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"COMPARATIVE STUDY ON COMPRESSIVE STRENGTH & SPLITTING TENSILE STRENGTH OF FIBRE REINFORCED CONCRETE & CONVENTIONAL CONCRETE"

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Abstract –The usefulness of fiber reinforced concrete (FRC) in various civil engineering applicationsis indisputable. Fiber reinforced concrete has so far been successfully used in slabs on grade, architectural panels, precast products, offshore structures, structures in seismic regions, thin and thick repairs, crash barriers, footings, hydraulic structures and many other applications. Fiber Reinforced Concrete (FRC) is gaining attention as an effective way to improve the performance of concrete. Fibers are currently being specified in tunneling, bridge decks, pavements, loading docks, thin un-bonded overlays, concrete pads, and concretes slabs. These applications of fiber reinforced concrete are becoming increasingly popular and are exhibiting excellent performance. 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 this work presents understanding strength parameters ofindustrial crimped steel fiber, achieved high compressive and tensile strength.

Index terms: Fiber, FRC, Industrial Crimped Steel Fiber, Performance, Compressive Strength, TensileStrength

1. INTRODUCTION

1.1 GENERAL

Compared to other building materials such as metals and polymers, concrete is significantly more brittle and exhibits a poor tensile strength. Based on fracture toughness values, steel is at least 100 times more resistant to crack growth than concrete. Concrete in service thus cracks easily and this cracking creates easy access routes for deleterious agents resulting in early saturation, freeze-thaw damage, scaling,discoloration and steel corrosion.
The concerns with the inferior fracture toughness of concrete are alleviated to a large extent by reinforcing it with fibers of various materials. The resulting material with a random distribution of short, discontinuous fibers is termed fiber reinforced concrete (FRC) and is slowly becoming a well-accepted mainstream construction material. Significant progress has been made in the last thirty years towards understanding the short and long-term performances of fiber reinforced cementitious materials, and this has resulted in a few novel and innovative applications.

1.2 HISTORY OF FIBER REINFORCED CONCRETE

A French gardener by name Joseph Monier first invented the reinforced concretein the year 1849. If not for this reinforced concrete most of the modern buildings wouldnot have been standing today. Reinforced concrete can be used to produce frames, columns, foundation, beams etc. Reinforcement material used should have excellent bonding characteristic, high tensile strength, andgood thermal compatibility. Reinforcement requires that there shall be smooth transmission of load from the concrete to the interface between concrete and reinforcement material and then on to reinforcement material. Thus, the concrete and the material reinforced shall have the same strain.

Hence concrete is very well suitable for a wide range of applications. However,concrete has some deficiencies as listed below:

1. Low tensile strength
2. Low post cracking capacity
3. Brittleness and low ductility
4. Limited fatigue life
5. Incapable of accommodating large deformations.
6. Low impact strength

A major advantage of using fiber reinforced concrete besides reducing permeability and increasing fatigue strength is that Fiber addition improves the toughness or residual load carrying ability after the first crack. Additionally, a few studies have shown that the impact resistance of concrete can also improve dramatically with the addition of fibers.
Concrete containing cement, water, aggregate, and discontinuous, uniformly dispersed or discrete. fibers are called fiber reinforced concrete.
It is a composite obtained by adding a single type or blend of fibers to the conventional concrete mix. Fibers can be in the form of steel fibers, glass fibers, natural fibers, synthetic fibers, etc.
The use of fibers goes back at least 3500 years, when straw was used to reinforced sun baked bricks in Mesopotamia. Horsehair was used in mortar and straw in mud bricks. Asbestos fibers wereused in concrete in the early 1900. In the 1950s, the concept of composite materials came into picture. Steel, Glass and synthetic fibers have been used to improve the properties of concrete for thepast 30 or 40 years. Research into new fiber-reinforced concretes continues even today.

1.3 FRC

Concrete containing cement, water, aggregate, and discontinuous, uniformly dispersed or discrete fibers is called **Fiber Reinforced Concrete**.

Main role of fibers is to bridge the cracks that develop in concrete and increase the ductility of concrete elements. There is considerable improvement in the post- cracking behavior of concrete containing fibers due to both plastic shrinkage and drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater abrasion and shatter resistance in concrete. It Imparts more resistance to Impact load.

Different types of Fibers:

SFRC - Steel fiber reinforced concrete
GFRC – Glass fiber reinforced concrete
SNFRC- Synthetic fiber reinforced concrete
NFRC - Natural fiber reinforced concrete.

2. MATERIALS AND METHODOLOGY

2.1 INDUSTRIAL CRIMPED STEEL FIBER

Industrial Crimped Steel Fibers (ICSF): Shaktiman Crimped Steel Fiber in Size MSC 4535 (cold drawn type from mild steel wire) for general engineering purpose conforming to ASTM A82O I EN 14889-1. **Aspect ratio of 77.78**, **length 35mm diameter 0.45mm** and **specific gravity 7.85 Fig(1).**

Fig(1)

2.1 FINE AGGREGATE

Observation	Trial 1	Trial 2	Trial 3
Weight of Pycnometer W1 (g)	616	612	616
Weight of Pycnometer +FineAggregate W2 (g)	1048	1032	1045
Weight of Pycnometer +Fine Aggregate+ water W3 (g)	1772	1748	1764
Weight of Pycnometer+Water W4 (g)	1500	1498	1500
Specific gravity (w2-w1)/[(w2-w1) -(w3-w4)]	2.73	2.87	2.66

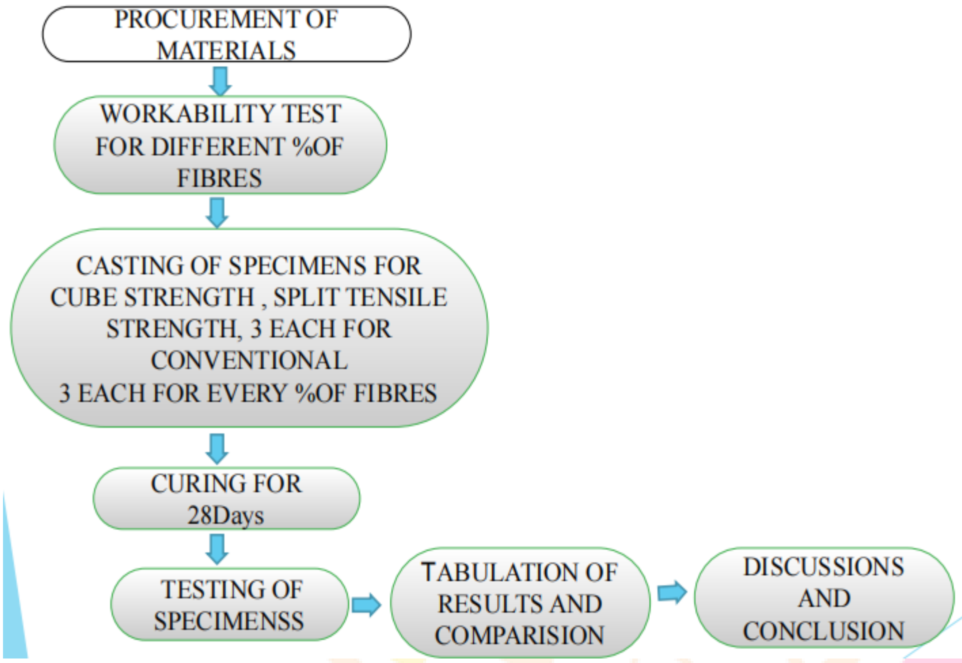
The specific gravity of fine aggregate is **2.6**.

2.2 COARSE AGGREGATE

Observation	Trial 1	Trial 2	Trial 3
Weight of Pycnometer W1 (g)	616	612	616
Weight of Pycnometer + coarse Aggregate W2 (g)	1007	1020	1013
Weight of Pycnometer +coarse Aggregate+ water W3 (g)	1753	1765	1748
Weight of Pycnometer+ Water W4(g)	1500	1498	1500
Specific gravity (w2-w1)/[(w2-w1) -(w3-w4)]	2.83	2.87	2.66

Specific gravity of coarse aggregate is **2.78.**

2.3 METHODOLOGY

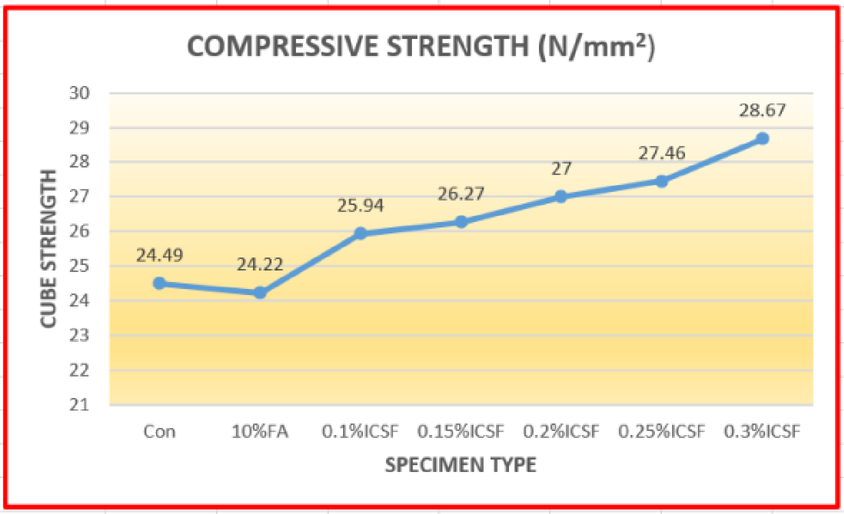


3. TESTS AND RESULTS

3.1 COMPRESSIVE STRENGTH

Fig(2)

Specimen No	Conventional	10% replacementof Fly ash	0.1% ICSF	0.15% ICSF	0.2% ICSF	0.25% ICSF	0.3% ICSF
1	25.40	24.53	25.96	25.76	26.57	27.23	28.15
2	24.75	24.12	26.13	26.32	26.97	27.27	28.76
3	23.32	24.00	25.74	26.74	27.46	27.87	29.10
AVG	24.49	24.22	25.94	26.27	27.00	27.46	28.67



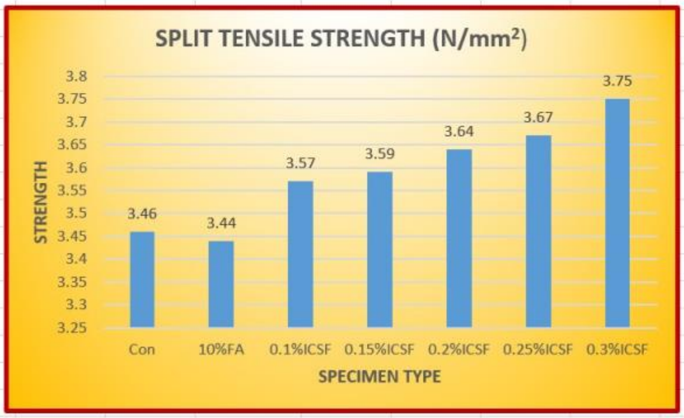
Percentage increase in compressive strength:

$$((28.67 - 24.22) / 24.22) \times 100 = \underline{\mathbf{18.37}}\%$$

3.2 SPLIT TENSILE STRENGTH

Fig(3)

Specimen No	Conventional	10% replacementof Fly ash	0.1% ICSF	0.15% ICSF	0.2% ICSF	0.25% ICSF	0.3% ICSF
1	3.53	3.47	3.57	3.55	3.61	3.65	3.71
2	3.48	3.44	3.58	3.59	3.64	3.66	3.75
3	3.38	3.43	3.55	3.62	3.67	3.70	3.78
AVG	3.46	3.44	3.57	3.59	3.64	3.67	3.75



Percentage increase in splitting tensile strength

((3.75 – 3.44) / 3.44) x 100 = **9.01** %

3.3 DISCUSSIONS

- Aspect ratio & percentage of fiber plays a role in improving Compressive &Splitting Tensile Strength
- Can expect improvement in Compressive & Splitting Tensile Strength for aspect ratioup to 50.
- Can expect improvement in Compressive & Splitting Tensile Strength for percentageof fiber beyond 0.3%.
- Care should be taken to maintain the workability of concrete.
- Admixtures can be used to improve workability without adding extra water.

4. CONCLUSION

- Compressive strength increased as the percentage of fibers increased
- Tensile strength increased as the percentage of fibers increased.
- There is no much difference in strength by the replacement of 10% fly ash.
- Use of fly ash makes the concrete economical.
- There is a continuous increase in strength parameters by increase in the percentage offiber from 0.1 -0.3 %.
- Workability reduces by increasing percentage of fiber, hence care should be taken tomaintain workability.
- Increase in strength parameter improves limit state of serviceability, prevents cracks, hence prevents corrosion.
- Future scope of this work is can find strength parameters for optimum dosage offiber content and fly ash.

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