Enhancing Flexural Properties of Concrete Using Steel and Carbon Fiber Composite Reinforcement

Meera.M[1], A.Thangadurai[2]
[1]MEStudent, JCT, AnnaUniversity, India
[2]Asst.Professor, JCT, AnnaUniversity, India

Abstract— The main disadvantage of the plain concrete is its brittle character. Fibers are introduced into the concrete to make them ductile and such concrete is called fiber reinforced concrete. In this study, steel fibre and carbon fibre are used. Steel fiber-reinforced concrete is basically a cheaper and easier to use form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are laid within the liquid cement, which requires a great deal of preparation work but make for a much stronger concrete. Steel fiber-reinforced concrete uses thin steel wires mixed in with the cement. This imparts the concrete with greater structural strength, reduces cracking and helps protect against extreme cold. Steel fiber is often used in conjunction with rebar or one of the other fiber types.Different types of steel fibres- straight steel fibre, hooked ends steel fibres, round crimped steel fibres, flat corrugated steel fibres.here we are using crimped steel fibre. Carbon fibers are a type of high-performance fiber available for civil engineering application. It is also called graphite fiber or carbon graphite. Carbon fiber consists of very thin strands of element carbon. Carbon fibers have high tensile strength and are very strong foe their size. In fact, carbon fiber might be the strongest material. Each fiber is 5-10 microns in diameter. Carbon fibers have high elastic modulus and fatigue strength than those of glass fibers. Considering service life, studies suggests that carbon fiber reinforced polymers have more potential than glass fibers. They are inert, medically safe and stronger than steel fibers and more chemically stable than glass fibers in an alkaline environment. The main aim of the present experimental investigation is to use different volume fractions of carbon fiber(PAN TYPE) and continuously crimped steel fibers to produce HFRC and thus to evaluate its performance under compression, tension, flexure, shear and impact types of loading.

Index Terms— Hybrid Fiber Reinforced Concrete, steel fibers, carbon fibers, PAN TYPE, compression, tension, flexure.

1 Introduction

The concept of using fibers or as reinforcement is not new. Fibers have been used as reinforcement since ancient times. In the 1900s, asbestos fibers were used in concrete. In the 1950s, the concept of composite materials came into being and fiber-reinforced concrete was one of the topics of interest. Once the health risks associated with asbestos were discovered, there was a need to find a replacement for the substance in concrete and other building materials. By the 1960s, steel, glass (GFRC), and synthetic fibers such as polypropylene fibers were used in concrete. Research into new fiber-reinforced concretes continues today.Fibers are introduced into the concrete to make them ductile and such concrete is called fiber reinforced concrete.

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 – each of which lead varying properties to the concrete. In addition, the character of fiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation, and densities. Research into new fiber-reinforced concretes continues today.

A Hybrid Fiber Reinforced Concrete (HFRC) is formed from a combination of different types of fibers, which differ in material properties, remain bonded together when added in concrete and retain their identities and properties.

2 Objective

1. To prepare M25 grade conventional concrete mix and to test the specimens for mechanical properties
2. To study the flexural properties of HFRC with steel fibres and carbon fibres
3. To compare flexural strength of steel fiber reinforced concrete with HFRC.

3 MATERIALS

1. Cement

Ordinary Portland cement of 53 grade available in local market

Conforming to IS269-1976 and IS4031-1968 is used in investigation.

2. FineAggregate

Locally available clean, well graded M-sand was used as fine aggregate. The size of manufactured sand (M-Sand) is less than 4.75 mm. It has cubical or rounded shape with smooth surfaceTexture

3. CoarseAggregate

Crushed granite angular aggregate of size 20 mm nominal used.

4. Water

Water used should be free from impurities. Water from college water supply system was used for both concreting and curing **purposes.**

5. Steel fibre

Crimped steel fibres were used in this investigation. Steel fibres were added as a volume fraction with respect to the volume of concrete. The features imparted on addition of steel fibers are improved structural strength, reduced steel reinforcement requirements, improved ductility, reduced crack widths and control of crack width thus improving durability, improved impact & abrasion resistance

6. Carbon fibre

Carbon fibre used was of PAN type. They were used to replace the optimum steel fibre dosage by volume fraction of concrete. 10 mm length 7micron diameter with aspect ratio of 666.67

4 FLEXURAL STRENGTH

Beam tests are found to be dependable to measure flexural strength property of concrete. Beam specimens of size 100mm x 100mmx 500mm were tested for determining the flexural strength. Two-point loading was applied and breaking load was noted. The flexural strength was determined after 28 day curing. Flexural strength values for SFRC beam of size 100 x100 x500 mm on 28 day are shown in table 1 and fig 1

TABLE 1 FLEXURAL STRENGTH OF SFRC

Specimens	28th day flexural strength (N/mm^2)
Conventional concrete	5.56
SFRC-0.25% steel	6.00
SFRC-0.50%steel	6.10
SFRC-0.75%steel	6.60
SFRC-1.00%steel	6.66
SFRC-1.25%steel	6.90

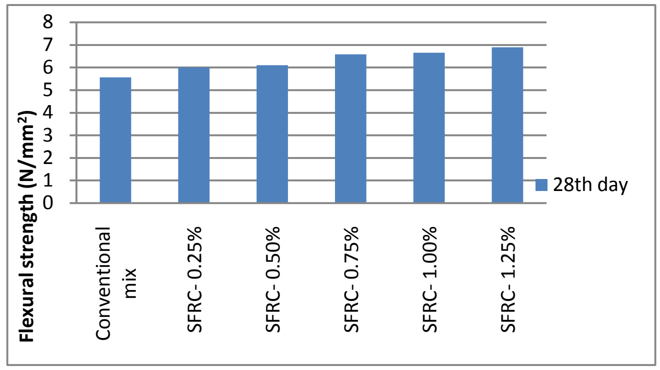

FIG 1 FLEXURAL STRENGTH VARIATION OF SFRC

From the result and fig 1 it is clear that flexural strength of SFRC is higher than conventional concrete.

While incorporating, the flexural strength is tested for 28 days. The results are shown in table 2 and fig 2.

TABLE 2 FLEXURAL STRENGTH OF HFRC

Specimen	28th day flexural strength (N/mm^2)
HFRC-S75C25	7.4
HFRC-S50C50	7.5
HFRC-S25C75	7.22
HFRC-S0C100	6.2

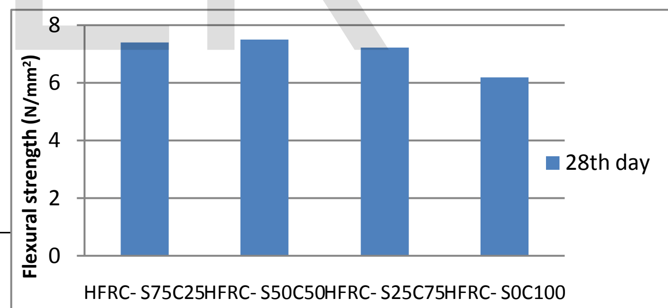

FIG 2 FLEXURAL STRENGTH VARIATION OF HFRC

For hybrid fibre combination, from fig 2 and results the flexural strength increased with reference to SFRC mix.

4 CONCLUSION

The main objective of this present investigation is to find out the flexural strength of HFRC and compare it with ordinary concrete and steel fiber reinforced concrete. For this purpose specimens were cast by varying fiber dosage and they were tested mechanically. Steel fiber dosage varied from 0.25% to 1.25% at an increment of 0.25% and its optimum dosage is found out. Maximum compressive strength for SFRC is obtained for 1.00% of Steel fiber by volume of concrete.SFRC result at 28 days shows 6.9N/ mm3 at 1.25% addition of steel fiber .The flexural strength increases with increase in steel content; HFRC shows better result at equal percent of addition of steel fiber and carbon fiber. Result shows 7.5N/ mm2 flexural strength at 28 days. Further replacement of steel with carbon reduces the strength drastically.

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