REVIEW ON FIBRE REINFORCED CONCRETE- A CASE STUDY

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ABSTRACT - *The helfulness of fiber reinforced concrete (FRC) in various civil engineering applications is indisputable. Fiber Reinforced Concrete (FRC) is gaining consideration as an effective way to improve the performance of concrete. Fibers are currently being specified in tunneling, bridge decks, pavements, docks, thin unbounded 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 growths its structural integrity. It contains short discrete fibers that are evenly distributed and randomly oriented. Fibers contain steel fibers, glass fibers, synthetic fibers and natural fibers.*

This study presents thoughtful strength of fiber reinforced concrete. Mechanical properties and durability of fiber reinforced concrete.

Key Words:

1. INTRODUCTION

Compared to other building materials such as metals and polymers, concrete is meaningfully more brittle and exhibits a poor tensile strength. Based on fracture toughness values, steel is at least 65 times more resistant to crack growth than concrete. Concrete in service thus cracks simply and this cracking makes easy access routes for deleterious agents resulting in early saturation, freeze-thaw damage, scaling, discoloration and steel corrosion.

The disquiets 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 circulation 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 cementations materials, and this has resulted in a number of novel and innovative applications.

Concrete is one of the most adaptable building materials. It can be cast to fit any structural shape from a cylindrical water storage tank to rectangular beam or column in a high rise building. The advantages of using concrete involve high compressive strength, good fire resistance, high water resistance, low maintenance, and long service life.

The disadvantages of using concrete involve poor tensile strength, low strain of fracture and formwork requirement. The major drawback is that concrete develops micro cracks during curing. It is the rapid broadcast of these micro cracks under applied stress that is responsible for the low tensile strength of the material. Hence fibers are added to concrete to overcome these disadvantages.

2. LITERATURE REVIEW

Zoran J. Grdic et al. (2012): The authors concluded that: Abrasive resistance of concrete is reduced with the increase of water/cement ratio from 0.5 to 0.7 which is reflected in the increase the addition of fibers increases tensile strength across the whole range of W/C factors from 0.5 to 0.7 in respect to the benchmark concrete. The concretes with extreme compressive and tensile strength (at bending) have higher abrasive resistance, so these limits may serve as indicators of the abrasive–erosive resistance of concrete. The polypropylene fibrillated fibers verified better in respect to the monofilament fibers in terms of abrasive– erosive resistance of concrete.

S.Sharmila et al. (2013): The authors indicated that: The effect of adding hybrid fibers influence the behavior of beams by increasing the ductility characteristics by 80% and energy absorption characteristics by more than 160%. Instead of adding single fiber, the combination of different types of fibers (Hybrid fibers) increases the energy absorption capacity substantially.

Gurunathan k et al. (2014): The authors conversed that the tallying of polypropylene fibers, reckons fibers, fly ash and silica fume in different concrete mixes marginally improve the compressive strength at 28 days. The least percentage of fly ash and silica fume were added in concrete so that the presentation of the concrete increases. There is an increase from 3% to 9% in split tensile strength for all fiber mixes when equated with that of control mix. Then from the test results the authors determined that the volume fraction of hybrid fiber concrete.

D. Chaitanya Kumar (2016): Study where carried out using an M20 grade of concrete and glass fiber is added as 0.5%, 1%, 2%, and 3%. And the specimens are cast for a compressive and tensile test of the concrete. In this experiment, concrete achieves strength when 2% of the fiber is added to the concrete and when 3% fiber is added to the concrete the strength of concrete declines. When the fiber is added 2% the strength of the concrete attains 26.98 Mpa of compressive strength, 2.94 Mpa of Flexural Strength and 3.57 Mpa of the Tensile strength of the concrete after 28 days of curing. In this experiment, the author mentioned that the work ability of the concrete is increased and thus the glass fiber reduces the crack under different loading.

Majid Ali: He studied the mechanical and dynamic properties of coconut fiber reinforced concrete (CFRC). He investigated then the mix proportions of 2%, 3% and 5% fiber contents by mass of cement and fiber lengths of 2.5, 5 and 7.5 cm is investigated. Noor Md. Sadiqul Hasan, etc. They have investigated the physical and mechanical characteristics of concrete after adding coconut fiber on a volume basis.

Mahyuddin Ramli: Studied the strength and durability of coconut fiber reinforced concrete in aggressive environments. The aim was to reduce the enlargement of cracks in structures by introducing coconut fibers. Domke P. V et.,(4) had investigated the use of natural and agricultural waste products like coconut fibers and rice husk ash to enhance the properties of concrete and their studies describes the strength of the concrete.

Foti (2013): Investigate use of different forms of reinforcements with pet bottle viz circular fibers, half bottles and rectangular strips. The tests resulted in high concrete PET adherence. Further, more ductile behavior was observed when subjected to bending load.

Ramadevi and Manju (2012): Examined the impact of 0.5%, 1%, 2%, 4% and 6% replacement of fine aggregates with ground pet fibers. Pet bottles were first shredded into flakes and subsequently ground. Optimal compressive strength, split tensile strength and flexural strength was recorded on 2% replacement.

Safinia and Alkalbani (2016): Compared the compressive strength of concrete blocks with empty 500ml PET bottles placed in between to that of hollow concrete blocks procured from a local market. Concrete specimen with bottles resulted in an increase of 57% as compared to hollow concrete block from market.

Asha and Resmi (2015): Checked strength of concrete by replacing cement in dry mix by 0.5%, 1% and 1.5% plastic fibers. Straight and crimped fibers were used in different specimens. Both types of fibers gave optimal results at 1% fiber. For straight fibers compressive and tensile strength increased by 16% and 37% respectively on the other hand, for crimped fibers there was increase of 18% and 42% in compressive and split tensile strength.

3. PROCEDURE AND METHODOLOGY

The concrete mix (M20) used for casting the specimens contained 0.27kg/m^3 of cement, 0.41kg/m^3 of sand, and 0.81kg/m^3 for the 1 cube sample specimen.
After concrete mixing the fiber reinforced concrete was mould into 5 samples of cube 150mm x 150mm x 150mm for the tests. Cubes are cast for each type of fiber.

After the completion of 48 hours, the sample specimens were de-moulded and were cured in curing tank with maintained temperature of 30^{0}C and 75-100% relative humidity for next 28 days.

3.1 Mixture Compositions and Placing

The mix should have a uniform scattering of the fibers in order to prevent segregation or balling of the fibers during mixing. Most balling occurs during the fiber addition process. Increase of aspect ratio, volume percentage of fiber, and size and quantity of coarse aggregate will strengthen the balling tendencies and decrease the workability. To coat the large surface area of the fibers with paste, experience focused that a water cement ratio between 0.4 and 0.6, and minimum cement content of 400 kg/m3 are required.

Associated to conventional concrete, fiber reinforced concrete mixes are generally characterized by cement factor, fine aggregate content and coarse aggregate. A fiber mix usually requires more vibration to associate the mix. External vibration is preferable to prevent fiber segregation. Metal trowels and rotating power floats can be used to close the surface. High aspect ratio was found to have improved effectiveness. It was revealed that for the same length and diameter, crimped-end fibers can achieve the same possessions as straight fibers using 40 percent less fibers. In defining the mechanical properties of FRC, the same equipment and procedure as used for conventional concrete can also be used.

3.1.1 Compressive Strength:

The presence of fibers may alter the failure mode of cube, but the fiber effect will be minor on the improvement of compressive strength values (0 to 15 percent).

3.1.2 Modulus of Elasticity:

Modulus of elasticity of FRC evolutions marginally with an increase in the fibers content. It was introduce that for each 1 percent increase in fiber content by volume there is an growth of 3 percent in the modulus of elasticity.

3.1.3 Flexure:

The flexural power was reported to be increased by 2.5 times using 4 percent fibers.

3.1.4 Toughness:

For FRC, hardness is about 10 to 40 times that of plain concrete.

3.1.5 Impact Resistance:

The impact power for fibrous concrete is generally 5 to 10 times that of plain concrete depending on the volume of fiber.

3.1.6 Corrosion of Steel Fibers:

Corrosion was found to be restrained only to fibers actually showing on the surface. Steel fibrous mortar constantly submerse in seawater for 10 years revealed a 15 percent loss compared to 40 percent strength decrease of plain mortar.

3.1.7 Structural Behavior of FRC:

Fibers merged with reinforcing bars in structural members will be generally used in the future
The following are some of the structural behavior:

3.1.8 High Strength Concrete:

A fiber increases the ductility of high strength concrete. The use of extreme strength concrete and steel produces slim members. Fiber adding will help in leading cracks and deflections.

3.1.9 Cracking and Deflection:

Tests have shown that fiber reinforcement well controls cracking and deflection, in addition to strength development. In traditionally reinforced concrete beams, fiber addition increases stiffness, and reduces deflection.

3.2 Steel Fiber Reinforced Concrete

Steel fiber-reinforced concrete is mostly a cheaper and easier to use form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are placed within the liquid cement, which requires a great deal of work but make for a much stronger concrete. Steel fiber-reinforced concrete uses thin steel wires hybrid in with the cement. This imparts the concrete with greater structural strength, reduces cracking and helps protect against intense cold. Steel fiber is often used in aggregation with rebar or one of the other fiber types.

Fig -1: Steel Fibers

3.3 Glass Reinforced Concrete

Glass fiber-reinforced concrete practices fiberglass, much like you would find in fiberglass insulation, to reinforce the concrete. The glass fiber helps protect the concrete in addition to making it stronger. Glass fiber also helps avert the concrete from cracking over time due to mechanical or thermal stress. In addition, the glass fiber does not inhibit with radio signals like the steel fiber reinforcement does.

Fig -2: Glass Fibers

3.4 Synthetic Reinforced Concrete

Synthetic fiber-reinforced concrete practices plastic and nylon fibers to progress the concrete's strength. In addition, the synthetic fibers have a number of welfares over the other fibers. While they are not as strong as steel, they do help improve the cement pump ability by keeping it from sticking in the pipes. The synthetic fibers do not swell in heat or contract in the cold which helps avoid cracking. Finally synthetic fibers help keep the concrete from spilling during impacts or fires.

Fig -3: Synthetic Fibers

3.5 Natural Fiber Reinforced Concrete

Fiber-reinforced concrete have used natural fibers, such as coconut fiber. While these fibers benefit the concrete's strength they can also make it weaker if too much is used. In addition, if the natural fibers are decomposing when they are mixed in then the rot can continue while in the concrete.

4. EXPERIMENTAL STUDY:

The materials used and their specifications are as follows:

CEMENT: Ordinary Portland cement was utilized and its specific gravity is 3.15*. The creation used was "UltraTech" with 53 grades.

FINE AGGREGATE: River sand was used and tests were conducted. Specific gravity of fine aggregate is 2.65. Water absorption is 0.99%.

COARSE AGGREGATE: Crushed granite stone aggregates of maximum size of 20 mm were used tests were conducted Specific gravity of coarse aggregate is 2.73. Water absorption is 0.25%.

WATER: Potable water was used for mixing of concrete as pr IS 456-2000 recommendations.

5. CASTING OF SPECIMENS

The materials were weighed accurately using a digital the mixture machine and mixed thoroughly for three minutes. Steel fibers were mechanically sprinkled inside the mixture machine after thorough mixing of the ingredients of concrete. For preparing the specimen for compressive, tensile, and flexure strength permanent steel moulds were used.

5.1 Casting of cubes
Steel moulds

Steel moulds were fabricated to cast the test specimens for panel testing. Five steel moulds were fabricated to facilitate simultaneous casting of test panels. Two different layers were adopted for the moulding; the panel sizes adopted was 150×150×150 mm.

Before integration the concrete the moulds were kept ready. The sides and the bottom of the all the mould were properly oiled for easy demoulding. The panel was kept at an angle of 45° and then the concrete was splashed over the panel from a distance of one meter. Then the top surface was given a uneven finish.

Fig -4: Casting by Steel Moulds

5.2 CURING OF SPECIMENS

The test specimens were stored in place free from vibration and kept at a temperature of 27°±2°C for 24 hours ± ½ hour from the time of addition of water to the dry ingredients. After this period, the specimen were marked and removed from the moulds and immediately submerged in clean fresh water and kept there until taken out prior to test. The specimens were allowed to become dry before testing. The panels were cured by dry curing method, i.e. moist gunny bags were covered over the panels.

Table -1: Compressive Strength

AVERAGE COMPRESSION STRENGTH IN KN/SQMM			
Specimen Type	**3 Days**	**7 Days**	**28 Days**
PCC	25.27	39.59	59.89
HSFRC 0.5%	24.50	37.29	58.24
CSFRC 0.5%	27.38	39.76	58.43
HSFRC 1%	26.32	38.48	59.01
CSFRC 1%	40.35	32.17	60.00

It shows compressive strength for fiber reinforced concrete. It can be clearly seen that strength at 28 days for CSFRC 1% is better than other cases hence recommended.

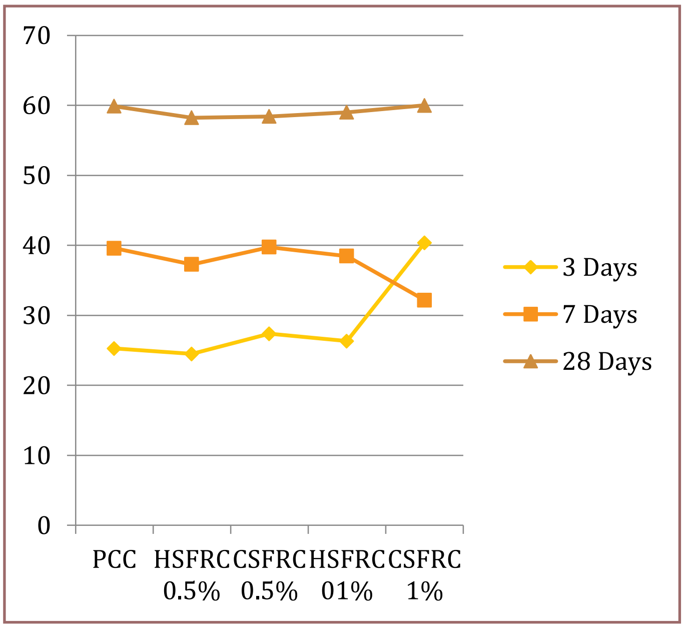

Fig -5: Graphical representation of compressive strength of fiber reinforced concrete

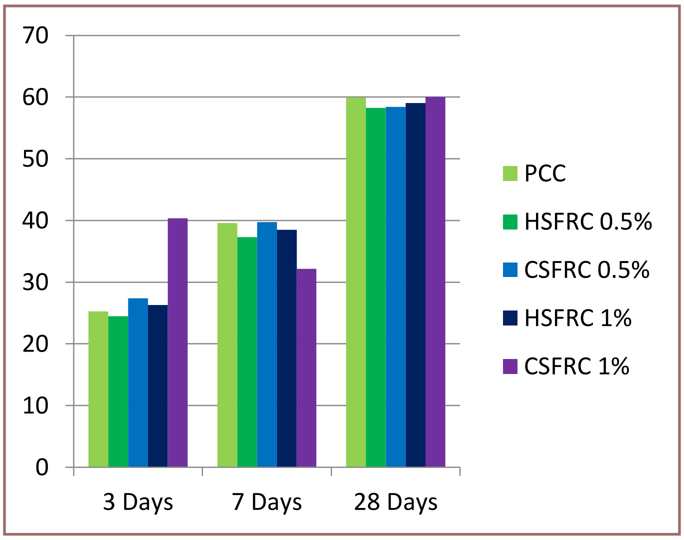

Fig -5: Bar Chart of compressive strength

6. Benefits of Fiber Reinforced Concrete

- Main role of fibers is to bridge cracks that develop in concrete and increase the ductility of concrete elements.
- Improvement on Post-Cracking Behavior of concrete
- Imparts more resistance to Impact Load
- Controls drying shrinkage cracking
- Reduces the permeability of concrete matrix and thus reduce the bleeding of water.

7. CONCLUSION

The efficient utilization of fibrous concrete involves improve static and dynamic properties like tensile strength, energy absorbing characteristic, Impact strength and fatigue strength. Also provide likely to replace the conventional structural concrete in total.

The significant increase in compressive and tensile strength is observed with the addition of glass, coconut, plastic, synthetic fiber in plain concrete. The strength properties are not common in the conventional concrete. It will, however be wrong to say that fibrous concrete will provide a universal solution to the problem associated with plain concrete.

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