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"Experimental Study of Steel Fiber Concrete Beam For Bending"

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ABSTRACT

In this modern age, civil engineering constructions have their own structural and durability requirements. Fiber Reinforced Concrete (FRC) is a composite material made primarily from hydraulic cements, aggregates and discrete reinforcing fibers. Fiber incorporation in concrete, mortar and cement paste enhances many of the engineering properties of these materials such as fracture toughness, flexural strength, resistance to fatigue, impact, thermal shock and spalling. The FRC is a composite material made of cement, fine and coarse aggregates and discontinuous discrete steel fibers.

Recently developed an analytical model to predict the shear, tensional strength and bending torsion behaviour of fiber reinforced concrete beam with experimental substantiation. However, very little work has been reported in combined torsion and shear. Similarly to beam with conversional reinforcement, the presence of shear may significance influence on tensional strength of fiber concrete beams. Present paper investigates the mechanical properties like as shear strength, and torsion strength of concrete with different types of steel fiber with constant volume fractions and different aspect ratio. A primary finding emerging from the experimental program was that the placement of fibers, increased load carrying capacity of high strength fiber reinforced concrete [HSFRC] beam. Ductility, toughness significantly improved. In large scale applications it is expected that this would be economical and lead to considerable cost saving in the design without sacrificing on the desired structural performance.

***Key words:*Reinforced concrete, Aspect ratio, Flexural strength, Volume fraction, steel fiber, Flexural strength, High-strength fibre concrete**

I. INTRODUCTION

Concrete is most widely used construction material in the world due to its ability to get cast in any form and shape. It also replaces old construction materials such as brick and stone masonry. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cementitious material, aggregate and water and by adding some special ingredients. Hence concrete is

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very well suitable for a wide range of applications. The well-known inherent deficiencies of concrete are its tensile strength and its brittleness. These weaknesses of concrete lead to immediate collapse of plain concrete beams after formation of the first crack and its propagation, at very low values of tensile stress developed in the cross section due to direct (axial) and / or indirect (flexural, shear or torsional) nature of loading. These deficiencies are overcome by fiber reinforced concrete and pre-stressed concrete systems. These systems are not improving the weaknesses of the concrete matrix but are aiding the concrete with tensile reinforcement for sharing almost totally the tensile load on the elements. They and many other investigators have well established that the inclusion of high strength, high elasticity modulus steel fibers of short length and small diameter enhances the tensile strength, ductility and other properties of concrete significantly and also acts as crack arrestors Concrete with steel fibers is known as steel fiber reinforced concrete (SFRC).Many researchers carried out tests on reinforced concrete beams under bending-shear-torsion, bending-torsion and shear torsion and proposed modes of failure, empirical formulae and interaction curves. The investigations made in the field of the analysis of behavior of SFRC rectangular beams in combined loading, available in the literature, are fewer as compared with that in the field of pure torsion. In the present investigation 6 fiber reinforced concrete beams with steel fibers were test under combined bending-shear.Technically, it is possible to produce FRC of very high tensile strength using high fiber content but it is not feasible for structural applications due to practical reasons. E.g. the use of high fiber content leads to severe reduction of the workability of the fresh concrete. Recently, research interest has been directed toward understanding the torsional phenomenon as well. Several reports of investigations have appeared describing the improvement in strength under bending of concrete when fiber includes. Recently developed an analytical model to predict the shear, torsional strength and bending behavior of fiber reinforced concrete beam with experimental substantiation. However, very few works has been reported in combined torsion and shear. Similarly to beam with conventional reinforcement, the presence of shear may influence on torsional strength of fiber concrete beams. The fibre reinforcement may be used in the form of three – dimensionally randomly distributed fibres throughout the structural member when the added advantages of the fibre to shear resistance and crack control can be further utilized. On the other hand, the fibre concrete may also be used as a tensile skin to cover the steel reinforcement when a more efficient two – dimensional orientation of the fibres could be obtained. The objective of this paper is to investigate the mechanical properties like as shear strength, and bending strength of concrete with different types of steel fiber with constant volume fractions and different types of concrete.

II.PROBLEM STATEMENT

As it is mentioned, concrete is good in compression but week in tension that is, concrete is a brittle material. So, in order to improve the tensile properties, short fibers are used. Effects of steel fibers on flexural performance of RC beams were investigated in this study.

III.METHODOLOGY

When we say concrete in the building trade, we actually mean reinforced concrete. Its full name is reinforced cement concrete, or RCC. RCC is concrete that contains steel bars, called reinforcement bars, or rebars. This combination works very well, as concrete is very strong in compression, easy to produce at site, and inexpensive, and steel is very very strong in tension. To make reinforced concrete, one first makes a mould, called formwork, that will contain the liquid concrete and give it the form and shape we need. Then one looks at the structural engineer's drawings and places in the steel reinforcement bars, and ties them in place using wire. The tied steel is called a reinforcement cage, because it is shaped like one. Once the steel is in place, one can start to prepare the concrete, by mixing cement, sand, stone chips in a range of sizes, and water in a cement mixer, and pouring in the liquid concrete into the formwork tilll exactly the right level is reached

3) Concrete Mix Design: IS 10262:1982 code method of mix design was used for mix design of M40 grade of concrete. Concrete specimens with 1% percentage or no steel fiber were prepared

Stipulation For Properties:

1)	Grade designation	=	M40
2)	Type of cement	=	PPC Cement 43 grade IS: 1489-1-1991
3)	Maximum size of aggregate	=	20mm
4)	Minimum cement content	=	300 kg/m^3
5)	Maximum W/C ratio	=	0.40
6)	Workability	=	75mm(slump)
7)	Exposure condition	=	Severe(for reinforced concrete)
8)	Type of aggregate	=	Crushed angular aggregate
9)	Degree of quality control	=	Good

10	Compaction factor	=	0.8 (25 mm slump
11	Specific gravity of cement	=	3.15
12	S.G. of fine aggregate (F.A	=	2.6
13	S.G. of Coarse aggregate (C.A)	=	2.6

Step – 1) Target mean strength for mix design

Refer IS 10262: 1982 clause 3.2

Where, F_{ck} = target average compressive strength at 28 days

F_{ck} = characteristic compressive strength at 28 days, and

S= standard deviation

T= 1.65 (value of tolerance factor / Risk factor)

From Table 1, standard deviation, s = 5.0 N/mm^2

Target Mean Strength (T.M.S.)= Fck +1.65 x S.D.

=40 +1.65 x 5

=48.25 N/mm^2

Step – 2) Selection of water cement ratio

Refer IS 456: 2000, Table 5

For mild exposure RC work,

Maximum free water cement ratio = 0.4

Adopt water cement ratio = 0.4 based on experience < 0.55 hence ok.

Step 3) Selection of water

Degree of workability – Compaction factor = 0.8(Slump= 25 mm)

The maximum nominal size of aggregate=20 mm

Refer IS 10262:1982, Table 2

Maximum water content = 186 liter

Step 4) Calculation of cement content

Water cement ratio = 0.4

Cement content = 186/0.4

= 465 Kg/m^3

From IS 456 – 2000 Table 3

Minimum cement content

For mild exposure = 300 Kg/m^3

Step 5) the portion of volume of course aggregate and fine aggregate :

From table 3, Volume of coarse aggregate 20 mm size (II) & Fine Aggregate (Zone II)

Volume of coarse aggregate = 0.64

Volume of coarse aggregate is corrected = .64+.02 = 0.66

Volume fine aggregate = 1-0.66 = 0.34

Step 6) Mix calculation:

1)Volume of concrete = $1m^3$

2)Volume of cement= mass of cement / specific gravity of cement

=465÷(3.15 X 1000)
=0.147 m^3
3)Volume of water= mass of water / specific gravity of water

=(186÷1) X 1000
=0.186 m^3
3)Volume of all in aggregate = [a- (b+ c+ d)]
=[1-(0.147+0.186)]
=0.67 m^3
5)Mass of coarse aggregate = (Volume of all in aggregate) × (specific gravity of coarse aggregate) × (volume of coarse aggregate) × 1000

=0.67 × 2.6 × 0.66 × 1000

=1149.7 Kg

6)Mass of fine aggregate = (volume of all in aggregate) × (specific gravity of fine aggregate) × (Volume of fine aggregate) × 1000

0.67 × 2.6 × .34 × 1000 = 592.28 Kg

Step 7) Mix proportion for trial number:

Cement = 465 kg/m^3

Water = 186 Kg/m^3

Fine aggregate = 592.28 Kg/m^3

Coarse aggregate = 1149.70 Kg/m^3

Water cement ratio = 0.4

Mix proportion = (1: 1.27: 2.52)

3.4.1 Quantity of materials required for one cube:

Volume of cube = 0.15x0.15x0.15 = 0.003m^3

Weight of material = volume x density = 0.003 x2500 = 8.4 kg

Assume it has 9 kg

Cement = 9/1+1.27+2.52 = 1.87 Kg

Sand = 9x1.27/1+1.27+2.52 = 2.38 Kg

Water = cement x 0.4 = 0.75 litre

Aggregate = 9x2.5/1+1.27+2.52 = 4.69 Kg

3.4.2 Quantity of materials required for one beam :

Volume of beam = 0.7x0.15x0.15 = 0.015 cubicmetre

Weight of material = volume x density = 0.015 x2500 = 37.5 kg

Assume it has 38 kg

Cement = 38/1+1.27+2.52 = 8 kg

Sand = 38x1.27/1+1.27+2.52 = 10 kg

Water = cement x 0.4 = 3.2 litre

Aggregate = 38x2.5/1+1.27+2.52 = 20 Kg

IV.TESTS

1) **SLUMP TEST**:-The slump test is a means of assessing the consistency of fresh concrete .

2) **COMPRESSIVE STRENGTH**:-A universal testing machine also known as a universal tester .It is used to test the tensile strength and compressive strength of materials**.**

V. CONCLUSION

The purpose of this research project is to study the behavior of Steel Fiber Concrete (PSFC) beams or Reinforced Steel Fiber Concrete under flexural design of concrete beam..

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