International Journal of scientific research and management (IJSRM)
\||Volume||3||Issue||7||Pages|| 3379-3395||2015||
Website: www.ijsrm.in ISSN (e): 2321-3418

"Strength Analysis of Class F-Fly Ash Based Coconut Fiber Composite"

B.Rajasekhar[1], M.Prakash[2], P.Suresh[3]

[1] Associate Professor Department of Civil Engineering, Sri Venkateswara College of Engineering and Technology, Chittoor, Andhra Pradesh, India

[2] M.Tech Student, Department of Civil Engineering, Sri Venkateswara College of Engineering and Technology, Chittoor, Andhra Pradesh, India
[3]An AMIE Student

ABSTRACT

The report 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 area's 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. In present experiment the fly ash is obtained from Raichur thermal plant, Karnataka and the natural coconut fiber is obtained from coir factory, Tiptur, Karnataka. The studies were conducted on a M20 Mix with W/C of 0.45 of 53 grade OPC was replaced with three percentages (10%, 20%, 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 are casted as per Indian standards and tested at the age of 7 days, 14 days and 28 days as per Indian standards. The results are compared with plain concrete, fly ash concrete and fly ash based coconut fiber reinforced composite. 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 observed that the maximum compressive strength, splitting tensile strength of cylinder and flexural strength was 27 Mpa, 3.9 Mpa and 4.2 Mpa respectively for a mix fiber length of 40mm, 10% fly ash and fiber content of 0.25% by weight. 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.

INTRODUCTION

The infrastructure needs our country is 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. Concrete in general has a higher brittleness with increase in strength. This is a major drawback since brittleness can cause sudden & catastrophic failure, especially in structures which are subjected to earthquake, blast or suddenly applied loads i.e., impact. This serious disadvantage of concrete can at least partially be 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. The utilization of fly ash instead of dumping it as a waste material can be both on economic and environmental grounds and also because of its beneficial effects of lower water demand for similar workability reduced bleeding and lower evolution of heat. The proportion of fly ash used as a cementitious component in concrete depends on several factors. The design strength and workability of concrete, water demand and relative cost of fly ash compared with cement are particularly important in mixture proportioning of concrete. To bring into focus the use of coconut fibers in concrete and experimental programme was planned to study the material characteristics. The primary objective of this investigation is to study experimentally the properties of fibers. The properties of concrete namely, compressive strength, flexural strength, split tensile strength were studied.

METHODOLOGY AND EXPERIMENTAL PROGRAM

Aim:

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

1. Mechanical properties like Compressive strength, Split Tensile strength, Flexural strength test and Modulus of Elasticity.

Figure 1: Mixing of materials and casting

Figure 2: Freshly Placed Specimen

Figure 3: Cubes, prisms, and cylinders ready for curing

Figure 4: Curing of Specimens

M-1	Control Concrete or Conventional Concrete
M-2	10% replacement of Cement by Fly Ash
M-3	20% replacement of Cement by Fly Ash
M-4	30% replacement of Cement by Fly Ash
M-5	10% replacement of Cement by Fly Ash, 0.25% coconut fiber of 20mm length.
M-6	20% replacement of Cement by Fly Ash, 0.25% coconut fiber of 20mm length.
M7	30% replacement of Cement by Fly Ash, 0.25% coconut fiber of 20mm length.
M8	10% replacement of Cement by Fly Ash, 0.25% coconut fiber of 40mm length.
M9	20% replacement of Cement by Fly Ash, 0.25% coconut fiber of 40mm length.
M10	30% replacement of Cement by Fly Ash, 0.25% coconut fiber of 40mm length.
M11	10% replacement of Cement by Fly Ash, 0.25% coconut fiber of 60mm length.
M12	20% replacement of Cement by Fly Ash, 0.25% coconut fiber of 60mm length.
M13	30% replacement of Cement by Fly Ash, 0.25% coconut fiber of 60mm length.
M14	10% replacement of Cement by Fly Ash, 0.5% coconut fiber of 20mm length.
M15	20% replacement of Cement by Fly Ash, 0.5% coconut fiber of 20mm length.
M16	30% replacement of Cement by Fly Ash, 0.5% coconut fiber of 20mm length.
M17	10% replacement of Cement by Fly Ash, 0.5% coconut fiber of 40mm length.
M18	20% replacement of Cement by Fly Ash, 0.5% coconut fiber of 40mm length.
M19	30% replacement of Cement by Fly Ash, 0.5% coconut fiber of 40mm length.
M20	10% replacement of Cement by Fly Ash, 0.5% coconut fiber of 60mm length.
M21	20% replacement of Cement by Fly Ash, 0.5% coconut fiber of 60mm length.
M22	30% replacement of Cement by Fly Ash, 0.5% coconut fiber of 60mm length.

Table.1 Compressive Strength of Grade M20 as M1, M2, M3, M4, M5, M6

Mix	**M-1**	**M-2**	**M-3**	**M-4**	**M-5**	**M-6**
Fly as (%)	0	10	20	30	10	20
FIBER (%)	0	0	0	0	0.25	0.25
FIBER LENGTH	0	0	0	0	20mm	20mm
Test age (days)	**3-3 SAMPLES COMPRESSIVE STRENGTH (N/mm²)**					
7	**12.1**	**12.56**	**13.3**	**13.8**	**15.3**	**14.4**
14	**15.2**	**16.8**	**17.8**	**18.4**	**20.4**	**19.2**
28	**19.3**	**21**	**22.3**	**23**	**25.5**	**24**

Table.2 Compressive strength of grade M20 as M7, M8, M9, M10, M11, M12

Mix	**M-7**	**M-8**	**M-9**	**M-10**	**M-11**	**M-12**
Fly as (%)	30	10	20	30	10	20
FIBER (%)	0.25	0.25	0.25	0.25	0.25	0.25
FIBER LENGTH	20mm	40mm	40mm	40mm	60mm	60mm
Test age (days)	**3-3 SAMPLES COMPRESSIVE STRENGTH (N/mm²)**					
7	**14.1**	**17.9**	**15.9**	**14.7**	**14.5**	**14.3**
14	**18.8**	**22.8**	**21.2**	**19.6**	**19.3**	**19.1**
28	**23.5**	**27**	**26.5**	**24.5**	**24.2**	**23.9**

Table.3 Compressive strength of grade M20 as M13, M14, M15, M16, M17, M18

Mix	**M-13**	**M-14**	**M-15**	**M-16**	**M-17**	**M-18**
Fly as (%)	30	10	20	30	10	20
FIBER (%)	0.25	0.5	0.5	0.5	0.5	0.5
FIBER LENGTH	60mm	20mm	20mm	20mm	40mm	40mm
Test age (days)	**3-3 SAMPLES COMPRESSIVE STRENGTH (N/mm²)**					
7	**13.8**	**15**	**14.7**	**13.5**	**15.6**	**14.4**
14	**18.4**	**20**	**19.6**	**18**	**20.8**	**19.2**
28	**23**	**25**	**24.5**	**22.5**	**26**	**24**

Table.4 Compressive Strength of Grade M20 as M19, M20, M21, M22

Mix	**M-19**	**M-20**	**M-21**	**M-22**
Fly Ash (%)	30	10	20	30
Fiber (%)	0.5	0.5	0.5	0.5
Fiber Length	40mm	60mm	60mm	60mm
Test age (days)	**3-3 SAMPLES COMPRESSIVE STRENGTH (N/MM²)**			
7	**13.8**	**14.3**	**13.5**	**12.9**
14	**18.4**	**19.1**	**18**	**17.2**
28	**23**	**23.9**	**22.5**	**21.5**

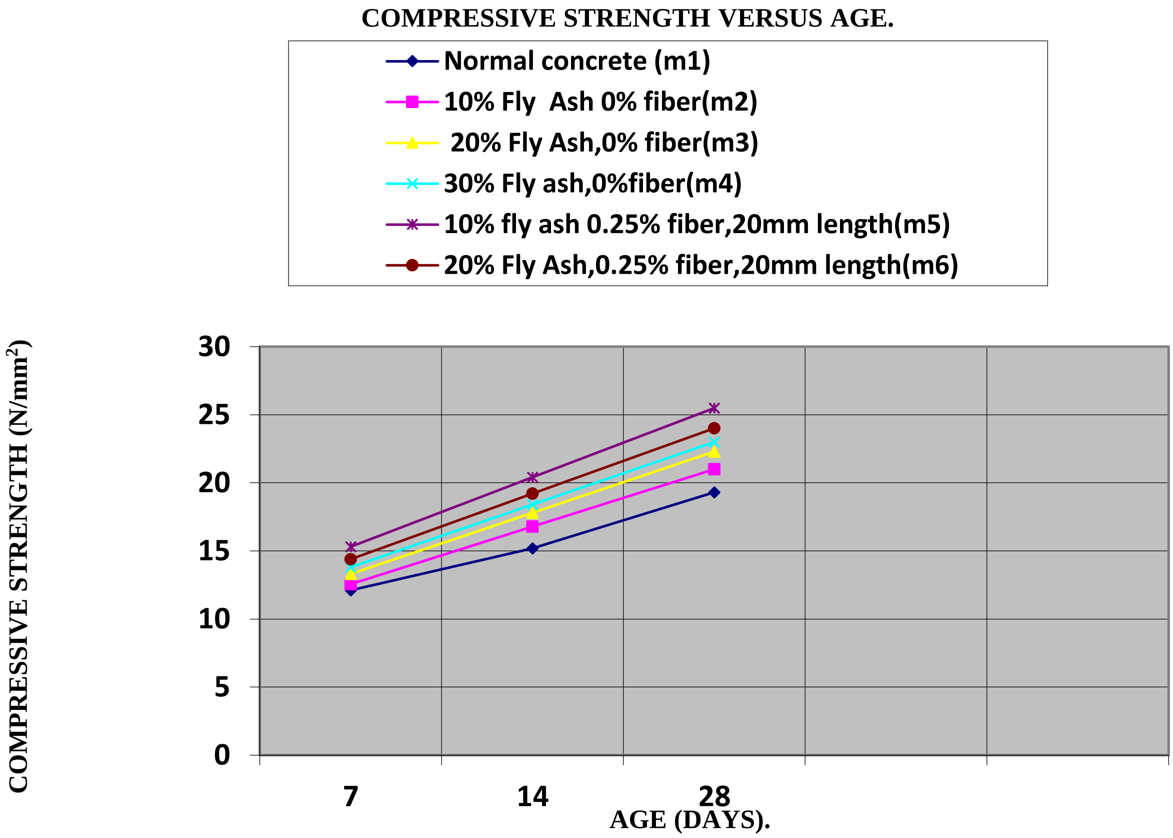

Figure.5 Showing the variation of compressive strength with age for various fly ash and fiber percentages of M20 grade

COMPRESSIVE STRENGTH VERSUS FLY ASH AND FIBER PERCENTAGE.

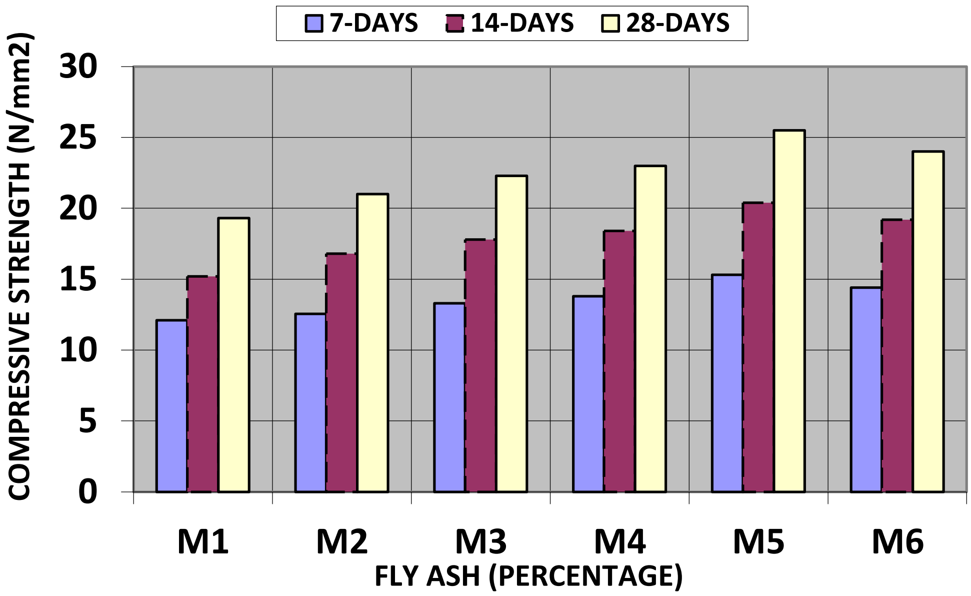

Figure.6 Showing the variation of fly ash and fiber percentage versus compressive strength in n/mm^2 of M20 grade

COMPRESSIVE STRENGTH VERSUS AGE.

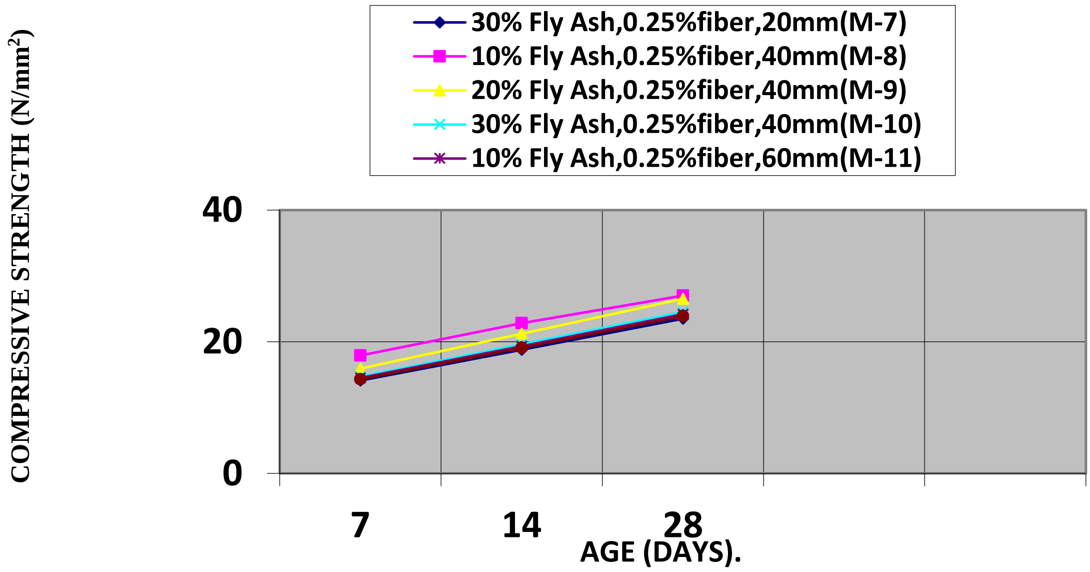

Figure.7 Showing the variation of compressive strength with age for various fly ash and fiber percentages of M20 grade.

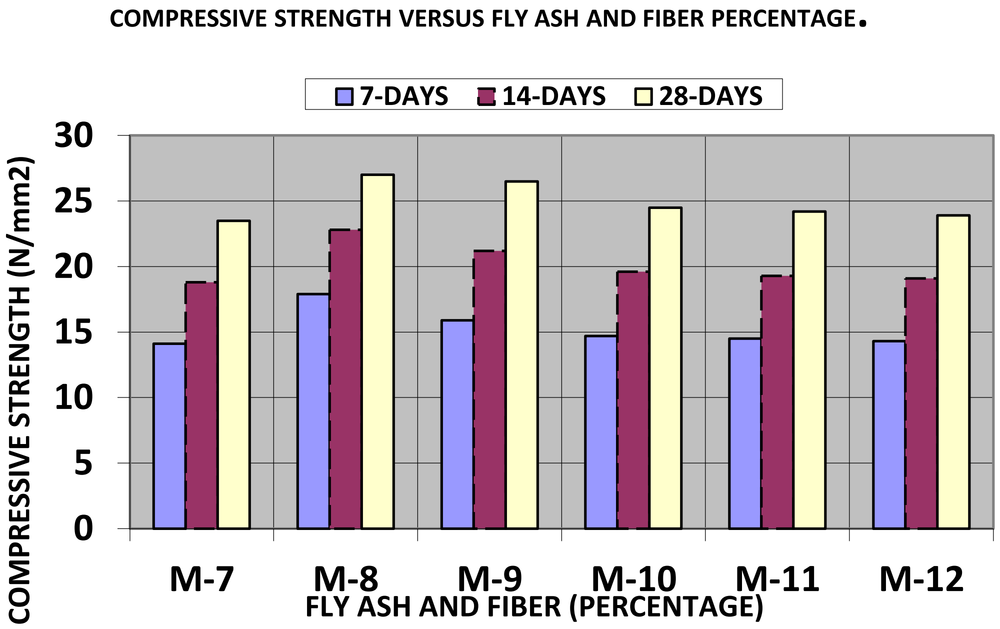

Figure.8 Showing the variation of fly ash and fiber percentage versus compressive strength in N/mm^2 of M20 grade.

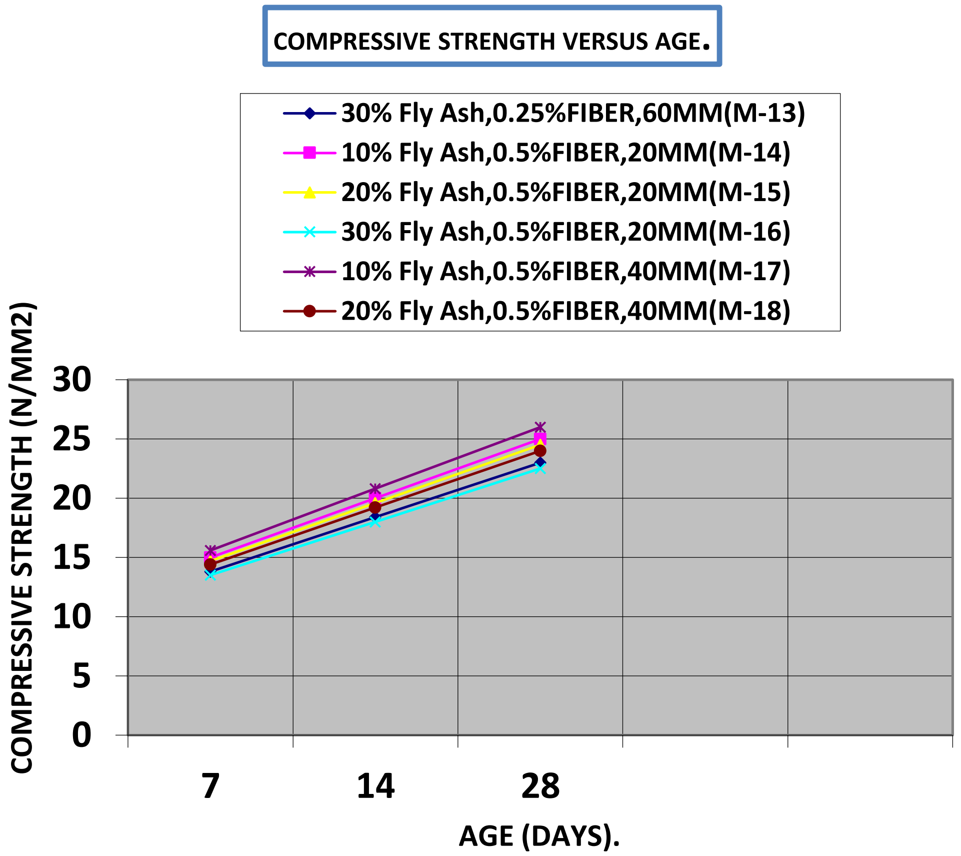

Figure.9 Showing the variation of compressive strength with age for various fly ash and fiber percentages of M20 grade.

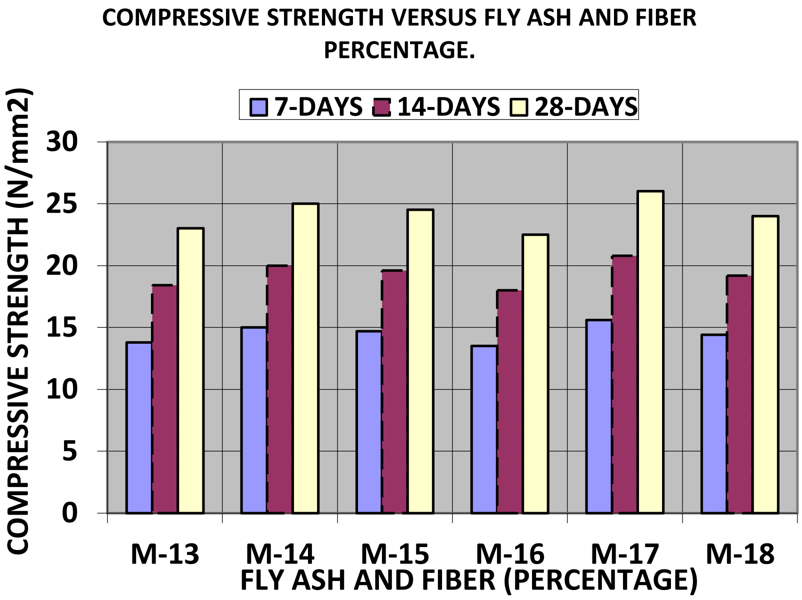

Figure.10 showing the variation of fly ash and fiber percentage versus compressive strength in N/mm^2 of M20 grade

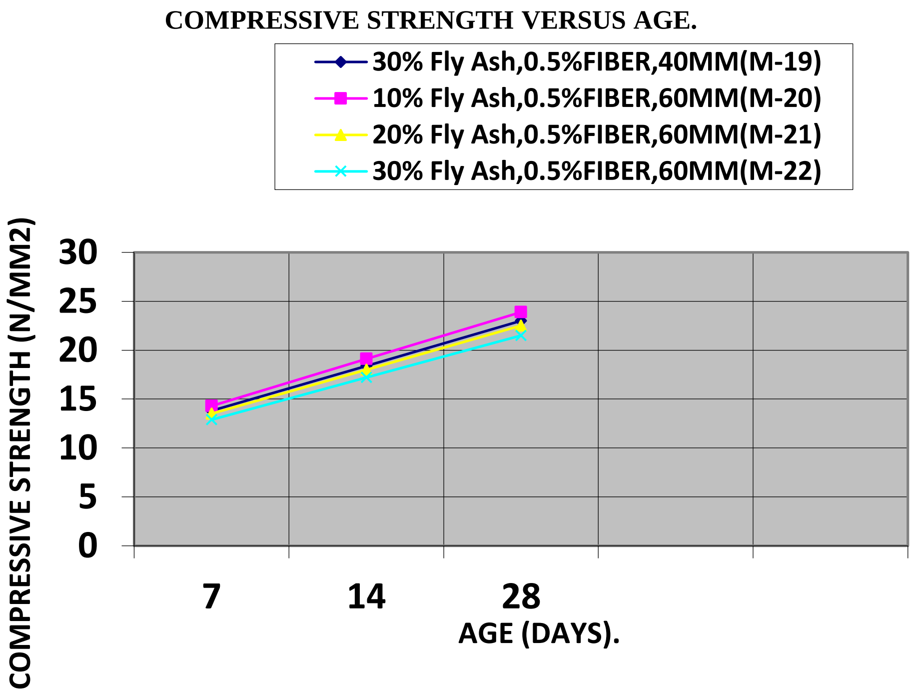

Figure.11 Showing the variation of compressive strength with age for various fly ash percentages of M20 grade

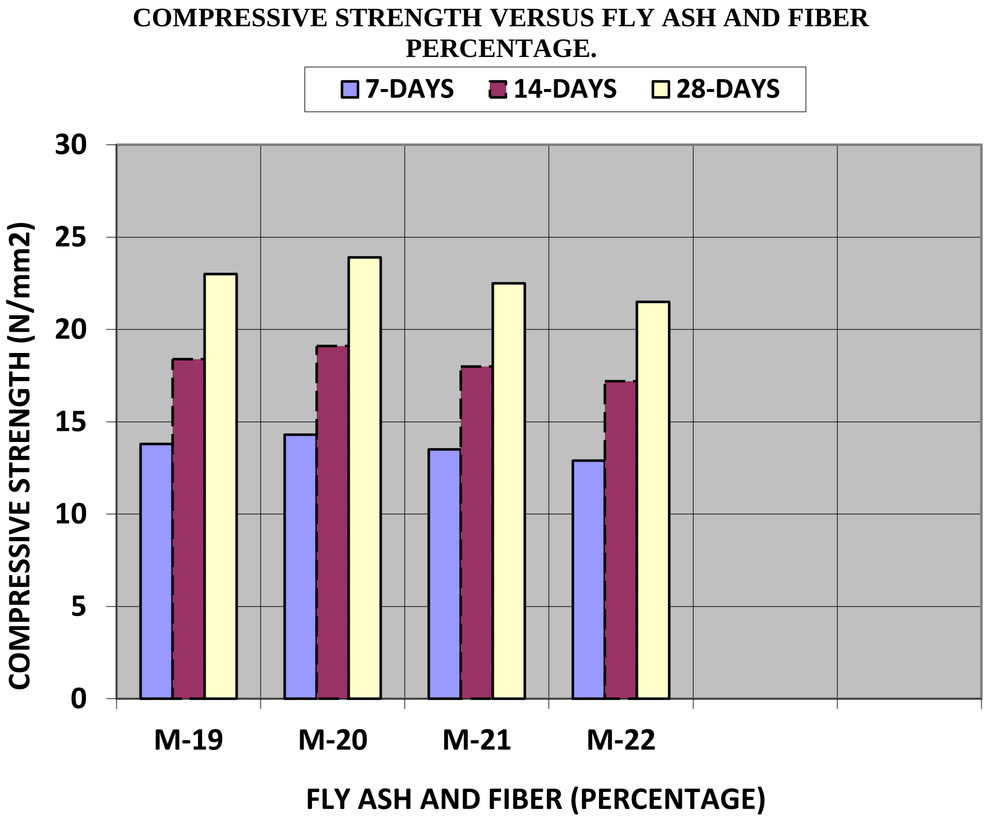

Figure.12 Showing the variation of fly ash percentage versus compressive strength in N/mm^2 of M20 grade

Table.5 Split tensile strength of grade M20 as M1, M2, M3, M4, M5, M6 mix

Mix	**M-1**	**M-2**	**M-3**	**M-4**	**M-5**	**M-6**
Fly as (%)	0	10%	20%	30%	10%	20%
FIBER (%)	0	0	0	0	0.25%	0.25%
FIBER LENGTH	0	0	0	0	20mm	20mm
Test age (days)	**3-3 Samples Split Tensile Strength (N/mm²)**					
28	**2.46**	**2.96**	**2.99**	**3.10**	**3.30**	**3.20**

Table.6 Split tensile strength of grade M20 as M7, M8, M9, M10, M11, M12 mix

Mix	**M-7**	**M-8**	**M-9**	**M-10**	**M-11**	**M-12**
Fly as (%)	30%	10%	20%	30%	10%	20%
FIBER (%)	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
FIBER LENGTH	20mm	40mm	40mm	40mm	60mm	60mm
Test age (days)	**3-3 Samples Split Tensile Strength (N/mm²)**					
	2.9	**3.9**	**3.3**	**3**	**2.6**	**2.4**

28						

Table.7 Split tensile strength of grade M20 as M13, M14, M15, M16, M17, M18 mix

Mix	**M-13**	**M-14**	**M-15**	**M-16**	**M-17**	**M-18**
Fly as (%)	30%	10%	20%	30%	10%	20%
FIBER (%)	0.25%	0.5%	0.5%	0.5%	0.5%	0.5%
FIBER LENGTH	60mm	20mm	20mm	20mm	40mm	40mm
Test age (days)	**3-3 Samples Split Tensile Strength (N/mm²)**					
28	**2.3**	**2.9**	**2.7**	**2.5**	**3.2**	**3.0**

Table.8 Split tensile strength of grade M20 as M19, M20, M21, M22 mix.

Mix	**M-19**	**M-20**	**M-21**	**M-22**
Fly as (%)	30%	10%	20%	30%
FIBER (%)	0.5%	0.5%	0.5%	0.5%
FIBER LENGTH	40mm	60mm	60mm	60mm
Test age (days)	**3-3 Samples Split Tensile Strength (N/mm²)**			
28	**2.5**	**2.4**	**2.2**	**2**

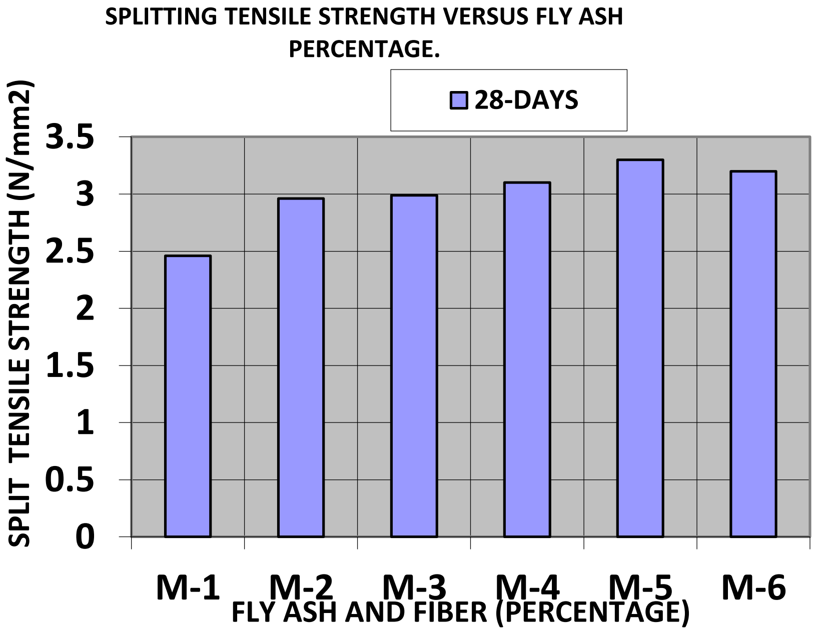

Figure.13 Showing the variation of fly ash and fiber percentage versus splitting tensile strength in N/mm² of M20 grade.

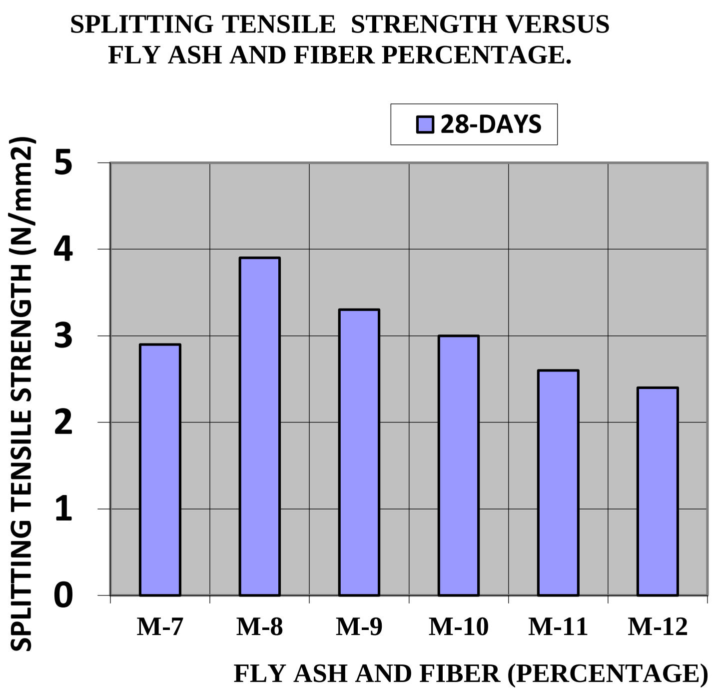

Figure.14 Showing the variation of fly ash and fiber percentage versus splitting tensile strength in N/mm^2 of M20 grade

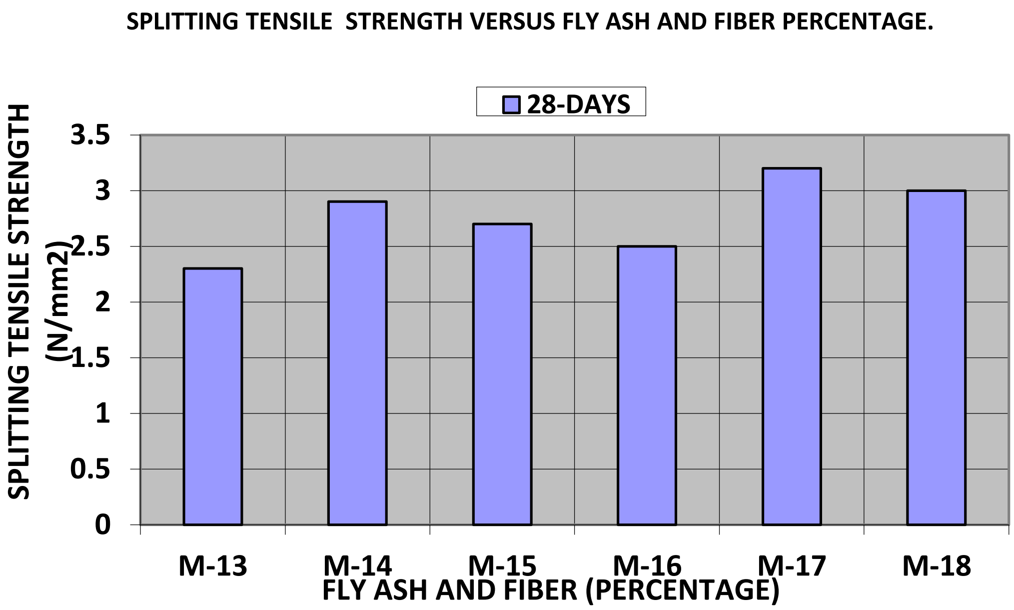

Figure.15 Showing the variation of fly ash and fiber percentage versus splitting tensile strength in N/mm^2 of M20 grade.

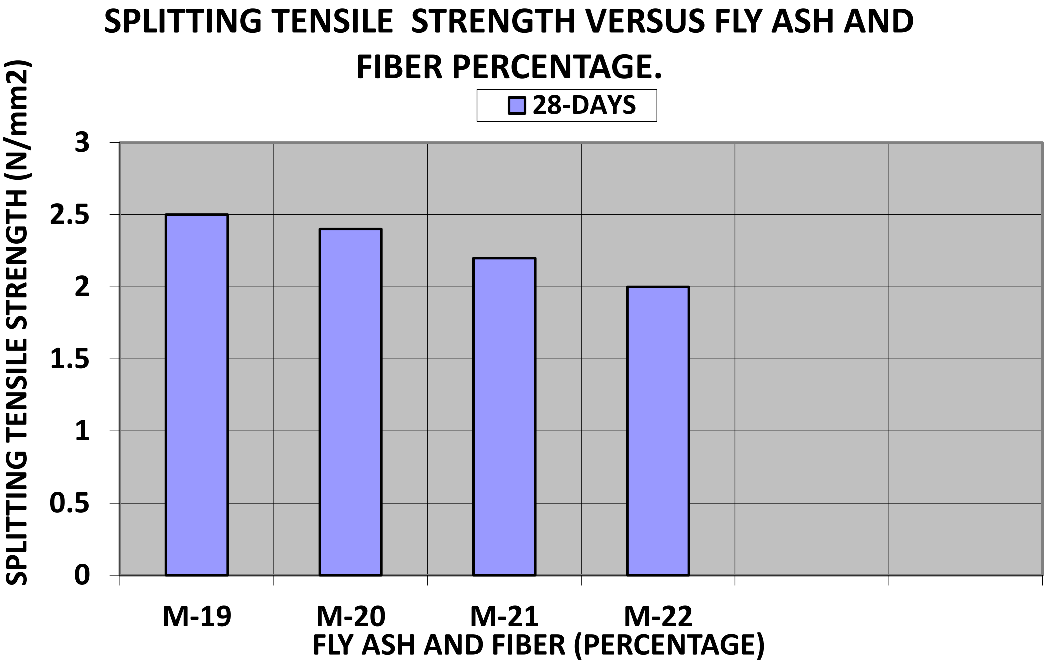

Figure.16 Showing the variation of fly ash and fiber percentage versus splitting tensile strength in N/mm^2 of M20 grade.

Table.9 Flexural Strength of Grade M20 as M1, M2, M3, M4, M5, M6

Mix	**M-1**	**M-2**	**M-3**	**M-4**	**M-5**	**M-6**
Fly as (%)	**0**	10%	20%	30%	10%	20%
FIBER (%)	**0**	0	0	0	0.25%	0.25%
FIBER LENGTH	**0**	0	0	0	20mm	20mm
Test age (days)	**3-3 Samples Flexural Strength (N/mm²)**					
28	**2.3**	**2.6**	**3.2**	**3.3**	**3.80**	**3.30**

Table.10 Flexural Strength of Grade M20 as M7, M8, M9, M10, M11 and M12 Mix.

Mix	**M-7**	**M-8**	**M-9**	**M-10**	**M-11**	**M-12**
Fly as (%)	30%	10%	20%	30%	10%	20%
FIBER (%)	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
FIBER LENGTH	20mm	40mm	40mm	40mm	60mm	60mm
Test age (days)	**3-3 Samples Flexural Strength (N/mm²)**					
28	**2.8**	**4.2**	**4**	**3**	**3.9**	**3.2**

Table.11 Flexural strength of grade M20 as M13, M14, M15, M16, M17, and M18 mix.

Mix	**M-13**	**M-14**	**M-15**	**M-16**	**M-17**	**M-18**
Fly as	30%	10%	20%	30%	10%	20%

(%)						
FIBER (%)	0.25%	0.5%	0.5%	0.5%	0.5%	0.5%
FIBER LENGTH	60mm	20mm	20mm	20mm	40mm	40mm
Test age (days)	**3-3 Samples Flexural Strength (N/mm²)**					
28	**2.9**	**4**	**3.5**	**3**	**4.6**	**4.3**

Table.12 Flexural strength of grade M20 as M19, M20, M21, and M22 mix.

Mix	**M-19**	**M-20**	**M-21**	**M-22**
Fly ash (%)	30%	10%	20%	30%
FIBER (%)	0.5%	0.5%	0.5%	0.5%
FIBER LENGTH	40mm	60mm	60mm	60mm
Test age (days)	**3-3 Samples Flexural Strength (N/mm²)**			
28	**3.4**	**4.1**	**3.8**	**3**

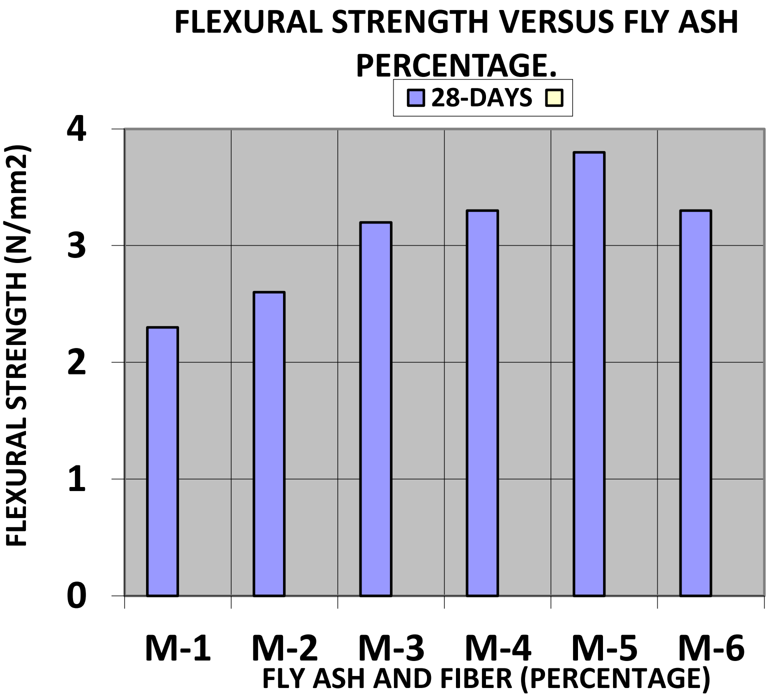

Figure.17 Showing the variation of fly ash and fiber and fiber percentage versus flexural strength in N/mm^2 of M20 grade.

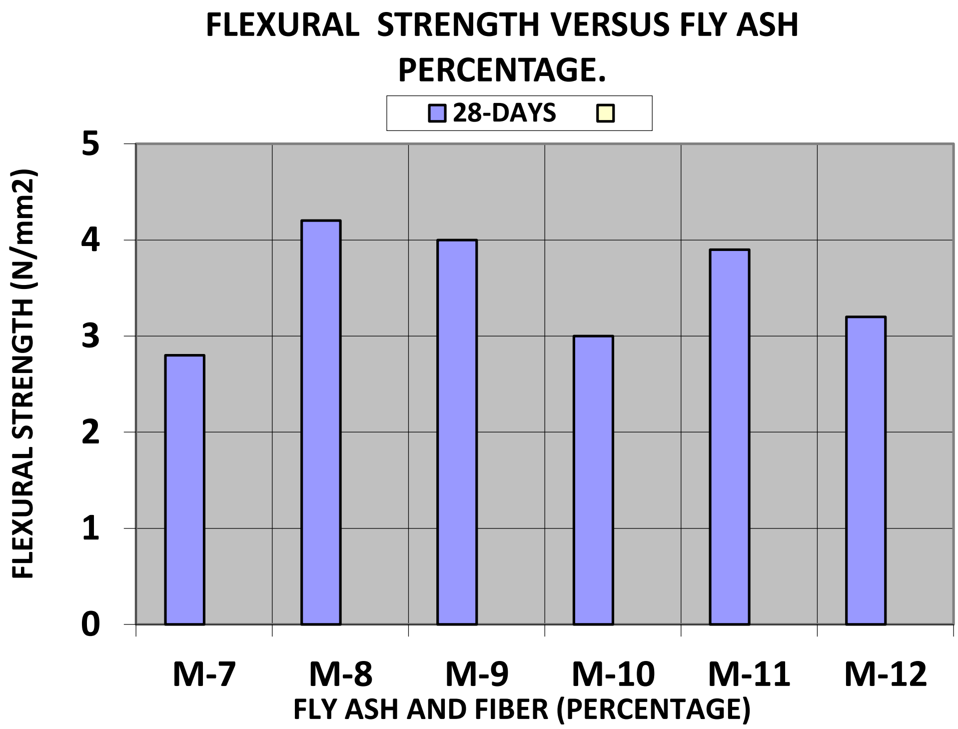

Figure.18 Showing the variation of fly ash and fiber percentage versus flexural strength in N/mm^2 of M20 grade.

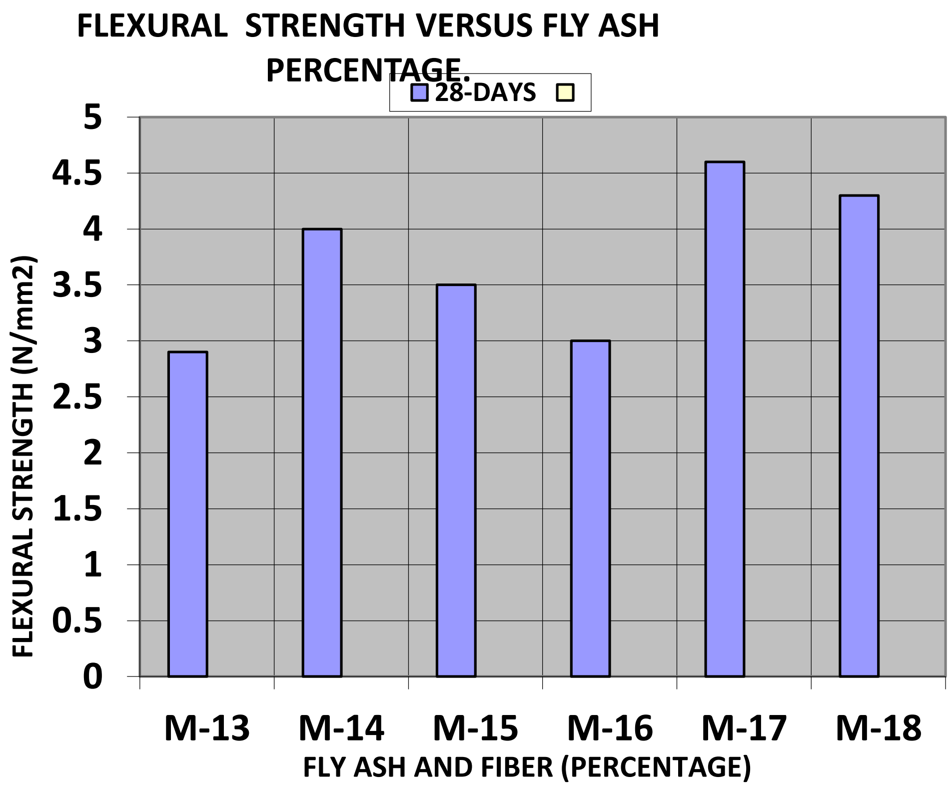

Figure.19 Showing the variation of fly ash percentage versus flexural strength in N/mm^2 of M20 grade.

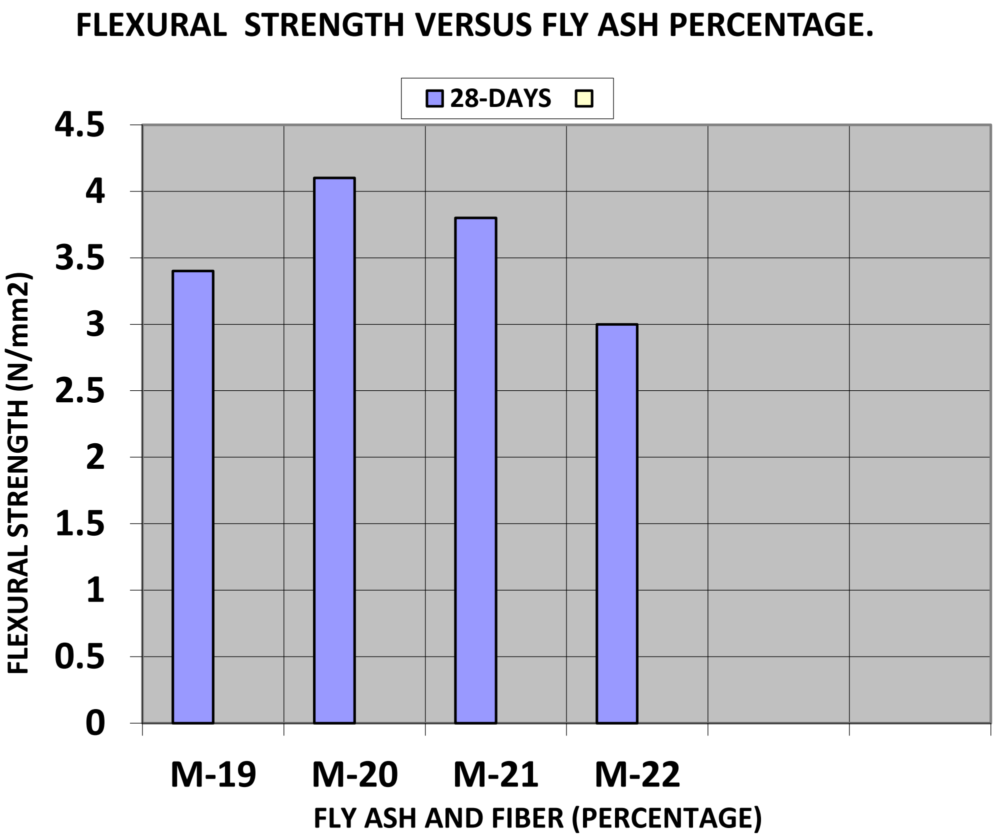

Figure.20 Showing the variation of fly ash and fiber percentage versus flexural strength in N/mm^2 of M20 grade

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%. 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, addition of coconut 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.

REFERENCES

1. Saravana raja mohan, P.Jayabalan, A Rajaraman on properties of fly ash based coconut fiber composite, American Journal of Engg and Applied Science 5(1):29-34,2012
2. A.Zutaida, S.Norshahida, I.Sopian and H.Zahurin (malaysia) on effect of fiber length variation on mechanical and physical properties of coir fiber reinforced cement albumen composite. IIUM Engg Journal Vol.12 No 1, 2011.
3. Alida Abdullah, Shamsul Baharin Jamaludin, Mazlee Mohd Noor, Kamarudin Hussin on Composite Cement Reinforced Coconut Fiber: Physical and Mechanical Properties Australian Journal of Basic and Applied Sciences, 5(7): 1228-1240, 2011
4. IS: 8112-1989 Specifications for 43-Grade Portland cement, Bureau of Indian Standards, and New Delhi, India.
5. IS: 383-1970, Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete, Bureau of Indian Standards, New Delhi, India.
6. IS: 10262-1982, Recommended Guidelines for Concrete Mix Design. Bureau of Indian Standards, New Delhi, India.
7. IS: 1199-1959, Indian Standards Methods of Sampling and Analysis of Concrete, Bureau of Indian Standards, New Delhi, India.
8. IS: 516-1959, Indian Standard Code of Practice-Methods of Test of Strength of Concrete, Bureau of Indian Standards, New Delhi, India.
9. IS: 456-2000 "Plain and Reinforced concrete code of practice".
10. SP16, Design Aids to IS 456-1978.
11. IS: 516-1959 "Method of Test for Strength of Concrete".

M-1	Control Concrete or Conventional Concrete
M-2	10% replacement of Cement by Fly Ash
M-3	20% replacement of Cement by Fly Ash
M-4	30% replacement of Cement by Fly Ash
M-5	10% replacement of Cement by Fly Ash, 0.25% coconut fiber of 20mm length.
M-6	20% replacement of Cement by Fly Ash, 0.25% coconut fiber of 20mm length.
M7	30% replacement of Cement by Fly Ash, 0.25% coconut fiber of 20mm length.
M8	10% replacement of Cement by Fly Ash, 0.25% coconut fiber of 40mm length.
M9	20% replacement of Cement by Fly Ash, 0.25% coconut fiber of 40mm length.
M10	30% replacement of Cement by Fly Ash, 0.25% coconut fiber of 40mm length.
M11	10% replacement of Cement by Fly Ash, 0.25% coconut fiber of 60mm length.
M12	20% replacement of Cement by Fly Ash, 0.25% coconut fiber of 60mm length.
M13	30% replacement of Cement by Fly Ash, 0.25% coconut fiber of 60mm length.
M14	10% replacement of Cement by Fly Ash, 0.5% coconut fiber of 20mm length.
M15	20% replacement of Cement by Fly Ash, 0.5% coconut fiber of 20mm length.
M16	30% replacement of Cement by Fly Ash, 0.5% coconut fiber of 20mm length.
M17	10% replacement of Cement by Fly Ash, 0.5% coconut fiber of 40mm length.
M18	20% replacement of Cement by Fly Ash, 0.5% coconut fiber of 40mm length.

M19	30% replacement of Cement by Fly Ash, 0.5% coconut fiber of 40mm length.
M20	10% replacement of Cement by Fly Ash, 0.5% coconut fiber of 60mm length.
M21	20% replacement of Cement by Fly Ash, 0.5% coconut fiber of 60mm length.
M22	30% replacement of Cement by Fly Ash, 0.5% coconut fiber of 60mm length.