wjert, 2016, Vol. 2, Issue 3, 37 -59 Research Article ISSN 2454-695X

World Journal of Engineering Research and Technology
WJERT
www.wjert.org
SJIF Impact Factor: 3.419

EXPERIMENTAL INVESTIGATION ON FLY ASH BASED COMPOSITE

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Article Received on 20/02/2016 Article Revised on 10/03/2016 Article Accepted on 02/04/2016

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ABSTRACT

This paper presents the result of an experimental investigation carried out to evaluate the mechanical property of fly Ash concrete composites with locally available natural fiber. In this context a composite with fly ash, concrete & natural coconut fiber available in plenty in rural areas of India can be a good proposition and with this background, experimental investigation to study the effects of replacement of cement by weight with different percentages of fly ash and the effects of addition of natural coconut fiber on compressive strength, flexural strength, split tensile strength, & modulus of elasticity was taken up. The study was conducted on a M20 Mix with Water-Cement ratio of 0.45 of 53 Grade OPC was replaced with three percentages (10%, 20%, and 30%) of class 'F' fly ash. Two percentages of coconut fibers (0.25% & 0.5%) with (20, 40, 60) mm length were used. For each mix standard sizes of cubes, cylinders and prisms were casted and tested at the age of 7 days, 14 days and 28 days. The test result shown that the compressive strength, spitting tensile strength, flexural strength and modulus of elasticity of fly ash based coconut fiber reinforced concrete specimens were higher than the plain concrete and fly ash concrete. It is also observed that reduction in strength with the addition of fibers continued to decrease with an increase in percentage of fly ash content.

KEYWORDS: Fly ash, Natural Coconut Fibre, Compressive Strength, Split Tensile Strength.

1. INTRODUCTION

The infrastructure needs are increasing day by day & with concrete is a main constituent of construction material in a significant portion of this infra-structural system, it is necessary to enhance its characteristics by means of strength & durability. It is also reasonable to compensate concrete in the form of using waste materials and saves in 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.

To bring into focus the use of coconut fibers in concrete and experimental program was planned to study the material characteristics. The primary objective of this investigation is to study experimentally the properties of fibers and the properties of concrete namely, compressive strength, flexural strength, split tensile strength were studied.

Coconut Fiber

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

Zuraida, S. Norshahida and co-workers. Carried out experimental investigation on effect of fiber length variation on mechanical and physical properties of coir fiber reinforced cement albumen composite, Albumen protein was added as a binder and the coir fiber with the length of (2.5, 5, 10 and 20mm) was used as partial replacement of the cement mixture. Flexural strength and compressive strength, Bulk density moisture content and water absorption were investigated the test results showed that increase in fiber length increase the flexural strength. Incorporation of long fiber into cement paste however decreased the workability and thus introduced voids which resulted in low density. In fact, the water absorption & moisture content were also increased.

Alida Abdullah, and co-workers Carried out experimental investigation on the effect of natural fiber content on the physical & mechanical properties of composite cement reinforce with coconut fiber. The mix design was based on 1:1 for cement sand ratio and 0.55 was fixed for amount of water per cement ratio. Coconut fiber was added as reinforcement and replacing the composition of sand. Composites wete developed base on 3% wt, 6%wt, 9% wt, 12% wt & 15%wt of coconut fiber by mixing & curing process. Composite were cured in water for 7, 14 & 28 days the test results showed that the composite reinforced with 9% wt of coconut fiber demonstrated the highest strength of modulus of rapture and compressive strength.

Wilson O Tablan carried out the experimental investigation on effect of coconut fiber as reinforcement to concrete on its flexural strength and cracking behavior. 25% coconut fiber was added as reinforcement. The ratio of 1:2:4 mixture of concrete was used in making the specimen & curing the period of 28 days. The result showed that the concrete reinforced with coconut fibers yielded a higher flexural strength compared to concrete without coconut fiber reinforcement. More ever the concrete with coconut fiber indicated transformation from abrupt to gradual failure of the specimens and splitting when ultimate load was applied hence the added coconut fibers enhanced the flexural strength of the concrete.

Siddique carried out experimental investigation to evaluate the mechanical properties of concrete mixes in which cement was partially replaced with class F fly ash, cement was replaced with 10%, 20%, 30%, 40%, 50% of class F fly ash by weight the test results showed that the compressive strength, splitting tensile strength & flexural strength of fly ash concrete mixes with 10% to 50% cement replacement with fly ash showed improvement in the results as compared to concrete.

2. EXPERIMENTAL PROGRAM

The aim of this experimental investigation was 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 coconut fibers 0.25% and 0.5% with different lengths of 20mm, 40mm and 60mm were used. The number of specimens casted for each case is as follows.

2.1 Experimental View

Table No. 01: Casting and Curing of M20 Grade of Concrete with 0% Fly Ash 0% Coconut Fiber.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in days	Remark
1	Cube	M20	M1	9 no's	7, 14,28	Cube size 150x150x 150mm
2	Cylinder	M20	M1	3 no's	28	Cylinder size 200x 100mm
3	Prism	M20	M1	3 no's	28	Prism size 500x100x 100mm

Table no. 02: Casting and curing of M20 grade of concrete with 10% cement replaced by fly ash and 0% coconut fiber.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M2	9 no's	7, 14,28	Cube size 150x150x 150mm
2	Cylinder	M20	M2	3 no's	28	Cylinder size 200x 100mm
3	Prism	M20	M2	3 no's	28	prism size 500x100x 100mm

Table no. 03: Casting and curing of M20 grade of concrete with 20% cement replaced by fly ash and with 0% coconut fiber.

Sl. No.	Particular	Mix Design	Code	No. Of Specimen	Curing period in Days	Remark
1	Cube	M20	M3	9 no's	7, 14,28	Cube size 150X150X 50mm
2	Cylinder	M20	M3	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M3	3 no's	28	Prism size 500X100X 100mm

Table No. 04: Casting and curing of M20 grade of concrete with 30% cement replaced by fly ash and 0% coconut fiber.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing Period in Days	Remark
1	Cube	M20	M4	9 no's	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M4	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M4	3 no's	28	Prism size 500X100X 100mm

Table No 05: Casting and curing of M20 grade of concrete with 10% cement replaced by fly ash and 0.25% of coconut fiber of 20mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M5	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M5	3 no’s	28	Cylinder size 200X 100mm
3	Prism	M20	M5	3 no’s	28	Prism size 500X100X 100mm

Table No: 06: Casting and curing of M20 grade of concrete with 20% cement replaced by fly ash and 0.25% of coconut fiber of 20mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	m20	m6	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	m20	m6	3 no’s	28	Cylinder size 200X 100mm
3	Prism	m20	m6	3 no’s	28	Prism size 500X100X 100mm

Table No. 07: Casting and curing of M20 grade of concrete with 30% cement replaced by fly ash and 0.25% of coconut fiber of 20mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M7	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M7	3 no’s	28	Cylinder size 200X 100mm
3	Prism	M20	M7	3 no’s	28	Prism size 500X100X 100mm

Table No. 08: Casting and curing of M20 grade of concrete with 10% cement replaced by fly ash and 0.25% of coconut fiber of 40mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M8	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M8	3 no’s	28	Cylinder size 200X 100mm
3	Prism	M20	M8	3 no’s	28	Prism size 500X100X 100mm

Table No. 09: Casting and curing of M20 grade of concrete with 20% cement replaced by fly ash and 0.25% of coconut fiber of 40mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M9	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M9	3 no’s	28	Cylinder size 200X 100mm
3	Prism	M20	M9	3 no’s	28	Prism size 500X100X 100mm

Table No. 10: Casting and curing of M20 grade of concrete with 30% cement replaced by fly ash and 0.25% of coconut fiber of 40mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing Period in Days	Remark
1	Cube	M20	M10	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M10	3 no’s	28	Cylinder size 200X 100mm
3	Prism	M20	M10	3 no’s	28	Prism size 500X100X 100mm

Table no 11: Casting and curing of M20 grade of concrete with 10% cement replaced by fly ash and 0.25% of coconut fiber of 60mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M11	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M11	3 no’s	28	Cylinder size 200X 100mm
3	Prism	M20	M11	3 no’s	28	Prism size 500X100X 100mm

Table No 12: Casting and curing of M20 grade of concrete with 20% cement replaced by fly ash and 0.25% of coconut fiber of 60mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period In Days	Remark
1	Cube	M20	M12	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M12	3 no’s	28	Cylinder size 200X 100mm
3	Prism	M20	M12	3 no’s	28	Prism size 500X100X 100mm

Table No 13: Casting and curing of M20 grade of concrete with 30% cement replaced by fly ash and 0.25% of coconut fiber of 60mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing Period in Days	Remark
1	Cube	M20	M13	9 no's	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M13	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M13	3 no's	28	Prism size 500X100X 100mm

Table No 14: Casting and curing of M20 grade of concrete with 10% cement replaced by fly ash, and 0.5% of coconut fiber of 20mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing Period in Days	Remark
1	Cube	M20	M14	9 no's	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M14	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M14	3 no's	28	Prism size 500X100X 100mm

Table No. 15: Casting and curing of M20 grade of concrete with 20% cement replaced by fly ash and 0.5% of coconut fiber of 20mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M15	9 no's	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M15	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M15	3 no's	28	Prism size 500X100X 100mm

Table No. 16: Casting and curing of M20 grade of concrete with 30% cement replaced by fly ash and 0.5% of coconut fiber of 20mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M16	9 no's	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M16	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M16	3 no's	28	Prism size 500X100X 100mm

Table No. 17: Casting and curing of M20 grade of concrete with 10% cement replaced by fly ash and 0.5% of coconut fiber of 40mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M17	9 no's	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M17	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M17	3 no's	28	Prism size 500X100X 100mm

Table No. 18: Casting and curing of M20 grade of concrete with 20% cement replaced by fly ash and 0.5% of coconut fiber of 40mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M18	9 no's	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M18	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M18	3 no's	28	Prism size 500X100X 100mm

Table No. 19: Casting and curing of M20 grade of concrete with 30% cement replaced by fly ash and 0.5% of coconut fiber of 40mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M19	9 no's	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M19	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M19	3 no's	28	Prism size 500X100X 100mm

Table No. 20: Casting and curing of M20 grade of concrete with 10% cement replaced by fly ash and 0.5% of coconut fiber of 60mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M20	9 no's	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M20	3 no's	28	Cylinder size 200X 100mm
3	Prism	M20	M20	3 no's	28	Prism size 500X100X 100mm

Table No. 21: Casting and curing of M20 GRADE of concrete with 20% cement replaced by fly ash and 0.5% of coconut fiber of 60mm.

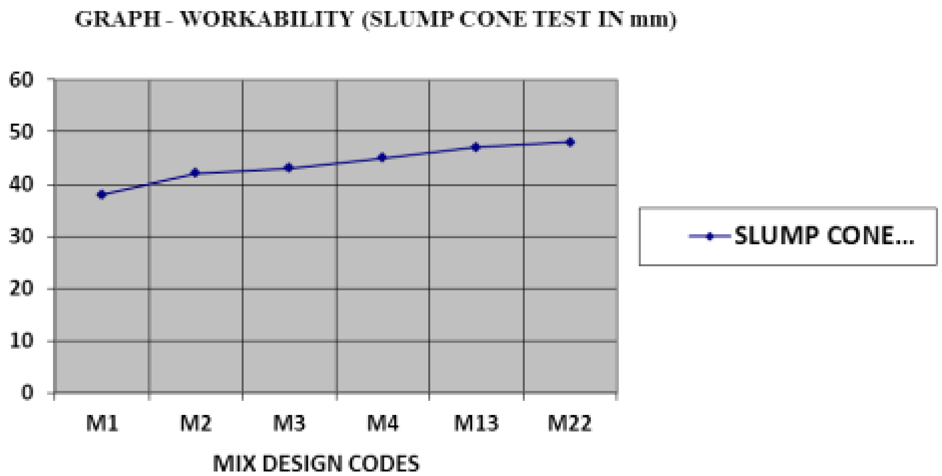
Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M21	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M21	3 no’s	28	Cylinder size 200X 100mm
3	Prism	M20	M21	3 no’s	28	Prism size 500X100X 100mm

Table No. 22: Casting and curing of M20 grade of concrete with 30% cement replaced by fly ash and 0.5% of coconut fiber of 60mm.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M20	M22	9 no’s	7, 14,28	Cube size 150X150X 150mm
2	Cylinder	M20	M22	3 no’s	28	Cylinder size 200X 100mm
3	Prism	M20	M22	3 no’s	28	Prism size 500X100X 100mm

Table No. 23: Workability of various concrete mixes design for slump cone test is as follows

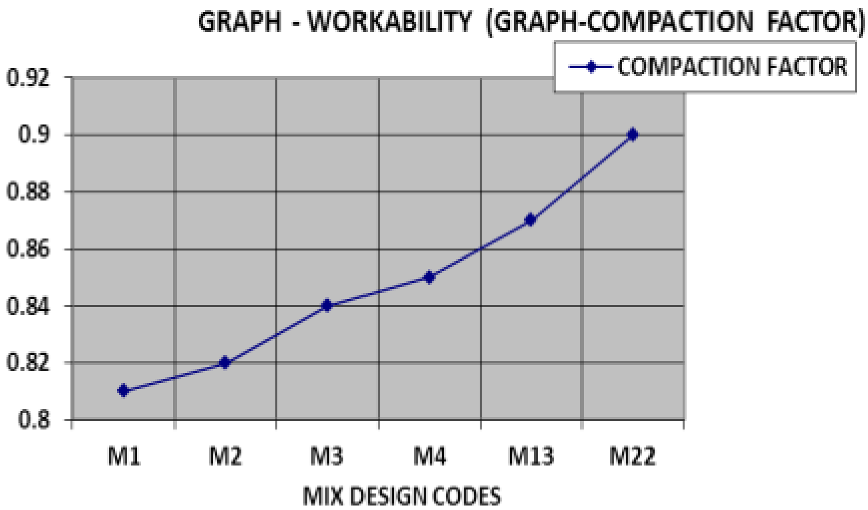
Mix design codes	Slump cone test in mm.
M1-MIX (normal concrete)	38
M2-MIX (10% fly ash)	42
M3-MIX (20% fly ash)	43
M4-MIX (30% fly ash)	45
M13-MIX (30% fly ash,0.25% fiber)	47
M22-MIX (30% fly ash, 0.5% fiber)	48



Graph No: 1: Workability (Slump Cone Test in mm)

Table No. 24: Workability of various concrete mix design for compaction factor test

Serial No.	Mix Design Code	Compaction Factor
1	M1	0.81
2	M2	0.82
3	M3	0.84
4	M4	0.85
5	M13	0.87
6	M22	0.90



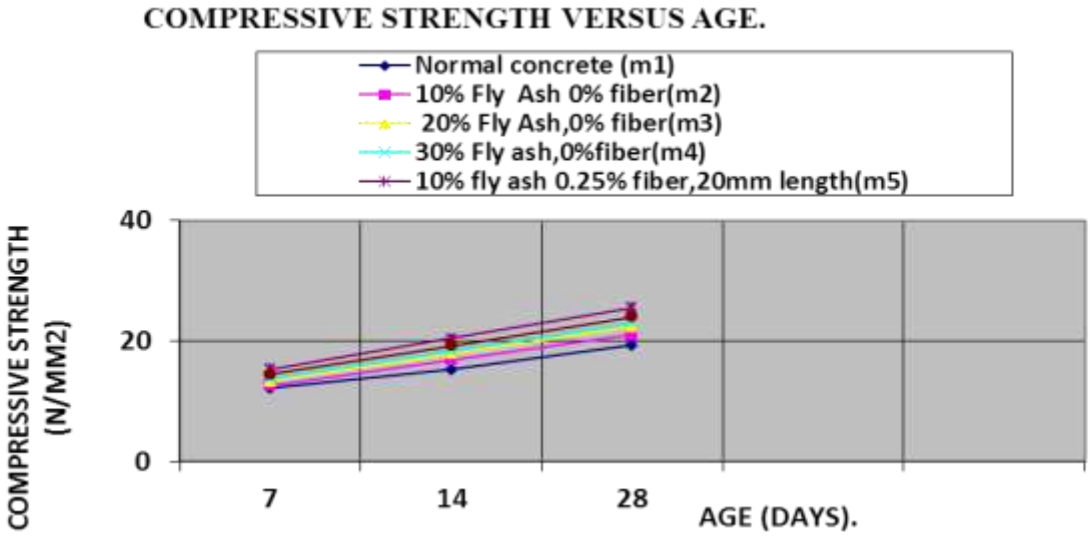
Graph No. 2: Workability (Graph Compaction Factor)

Details of Specimens Used

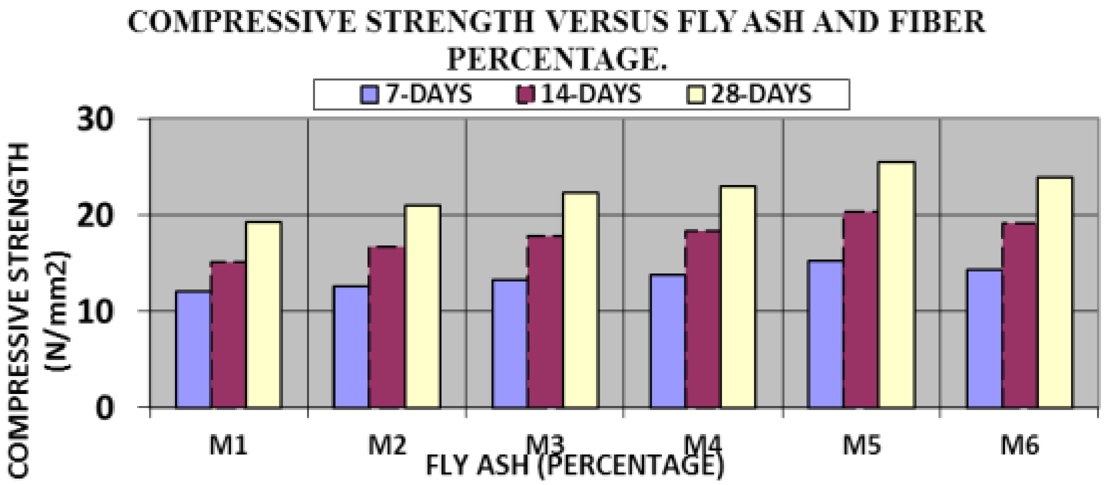
1. 150mm x 150mm x 150mm cube specimens for Compressive strength & Modulus of Elasticity.
2. 100mm diameter x 200mm length specimens are used for Split Tensile Strength test.
3. 100mm x 100mm x 500mm prisms specimens are used for Flexural Strength test.

2.2 Tests for Compressive Strength of Concrete

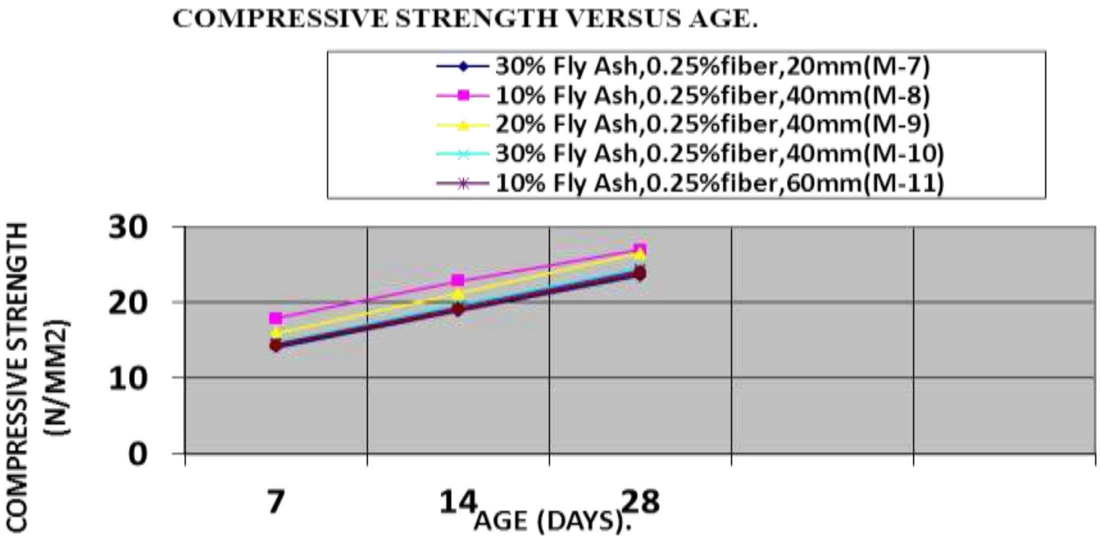
In the investigation, conventional concrete and fly ash based coconut fiber composite, concrete cubes of 150mm x 150mm x 150mm sizes were used for testing the compressive strength. The cubes are tested in a compression-testing machine of capacity 2000kn. The load has been applied at a rate of 315kn/mm. The load applied in such a way that the two opposite sides of the cubes are compressed. The load at which the control specimen ultimately fails is noted. The average of three cubes is taken as compressive strength.



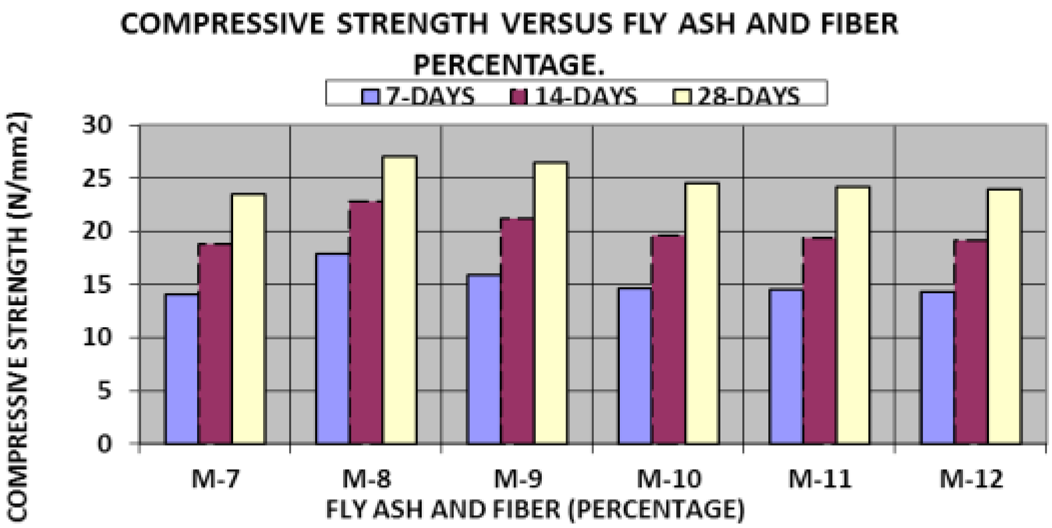
Graph No 3: Showing the variation of compressive strength with age for various fly ash and fiber percentages of M20 grade.



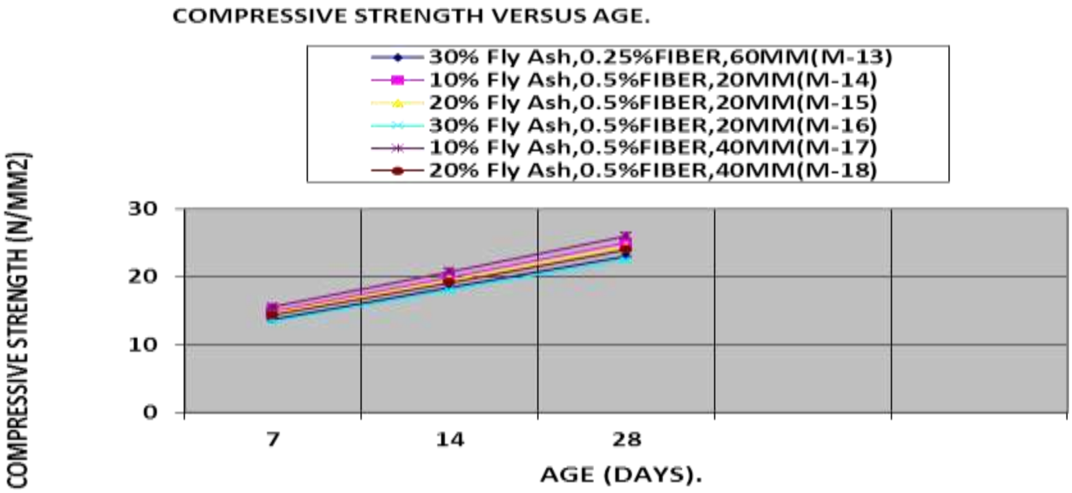
Graph No. 4: Showing the variation of fly ash and fiber percentage versus compressive strength in n/mm^2 of M20 grade



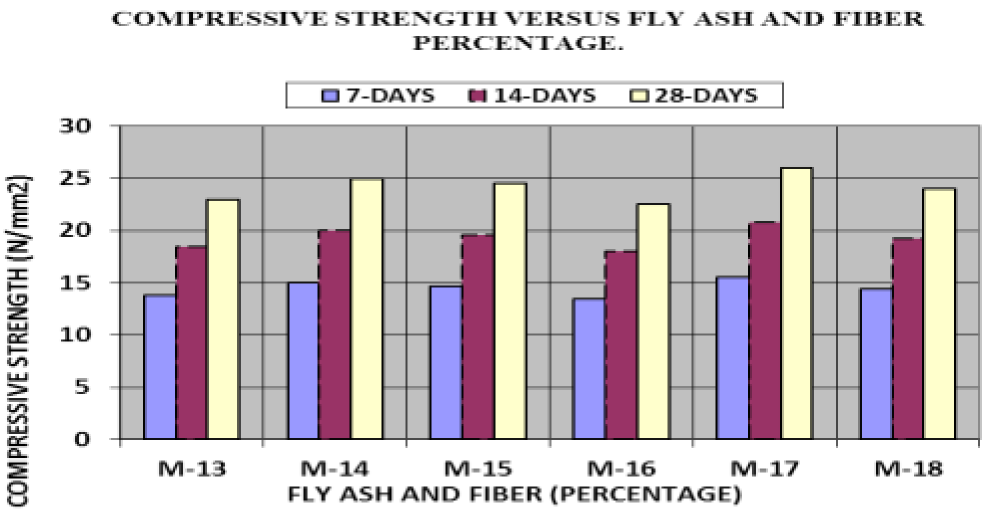
Graph No 5: Showing the variation of compressive strength with age for various fly ash and fiber percentages of M20 grade.



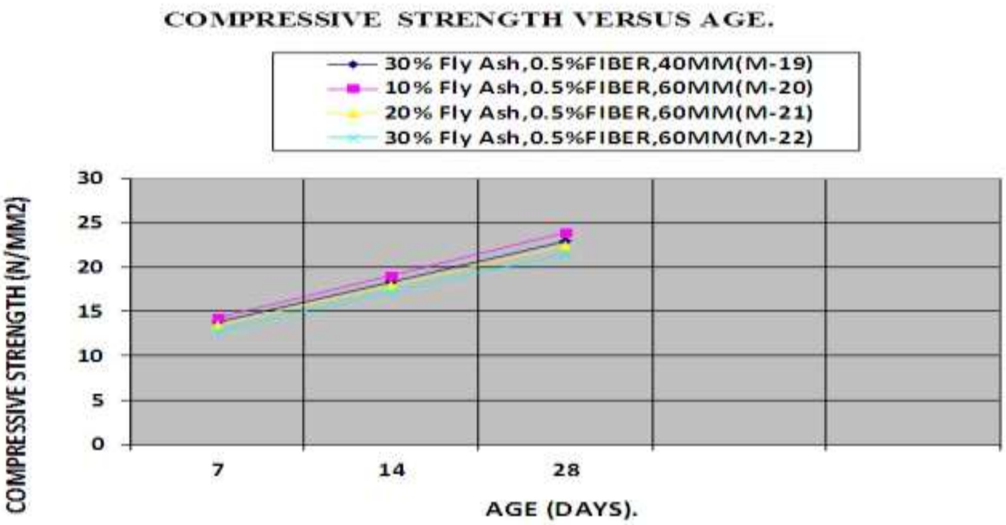
Graph No 6: Showing the variation of fly ash and fiber percentage versus compressive strength in n/mm^2 of M20 grade.



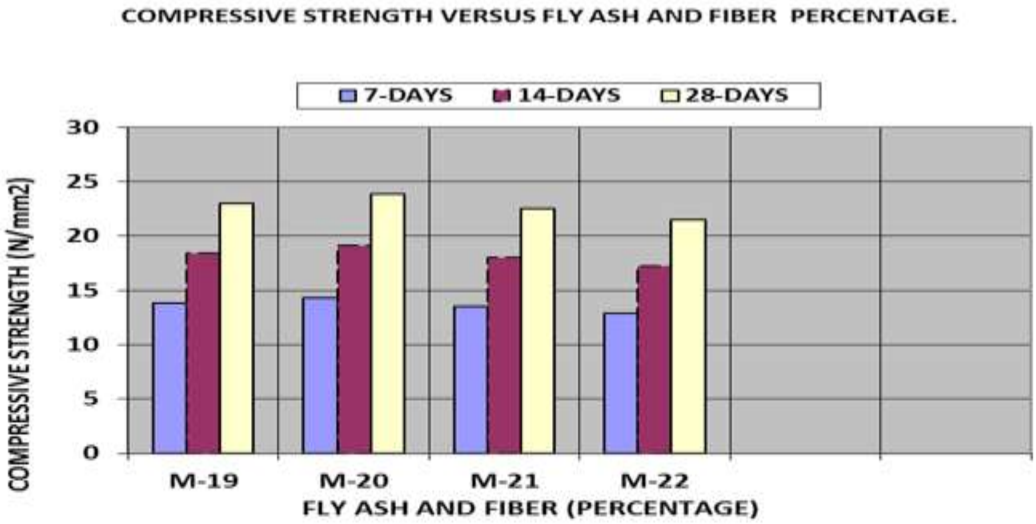
Graph No. 7: Showing the variation of compressive strength with age for various fly ash and fiber percentages of M20 grade.



Graph 8: Showing the variation of fly ash and fiber percentage versus compressive strength in n/mm^2 of M20 grade



Graph No 9: Showing the variation of compressive strength with age for various fly ash percentages of M20 grade



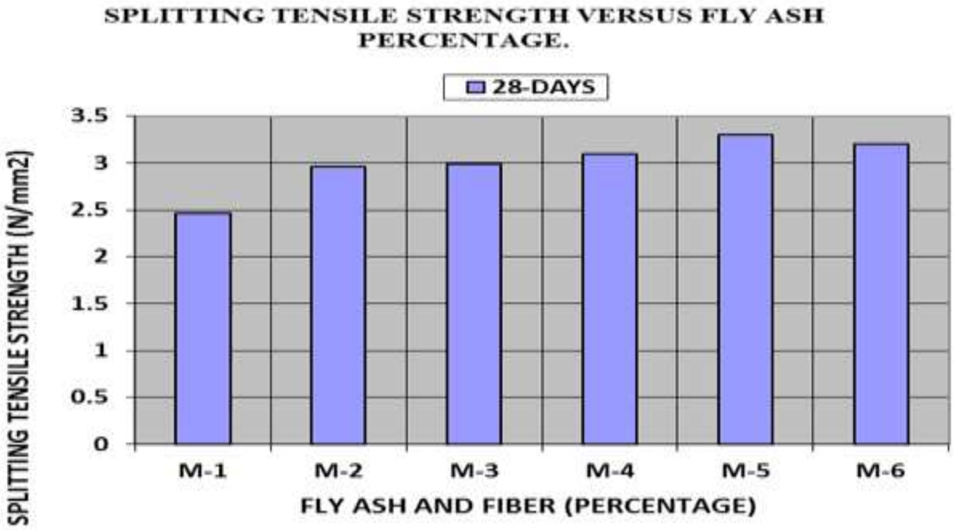
Graph No. 10: Showing the variation of fly ash percentage versus compressive strength in n/mm^2 of M20 grade

RESULTS AND DISCUSSION OF COMPRESSIVE STRENGTH

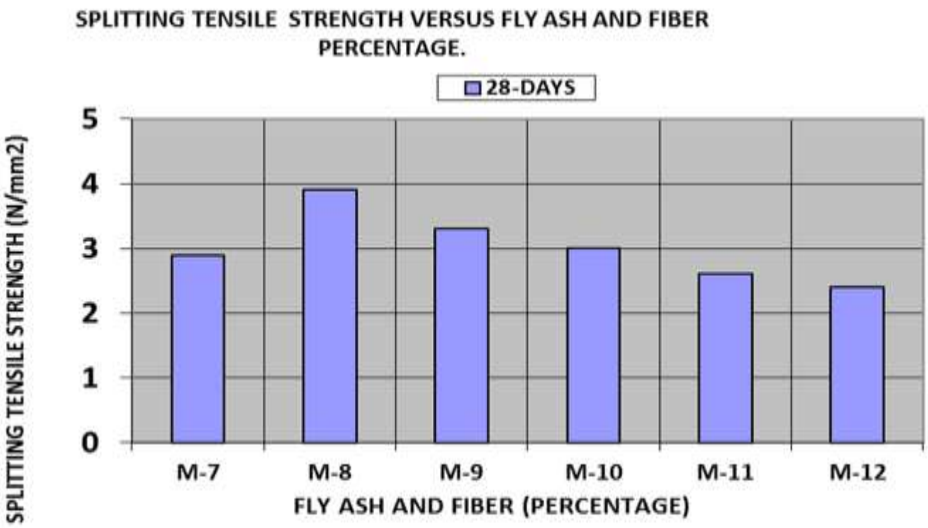
Compressive strength of concrete mixes made with and without fly ash and coconut fiber with different percentage and variation in length of fiber were determined at 7, 14, and 28 days of curing. The test results are given in table and shown in figure. The maximum compressive strength was obtained for 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 coconut 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.

2.3 Test for Split Tensile Strength

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: 58166-1970 (14) on three numbers of cylindrical specimens. The specimens were placed between the two patterns of the compression testing machine. Steel stripe of 3mm thick, 12mm wide and 300m long were placed between the plate and the surface of the cylinder. The load was applied at a uniform rate of 100kn/minute till the specimen failed along the vertical diameter.

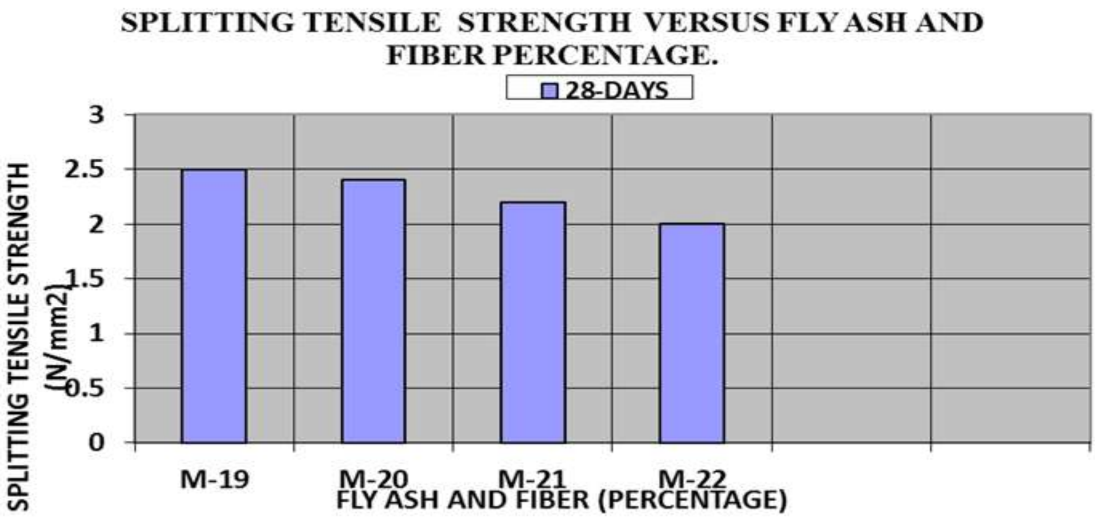


Graph No 11: Showing the variation of fly ash and fiber percentage versus splitting tensile strength in n/mm^2 of M20 grade.



Graph No: 12: Showing the variation of fly ash and fiber percentage versus splitting tensile strength in n/mm^2 of M20 grade

Graph No 13: Showing the variation of fly ash and fiber percentage versus splitting tensile strength in n/mm^2 of M20 grade.



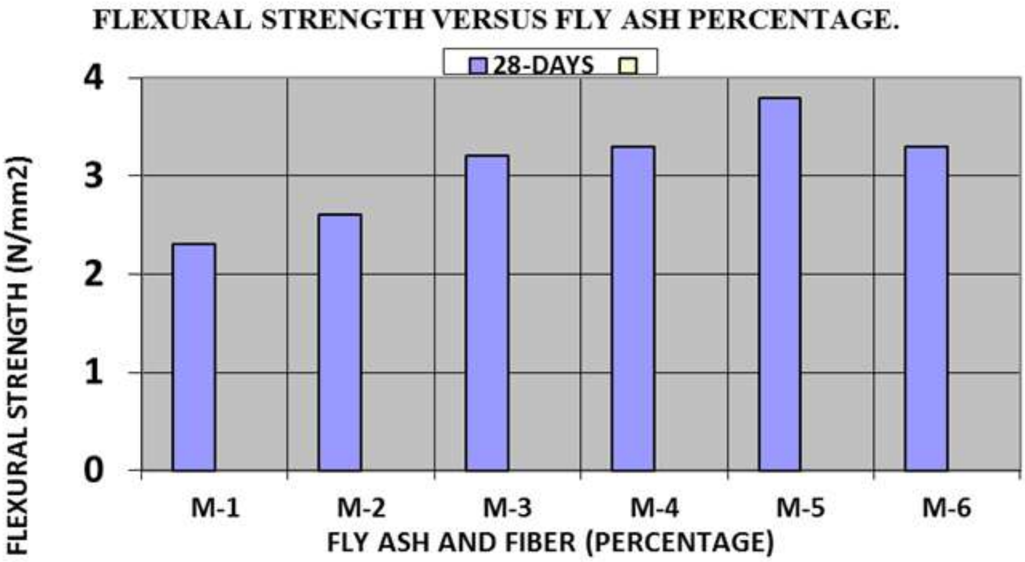
Graph No 14: Showing the variation of fly ash and fiber percentage versus splitting tensile strength in n/mm^2 of M20 grade.

RESULTS AND DISCUSSION ON SPLIT TENSILE STRENGTH

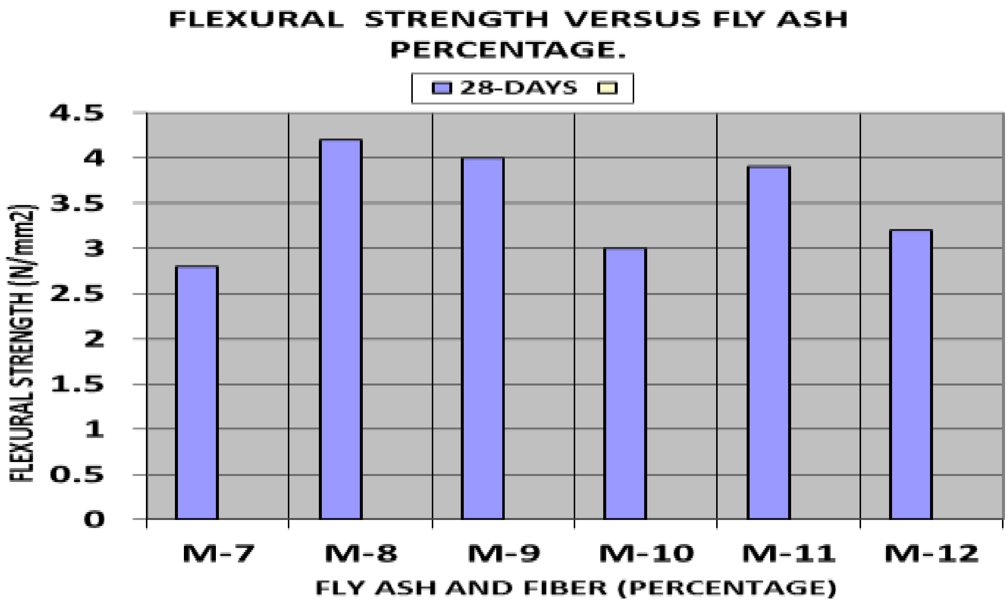
The splitting tensile strength of concrete mixes made with and without fly ash and fiber content were measured at the age of 28 days. The results are given in table and shown in figure respectively. In each mix, three standard cylinder specimens were tested to determine split tensile strength. The maximum 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.

2.4 Test for Flexural Strength:

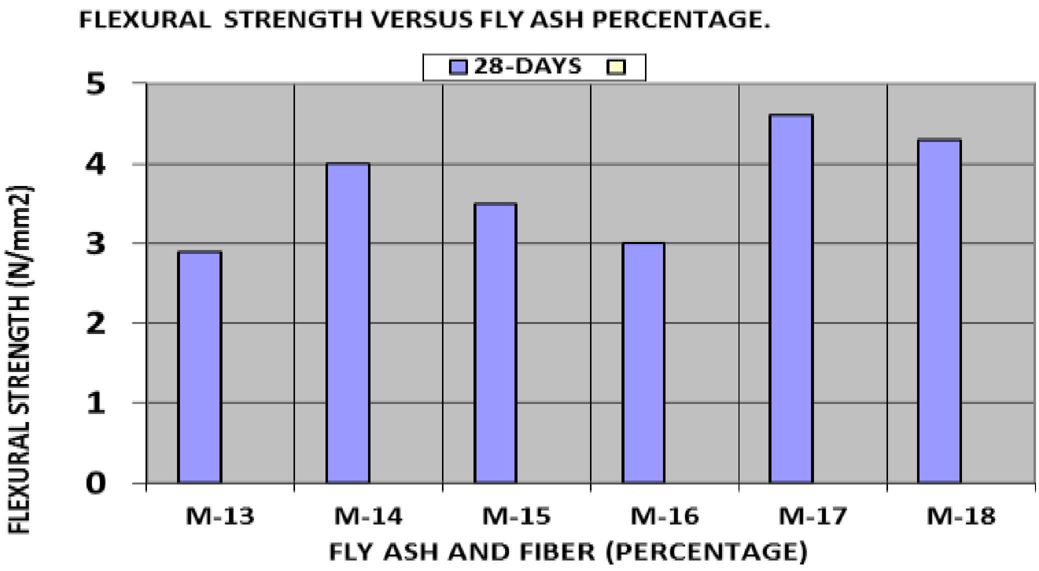
A common test performed for determination of tensile strength is flexure test, in which a simple plain concrete prism of size 100 x 100 x 500mm is loaded at the center of span. The test is performed in accordance with IS: 516 – 1959.



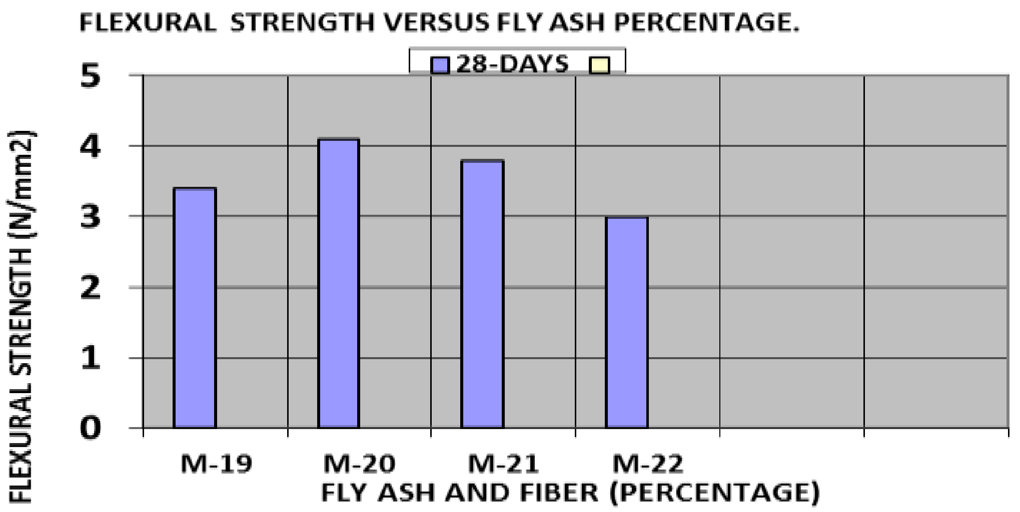
Graph No. 15: Showing the variation of fly ash and fiber and fiber percentage versus flexural strength in n/mm^2 of M20 grade.



Graph No. 16: Showing the variation of fly ash and fiber percentage versus flexural strength in n/mm^2 of M20 grade.



Graph No. 17: Showing the variation of fly ash percentage versus flexural strength in n/mm^2 of M20 grade.



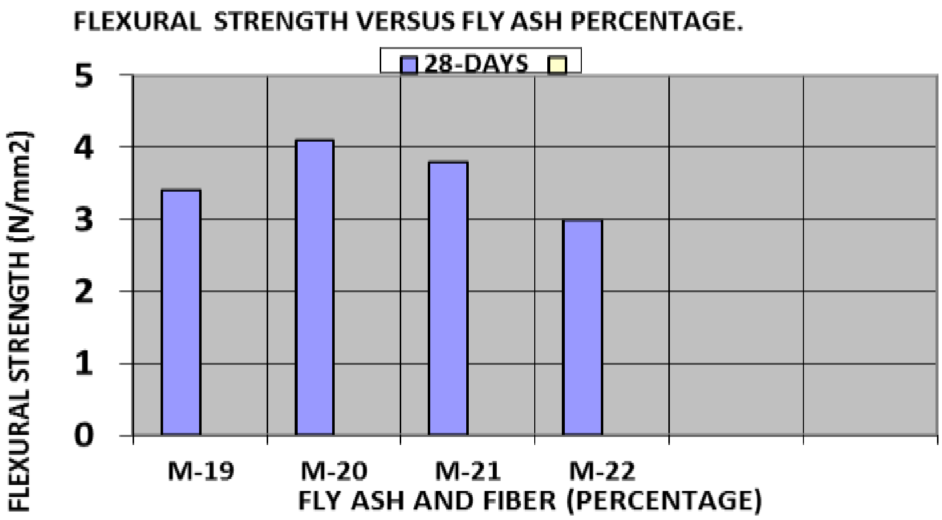
Graph No. 18: Showing the variation of fly ash and fiber percentage versus flexural strength in n/mm^2 of M20 grade

RESULTS AND DISCUSSION FLEXURAL STRENGTH

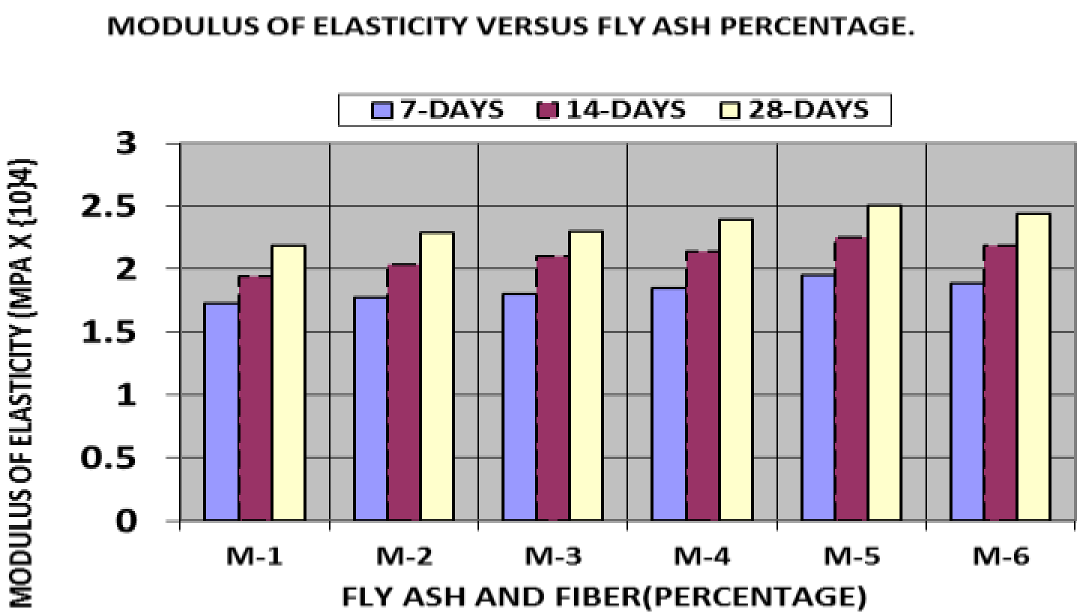
The flexural strength test results of fly ash concrete are given in table and shown in figure respectively. The maximum flexural strength obtained for coconut fiber reinforced concrete was 4.6 Mpa, which was more than ordinary and fly ash concrete. The maximum strength was obtained for a mix with 0.5% 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 percentage of fly ash from 0.25% to 0.5%.

2.5 Test for Modulus of Elasticity

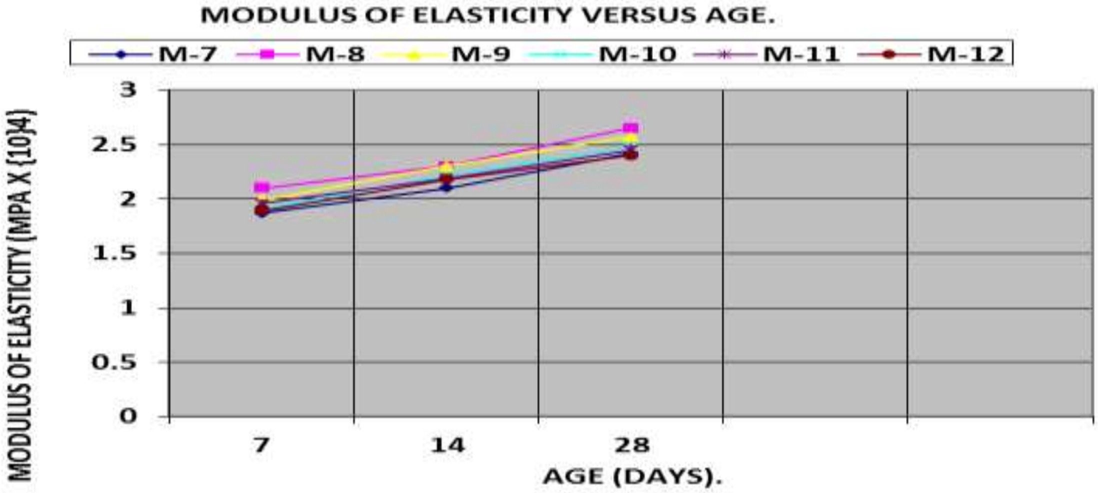
The modulus of elasticity is primarily influenced by the elastic properties of the aggregate and to a lesser extent by the conditions of curing and age of the concrete, the mix proportions and the type of cement. The modulus of elasticity is normally related to the compressive strength of concrete.



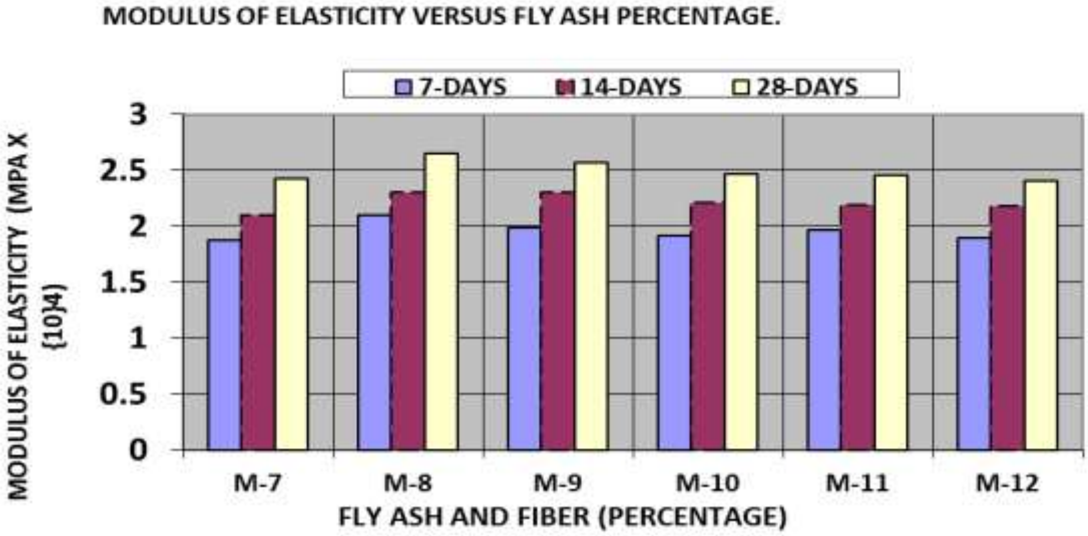
Graph No. 19: Showing the variation of modulus of elasticity with age for various fly ash percentages of M20 grade



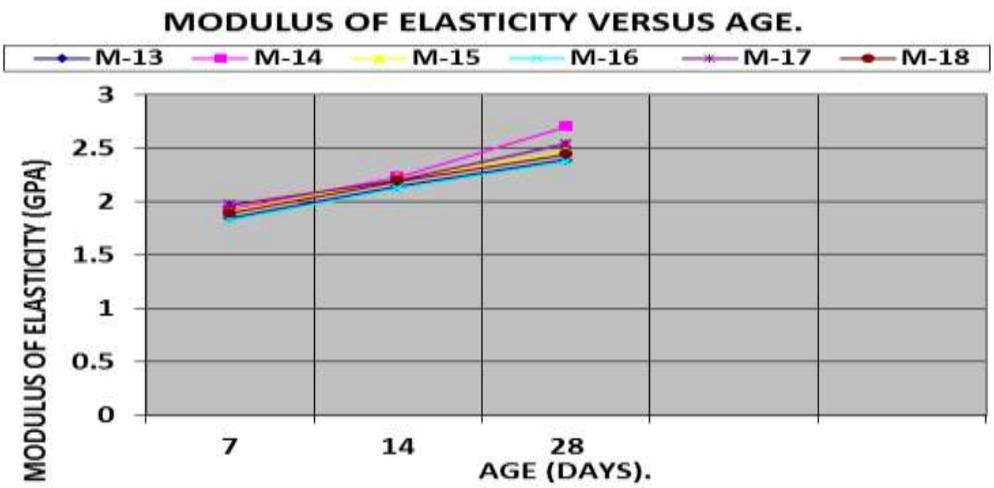
Graph No. 20: Showing the variation of fly ash percentage versus modulus of elasticity in mpax10^4 of M20 grade



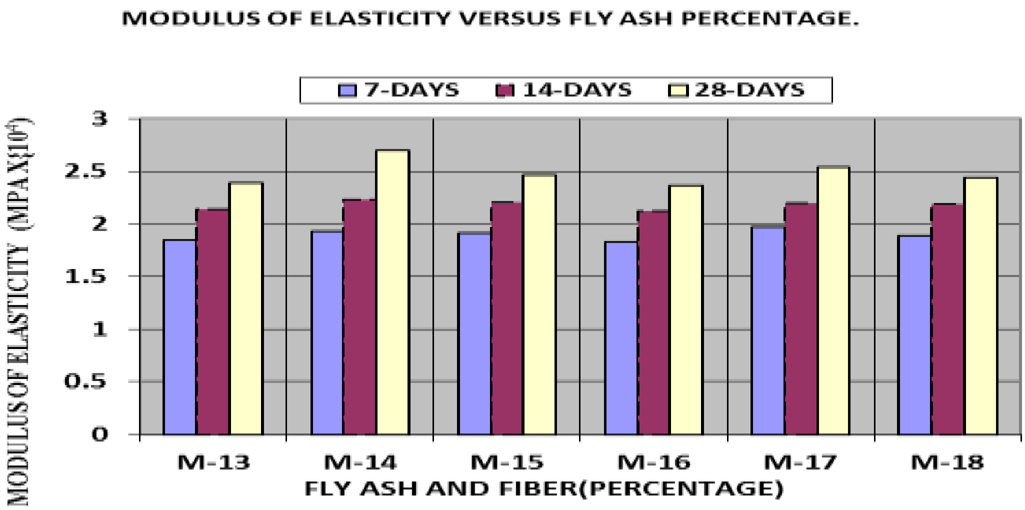
Graph No. 21: Showing the variation of modulus of elasticity with age for various fly ash and fiber percentages of M20 grade.



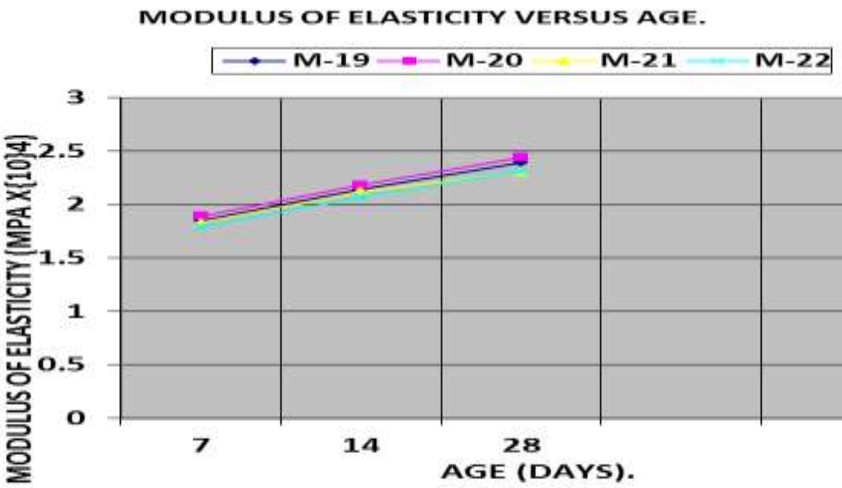
Graph No. 22: Showing the variation of fly ash percentage versus modulus of elasticity in mpax10^4 of M20 grade.



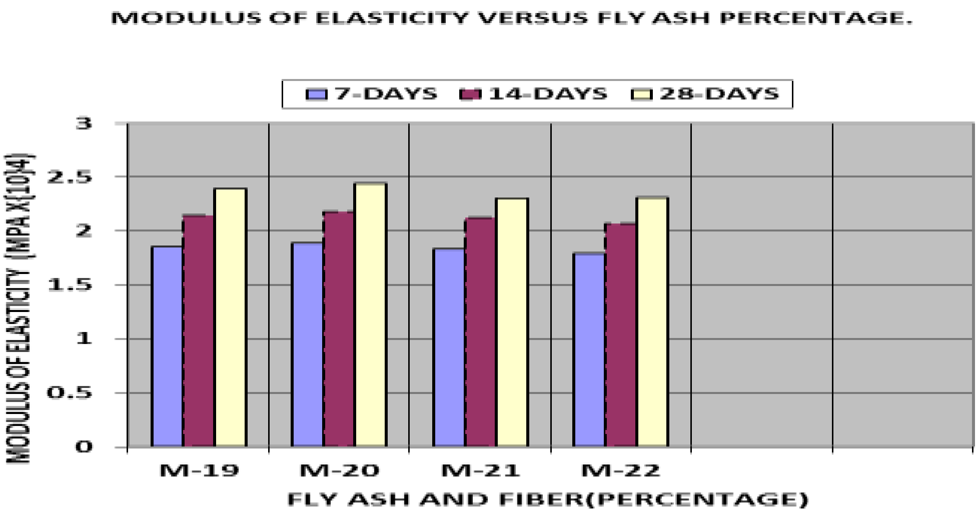
Graph No. 23: Showing the variation of modulus of elasticity with age for various fly ash percentages of M20 grade.



Graph No. 24: Showing the variation of fly ash percentage versus modulus of elasticity in MPA x 10^4 of M20 grade.



Graph No 25: Showing the variation of modulus of elasticity with age for various fly ash percentages of M20 grade.



Graph No. 26: Showing the variation of fly ash percentage versus modulus of elasticity in MPA x 10^4 of M20 grade.

RESULTS AND DISCUSSION OF MODULUS OF ELASTICITY

Modulus of Elasticity test results of fly ash concretes are given in table and shown in figure respectively. The variation of modulus of elasticity with age, and the variation of modulus of elasticity with fly ash percentages, fiber length and fiber content is shown in figure. The modulus of elasticity of this composite significantly increased with respect to fiber content and fly ash. From the test results, it can be seen that the modulus of elasticity of coconut fiber reinforced fly ash concretes with 10% fly ash, 0.5% fiber for 20mm length was higher than the control mix (M-1) at all ages. The modulus of Elasticity of all mixes continued to increase with age.

The Modulus of Elasticity of fly ash concretes continued to increase with the increase in fiber content. However, the rate of increase is becoming lesser with the increase in fly ash content. This trend is more obvious between 20% and 30% replacement level. However, maximum strength at all ages occurs at 10% cement replacement.

When cement is partially replaced by fly ash and reinforced with natural coconut fiber the Compressive Strength, Tensile Strength, Flexural Strength and Modulus of Elasticity of concrete reaches its maximum. The maximum strength is reached due to better packing and ball bearing effect produced by the spherical fly ash particles and interspatial forces which influences both the hydration and packing efficiency of concrete. The strength is increased because of the improved deflocculating of cement agglomerates resulting in an increased rate of CaOH generated and stimulated pozzolanic activity in the fly ash.

The high modulus of elasticity is achieved due to the fact that a considerable portion of unreacted fly ash consisting of glassy spherical particles act as times to fill the voids present in fine aggregates.

The strength is increased due to the increased cohesiveness, total absence of bleeding and decreases in voids.

CONCLUSIONS

The following conclusions can be drawn from the present Investigations

Compressive strength, Splitting Tensile strength, Flexural Strength and Modulus of Elasticity of fly ash based coconut 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 is 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 coconut fiber reinforced concrete was found to be 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 replacement of cement with 20% and 30% fly ash. Addition of coconut fibers increased the fly ash concrete as the percentage of fiber increased from 0.25% to 0.5%.

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