound material only when concrete crashes and cracked matrix is detained in position by the bars.

1.1 STEEL FIBER REINFORCED CONCRETE (SFRC)

Steel fibers are the one which is most often and broadly used in the development of FRC as per the current scenario. Both are safe as well as economical as these are easily available and at affordable cost. Most commonly used steel fibers can either be soften extract or shear cut. Significant improvement in the structural properties can be seen due to the different shape of the fibers are made of. As SFRC have higher shear, tensile, flexural, bond and 1compressive strengths, it is always a better option for nowadays rather than conventional concrete. Also, not like conventional concrete it has higher ductility and strength. Hence, for the places like airfield pavements, beam column joints, industrial 1floors, etc.; it has more potential and that is enough for it. Due to better ductility and strength, better safety of the structures in 1earthquake prone areas will be ensured.

These fibers can either be rectangular or can also be circular in 1cross-section. The single factor defining the fiber size is the aspect-ratio which is "the ratio of length to equivalent diameter of the fiber". The aspect-ratio lies in the range of 30 to 150 especially for the steel fibers. Steel fibers can be moulded into different shapes like straight, crimped, corrugated, Duo form, etc. Steel fibers have a diameter range from 5 to 500 micron value of Young's modulus of elasticity is $2x10^5$MPa. Steel fiber expressively improves the strength of the matrix and is mainly used for crack control. Steel fibers have found broad use in cast in-situ and precast engineering application.

1.2 BRASS COATED STEEL FIBRE:

The source of the brass coated steel fiber which were collected from the fiber zone 601-B Mahalay, Opp. President Hotel, off. C.G.Road, Delhi. For uniformity of the concrete production and convenience, all the brass coated steel fiber were collected from single supplier named fibre zone, off. C.G.Road, Delhi. The diameter of the brass coated steel fiber is 0.20-0.23mm and length is about 13mm approximately.

2. OBJECTIVES

The main objectives of the present research work are to evaluate and compare the followings:

- Conventional concrete strengths at normal temperature and pressure.

- Comparison of the strength of conventional plain cement concrete to the steel fiber reinforced concrete at 7 days having different concentration.
- Comparison of the strength of conventional plain cement concrete to the steel fiber reinforced concrete at 28 days having different concentration.
- Comparison of both types of compressive strengths of concrete.

3. METHODOLOGY

A mix design of grade M 25 has been prepared with all the different proportion of the addition with % of the volume by brass coated micro steel fiber. These additions are 0.25%, 0.5%, 1%, 1.5% and 2%. A mix design with 0% (no addition) of brass coated micro steel fiber was also prepared to make a comparative analysis.

For testing of compressive strength of concrete cubes, a total 18 concrete cube with % of addition of brass coated micro steel fiber varying 0% - 2% have been prepared for 7 days testing and other 18 concrete cubes are prepared for 28 days testing. Thus, total 36 specimens of concrete cubes are prepared for this research.

3.1 TESTING PROCEDURE

Materials such as cement, sand and coarse aggregate taken by weight is thoroughly mixed in the ratio 1:1.62:2.56 (MIX DESIGN – M25) and then water is added to it with the water cement ratio 0.45.

Next, cube moulds are filled (set of 6 each) with addition of brass coated micro steel fiber with 0% , 0.25% , 0.5% , 1% , 1.5% and 2% by volume.

These cube moulds are filled in three layers with concrete and each layer is tamped 25 times by a 600mm long tamping rod of diameter 16mm. Top surface is finished with the help of a trowel.

After 24 hours, the concrete cubes are taken out from moulds and kept in water tank for 7 days and 28 days for curing respectively.

On the day of testing, cube specimens are taken out from curing tank and dried to surface dry condition and further testing of specimen in CTM is carried out for 7 days as well as for 28 days.

4. RESULTS AND DISCUSSIONS

The result of compressive strength of all specimens of different mix proportions is discussed below in this chapter. Different identification marks were used for all specimens of cubes. They are designed as following:-

1. SD-0 = Cube specimen with 0% addition by volume.
2. SD-1 = Cube specimen with 0.25% addition by volume.
3. SD-2 = Cube specimen with 0.5% addition by volume.
4. SD-3 = Cube specimen with 1% addition by volume.
5. SD-4 = Cube specimen with 1.5% addition by volume.
6. SD-5 = Cube specimen with 2% addition by volume.

These identification marks were provided with all samples for their unique identity. 3 samples of cubes were cast for 7 Days testing and 3 samples of cubes were cast for 28 Days testing. A total of 36 specimens of concrete cubes were casted for experimentation of this research.

4.1 COMPRESSIVE STRENGTH OF SD-0 MIX AFTER 7 DAYS AND 28 DAYS:

Formula used: Compressive strength = Maximum load in N/Cross sectional area in mm^2 = P/A (N/mm^2)

Compressive strength after 7 days:

1. Cube SD-0/1 = 478.12X1000/22500 = 21.25MPa
2. Cube SD-0/2 = 492.75X1000/22500 = 21.9MPa
3. Cube SD-0/3 = 518.40X1000/22500 = 23.04MPa
4. Average compressive strength =
   = (SD-0/1 + SD-0/2 + SD-0/3)/3

Average compressive strength = 22.06 MPa

4.2 COMPRESSIVE STRENGTH OF SD-1 MIX AFTER 7 DAYS AND 28 DAYS

Formula used: Compressive strength = Maximum load in N/Cross sectional area in mm^2 = P/A (N/mm^2)

Compressive strength after 7 days:

1. Cube SD-1/1 = 541.12X1000/22500 = 24.05MPa

2. Cube SD-1/2 = 562.95X1000/22500 = 25.02MPa

3. Cube SD-1/3 = 609.07X1000/22500 = 27.07MPa

Average compressive strength

= (SD-1/1 + SD-1/2 + SD-1/3)/3

Average compressive strength = 25.56 MPa

Compressive strength after 28 days:

1. Cube SD-1/4 = 852.75X1000/22500 = 37.90MPa
2. Cube SD-1/5 = 857.25X1000/22500 = 38.10MPa
3. Cube SD-1/6 = 830.25X1000/22500 = 36.9MPa

Average compressive strength

= (SD-1/4 + SD-1/5 + SD-1/6)/3

Average compressive strength = 37.54 MPa

4.3 COMPRESSIVE STRENGTH OF SD-2 MIX AFTER 7 DAYS AND 28 DAYS:

Formula used: Compressive strength = Maximum load in N/Cross sectional area in mm^2 = P/A (N/mm^2)

Compressive strength after 7 days:

1. Cube SD-2/1 = 535.50X1000/22500 = 23.80MPa
2. Cube SD-2/2 = 540.00X1000/22500 = 24.00 MPa
3. Cube SD-2/3 = 596.25X1000/22500 = 26.50MPa

Average compressive strength

= (SD-2/1 + SD-2/2 + SD-2/3) / 3

Average compressive strength = 24.97 MPa

Compressive strength after 28 days:

1. Cube SD-2/4 = 830.25X1000/22500 = 36.90MPa
2. Cube SD-2/5 = 803.25X1000/22500 = 32.80MPa
3. Cube SD-2/6 = 783.00X1000/22500 = 34.80MPa

Average compressive strength

= (SD-2/4 + SD-2/5 + SD-2/6) / 3

Average compressive strength = 35.89 MPa

4.4 COMPRESSIVE STRENGTH OF SD-3 MIX AFTER 7 DAYS AND 28 DAYS:

Formula used: Compressive strength = Maximum load in N/Cross sectional area in mm^2 = P/A (N/mm^2)

Compressive strength after 7 days:

1. Cube SD-3/1 = 650.25X1000/22500 = 28.9MPa
2. Cube SD-3/2 = 614.25X1000/22500 = 27.30MPa
3. Cube SD-3/3 = 610.42X1000/22500 = 29.60MPa

Average compressive strength

= (SD-3/1 + SD-3/2 + SD-3/3) / 3

Average compressive strength = 28.46 MPa

Compressive strength after 28 days:

1. Cube SD-3/4 = 897.75X1000/22500 = 39.90MPa
2. Cube SD-3/5 = 938.25X1000/22500 = 41.70MPa
3. Cube SD-3/6 = 958.50X1000/22500 = 42.60MPa

Average compressive strength

= (SD-0/4 + SD-0/5 + SD-0/6) / 3

Average compressive strength = 41.40MPa

4.5 COMPRESSIVE STRENGTH OF SD-4 MIX AFTER 7 DAYS AND 28 DAYS:

Formula used: Compressive strength = Maximum load in N/Cross sectional area in mm^2 = P/A (N/mm^2)

Compressive strength after 7 days:

1. Cube SD-4/1 = 578.25X1000/22500 = 25.70 MPa
2. Cube SD-4/2 = 594.00X1000/22500 = 26.40 MPa
3. Cube SD-4/3 = 614.25X1000/22500 = 27.30 MPa

Average compressive strength

= (SD-4/1 + SD-4/2 + SD-4/3) / 3

Average compressive strength = 26.56MPa

Compressive strength after 28 days:

1. Cube SD-4/4 = 875.25X1000/22500 = 38.90MPa
2. Cube SD-4/5 = 848.25X1000/22500 = 35.70MPa
3. Cube SD-4/6 = 918.00X1000/22500 = 40.80MPa

Average compressive strength

= (SD-4/4 + SD-4/5 + SD-4/6) / 3

Average compressive strength = 39.15MPa

4.6 COMPRESSIVE STRENGTH OF SD-5 MIX AFTER 7 DAYS AND 28 DAYS:

Formula used: Compressive strength = Maximum load in N/Cross sectional area in mm^2 = P/A (N/mm^2)

Compressive strength after 7 days:

1. Cube SD-5/1 = 551.25X1000/22500 = 24.50MPa
2. Cube SD-5/2 = 582.75X1000/22500 = 25.90MPa
3. Cube SD-5/3 = 614.25X1000/22500 = 27.30MPa

Average compressive strength

= (SD-5/1 + SD-5/2 + SD-5/3) / 3

Average compressive strength = 25.90Mpa

Compressive strength after 28 days:

1. Cube SD-5/4 = 852.75X1000/22500 = 37.90 MPa
2. Cube SD-5/5 = 857.25X1000/22500 = 38.10 MPa
3. Cube SD-5/6 = 882.00X1000/22500 = 39.20 MPa

Average compressive strength

= (SD-5/4 + SD-5/5 + SD-5/6) / 3

Average compressive strength = 38.40MPa

4.7 COMPARISON BETWEEN 7 DAYS AND 28 DAYS COMPRESSIVE STRENGTH

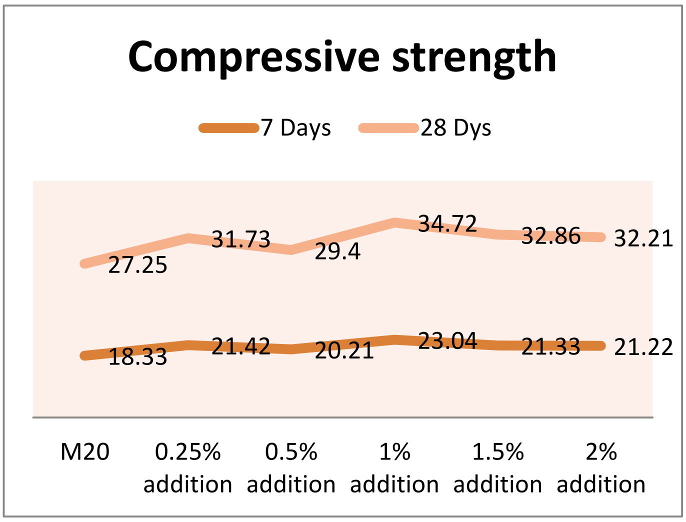

Fig.1: Showing 7&28 Days Compressive Strength Graph

The 7 days compressive strength of concrete with addition of brass coated steel fibre increases with increase in the percentage of brass coated steel fibre at some extent. The compressive strength of conventional mix SD-0 is 22.06 N/mm^2 and there is increase in compressive strength with 15.72% ,12.24% ,29% ,19.95% and 17.40% on addition of 0.25% ,0.5% ,1% ,1.5% and 2% (SD-1 ,SD-2 ,SD-3 ,SD-4 ,SD-5) mix with respect to conventional mix. With the addition of brass coated steel fibre, it increases the compressive strength continuously.

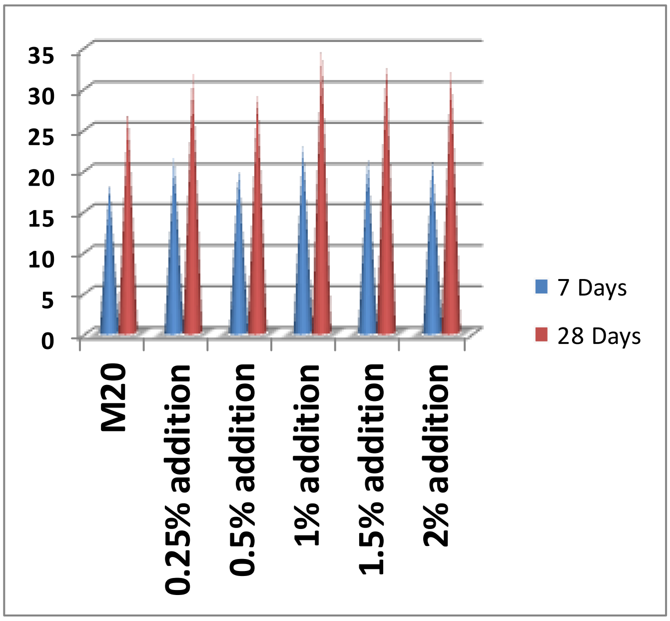

Fig.2: Showing 7 & 28 Days Compressive Strengths

The 28 days compressive strength of concrete with addition of brass coated steel fibre also increases with increase in the percentage of brass coated steel fibre at some extent. The compressive strength of conventional mix after 28 days of SD-0 is 32.26 N/mm^2 and there is increase in compressive strength with 16.64%, 10.97%, 28.33%, 21.29% and 19.03% on addition of 0.25%, 0.5% ,1% ,1.5% and 2% (SD-1,SD-2, SD-3, SD-4, SD-5) mix with respect to conventional mix. With the addition of brass coated steel fibre, it increases the compressive strength continuously and any other prepared concrete mix's compressive strength does not fall below target mean strength.

5. CONCLUSION

The 7 days compressive strength of concrete with addition of brass coated steel fibre increases with increase in the percentage of brass coated steel fibre at some extent. The compressive strength of conventional mix SD-0 is 22.06 N/mm^2 and there is increase in compressive strength with 15.72% ,12.24% ,29% ,19.95% and 17.40% on addition of 0.25% ,0.5% ,1% ,1.5% and 2% (SD-1 ,SD-2 ,SD-3 ,SD-4 ,SD-5) mix with respect to conventional mix. With the addition of brass coated steel fibre, it increases the compressive strength continuously.

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The above results conclude that 1% addition of steel fibre is optimum. Additions above 1% decrease the compressive strength continuously so it should be avoided due to boiling effect.

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