INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 6)
Available online at: www.ijariit.com

Effect on concrete properties using recron fiber with fly ash

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ABSTRACT

Extensive experimental investigation on recron fiber with fly ash reinforced concrete was carried out by researchers. Recron fiber mesh is more effective in resisting bending and punching shear. Recron Fibers are most popular metallic fibres used for the production of Recron Fiber Reinforced Concrete particularly from the point of view of strength and ductility. Experiments were conducted for both Ordinary Concrete and Recron Fibre Concrete with different percentages of Recron fibres. An experimental investigation is to study the variation in strength characteristics of concrete structural elements, for the proportion of M20 grade. In each mixes containing different percentages of fly ash is replaced by means of cement starting from 0% as normal concrete, i.e. controlled concrete 10%, 20%, and 30%, and two percentages of natural Recron fibers 0.25% and 0.5% the number of specimens casted for each case It was observed that as the addition of recron fibres to concrete mix increases, the workability of concrete mix was found to decrease as compared to control mix. At an optimum dosage of RF, the increase in compressive strength of recron fibre concrete mixes compared with control mix of concrete at 28 days compressive strength is observed from 17% to 25%. The percentage increase of split tensile strength of recron fibre concrete mixes compared with control mix at 28 days is observed from 17 to 20% for 0.25%+10%FA recron fibers by weight of the binder. The addition of recron fibres into the concrete mixture marginally improves the compressive strength at 28 days. It is observed from the experimental results and its analysis, that the compressive strength of concrete, splitting tensile strength, flexural strength of concrete increases with the addition of low Percentage of recron fibres. The 0.25%+10%FA addition of recron fibres into the concrete shows a better result in mechanical properties.

Keywords— *Recron fiber, Fly ash, Admixture, Workability, Compressive strength, Split tensile strength, Flexural strength*

1. INTRODUCTION

The infrastructure need in our country is increasing day by day & with concrete as the main constituent of construction material makes a significant portion of this infra-structural system. It is necessary to enhance its strength and durability characteristics. It is also reasonable to compensate concrete in the form of waste materials and save cost by the use of admixtures such as fly ash, silica fume etc. as partial replacement of cement, one of the many ways this could be achieved by developing new concrete composites with the fibers which are locally available. Concrete, in general, is brittle with an increase in strength. This is a major drawback since brittleness can cause sudden & catastrophic failure, especially in structures which are subjected to earthquake, blast, suddenly applied loads and impact. This serious disadvantage of concrete can at least be partially overcome by the incorporation of fibers. The incorporation of fiber can cause a change in the failure mode under compressive deformation from brittle, thereby imparting a degree of toughness to concrete.

2. MATERIALS USED

2.1 Cement

Ordinary Portland Cement of 53 Grade confirming to IS: 8112-1989 was used in the investigation. Cement, in general, can be defined as a material which possesses very good adhesive and cohesive properties which makes it possible to bond with other materials to form a compact mass.

Table 1: Properties and requirements of material used

S no.	Properties	Chart results	Requirements as per IS:8112-1989
1.	Specific gravity	3.15	-
2.	Fineness (specific gravity)	301m^2/kg	Should not be less Than 225m^2/kg
3.	Normal consistency	30%	-
4.	Setting time in a minute. 1. Initial setting time 2. Final setting time	 130 197	 Should not be less than 30min Should not exceed 600min.

5.	Soundness Test: Le Chatelier Method	0.5mm	Should not exceed 10mm
6.	Compressive strength 1. 3 – days 2. 7 – days 3. 28 –days	 34.5N/mm² 45.50N/mm² 65.00N/mm²	 Should not less than 27N/mm² Should not be less than 37N/mm² Should not be less than 53N/mm²
7.	Temperature during testing	27 ˚c	Min 25 ˚c and Max 29˚c

2.2 Course aggregate

The coarse aggregate used in this investigation in 20mm downsize crushed aggregate and angular in shape as per Indian Standard specifications IS 383 – 1970 [16]. Its physical properties and sieve analysis results are shown in the table as follows: Fineness modulus of coarse aggregates = cumulative percentage weight retained/100 Fineness Modulus 5.12 Specific gravity 2.7 Water absorption 1.12%

2.3 Fine Aggregate

The Aggregate which is passing through 4.75mm sieve is known as a fine aggregate. Locally available river sand which is free from organic impurities is used. Sand passing through 4.75mm sieve and retained on 150 microns IS sieve is used in this investigation. Fineness modulus 2.88 Specific gravity 2.68 Water absorption 0.86%

2.4 Fly ash

Fly ash obtained from Sanjay Gandhi Thermal Power Plant is situated near the Birsinghpur railway station on the Bilaspur-Katni section of the SE Railway. It is in Umaria district, Madhya Pradesh. With specific Gravity = 2.3

2.5 Recron Fiber

Recron fiber is extracted from the outer shell of a Recron. The common name, scientific name and plant family of Recron fiber is Coir, Cocos nucifera and Arecaceae (Palm), respectively. Recron cultivation is concentrated in the tropical belts of Asia and East Africa. There are two types of Recron fibers, a brown fiber extracted from matured Recrons and white fibers extracted from immature Recrons Recron fibers are stiff and tough and have low thermal conductivity Recron fibers are commercially available in three forms, namely bristle (long fibers), mattress (relatively short) and decorticated (mixed fibers).

3. RESULT AND DISCUSSION ON EXPERIMENTAL TESTS

3.1 Workability of Concrete Mixes

The workability of concrete mixes was found out by slump test as per procedure is given in chapter 3. w/b ratio was different for all the concrete mixes. The workability of concrete depends upon the water-cement ratio. The workability results of different concrete mixes were shown in Table 2.

Table 2: Workability of various concrete mixes design for slump cone test is as follows

Mix design codes	Slump cone test in mm.
S1-MIX (normal concrete)	38
S2-MIX (10% fly ash)	42
S3-MIX (20% fly ash)	43
S4-MIX (30% fly ash)	45
S13-MIX (30% fly ash,0.25% fiber)	47
S22-MIX (30% fly ash, 0.5% fiber)	48

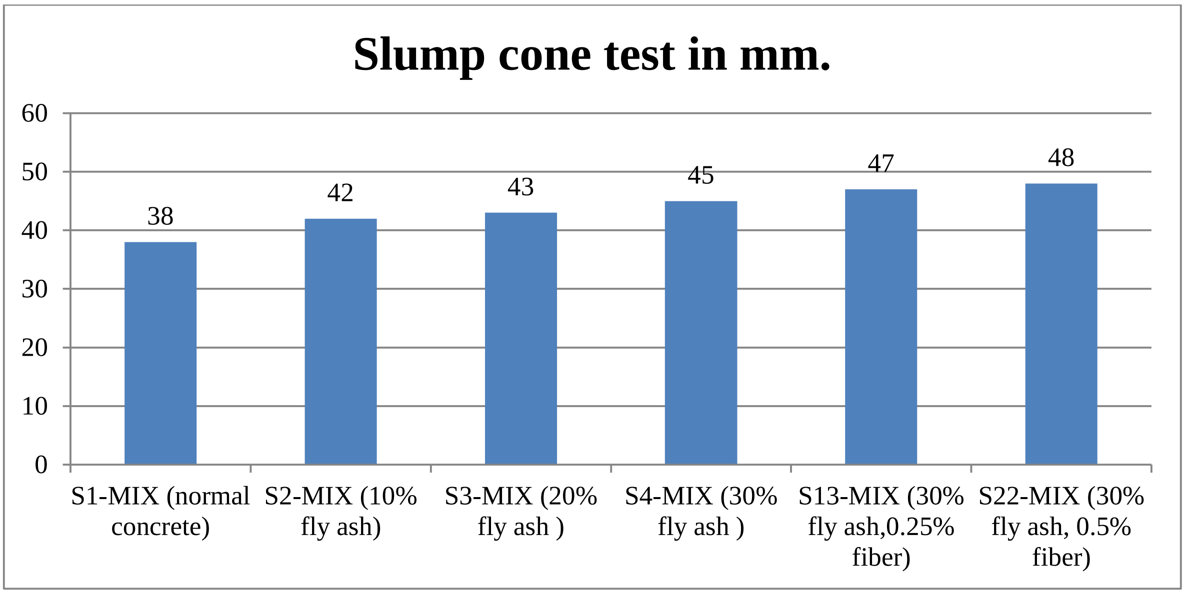

Fig. 1: Slump cone test results

3.2 Compressive Strength

The compressive strength of concrete is one of the most important Properties of concrete in most structural application concrete is implied primarily to resist compressive stress. In the investigation, conventional concrete and fly ash based Recron fiber composite, concrete cubes of 150mm x 150mm x 150mm sizes were used for testing the compressive strength.

Table 3: Compressive Strength of Grade M20 as S1, S2, S3, And S4

Mix	**S-1**	**S-2**	**S-3**	**S-4**
Fly ash (%)	0	10	20	30
FIBER (%)	0	0	0	0
FIBER	0	0	0	0
Test age (days)	**3-3 Samples compressive strength (N/mm²)**			
7	12.0 12.5 12.0 Av=12.1	11.6 11.5 11.6 Av=11.56	11.0 10.8 11.2 Av=11	10.7 10.8 10.9 Av=10.8
14	15.0 15.0 15.6 Av=15.2	14.7 14.8 14.9 Av=14.8	14.2 13.8 13.8 Av=13.9	13.4 13.3 13.5 Av=13.4
28	19.5 19.0 19.5 Av=19.3	19.0 18.8 19.2 Av=19	18.6 18.4 18.6 Av=18.5	18 18.2 18.6 Av=18.3

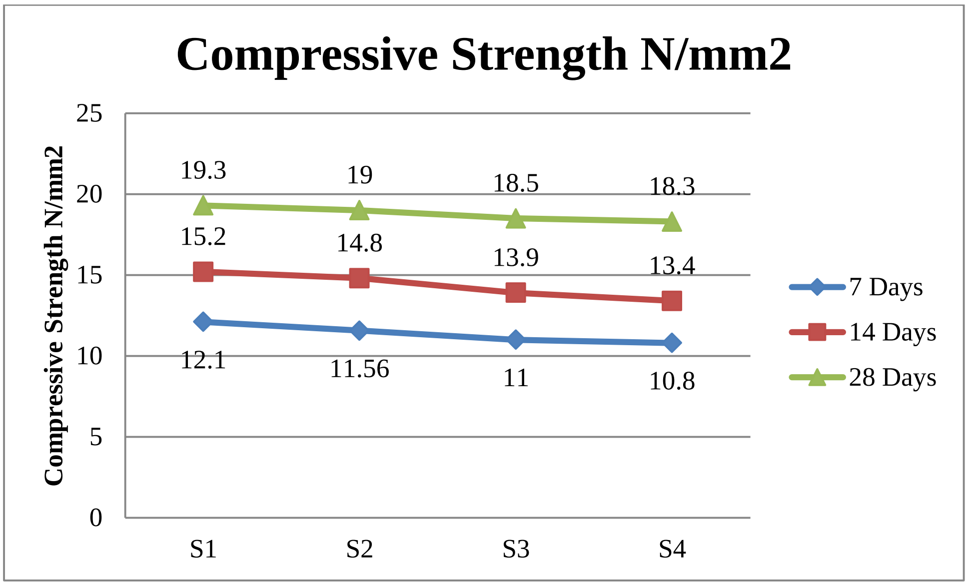

Fig. 2: Compressive Strength results

Table 4: Compressive strength of grade M20 as S1, S5, S6, S7

Mix	S-1	S-5	S-6	S-7
Fly ash (%)	0	10	20	30
FIBER (%)	0	0.25	0.25	0.25
FIBER	0	0	0	0
Test age (days)	**3-3 Samples Compressive Strength (N/mm²)**			
7	12.0 12.5 12.0 Av=12.1	15.3 15.5 15.1 Av=15.3	14.8 14.0 14.4 Av=14.4	14.0 13.1 15.2 Av=14.1
14	15.0 15.0 15.6 Av=15.2	19.0 21.8 20.4 Av=20.4	19.2 20.5 18.5 Av=19.2	19.6 18.0 18.8 Av=18.8
28	19.5 19.0 19.5 Av=19.3	26.5 24.5 25.5 Av=25.5	25.0 23.0 24.0 Av=24	24.5 22.5 23.5 Av=23.5

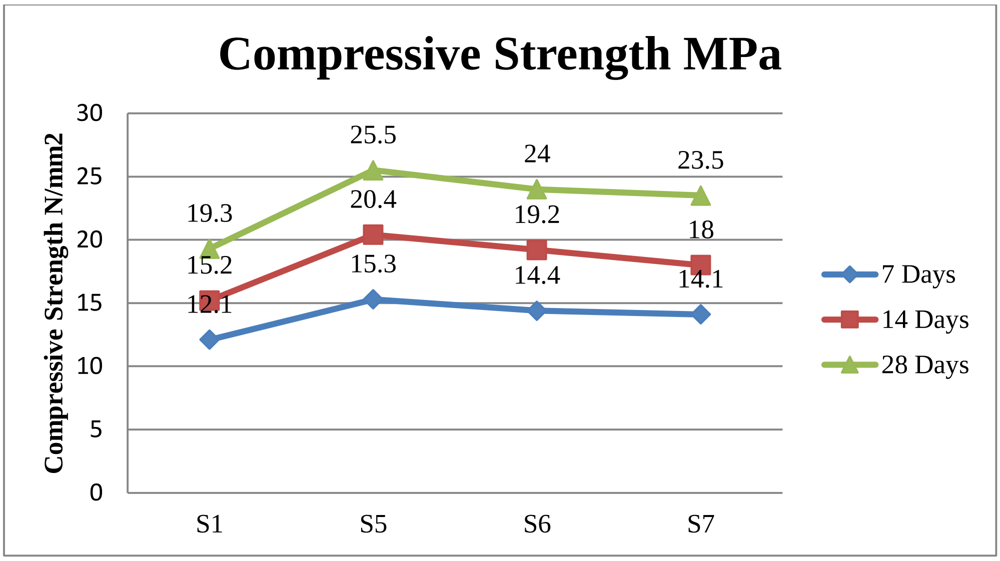

Fig. 3: Compressive Strength test results

The compressive strength of concrete mixes made with and without fly ash and Recron fiber with different percentage and variation in length of fiber were determined at 7, 14, and 28 days of curing. The test results are given in the table and shown in the figure. The maximum compressive strength was obtained for a mix having a fiber length of 40 mm, 10% fly ash and fiber content of 0.25% by weight and increase in strength over plain concrete and fly ash concrete without fiber content. The 7-day compressive strength of fly ash based Recron fiber concrete was found to be high as 17.9 Mpa. Which is more than ordinary concrete and fly ash concrete? Similarly 28-day compressive strength was found to be about 27 Mpa which is more than that of ordinary concrete and fly ash concrete. The effect of replacement of cement with three percentages of fly ash and addition of Recron fibers on the compressive strength of concrete is shown figure. It is clear that the replacement of cement with 30 % of fly ash reduced the compressive strength of concrete. And for a particular percentage of fly ash there was a decrease in the compressive strength of fly ash concrete, as the percentage of fiber increased from 0.25% to 0.5%.

3.3 Split tensile strength test results

The tensile strength of concrete was obtained indirectly by subjecting concrete cylinders to the action of a compressive force along two opposite generators. The "cylinder" split tensile test or "Brazilian Test" is an ingenious method for subjecting a large part of the cross-section of a specimen to uniform tensile stress. These tests were carried out as per the specifications of IS: 5816-1970 (14) on three numbers of cylindrical specimens.

Table 5: Split tensile strength of grade M20 as S1, S2, S3, S4

Mix	**S-1**	**S-2**	**S-3**	**S-4**
Fly ash (%)	0	10	20	30
FIBER (%)	0	0	0	0
FIBER LENGTH	0	0	0	0
Test age (days)	**3-3 Samples Split Tensile Strength (N/mm²)**			
28	2.3 2.5 2.6 **Av=2.46**	2.1 2.3 2.5 **Av=2.3**	2 2.2 2.1 **Av=2.1**	1.9 1.8 2 **Av=1.9**

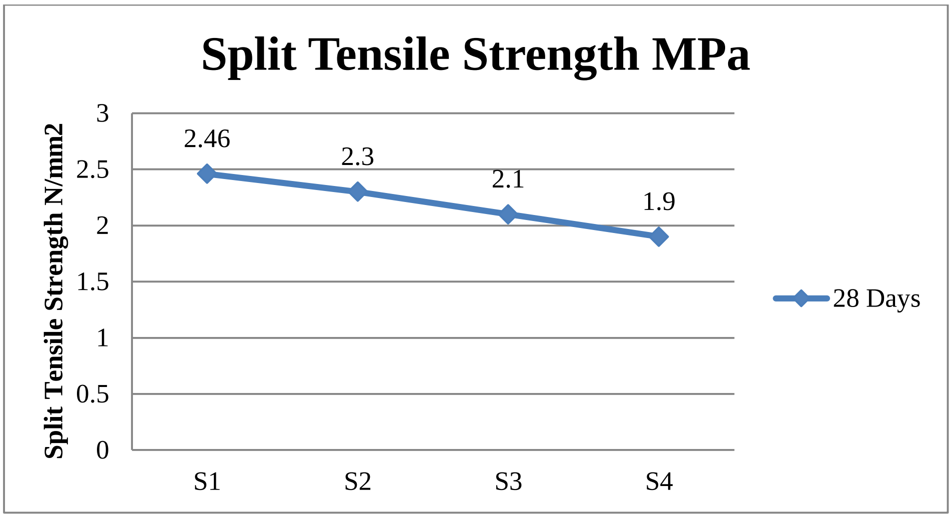

Fig. 4: Split tensile strength test results

Table 6: Split tensile strength of grade M20 as S1, S17, S18, S19

Mix	**S-1**	**S-17**	**S-18**	**S-19**
Fly ash (%)	0	10	20	30
FIBER (%)	0	0	0	0
FIBER LENGTH	0	0	0	0
Test age (days)	**3-3 Samples Split Tensile Strength (N/mm²)**			
28	2.3 2.5 2.6 **Av=2.46**	3.1 3.2 3.3 **Av=3.2**	3.0 3.1 2.9 **Av=3.0**	2.3 2.5 2.6 **Av=2.5**

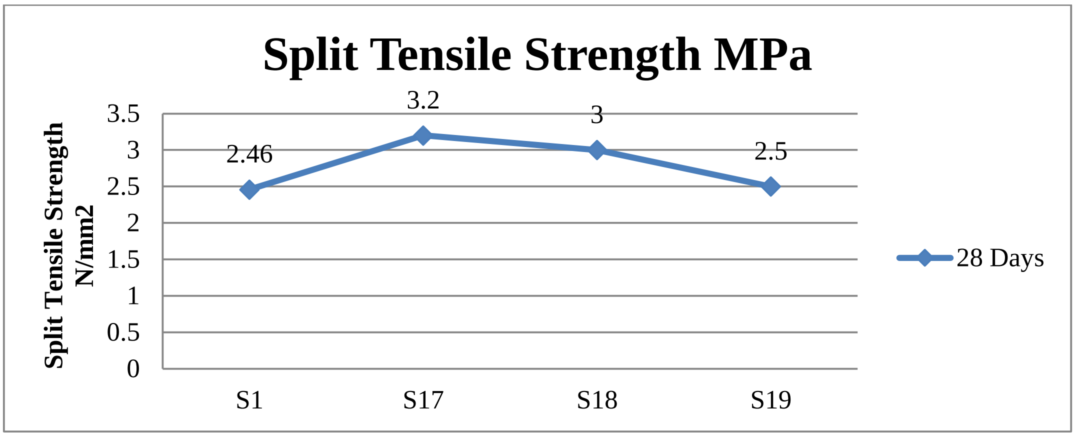

Fig. 5: Split tensile strength test results

The splitting tensile strength of concrete mixes made with and without fly ash and fiber content were measured at the age of 28 days. The results are given in the table and shown in figure respectively. In each mix, three standard cylinder specimens were tested to determine split tensile strength. The maximum value of split tensile strength obtained is 3.9Mpa, which is more than ordinary and fly ash concrete. The maximum strength was obtained for a mix with fiber length of 40mm, fiber content of 0.25% by weight and 10% fly ash replacement of cement. It is clear that the replacement of cement with 20% and 30% of fly ash reduced the splitting tensile strength of concrete. However, the rate of increase of strength is becoming lesser with the increase in fly ash content.

3.4 Flexural strength test results

A common test performed for determination of tensile strength is flexure test, in which a simple plain concrete prism of size 100 x 100 x 500mm is loaded at the center of the span. The test is performed in accordance with IS: 516 – 1959. The Flexural strengths shall be obtained as described in IS: 516-1959

Table 7: Flexural Strength of Grade M20 as S1, S2, S3, S4

Mix	**S-1**	**S-2**	**S-3**	**S-4**
Fly ash (%)	**0**	10%	20%	30%
FIBER (%)	**0**	0	0	0
FIBER LENGTH	**0**	0	0	0
Test age (days)	**3-3 Samples Flexural Strength (N/mm²)**			
28	2.3 2.4 2.2 **Av=2.3**	2.1 2.0 2.2 **Av=2.1**	1.9 1.8 1.8 **Av=1.83**	1.6 1.8 1.7 **Av=1.7**
$0.7\sqrt{fck}$	3.08	3.05	3.02	2.99

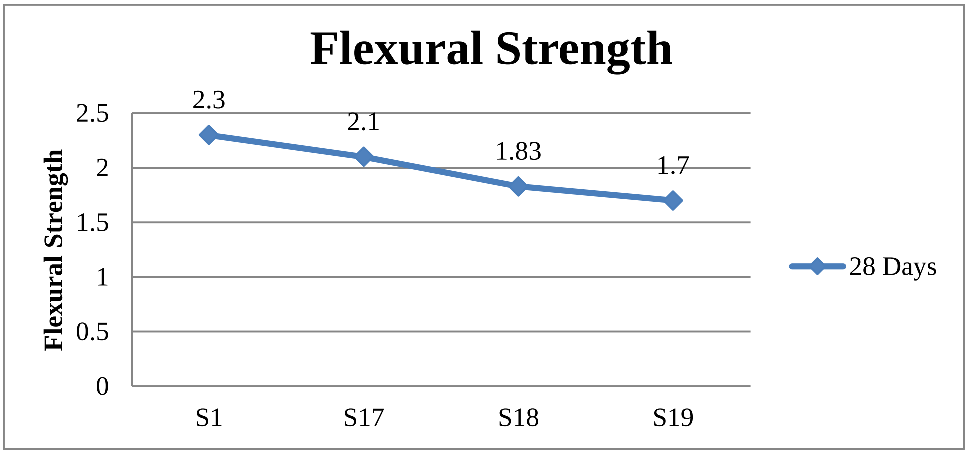

Fig. 6: Flexural Strength Test results

Table 8: Flexural Strength of Grade M20 as S1, S8, S9, S10

Mix	**S-1**	**S-8**	**S-9**	**S-10**
Fly ash (%)	**0**	10%	20%	30%
FIBER (%)	**0**	0.25%	0.25%	0.25%
FIBER LENGTH	**0**	40mm	40mm	40mm
Test age (days)	**3-3 Samples Flexural Strength (N/mm²)**			
28	2.3 2.4 2.2 **Av=2.3**	4.5 4.0 4.1 **Av=4.2**	4.0 4.0 4.0 **Av=4**	3.0 3.1 2.9 **Av=3**
0.7√fck	3.08	3.64	3.60	3.46

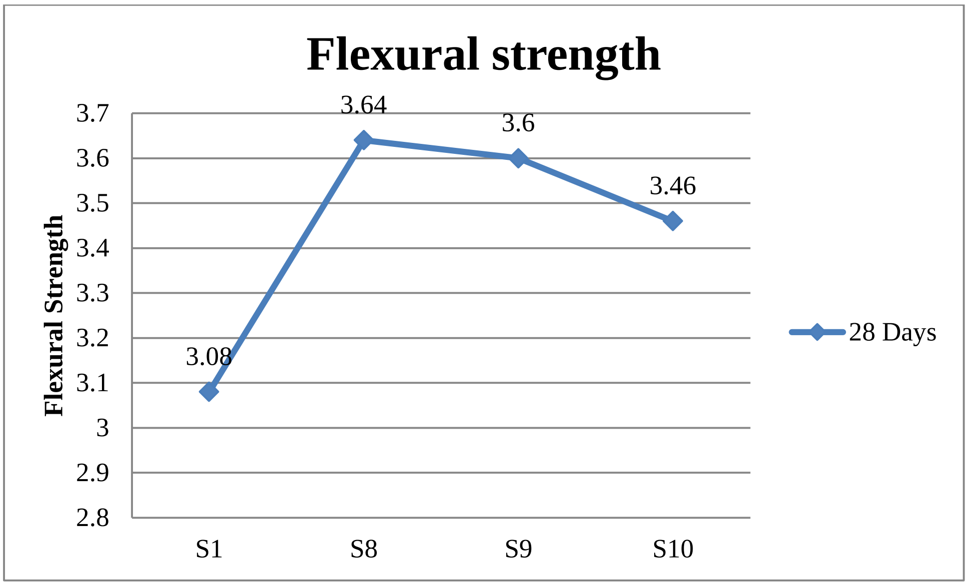

Fig. 7: Flexural Strength Test results

The flexural strength test results of fly ash concrete are given in the table and shown in figure respectively. The maximum flexural strength obtained for Recron fiber reinforced concrete was 4.6 Mpa, which was more than ordinary and fly ash concrete. The maximum strength was obtained for a mix with 0.5% fiber content, 10% fly ash replacement of cement and 40mm length. It is evident that the flexural strength of fly ash concretes continued to increase with the increase of the percentage of fly ash from 0.25% to 0.5%.

4. CONCLUSIONS

Compressive strength, Splitting Tensile strength, Flexural Strength and Modulus of Elasticity of fly ash based Recron fiber reinforced concrete specimens were higher than the plain concrete (Control Mix) and fly ash concrete specimens at all the ages. The strength differential between the plain concrete specimens and fly ash based fiber reinforced concrete specimens became more distinct after at 28 days.

- The maximum 28-day cube compressive strength obtained was 27 Mpa, for a mix with fiber length of 40mm, 10% fly ash and fiber content of 0.25% by weight and increase in strength over plain cement concrete are found to be 39.89% and increase in strength over fly ash concrete is 17.39%.
- The 7 day compressive strength of fly ash based Recron fiber reinforced concrete was found to be as high as 17.9, which is about 47.9% more than ordinary concrete.
- The replacement of cement with 20% and 30% fly ash reduced the compressive strength of concrete.
- It has been observed that as the percentage of fly ash increases the compressive strength increases initially, on further increase in its percentage reduces its compressive strength.
- The splitting tensile strength of concrete decreased with the replacement of cement with 20% and 30% fly ash. Addition of Recron fibers increased the fly ash concrete as the percentage of fiber increased from 0.25% to 0.5%.
- The maximum splitting tensile strength of the cylinder obtained was 3.9 Mpa for the mix 10% fly ash with fiber length of 40mm and fiber content of 0.25%.
- Replacement of cement with fly ash reduced the flexural strength. However, the addition of Recron fibers marginally increased the flexural strength of fly ash concrete as the percentage of fiber increased from 0.25 to 0.5%.
- The maximum value of flexural strength obtained was 4.2Mpa, for the mix with fiber length of 40mm, 10% fly ash and fiber content of 0.25%.
- Results of this investigation suggest that Class F fly ash could be very conveniently used in structural concrete.

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