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An ExperimentalInvestigation on Recron Fiber Reinforced Concrete

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Abstract: ***Advances in concrete have been taking place in concrete construction over the past decade. Researches started using different additives such as Recron fibre, metakaolin, coconut fibres, steel fibre, glass fibres etc.a replacement cement which was found to be sufficient for the improvement of the properties of concrete. In the recent times with the use of this fibres has lead to many advantages such as increase in the homogeneity of concrete with reduction in segregation of aggregates, reduction in shrinkage cracks and also rise in strengths like compressive strength,split tensile strength, flexural strength of concrete along with ductility property. For mix design of M30 grade concrete is taken to determine the compressive strength, split tensile strength and flexural strength of concrete. By adding different proportions of 0,0.3%,0.5%,0.7% of Recron fibres to concrete mix and the casting of different specimens such as cubes, cylinders and beams are done for 7days and 28days. The Strength and workability parameters have been compared to normal concrete and Recron fibre reinforced concrete.For strength parameters the maximum strength was obtained at 0.7% of Recron fiber and the workability decreases with increase in addition of Recron fibre to the concrete.***

Keywords: Cement, RECRON, Ductility,Tensile strength Compressive strength, PPC.

1.0 Introduction

Since the adaptation of concrete as a constructing material, lot of researches and studies has been made to improve the quality, strength and durability. By the same time efforts are additionally being made to economize concrete development in contrast to other materials. Plain concrete is good in compression however vulnerable in tensile strength with very limited ductility and little resistance to cracking. Internal micro-cracks are inherently present in concrete and its poor tensile strength is due to propagation of such micro-cracks, ultimately leading to brittle fracture of concrete. Attempts have been made to minimize the cracks and impart enhancements in tensile property of concrete members using conventionally reinforced steel bars and additionally by way of applying restraining techniques. Although each of these methods provide tensile strength to concrete members, they however do no longer increase the tensile strength of concrete itself. It has been recognized that the addition of small closely spaced and uniformly dispersed fibres to concrete would act as crack resistance and substantially improve its static and dynamic properties. This type of concrete is known as fibre reinforced concrete. In this study an attempt is made to understand the behavior of concrete combined with Recron 3s fibre in contrast with conventional concrete.

2.0 Objectives

Following are the main objectives of present study:

1. To compare the compressive strength of conventional concrete with Recron fibre reinforced concrete.
2. To evaluate the split tensile strength of traditional concrete and Recron fibre reinforced concrete.
3. To compare the flexural strength of normal concrete with Recron fibre reinforced concrete.

3.0 Literature Review

3.1 EXPERIMENTAL STUDY ON BEHAVIOUR OF RECRON FIBRE REINFORCED CONCRETE.

Authors:G.Jenitha et al, has done "Experimental Study on behaviour of Recron Fibre Reinforced Concrete"and concluded. The strength characteristics of the concrete (M30) had been done with varying percentage of additives was worked out giving certain proportions by means of adding Recron fibre in the proportion of 0%,0.5%,1% to the concrete mix and changes in strength, strength get increases and workability parameters were studied. On addition of 1% of Recron fibre the maximum compressive strength of 33.19 N/mm^2 is achieved therefore increase in compressive strength is 7.20 % than the traditional concrete. The increase in split tensile strength is 20.15% than the traditional concrete. Therefore, it is concluded that the most suitable dosage of Recron fibre that can be added in concrete is 1%.

3.2 STUDY ON PROPERTIES OF CONCRETE USING RECRON 3s FIBRES

Author: Korrapati Kumar et .al has done "Study on properties of concrete using Recron 3s fibres" and concluded. Recron 3s is a state of art reinforcing material which is used to increase strength in a variety of applications like automotive battery, paper, filtration fabrics, and asbestos cement sheets, cement-based pre-cast products and for improving quality of construction. A product of extensive R&D in Reliance Industry Limited (RIL) state-of-the-art Technology Centre.The Workability of concrete measured from slump cone test, as the percentage of Recron 3s fibre increases the slump value decrease. Hence, it can be concluded that with the increase in the fibre content workability decreases. From the experimental results, the optimum percentage recommended is 0.3% Recron 3s fibre for achieving maximum benefits in compressive strength, split tensile strength and flexural strength for the characteristics of Recron 3s fibre reinforced concrete.The compressive strength of concrete at 28 days increased with the addition of Recron 3s fibre up to 0.3% level when compared to that of plain concrete.The split Tensile strength of concrete at 28 days increased with the addition of Recron fibre up to 0.3% level when compared to that of plain concrete.The flexural strength of concrete at 28 days increased with the addition of Recron 3s fibre up to 0.3% level when compared to that of plain concrete.

3.3 A REVIEW ON FIBREREINFORCED CONCRETE

Authors: Girija.S et al has done "A Review on fibre reinforced concrete". The addition of Recon 3s fibres into concrete mix improves the Compressive strength, split tensile strength and Flexural strength at 28 days for fibre mixes when compared with that of control mix. The volume fraction of fibre concrete mix gives better strength values on par with control mix. The capillary absorption coefficient and porosity increases with addition of fibres. Industrial waste materials were found to be performing better than normal concrete, in properties such as workability, durability, permeability and compressive strength. Utilization of these wastes in concrete will not only provide economy but also help in reducing disposal problems. The authors concluded that the volume fraction of hybrid fibre concrete mix gives better strength values on par with control mix.

3.4 RECRON MEDIUM STRENGTH FIBRE REINFORCED CONCRETE

Author: T.Sandeep has done study on "Recron medium strength fibre reinforced concrete" and has concluded. The investigation of two design mix of concrete. The mix grades of M30 and M35 were used and the water cement ratio was 0.40% for the mixes. There was usage of different additive material of fly ash with different proportions of 20%,25% and 30% by weight of cement and keeping the percentage of Recron fibre of 0.25% of cement. The compressive strength was performed for 3,7,14,28 days. The 28 days in respect of both grades of concrete is attaining maximum value at 25-30% of fly ash replacement. There is an increase of 12%in compressive strength with addition of fly ash when compared plane concrete there appears to be greatest increase in 7 days strength with usage of fly ash when compared 28 days strength. Nearly 25% more strength is reported to have been secured at7 days with 25% replacement of fly ash this has an advantage in terms of early deshuttering and when the base of construction is expected to be very high there is a similar tendency absorbed and in fact more pronouncedly at 3days strength of concrete there is a 50% increase in strength at 3 days compared plane conventional concrete. These fibres are causing 30% f increase in the 28-days compressive strength in the presence of fly ash the maximum in 28-days strength is observed with 0.25% Recron and 25% fly ash substitution.

4.0 Material used in this Study

A**) CEMENT:** Conforming to Indian Standard Specifications (BIS 269-1987 & BIS 1987), the cement used was Portland Pozzolana cement (PPC) of Grade 53.The properties of cement as observed from the laboratory tests are shown in table no 1.

Table no:1 -Physical properties of cement

PHYSICAL PROPERTIES	RESULTS
Initial setting time	45min
Final setting time	600min
Specific gravity	2.90
Normal consistency	30%

B) **FINE AGGREGATE**: The fine aggregate used in this project were conforming to Indian standard specifications (BIS 383-1970 & BIS 1970). It was ensured that the sand was uniformly graded, free from organic matter, silt and clay. The properties of fine aggregate after undergoing laboratory tests are shown below in table no 2.

Table no: 2 - Physical properties of fine aggregate

PHYSICAL PROPERTIES	RESULTS
Fineness modulus	2.39
Specific gravity	2.60
Bulking of sand	28.2%
Zone of fine aggregate	III

C) **COARSE AGGREGATE**: The size of coarse aggregates used in this project are 20mm aggregates conforming to Indian Standard Specifications (BIS: 383 – 1970). The results obtained for laboratory tests are shown below in table no 3.

Table no: 3 – Physical properties of coarse aggregate

PHYSICAL PROPERTIES	RESULTS
Size of coarse aggregate	20mm
Specific gravity	2.68
Water absorption	0.22%

D**) RECRON FIBRE**: Recron 3s fibre is a modified polyester fibre with triangular cross-section. It is generally used as secondary reinforcing material in concrete. The cut length of Recron 3s fibre varies as 6mm and 12mm which is being widely used in Indian constructions.

Aspect Ratio: It is defined as ratio of fibre length to fibre diameter. The diameter of Recron 3s fiber is 30-40 microns. So, we neglect aspect ratio of Recron 3s fiber.

Table no 4 –Specifications of Recron 3s fiber

Cut length	6mm, 12mm, 24mm
Diameter	30-40 micron
Melting point	$>250^0$C
Tensile strength	6000kg/cm^2
Acid resistance	Excellent
Dispersion	Excellent
Moisture	<1%
Elongation	45-55%

5.0 MIX DESIGN:

1. Concrete designation: M35

2. Characteristic compressive strength f_{ck} = 38.25N/mm^2

5.1 Stipulations for Proportioning

Table no 5 – Stipulations for proportioning

Grade of cement	**M30**
Type of cement	PPC 53grade
Max. Nominal size of aggregate	20mm
Degree of supervision	Good
Max. water cement ratio	0.45
Exposure condition	Severe

5.2 TEST DATA FOR MATERIALS

Table no 6– Test data for materials.

Cement used	PPC 53 grade
Specific gravity of cement	3.12
Specific gravity: a) Coarse aggregate b) Fine aggregate	 2.68 2.60
Water absorption of coarse aggregate	0.22%
Sieve analysis: a) Coarse aggregate b) Fine aggregate	20mm retained Zone III (IS 383 table 4)

5.3 MIX RATIO = 1 : 1.54 : 2.83

Table no 7– Quantity of materials.

Type of material	**Quantity (kg/ m$^{3)}$**
Cement	413
Fine aggregate	638.35
Coarse aggregate	1169.7
Water	186
0 % Recron	0
0.3% Recron	0.092
0.5% Recron	0.153
0.7%Recron	0.215

5.4 MIX DESIGN FOR M35 GRADE CONVENTIONAL CONCRETE

Aggregate size: 20mm

Minimum cement content: 320 kg/m^3

(from table 5 IS 456)

W/c ratio: 0.45

Workability: 100mm (slump)

Exposure: Severe

5.4.1. MIX DESIGN:

1. TARGET STRENGTH FOR MIX PROPORTIONING:

$f^I = f_{ck}$ + 1.65 s

From IS: 10262-2009, the target mean strength for the specified characteristic cube strength is

$f^I = f_{ck}$ + 1.6 (5)

f^I = 38.25 N/mm^2

('s' is standard deviation N/mm^2 s =5, from table 1 IS 10262:2009)

2. SELECTION OF WATER–CEMENTRATIO:

From Table 5 of IS 456, maximum water-cement ratio = 0.45

Based on experience, adopt water-cement ratio as 0.45, Hence OK.

3. SELECTION OF WATER CONTENT:

From Table 2, maximum water content = 186 liter (for 25 to 50 mm slump range) for 20mm aggregate.

4. CALCULATION OF CEMENTCONTENT:

Cement content = 186/0.45 = 320 kg/m³

From Table 5 of IS 456, minimum cement content for 'Severe' exposure condition = 240kg/m³

320 kg/m³ > 240 kg/m³, hence, OK

5. PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT:

Fine aggregate = Zone III

Volume of coarse aggregate per unit volume of total aggregate for different zones of fine aggregate

= 0.64 (from table 3 IS 10262:2009)

Fine Aggregate = 1-0.64 = 0.36

MIX CALCULATIONS:

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = 1m³

b) Volume of cement = $\frac{\text{Mass of Cement}}{\text{Specific gravity of Cement}} \text{x } \frac{1}{100}$

= $\frac{413}{3.12} \text{ x } \frac{1}{100} = 0.132\ m^3$

c) Volume of Water = $\frac{\text{Mass of Water}}{\text{Specific gravity of Water}}$ x $\frac{1}{100}$

= $\frac{186}{1}$ x $\frac{1}{100}$ = $0.186\ m^3$

d) Volume of all in Aggregates = a-(b+c)

= 1- (0.132 + 0.186) = 0.682 m^3

e) Mass of Coarse Aggregates = d x Volume of Corse Aggregates x Specific Gravity of Coarse Aggregate x 1000 = 0.682 x 0.64 x 2.68 x 1000 = 1169.7 Kg

f) Mass of Fine Aggregates = d x Volume of Fine Aggregate x Specific Gravity of Fine Aggregate x 1000 = 0.682 x 0.36 x 2.60 x 1000 = 638.35 Kg

The Mix Proportions then becomes:

Mix Proportion for M30 by Weight

Water: Cement: Fine Aggregate: Coarse Aggregate

186 : 413 : 638.35 : 1169.7

0.45: 1 : 1.54 : 2.83

6.0 Results and Discussions

6.1 Properties of Fresh concrete:

a) Slump cone: The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. Results obtained for conventional concrete and fibre reinforced concrete of different proportions are given below.

TYPE OF CONCRETE	SLUMP VALUE
Normal concrete (M30)	70mm
Fibre reinforced concrete (FRC) of 0.3% Recron	85mm
FRC of 0.5% Recron	90mm
FRC of 0.7% Recron	100mm

Table no 8: Results of slump cone test

6.2 Hardened concrete:

a) Compressive strength: Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates.

Compressive Strength = Load / Cross-sectional Area

The compressive strength of the Recron Fibre concrete is tested on the 7 and 28days with four different percentage of Recron fibre mixing, viz 0, 0.3, 0.5, 0.7 percentage of Fibre is mixedwith the concrete cubes of dimension 150*150*150.

Results for 7 and 28 days are shown below

Recron fibre	Load (KN)	Compressive strength (N/mm^2)	Load (KN)	Compressive strength (N/mm^2)
7 DAYS			28 days	
0 %	621.6	27.63	833.3	37.03
0.3%	625	27.77	875	38.8
0.5%	648	28.8	880	39.11
0.7%	659.16	29.2	948.33	42.14

Table no 09: Results of Compressive strength test

b) Split Tensile strength: The cylindrical specimen is placed horizontally between the loading surfaces of a compression testing machine. The cylinder with diameter of 150mm and height 300mm is taken and the split tensile strength testing is done for 7 and 28 days. Calculate the splitting tensile strength of the specimen the formula is given as

$$T= 2P/ \pi LD$$

Where:

T = splitting tensile strength, MPa

P: maximum applied load indicated by the testing machine, N

D: diameter of the specimen, mm

L: length of the specimen, mm

Recron fibre	Load (KN)	Split tensile strength (N/mm^2)	Load (KN)	Split tensile strength (N/mm^2)
7 days			28 days	
0%	80	1.13	125	1.76
0.3%	100	1.41	140	1.98
0.5%	120	1.69	165	2.33
0.7%	148	2.09	185	2.61

Table no 10: Results of Split Tensile strength

c) Flexural strength:Flexural test evaluates the tensile strength of concrete indirectly. It tests the ability of unreinforced concrete beam or slab to withstand failure in bending. The dimensions of the specimen are 150*150*750mm. The following expression is used for estimation of modulus of rupture:

$$MR = PL/bd^2$$

Where:

MR: modulus of rupture

P: ultimate applied load indicated by testing machine

L: span length

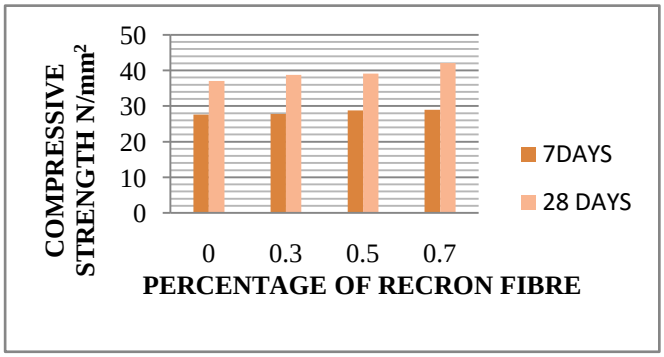
b: average width of the specimen at the fracture

d: average depth of the specimen at the fracture.

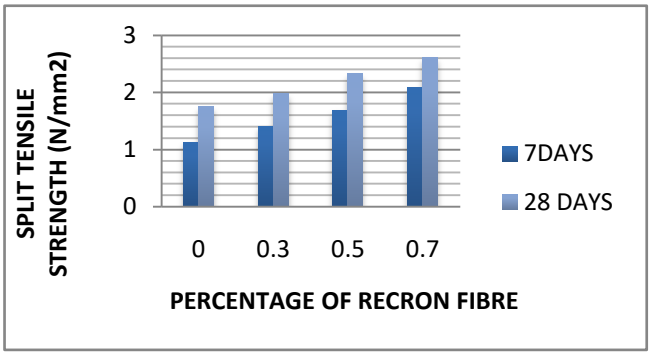
Recron fibre	Loads (KN)	Flexural strength $(N/mm)^2$	Loads (KN)	Flexural strength $(N/mm)^2$
7days			28days	
0%	18	4	23.5	5.22
0.3%	24	5.33	28	6.22
0.5%	25.5	5.67	29.60	6.57
0.7%	26.75	5.94	31.2	6.93

Table no 11: Results of flexural strength test

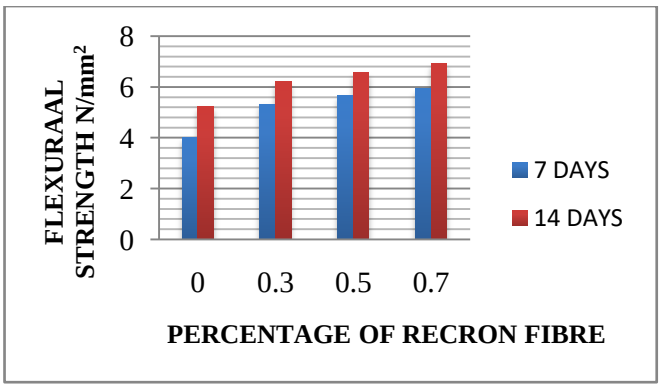
Results obtained are reported in above shows that there is 32.75% increase in flexural strength compared to the normal concrete.



Graph no 1: Compressive Strength results



Graph no 2: Tensile strength graph



Graph no 3: Flexural strength

Conclusions:

Concrete is one of the most important elements of construction field. But it's must be having a proper binding actions and economic for all sides of construction activities. Based on the investigation for various concentration of Recron fibre and the concrete cured for 28 days, the following conclusions can be drawn.

1. From slump values we can observe that with increase in fibre content the workability of concrete is decreased.
2. On addition of 0.3%, 0.5% and 0.7% of Recron fibre there is an increase of 4.77%, 5.61% and 13.80% in compressive strength respectively at 28days.
3. On addition of 0.3%, 0.5% and 0.7% of Recron fibre there is an increase of 12.5%, 32.38% and 48.29% in tensile strength respectively at 28days.
4. On addition of 0.3%, 0.5% and 0.7% of Recron fibre there is an increase of 19.15%,25.86% and 32.75% in flexural strength respectively at 28days.
5. Maximum increase in strength is observed at 0.7% in compressive, tensile and flexural strength of Recron fibre reinforced concrete.

   For all sides of construction activities. Based on the investigation for various concentration of Recron fibre and the concrete cured for 28 days, the following conclusions can be drawn.

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9. On addition of 0.3%, 0.5% and 0.7% of Recron fibre there is an increase of 19.15%,25.86% and 32.75% in flexural strength respectively at 28days.
10. Maximum increase in strength is observed at 0.7% in compressive, tensile and flexural strength of Recron fibre reinforced concrete.

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