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Experimental Study on The Steel Fiber Reinforcement Concrete

Mr. K. C. Denesh[1], V. Senthilkumar[2]
[1]AssistantProfessor, Department of Civil Engineering, Nandha Engineering College, Erode, TamilNadu, India
[2]Student, Department of Civil Engineering, Nandha Engineering College, Erode, TamilNadu, India

Abstract: Concrete is one of the world most widely used construction material. However, since the early 1800's, it has been known that concrete is weak in tension. Weak tensile strength combined with brittle behavior result in sudden tensile failure without warning. This is obviously not desirable for any construction material. Thus, concrete requires some form of tensile reinforcement to compensate its brittle behavior and improve its tensile strength and strain capacity to be used in structural applications. Historically, steel has been used as the material of choice for tensile reinforcement in concrete. Unlike conventional reinforcing bars, which are specifically designed and placed in the tensile zone of the concrete member, fibers are thin, short and distributed randomly throughout the concrete member.

Fibers are commercially available and manufactured from steel, plastic, glass and other natural materials. Steel fibers can be defined as discrete, short length of steel having ratio of its length to diameter (i.e. aspect ratio) in the range of 20 to 100 with any of the several cross-section, and that are sufficiently small to be easily and randomly dispersed in fresh concrete mix using conventional mixing procedure. The random distribution results in a loss of efficiency as compared to conventional rebars, but the closely spaced fibers improve toughness and tensile properties of concrete and help to control cracking. In many situations it is prudent to combine fiber reinforcement with conventional steel reinforcement to improve performance.

Fibre Reinforced Concrete (FRC) is defined as a composite material essentially consisting of conventional concrete or mortar reinforced by the random dispersal of short, discontinious, and discrete fine fibres of specific geometry. Since Biblical times, approximately 3500 years ago, brittle building materials, e.g. clay sun baked bricks, were reinforced with horse-hair, straw and other vegetable fibres. Although reinforcing brittle materials with fibers is an old concept, modern day use of fibers in concrete is only started in the early 1960s. Realizing the improved properties of the fiber reinforced concrete products, further research and development on fiber reinforced concrete (FRC) has been initiated since the last three decades. This paper presents an overview of the mechanical properties of Steel Fiber Reinforced Concrete (SFRC), its advantages, and its applications.

Keywords: Fiber Reinforced Concrete (FRC), Steel Fiber Reinfoced Concrete (SFRC), Mechanical properties.

I. INTRODUCTION

One of the undesirable characteristics of the concrete as a brittle material is its low tensile strength, and strain capacity. Therefore it requires reinforcement in order to be used as the most widely construction material. Conventionally, this reinforcement is in the form of continuous steel bars placed in the concrete structure in the appropriate positions to withstand the imposed tensile and shear stresses. Fibers, on the other hand, are generally short, discontinuous, and randomly distributed throughout the concrete member to produce a composite construction material known as fiber reinforced concrete (FRC). Fibers used in cement-based composites are primarily made of steel, glass, and polymer or derived from natural materials. Fibers can control cracking more effectively due to their tendency to be more closely spaced than conventional reinforcing steel bars. It should be highlighted that fiber used as the concrete reinforcement is not a substitute for conventional steel bars. Fibers and steel bars have different roles to play in advanced concrete technology, and there are many applications in which both fibers and continuous reinforcing steel bars should be used.

In case of structure of odd shapes it is very difficult to ascertain the proper placement ofreinforcements however, this problem does not arise in case of fiber reinforced concrete andalsotheprogress ofworkcanbeachievedatmuch fasterrate.

Steel fiber (SF) is the most popular type of fiber used as concrete reinforcement. Initially, SFs are used to prevent/control plastic and drying shrinkage in concrete. Further research and development revealed that addition of SFs in concrete significantly increases its flexural toughness, the energy absorption capacity, ductile behaviour prior to the ultimate failure, reduced cracking, and improved durability (Altun et al., 2006). This paper reviews the effects of addition of SFs in concrete, and investigates the mechanical properties, and applications of SFRC.

II. LITERATURE REVIEW

1) Banthia and pigeon (2002) showed that the conductivities of hybrid fiber systems are far better than their equivalent mono fiber systems. They also showed that if hybrid fibers are incorporated in a cement matrix, presence of one fiber enables the utilization of the potential properties of the other fiber.
2) Cengiz Duran Atis, OkanKarahan (2007) CBS used different proportions of fly ash such as 0, 15&30% and volume fraction of fiber steel used was 0, 0.25, 0.5, 1, 1.5% in volume basis of aspect ratio varying from 50 to 70.he found that addition of steel fiber of 1% with 0 to 15% of fly ash gave an increase in strength of 30% tensile strength and usage of 1.5% fiber gave an 66% increase in tensile strength.
3) Dhillon, et.al (2014) carried out a study to see the effect of the fly ash content with steel and polypropylene fibers Cement had been replaced with 15, 20 and 25 per cent fly ash by mass. 7 Two types of fibers, steel as well as polypropylene fibers had been used in percentages of 0.5% and 1.0% by volume the results showed that with increase in percentage of fly ash replacement there was decrease in compressive, flexural and split tensile strength.
4) AmanJatale, et.al (2013) studied the compressive strength of concrete when cement was partially replaced with 20%, 40% and 60% of fly ash. The results showed that using fly ash improves workability of concrete. Compression strength reduced with increase in fly ash content. The strength reduced up to 50% when 60% of fly ash was replaced with cement
5) Jo Jacob Raju, Jino John (2014) used fly ash concrete with PP fibers to examine its strength. Fibers were added at 0.1%, 0.2% & 0.3% of cement and almost 60% of fly ash has been replaced. They showed that strength gain at 90 days is higher for fiber added fly ash based concrete than OPC concrete. Fiber addition of 0.1% has the maximum compressive and tensile strength compared to other ratios. Addition of higher amount of fly ash results in strength gain only after 90 days.

III. MATERIAL AND PROPERTIES

A. Material

The raw materials of casting are cement, coarse aggregate, fine aggregate, water fly ash has been collected and the aggregate are cleared and preserved.

1) Cement

Ordinary Portland cement or rapid hardening Portland cement confirming to IS 269 or IS 8041 shall be used. The fineness of the cement shall not exceed 10%, the initial setting time shall not be less than 30 minutes and the final setting time shall not be greater than 10 hours. The average compressive strength after 28 days of curing, of 1:3 cement mortar cubes shall not be less than 43N/$mm2$.

Table 1: Cement Properties

S.No.	Description of Test	Test Results
1	Cement used	OPC 43 grade
2	Specific gravity of cement	3.15
3	Finesse (Sieve Analysis)	95% passing (90mm)
4	Standard Consistency	33%

2) Sand

Sand used shall be clean sharp heavy and gritty. It should be free from clay, salt, mica, and organic impurities. It shall not contain harmful chemicals in any form. Medium and fine sand are to be used in making a concrete. Coarse sand should be sieved through 600 micron sieve

Table 2: Fine Aggregate Properties.

S.No.	Description of Test	Test Results
1	Specific gravity of fine aggregate	2.64
2	Water absorption of fine aggregate	0.80%
3	Grading of fine aggregate	Zone-II

3) Coarse Aggregates

The aggregate to be used in reinforced cement concrete shall be of blue granite broken stone, machine crushed and well graded with a nominal size of 20 mm. It shall be hard, dense, durable, strong and free from flakes. The aggregate shall not contain harmful materials such as coal, mica, clay shells, and organic impurities. The compressive strength, crushing value etc., of the aggregate shall be in accordance with the requirements of IS 383. It should not absorb more than 10% of its own mass of water

Table 3: Coarse Aggregate Properties

S.No.	Description of Test	Test Results
1	Specific gravity of coarse aggregate	2.7
2	Water absorption of coarse aggregate	0.81%
3	Grading of coarse aggregate	2nd Grade
4	Aggregate Impact Value	26.33%
5	Crushing Value	22.56%

4) Water

Water used for mixing and curing concrete should be clean and free from injurious amounts of oils, acids, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water may be used for mixing concrete. The suspended organic solid matter in the water shall not exceed200 mg/l and inorganic solid matter shall not exceed 3000mg/l. 10 The pH value of water shall not be less than 6.Water used for curing should not produce any objectionable stain or deposit on the concrete surface. The presence of tannic acid or iron compounds in the water is objectionable. The water shall satisfy the requirements of IS: 3025

5) Steel Fiber

Steel fibers are relatively short and closely spaced as compared with continuous reinforcing bars of wires. They are generally distributed throughout a given cross section whereas reinforcing bars or wires are placed only when required. It is generally not possible to achieve the same area of reinforcement to area of concrete using steel fibre as compared to using a network of reinforcing bars of wires. Steel fibres are typically added to concrete in low volume dosages (often less than 1%) and have been shown to be effective in reducing plastic shrinkage cracking. 13 Steel fibres do not alter free shrinkage of concrete, however at high enough dosages it increases the resistance to cracking and decrease crack width.

6) Flyash

Fly ash is a finely divided residue resulting from the combustion of ground or powdered coal. It is a by-product of coal fired in electronic generating plants. .Fly ash material solidifies while suspended in the exhaust gases and is collected by electrostatic precipitators or filter bags. They are generally spherical in shape and range in size from 0.5 μm to 300 μm and it is a heterogeneous material. Two class of fly ash are produced namely Class C and Class F, according to the type of coal used for ignition.Fly ash can be used with cement in construction of concrete. Fly ash offers both environmental advantages and also improves the performance and quality of concrete. It affects the plastic properties of concrete by improving workability, reducing water demand, segregation and bleeding and lowers heat of hydration increases the strength, reduces permeability, reduces the corrosion of steel, increases sulphate resistance, and reduces alkali aggregate reaction. It reaches its maximum strength more slowly than concrete made with the port land cement.

Table 5: Basic Properties of Fly Ash

S.No.	Description of Test	Test Results
1	Fineness of test fly ash	8.4%
2	Specific gravity of fly ash	2.55

IV. SCOPE OF FUTURE STUDY

1) To minimize the usage of cement and for effective utilization of fly ash in concrete.
2) To study the Compressive strength, flexural strength and split tensile strength of concrete using fly ash as a replacement of cement & adding steel and polypropylene fibres.
3) The scope of this investigation also involves the following salient features to achieve the desired objective.

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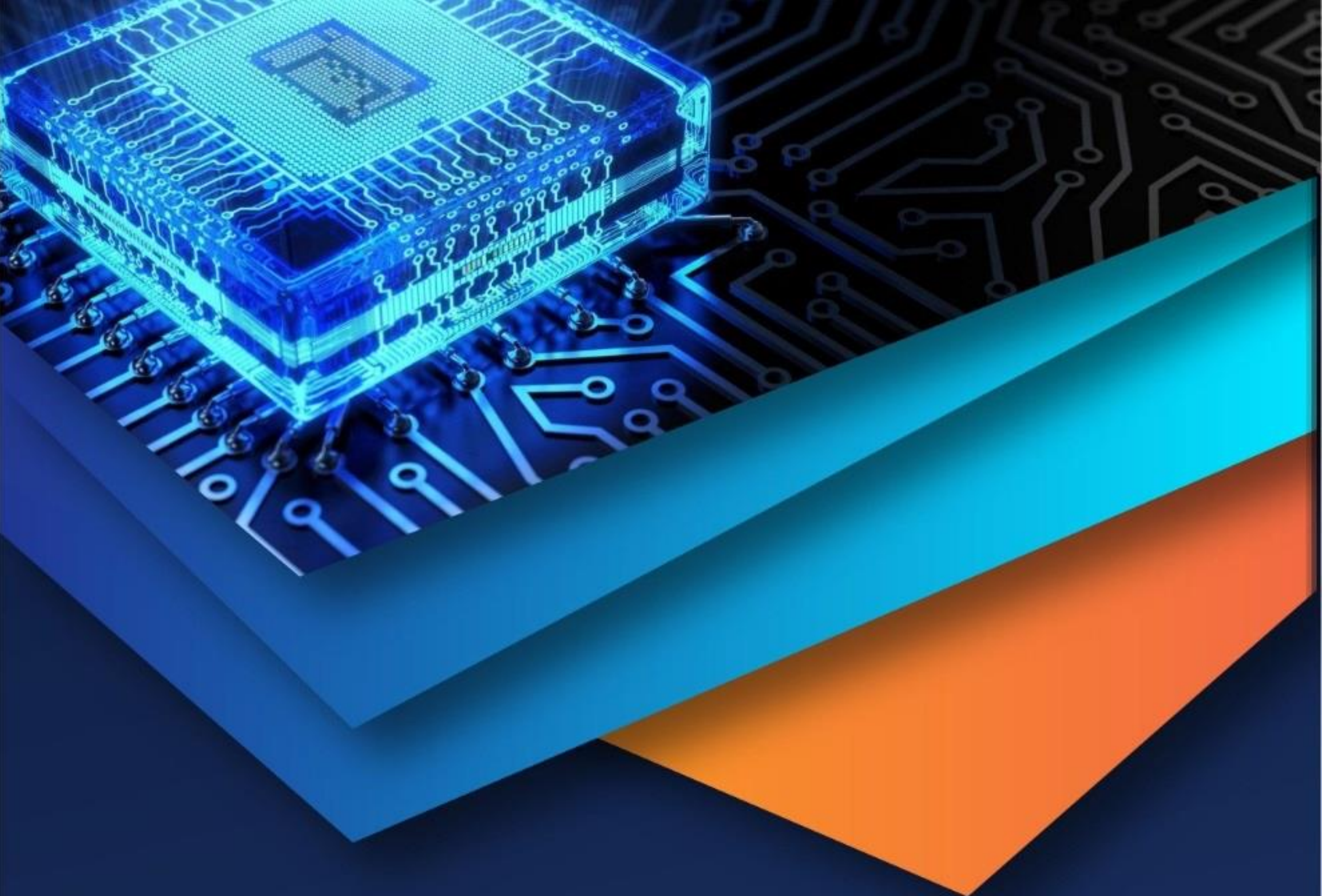

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