MECHANICAL PROPERTIES OF STEEL FIBRE CONCRETE

PROJECT REPORT

Submitted for the course: **ADVANCED CONCRETE TECHNOLOGY (CLE2007)**

By

UMAR AHMED	**16BCL0113**
SHEKHAR SAURAV	**16BCL0131**
KUMAR SUNDRAM	**16BCL0185**
CHIRAG TANNA	**16BCL0368**

Slot: D1+TD1

Name of Faculty: DR. BALA MURUGAN S

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CERTIFICATE

This is to certify that the project work entitled **" MECHANICAL PROPERTIES OF STEEL FIBRE CONCRETE "** that is being submitted by **"UMAR AHMED, SHEKHAR SAURAV, KUMAR SUNDRAM, CHIRAG TANNA"** for**Advanced**
Concrete Technology (CLE2007) is a record of bonafide work done under my supervision. The contents of this Project work, in full or in parts, have neither been taken from any other source nor have been submitted for any other CALcourse.

Place: Vellore

Date: 30.03.2018

Signature of Students

Umar Ahmed 16BCL0113

Shekhar Saurav 16BCL0131

Kumar Sundram 16BCL0185

Chirag Tanna 16BCL0368

Signature of Faculty

(DR. BALA MURUGAN S)

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By,

16BCL0113

16BCL0131

16BCL0185

16BCL0368

ABSTARCT

As concrete is brittle material the failure in concrete due to tension is sudden. There are also cracks in concrete due to shrinkage and these micro-cracks propagate and leads to failure.

To safeguard the concrete against flexural cracks fibres are used in concrete section which is known as fibre reinforced concrete which increases its structural integrity.

Concrete(M 25) is most widely used construction material in the world. The strength and durability of concrete can be changed by making appropriate changes in its ingredients.

Hence to determine the strength and effect of addition of addition of steel reinforcement fibre we performed compressive and tensile strength of the concrete cubes and cylinders we casted following the design mix procedures from IS-10262:2009 and IS 456:2000. The tests were performed on duration of seven days and twenty eight days after casting and were kept in curing tank the entire time. The results are depicted in the followingreport.

1. Introduction:

Fiber reinforced concrete (FRC) may be defined as a composite materials made with Portland cement, aggregate, and incorporating discrete discontinuous fibres. Now, why would we wish to add such fibres to concrete? Plain, unreinforced concrete is a brittle material, with a low tensile strength and a low strain capcity. The role of randomly distributes discontinuous fibres is to bridge across the cracks that develop provides some post-cracking “ductility”. If the fibres are sufficiently strong, sufficiently bonded to material, and permit the FRC to carry significant stresses over a relatively large strain capacity in the post-cracking stage.

The real contribution of the fibres is to increase the toughness of the concrete (defined as some function of the area under the load vs. deflection curve), under any type of loading. That is, the fibres tend to increase the strain at peak load, and provide a great deal of energy absorption in post-peak portion of the load vs. deflection curve.

When the fibre reinforcement is in the form of short discrete fibres, they act effectively as rigid inclusions in the concrete matrix. Physically, they have thus the same order of magnitude as aggregate inclusions; steel fibre reinforcement cannot therefore be regarded as a direct replacement of longitudinal reinforcement in reinforced and prestressed structural members.

However, because of the inherent material properties of fibre concrete, the presence of fibres in the body of the concrete or the provision of a tensile skin of fibre concrete can be expected to improve the resistance of conventionally reinforced structural members to cracking, deflection and other serviceability conditions. 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 furtherutilised

2. Methodology:

2.1 Mix design:

A concrete mix as prepared with help of the above mentioned materials, following the guidelines given in IS 456 and IS 10262.

1. STIPULATIONS FORPROPORTIONING

- Grade design =M25
- Type of cement = OPC (53Grade)
- Maximum nominal size of aggregate = 20mm
- Water-cement ratio =0.4
- Workability = 125 mmslump
- Exposure = moderatecondition
- Method of concrete placing =manual
- Type of aggregate = crushedangular
- Chemical admixture type =polyhede

2. TEST DATA FOR MATERIALS

- Cement used = OPC (Grade53)
- Specific gravity of cement = 3.15kg/m^3
- Chemical admixture = Polyhede
- Specific gravity of coarse aggregate = 2.74kg/m^3
- Specific gravity of fine aggregate = 2.74kg/m^3
- Free Moisture: Fine Aggregate : Nil ; Coarse Aggregate:Nil

3. TARGET STRENGTH FOR MIXPROPORTIONING

$F'_{ck}= F_{ck} + 1.65*s$ [using table 1 of IS 10262:2009]
$= 25 + 1.65*4$
$= 31.6$ N/mm^2
F'_{ck}– target average compressive strength at 28 days
F_{ck} - characteristic compressive strength at 28 days
S - standarddeviation

4. SELECTION OF WATER CEMENTRATIO

[Using table 5 of IS 456:2000 – page 20]
Water-cementratiotaken =0.50

5. SELECTION OF WATERCONTENT

[Using table 2 of IS 10262:2009 – page 3]
Maximum water content for 20 mm aggregate = 186 kg (for 25 to 50mm slump size)
Considering theslump height = 50mm
Water reduction due toplasticizer = 12%
Arrived water content =186*0.88
= 163.68 l

6. CALCULATION OF CEMENT CONTENT

[From the table 5 of IS 456:2000]
Minimum cement content for moderate exposure condition = 320 kg
Water-cement ratio = 0.50
Cement content = 163.68/0.50 = 327.36 kg > 320 kg (O.K.)

7. PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINEAGGREGATE

[As per IS 10262:2009]

Volume % of coarse aggregate for 0.5 water-cement ratio = 0.62

(As for 0.5 water-cement ratio, the volume % of coarse aggregate to be taken as 0.6 and for decrease of 10% of water-cement content ratio, the value of volume % of coarse aggregate will increase by 0.02 %)

For pumpable concrete these values should be reduced by 10%.

Volume ofcoarseaggregate =0.62 x 0.9 = 0.56

Volume % of fine aggregate for 0.50 water-cement ratio = 1 - 0.56
= 0.44

8. MIXCALCULATION

a) Volume of concrete = 1m^3

b) Volume of cement = [mass of cement/(specific gravity of cement *1000)]
= 327.36/ (3.15*1000) = 0.103 m^3

c) Volumeofwater = [mass of water/ (specific gravity of water *1000)]
= 163.68/ (1*1000)
= 0.163 m^3

d) Volume of chemical admixture = [mass of admixture/ (specific gravityof admixture *1000)]
= (0.5* 327.36)/ (1.1*1000)
= 0.001488 m^3
(Here, @ 0.5% of mass of cementious mixture)

e) Volume of allaggregate, e = [a- (b + c +d)]
= 1- 0.267
= 0.733

Thus, e = 0.733 m^3

f) Mass of coarse aggregate = e * volume of coarse aggregate * specific gravityof aggregate of coarse aggregate * 1000
= 0.733 * 0.56* 2.74 * 1000
= 1124.7152 kg

g) Mass of fine aggregate = e * volume of fine aggregate * specific gravityof aggregate of fine aggregate * 1000
= 0.733 * 0.44* 2.74 * 1000
= 883.704 kg

9. MIX PROPORTION for 1 m^3 ofconcrete.

Cement = 327.36 kg/m^3

Water = 163.68 kg/m^3

Fine aggregate = 883.704 kg/m^3

Coarse aggregate = 1124.72kg/m^3

Chemical admixture = 1.1488 kg/m^3

Water-cement ratio = 0.5

10. Now for mix calculation for 6 cubes and 3cylinders.

Vol. For6cube = 0.1* 0.1 * 0.1*6 = 6 * 10 ^ (-3)m^3

Vol For3 cylinders = ((3.14 * (0.1)^2) /4)* 0.2*3 = 4.71 * 10 ^ (-3)m^3

So total vol. (withF.O.S1.2) = 10.71*1.2 = 12.8 * 10^ (-3) m^3

<u>Now Total Quantity of materials in concrete for casting of 6 cubes and 3 cylinders</u>

Cement = 4.2 kg

Water = 2.1 litre

Fine aggregate =11.34

Coarse aggregate = 14.43 kg

Chemical admixture = 21 gm

Quantity of steel added is 0.75 % and 1.5 %.

For 0.75 % steel required

Vol. of steel req. for 1 m^3 = (0.75 /100) * 1 m^3
= 0.0075 m^3

Weight of steel requires for1m^3 = 0.0075 * 7850 kg/m^3 = 58.875 kg

Weight of steel required inourmix = 58.875*0.0128 = 0.7065 kg

For 1.5 % steelrequired

Vol. of steel req. for1 m^3 = (1.5/100) * 1m^3
= 0.015 m^3

Weight of steel requires for1m^3 = 0.015 * 7850 kg/m^3 = 117.75 kg

Weight of steel required inourmix = 117.75*0.01285 = 1.513kg

2.2 Preparation of Cube specimens (Casting) :SPECIMEN: 18 cubes of 10 cmsize 9 cylinders of 10 cm dia and 20 cmheight.

MIXING: Mix the concrete by hand.

PRECAUTIONS TAKEN WHILE HAND MIXING:

(i) Mix the cement and fine aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform color.

(ii) Add the coarse aggregate and mix with cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch.

(iii) Add water and mix it until the concrete appears to be homogeneous and of the desiredconsistency.

SAMPLING:

(i) Clean the molds and applyoil.

(ii) Fill the concrete in the molds in layers approximately 5cmthick.

(iii) Compact each layer with not less than 35 strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm long, bulletpointed at lowerend).

(iv) Level the top surface and smoothen it with atrowel.

DEMOULDING:

At the end of 24hr, the mould is stripped and the cube is further cured in water.

3. TESTPERFORMED

i. COMPRESSIVE STRENGTH TEST:

In compressive strength test, the cube while still wet is placed with the castfaces in contact with the plates of the testing machine i.e. the position of cube when tested is at right angles to that as casted. Take the dimension of the specimen to the nearest 0.2m. Clean the bearing surface of the testing machine. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast. Align the specimen centrally on the base plate of the machine. Rotate the movable portion gently by hand so that it touches the top surfaceofthespecimen.Applytheloadgraduallywithoutshockandcontinuously at the rate of 2.5kN/sec till the specimenfails

ii. TENSILE STRENGTH TEST:

For Split tensile strength test, cylinder specimens of dimension 100 mm diameter and 200 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. These specimens were tested under compression testing machine. In each category three cylinders were tested and their average value is reported. Split Tensile strength was calculated as follows as:-

Split Tensile strength (MPa) = $2P / \pi DL$,

Where, P = failure load, D = diameter of cylinder,

L = length ofcylinder

4. RESULTS

4.1 – compressive loads at 7 days forcubes

Sample	S.No.	Percentage of Steel		
		0%	0.75%	1.5%
Compressive load for cubes	1	232	312	377
	2	227	298	358
	3	199	292	361

4.2 compressive strength at 7 days for cubes andcylinder

	Sample	S.No.	Percentage of Steel		
			0%	0.75%	1.5%
Compressive strength(N/mm2)	Cube	1	23.2	31.2	37.7
		2	22.7	29.8	35.8
		3	19.9	29.2	36.1
average			21.9	30.1	36.5

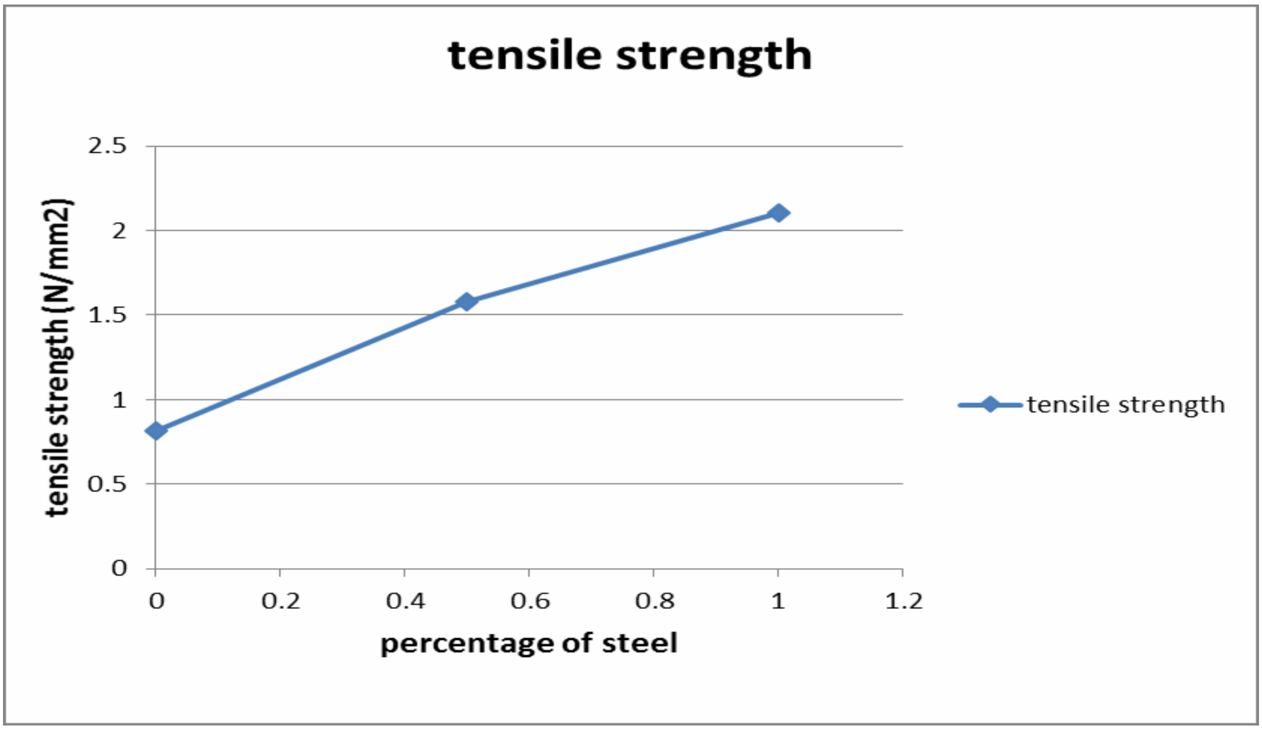
4.3 compressive loads at 14 days for cubes andcylinder.

Sample	S.No.	Percentage of Steel		
		0%	0.75%	1.5%
Cube	1	255	367	439
	2	257	353	428
	3	265	360	417
Cylinder	1	50	101	135
	2	59	105	129
	3	44	92	133

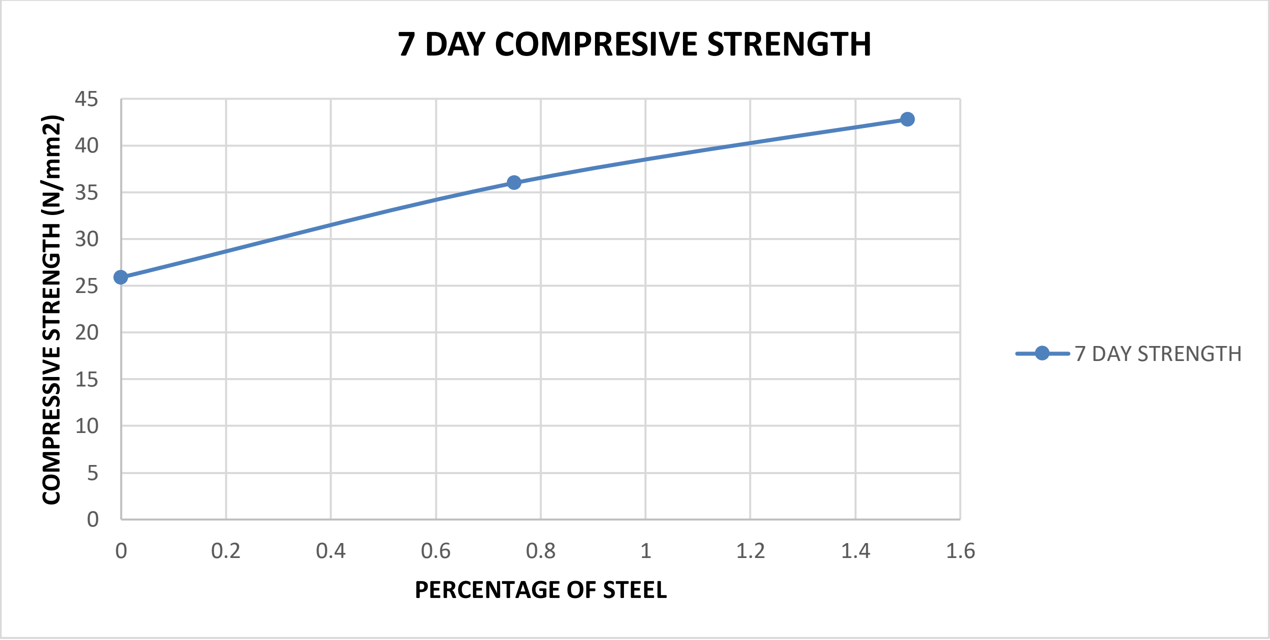
4.4 compressive strengths at 14 days for cubes andcylinders.

	Sapmle	S.No	Percentage of Steel		
			0%	0.75%	1.5%
Compressive Strength(N/mm^2)	Cube	1	25.5	36.7	43.9
		2	25..7	35.3	42.8
		3	26.5	36.0	41.7
Average			**25.9**	**36.0**	**42.8**
Tensile Strength(N/mm^2)	Cylinder	1	0.796	1.608	2.15
		2	0.939	1.672	2.05
		3	0.704	1.465	2.12
Average			**0.813**	**1.582**	**2.106**

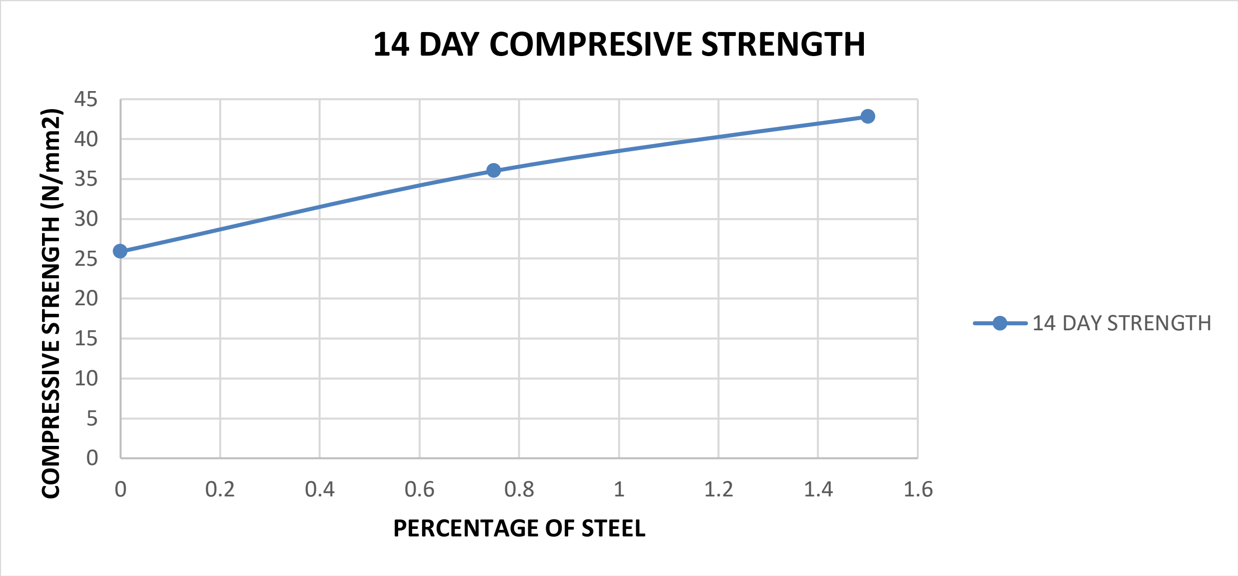
3.1 Results:



tensile strength
tensile strength (N/mm2)
2.5
2
1.5
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
percentage of steel
tensile strength



7 DAY COMPRESIVE STRENGTH
COMPRESSIVE STRENGTH (N/mm2)
45
40
35
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
PERCENTAGE OF STEEL
7 DAY STRENGTH



3.3 APPLICATION OF STEEL REINFORCEDCONCRETE:

- Tunnel linings
- Manholes,
- Risers,
- Burial Vaults,
- SepticTanks,
- Curbs,
- Pipes,
- Covers,
- Sleepers
- Roller compacted concrete with steelfibers
- Highway And AirfieldPavements:
    1) Repair of existingpavement.
    2) Reduction in pavementthickness.
    3) Increase in resistance toimpact.
    4) Increase in transverse and longitudinal jointspacing
    5) Smooth ridingsurface.

- HydraulicStructures:
  1) Resistance to cavitations or erosion damage.
  2) Repair of spillingbasin.
- Fiber Shotcrete(FRS):
  1) Rock stabilization, tunnels, dams,mines.
  2) Bridges arches, dome structures,power-house
  3) Stabilization of slopes to prevent landslides repair of deteriorated concrete surface, water channel etc.

4. Conclusion:

Steel reinforced fiber, upon experimenting proved to be stronger than normal concrete block. The reinforcement also helps in reducing the cracks and the chances of concrete to fail under shear. It is known that plain cement concrete does not have good tensile properties to resist flexure in structural members. In case of concrete reinforcement steel, cracks still appear on the tension face due to bending. So, to prevent cracking of concrete, specially in the case of water retaining structures, or water transporting structures, it is advisable to design structural concrete as uncracked section. This results in heavy structural design with resulting in high cost. Fibers in concrete has the ability absorb more energy.

5. Bibliography:

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