STUDY OF WORK ABILITY WITH USE OF COIR FIBRES IN CONCRETE COMPOSITES

Er Mayank Varshney, Er. Sanjay Sharma, Ar. Meenu Varshney

Abstract— **Investigations to overcome the brittle response and limiting post – yield energy absorption of concrete led to the development of fibre reinforced concrete using discrete fibres within the concrete mass. A wide variety of fibres have been proposed by the researchers such as steel, glass, polypropylene, carbon, polyester, acrylic and aramid etc., Over half of the population around the world is living in slums and villages. The earthquake damages in rural areas get multiplied mainly due to the widely adopted non– engineered constructions. On the other hand, in many smaller towns and villages in southern part of India, materials such as nylon, plastic, tyre, coir, sugarcane bagasse and rice husk are available as waste. So, here an attempt has been made to investigate the possibility of reusing these locally available rural waste fibrous materials as concrete composites.**

Since the materials used are locally available rural fibres, a detailed characterization is planned. A concrete mix has been designed to achieve the minimum grade of M20 as required by IS 456 – 2000. The investigation contains four phases. In the first phase, to identify the effects on workability and mechanical strength properties due to the addition of these rural fibres, workability tests such slump, vee – bee, air content tests and the mechanical strength tests on standard specimens such as compressive strength, split tensile strength, modulus of rupture, modulus of elasticity and shear strength were conducted on the different fibrous concrete specimens to obtain the optimum volume fraction and length of fibres.

Totally 96 cubes, 162 cylinders, 54 prism beams ,15 flexure specimens and 54 shear specimens and 4 nos Beam-column joints (Tee) were cast and tested to study the workability, mechanical strength, static loading behavior, seismic loading and beam column joint behavior under cyclic loading

Based on the experimental results of workability and mechanical strength studies, a constant length of 50 mm and two volume fractions such as 0.5% and 1% are chosen for further studies. By analyzing the results, empirical relations also have been proposed for mechanical strength properties and compared with the experimental results. From these results, it is concluded that even though addition of fibres reduces the workability of fresh concrete, marginal improvements in the mechanical strength properties are observed which ranges from 10% to 20%.

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I. INTRODUCTION

1.1 FIBRE REINFORCED CONCRETE

A. General

Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses and impact loads, where tensile strength is approximately just one tenth of its compressive strength. As a result for these characteristics, concrete flexural members could not support such loads that usually take place during their service life. Historically, concrete member reinforced with continuous reinforcing bars to withstand tensile stresses and compensate for the lack of ductility and strength. Furthermore, steel reinforcement is adopted to overcome high potentially tensile stresses and shear stresses at critical location in concrete member. Even though the addition of steel reinforcement significantly increases the strength of concrete, the development of micro cracks must be controlled to produce concrete with homogenous tensile properties. The introduction of fibres is brought in as a solution to develop concrete with enhanced flexural and tensile strength, which is a new form of binder that could combine Portland cement in bonding with cement matrices. Fibres are most generally discontinuous, randomly distributed throughout the cement matrices. According to terminology adopted by the American Concrete Institute (ACI) Committee 544, in Fibre Reinforced Concrete, there are four categories namely,

SFRC – Steel Fibre Reinforced Concrete

GFRC – Glass Fibre Reinforced Concrete

SNFRC – Synthetic Fibre Reinforced Concrete and

NFRC – Natural Fibre Reinforced Concrete.

Coir fibre falls under the category NFRC

B. Applications of Fibre Reinforced Concrete

The inclusion of fibres in concrete is to delay and control the tensile cracking of composite material. Fibres thus transform an inherent unstable tensile crack propagation to a slow controlled crack growth. This crack controlling property of fibre reinforcement delays the initiation of flexural and shears cracking. It imparts extensive post cracking behavior and significantly enhances the ductility and the energy absorption capacity of the composite. Earlier fibre-reinforced concrete was used in pavements and industrial floors. But subsequently, Fibre Reinforced Concrete have wide variety of usages in structures such as heavy-duty pavements, Airfields, industrial floor, water retaining and hydraulic structures, parking structure decks, water and waste water treatment plants, pipes, precast roof and wall panels, and the techniques of shot Crete application.

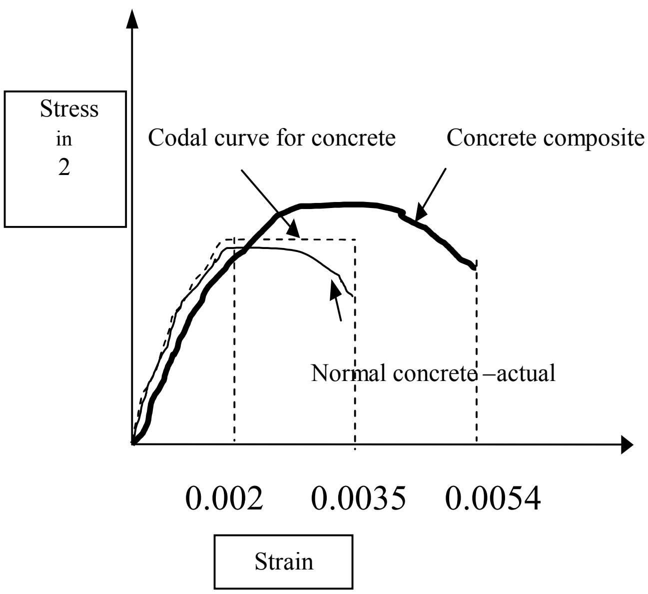

Fig.1 Concept of Ductility Enhancement

Figure 1 indicates the enhancement of ductility in the case of Fibre Reinforced Concrete Composites. Hence the FRC has the potential application in Earthquake resistant structures.

C. Limitations of Fibre Reinforced Concrete

Fibres, which are randomly distributed throughout the concrete, can overcome cracks and control shrinkage more effectively. These materials have outstanding combinations of strength and energy absorption capacity. In general, the fibre reinforcement is not a substitution to conventional steel reinforcement. The fibres and steel reinforcement have their own role in concrete technology. Therefore, many applications in which both fibres and continuous reinforcing steel bars can be used together. However, fibres are not efficient in withstanding the tensile stresses compared to conventional steel reinforcements. But, fibres are more closely spaced than steel reinforcements, which are better in controlling crack and shrinkage. Consequently, conventional steel reinforcements are used to increase the load bearing capacity of concrete member; fibres are more effective in crack control. The lack of corrosion resistance of normal steel fibres could be a disadvantage in exposed concrete situations. The synthetic fibres are uneconomical to medium level people. Fire resistance of synthetic fibres is also needed to be evaluated.

For example, 1 m^3 of concrete will cost about Rs. 5,000/-. If 1% of steel fibre is put to 1 m^3 of concrete, the cost of steel fibres would come around Rs.5,000/-. Hence people living in rural areas that always prefer the non-engineered constructions can not use these fibres. So

for medium level constructions, particularly located in medium to high seismic prone areas locally available new construction materials which would cost are required to be cost effective.

II. LITERATURE REVIEW

M.Lakshmipathy and A.R.Santhakumar (1987) have conducted an experimental analytical investigation on two span continuous beams with steel fibres. The important characteristics such as cracking behavior, ductility and energy absorption were ascertained from experimental investigation and compared with analytical results. The fibrous concrete beams served superior than conventional concrete.

An experimental investigation was carried out by D.L.N Rao, M.R.A Kadir and Kawa Taha Abu Al Awffa (1987) on deformation characteristics and strength of reinforced concrete beams made with steel fibres in pure bending. 1.85m span beams were casted and tested under static flexural loading. The increase in depth of neutral axis and hence flexural stiffness of fibre reinforced concrete beams at all stages of loading reflected the ability of fibres in arresting the crack growth. The inclusion of steel fibres in the concrete significantly increased the post cracking stiffness at all the stages up to failure. Lim.T.Y, Paramasivam.P and Lee.S.L (1998) carried out some experimental and analytical study on bending behavior of steel fibre reinforced concrete beams. A simplified Moment – Curvature (M–Ø) relationship for beam with rectangular was proposed. The proposed model was verified with experimental results carried out 2.2m span reinforced concrete beams. The enhancement in ductility and energy absorption under static loading was delivered through the study.

Balaguru and Shah (1992) , Cheng-Tzu Thomas Hsu, Rujun Linda He and Samer Ezeldin in 1992,, H.V.Dwarakanath and T.S.Nagaraj in 1998 regarding flexural behavior, Piti Sukontasukkul (2004) conducted an experimental investigation on toughness of steel and polypropylene fibre reinforced concrete beams have done the work and reported regarding fibrous concrte.

III. EXPERIMENTAL INVESTIGATION

3.1 INTRODUCTION

This chapter demonstrates the detailed experimental programme of this investigation . It includes materials and fibres used, detailed methodology of experimental programme, mix proportions, specimen details, reinforcement detailing and test set up. In this experimental investigation, initially three organic fibres such as plastic, nylon, tyre and three inorganic fibres such as coconut coir, sugarcane bagasse and rice husk have been taken. The properties are compared with well known steel fibres. Their physical properties such as aspect ratio, specific gravity, water absorption, density and ultimate tensile load are studied. However natural inorganic fibres are subjected to ageing process in different environments in which they may suffer a reduction in strength and toughness. So it is mandatory to study the microstructure properties of fresh as well as used (reacted with concrete for two years) natural fibres through SEM with EDS and X-ray diffraction. Since the focus of this research is aimed on reuse of waste fibrous materials, an overall characterization with different characteristics are required to recommend the materials. This characterization is divided into many parts. Initially seven fibres (steel, nylon, plastic, tyre, coconut coir, sugarcane bagasse and rice husk) of three different aspect ratios (30, 60, 90) and three volume fractions (0.5%, 1.0% and 1.5%) have been taken. First the influence of different fibres on workability of concrete are studied. Whilst the slump test is commonly used to assess the workability of conventional concretes, it is not generally suitable for natural fibre reinforced concrete (Aziz M.A et.al 1984). Hence in this investigation, both slump test as well as Vee-bee test have been conducted to assess the workability of fibre reinforced concretes.

To achieve the optimum length and volume fractions of fibres for structural studies, mechanical strength properties such as compressive strength, split tensile strength, modulus of rupture, modulus of elasticity, shear strength and impact energy have been conducted. From the test results optimum length of 50mm and two different volume fractions 0.5% and 1.0% have been selected for further structural study. Behavior of reinforced concrete beams with all seven fibres of two different volume fractions have been studied under both monotonic and cyclic (pseudo static) loading. From the performance behavior of beams nylon, plastic and coir fibres of 1.0% volume fraction are selected for further study. Since the field studies have shown that beam-column joints are vulnerable during an intensive earthquake, the work has been extended to study the behavior of beam-column joints with fibre composites.

Besides the strength behavior, durability of proposed concrete is also important. Durability relates to its resistance to deterioration resulting from external and internal causes. The internal causes include volume change and permeability of concrete. So, in this study effects of plastic shrinkage, drying shrinkage and permeability on selected fibre reinforced concrete have been studied.

3.2 MATERIALS AND MIX

The materials used in this investigation were: ordinary Portland cement, coarse aggregate of crushed rock with a maximum size of 20 mm, fine aggregate of clean river sand and portable water. 8mm dia HYSD bars were used as main reinforcement. 6mm dia MS bars were used as stirrups. Commercially used MS wires (binding wires) were used as steel fibres. Locally available materials such as nylon, plastic, tyre, coconut coir, sugarcane bagasse, rice husk were taken from the waste stream and converted in to fibres of required length and diameter. The detailed properties are given in subsequent contents.

A. Cement

Ordinary Portland Cement of 43 grade conforming to IS 8112-1989 was used. Tests were carried out on various physical properties of cement and the results are shown in Table 3.1

B. Fine Aggregate

Natural river sand was used as fine aggregate. The properties of sand were determined by conducting tests as per IS: 2386 (Part- I). The results are shown in Table 3.2. The results obtained from sieve analysis are furnished in Table 3.3. The results indicate that the sand conforms to Zone II of IS: 383 – 1970

C. Coarse Aggregate

Crushed granite stones obtained from local quarries were used as coarse aggregate. The maximum size of coarse aggregate used was 20 mm. The properties of coarse aggregate were determined by conducting tests as per IS: 2386 (Part – III). The results are tabulated in Table 4.4

D. Water

Portable water free from salts was used for casting and curing of concrete as per IS: 456– 2000 recommendations.

E. Fibres

Locally available waste materials were collected from different stream and properly shaped in the form of fibres. Uniform length of fibres was obtained by using cutting machine. Plastic fibres were collected from plastic pot industry waste. Nylon waste fibres were collected from nylon industries.

Table.3.1 Physical Properties of 43 Grade Ordinary Portland Cement

Physical Properties	Values of OPC used	Requirements as per IS 8112-1989
Standard Consistency	29.2%	-
Initial Setting Time	45 Minutes	Minimum of 30 minutes
Final Setting Time	265 Minutes	Maximum of 600 minutes
Specific gravity	3.15	-
Compressive strength in N/mm^2 at 3 days	29	Not less than
Compressive strength in N/mm^2 at 7 days	38.5	Not less than
Compressive strength in N/mm^2 at 28 days	48	Not less than

Bi-cycle rubber tyres were collected from local automobile workshops. Locally and easily available natural fibres such as coconut coir fibre, sugarcane baggasse and rice husk were collected from local coconut oil mills, sugar industries and rice mills respectively. Commercially available GI Steel wires which are used as binding wires for reinforcement tieing were used. The clear photographs of different fibres are shown in Fig. 4.2 to Fig.4.8. The geometrical and physical properties of different fibres are tabulated in Table 4.5.

Table.3.2 Sieve Analysis of Fine Aggregate

I.S. Sieve Size	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Percentage Weight Retained	Cumulative Percentage Weight Passing
10 mm	2	2	0.4	99.6
4.75 mm	6	8	1.6	98.4
2.36 mm	20	28	5.6	94.4
1.18 mm	76	104	20.8	79.2
600 microns	224	328	65.6	34.4
300 microns	114	442	88.4	11.6
150 microns	54	496	99.2	0.8
< 150 microns	4	500	100	0.0

Remarks: Conforming to Zone II of Table 4 of IS: 383-1970

Table.3.3 Physical Properties of Fine Aggregate (Tests as per IS: 2386 – 1968: Part III)

Physical properties	Values
Specific gravity	2.6
Fineness Modulus	2.83
Water Absorption	0.75%
Bulk density (kg/m^3)	1654
Free moisture content	0.1%

Table.3.4 Physical Properties of Coarse Aggregate (Tests as per IS: 2386 – 1968 Part III)

Physical properties	Values
Specific gravity	2
Fineness Modulus	2.
Water Absorption	0.5
Bulk density (kg/m^3)	15
Free moisture content (%)	0.2
Aggregate Impact value (%)	11
Aggregate Crushing value	25.

Diameter of fibres were measured through microscope of capacity 0.05mm. The specific gravity was determined based on the method specified in IS: 2386 (Part III). Five gram of each fibre samples was accurately weighed in an electronic balance of micro accuracy. and the water absorbed after 24 hours of continuous immersion was determined. Except for rice husk, the ultimate tensile strength was determined by the tension test using 4 kN tensile testing machine. A gauge length of 100 mm was chosen to measure the maximum elongation.

Table 3.5 Typical Properties of Fibres

Properties of Fibres	**Type of Fibre**						
	Steel	**Nylon**	**Plastic**	**Tyre**	**Coir**	**Sugar cane**	**Rice**
Diameter/Equivalent Diameter (mm)	0.60	0.44	1.51	1.50	0.48	1.50	1.60
Aspect Ratio	83.3	113.6	33.1	33.1	104.2	33.1	12.5
Specific gravity	5.86	0.7	1.25	1.08	0.87	0.52	0.4
Water Absorption (%)	33.33	66.66	66.66	75	210	286.6	225.6
Density in kg/m^3	6879	657	763	530	2057	260	564

Fig.3.1 Steel Reinforcements


Fig.3.2 Steel Fibres


Fig.3.3 Nylon Fibres


Fig.3.4 Plastic Fibres


Fig.3.5 Tyre Fibres


Fig.3.6 Coir Fibres


Fig.3.7 Rice Husk Fibres

F. Reinforcements

Fe 415 steel bars of diameters 8 mm and 12 mm were used as main reinforcements for beams and beam-column joints respectively. Mild steel 6 mm diameter rods were used as stirrups and ties.

G. Mix Proportion

A mix was designed as per IS 10262 – 1982 to achieve a minimum target strength of 20 N/mm^2. The same mix was used for all type of fibre reinforced concretes. The mix proportion was 1:1.38:3.09. A constant water cement ratio of 0.5 was used. The quantities of different ingredients per cubic meter of concrete mix were given in Table.4.6.

Table.3.6 Quantities of ingredients of Concrete Mix

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**
185 kg	350 kg	483 kg	571 kg

3.3 CASTING AND CURING

A laboratory type concrete mixer machine was used to mix the ingredients of concrete .To avoid balling of fibers, the following procedure was followed in casting . First, aggregates and cement were mixed for one minute, water being added within two minutes. Then fibers were uniformly dispersed by hand throughout the mass with slow increment. Now concrete was allowed to mix for three minutes. All the specimens were well compacted using a table vibrator, and cured for 28 days.

3.4 EXPERIMENTAL SET UP

This section deals about the experimental set up, specimen details and testing procedure of each test planned. The photographs of each test set up also presented in each sub sections.

A. Workability Studies

The rheological properties of fibre reinforced concrete are significant. The large surface area of fibres tends to restrain flow ability and mobility of the mix. Interlocking of fibres and consequently the formation of fibre balls can be very damaging to the hardened material properties (M.Ziad Bayasi et.al 1992). There are two important fibre parameters that strongly influence the degree of damage to concrete workability caused by fibres. It is already mentioned in the introduction chapter, slump test is not sufficient for measuring the workability of fibre reinforced concrete. So, both slum test and vee be tests are planned.

Slump Test

The slump test was conducted as per IS: 7320 – 1974, The slump was measured in mm.

Vee -Bee Test

By using this method, consistency is being found by determining the time required for transforming b vibration, a concrete specimen in the shape of a conical frustum into a cylinder. The test was conducted as per Indian Standards.

Air Content

The exact air content in concrete is extremely important as it affects the various parameters of concrete. If the amount of air in a mix differs widely from the design value, the properties of the concrete may be seriously affected. Too little air results in insufficient workability and too much air will result in low strength. There are three methods for measuring air content of fresh concrete namely Gravimetric meter method, volumetric method and pressure method. Out of which pressure method is perhaps the best method for finding the air content of fresh concrete because of its superiority and ease of operation.

The water meter type has been used in this investigation. The vessel was filled with concrete, compacted in a standard manner and struck off level. A cover was then clamped in position. Water was added until the level was reached '0' mark on the tube of the cover and then pressure is applied by means of a bicycle pump. The pressure was transmitted to the air entrained in the concrete, which contracts accordingly. The water level has fallen. The pressure has been increased to a predetermined value as indicated by a small pressure gauge mounted on the cover. The glass gauge tube was so calibrated that the percentage of air by volume was indicated directly.

IV. RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

The results obtained from the above elaborative experimental as well as analytical investigations are discussed in this chapter. Initially the workability properties such as slump value, vee-bee time and air content percentage have been discussed. Then the results of mechanical strength properties such as cube compressive strength, cylinder compressive strength, split tensile strength, modulus of rupture, modulus of elasticity, shear strength and impact energy have discussed. Comparison of experimental and predicted values of proposed expressions has been made for all the fibre concrete mixes. Even the natural fibres have given comparable strength properties, durability of such natural fibres are questionable. So the natural fibres have been allowed to react with concrete for about two years under alternative wetting and drying conditions. After two years they have been taken from the concrete and subjected to micro structural study. The results obtained from the investigations are discussed. Next the structural properties of conventionally reinforced and fibre reinforced concrete beams under static loading are discussed. The critical seismic parameters such as ductility, energy absorption capacity are discussed and the results are discussed in the subsequent heading. Then the damage indices based on the expressions proposed by earlier researchers for different fibre reinforced concrete beams have been evaluated from the experimental results and discussed. Finally the results obtained from the beam – column joint test are discussed.

4.2 Workability Properties

Fresh mix characteristics are more emphasized in fibre concrete compared to the plain concrete. There are two parameters that strongly influence the degree of damage to concrete workability caused by fibres. These are fibre volume fraction and aspect ratio. Generally increasing volume fraction and/or increasing aspect ratio of fibres results in further reduction of fresh concrete workability.

In this study, fibres such as steel, nylon, plastic, tyre, coir, sugarcane and rice husk of three different volume fractions like 0.5%, 1.0% and 1.5% were taken. Regarding length of fibres, except rice husk (since it has its own length) the remaining fibres of three different lengths like 30mm, 60mm and 90mm were chosen. Totally 21 different mixes were prepared and tested.

A. Slump Test

The decrease in the height of slumped cone is called 'slump of concrete'. Fig. 5.1 and 5.2 show the measured values of slump value of fresh fibrous mixes versus their fibre reinforcement index (F) of inorganic fibres such as steel, nylon, plastic, tyre and organic fibres such as coir, sugarane and rice husk respectively. Table 5.1 shows the test results of slump test. It is obvious in all the figures that fresh concrete mix workability is damaged by increasing the fibre reinforcing index. The rate of drop in workability with increase of fibre reinforcing index seems to be comparable.

Table 4.1 Slump Test Results

Mix	Fibre Reinforcing Index						
	0.0	**0.15**	**0.3**	**0.45**	**0.6**	**0.9**	**1.35**
SFC	120	96	90	78	65	52	45
NFC	120	108	96	84	71	68	62
PFC	120	100	94	80	69	58	50
TFC	120	95	82	68	53	42	35
CFC	**120**	**96**	**85**	**70**	**59**	**52**	**42**
SCFC	120	92	80	64	50	42	36
RFC	120	95	82	74	-	-	-

Explanations-At specific fibre reinforcing index value, tyre fibre seems to give higher slump value. Next to tyre, sugarcane, plastic, steel and coir have given the higher slumps respectively. Among all the fibres, nylon possessed higher workability by having less water absorption capability as well as less surface area. As the datas obtained indicates that the coir fibre concrete has the good workability.

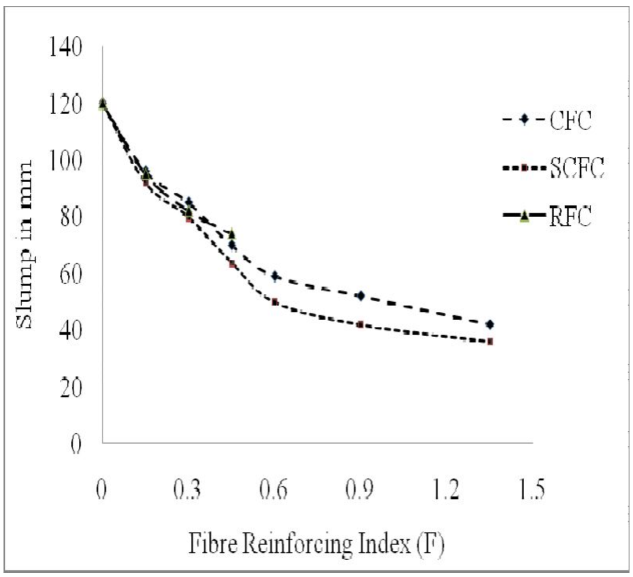

Fig 4.1 Comparision of FRI Index and Slump of Organic Fibres

B. Vee-Bee Test

Table 5.2 and Fig. 5.3 – 5.4 have given the vee-bee test results. Fig. 5.3 shows the variation of vee-bee seconds with fibre reinforcing index for inorganic fibres and Fig 5.4 shows for organic fibres. From Fig. 5.4, it is observed that increase in fibre reinforcing index increases the vee bee time for all the types of mixes. Tyre fibre mix possess the highest vee-bee seconds value which denotes it will create more damage in workability of concrete.

Table 4.2 Vee-Bee Test Results

Mix	Fibre Reinforcing Index						
	0.0	0.15	0.3	0.45	0.6	0.9	1.35
SFC	1.50	2.25	3.00	3.50	3.75	4.25	5.00
NFC	1.50	1.75	2.50	2.75	3.50	3.75	4.25
PFC	1.50	2.00	2.75	3.25	3.75	4.50	5.25
TFC	1.50	2.25	3.00	3.25	3.75	4.75	6.25
CFC	**1.50**	**2.00**	**2.50**	**3.25**	**3.75**	**4.25**	**5.00**
SCFC	1.50	2.25	3.00	3.50	4.00	4.75	5.25
RFC	1.50	1.75	2.00	2.25	3.25	3.75	4.50

Coir fibre shows the intermediate value of vee bee seconds..Vee bee seconds Core fibre concrete stated from 1.5 seconds for zero fibre reinforcing index ,to 5.0 seconds for fibre reinforcing index 1.35. Nylon fibre concrete possesses lowest vee bee seconds values while comparing with other fibres. So from the vee bee test results also it is proved that fibres having large surface area and higher water absorption capacity tends the concrete to less workable**,** Anyway it is also observed that addition of any fibre ,damages the workability from 150% to 250%.

C. Air Content

The experimental results of pressure method which was conducted to measure the air content are shown in Fig.5.5 – 5.4. There is no any direct relation for air content with fibre reinforcing indices. So, in this study comparisons were made with volume fractions and length of fibres. From the Figures, it can be known that increase in volume fraction of any fibre increases the air content values. But length of fibre concerned, decrease in length of fibres, in thinner fibres increases the air content where as in thicker fibres increase in length of fibres increases the percentage of air content.

Among the seven fibres used, steel, nylon, coir and sugarcane are comparatively thinner than the remaining fibres such as plastic, tyre and sugarcane. For constant volume fraction, decreasing the length of thinner fibres increases the air content. This may be due to the increase in number of fibres per unit volume of concrete area. Air content of conventional concrete was measured as 2%. This is increased for coir fibres upto 5.2%, of 30mm length and 1.5% volume fraction.

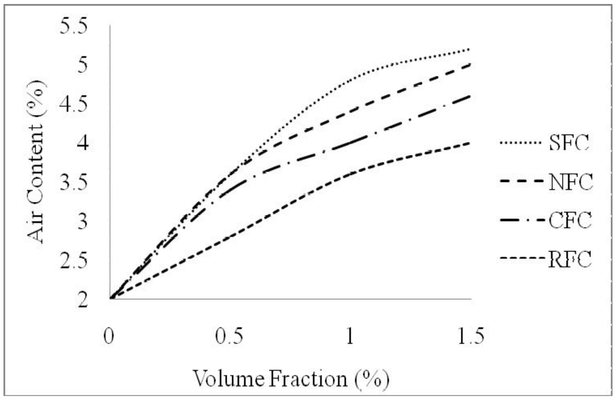

Fig 4.2 Comparison Between Volume Fraction of 30 mm long Thin Fibres and Air Content

Similarly in thick fibres also volume of fibres in concrete increases the air content of the concrete.. The air content of fibre concrete deviates from 50% to 140% from conventional concrete air content. Similarly for 60mm length and 90 mm length fibres, effect of volume fraction of fibres on air content percentage are shown in Fig. 5.7 to 5.10. In all the figures, at any particular length of fibre, volume fraction increases the air content significantly.

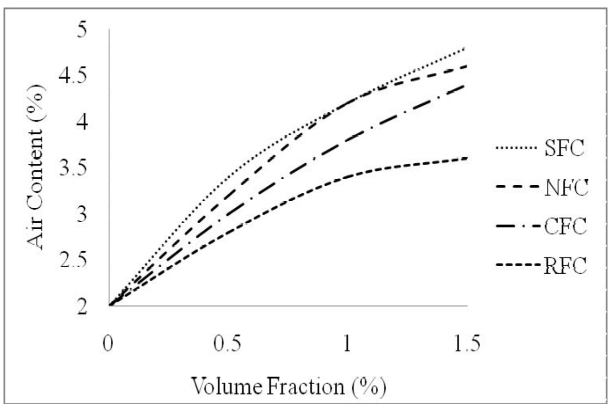

Fig 4.3 Comparison between Volume Fraction of 60mm long Thin Fibres and Air Content

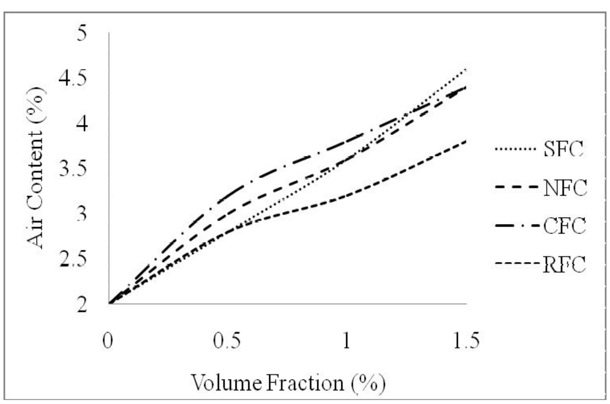

Fig 4.4 Comparison between Volume Fraction of 90mm long Thin Fibres and Air Content

While considering the effect of length of fibres on air content of fresh concrete at three different constant volume fractions such as 0.5%, 1.0% and 1.5%, thin fibres increases the air content with decrease in length whereas thick fibres increases the air content with increase in length. Fig.5.11 to 5.16 shows the effect of length of different fibres at three constant volume fraction of fibres. From Fig.5.11, Fig.5.13 and Fig.5.15, it is observed that thin fibres i.e, coir increases the air content in decreasing the length from 90 mm to 30 mm. On other hand, if thick fibres are considered, plastic, tyre and sugarcane fibres increases the air content while increasing the length of fibres. While observing the graphs, the decay pattern of all the fibres of three different lengths at three volume fractions is nearly same.

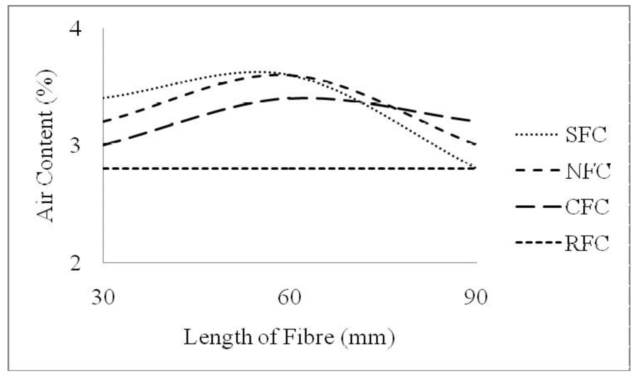

Fig 4.5 Comparison between Length of Thin Fibres at 0.5% Volume Fraction and Air Content

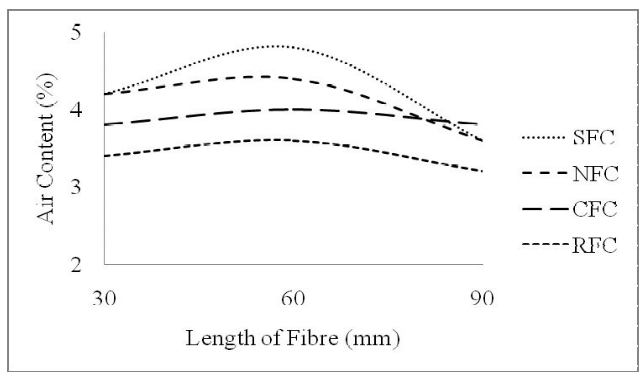

Fig 4.6 Comparison between Length of Thin Fibres at 1.0% Volume Fraction and Air Content

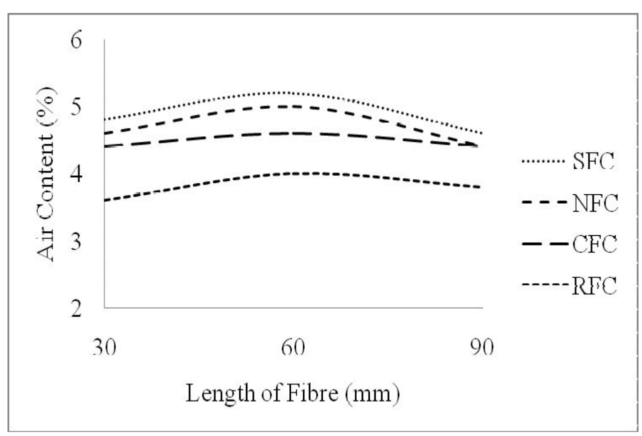

Fig 4.7 Comparison between Length of Thin Fibres at 1.5% Volume Fraction and Air Content

CONCLUSIONS

Among the seven fibres used, steel, nylon, coir and sugarcane are comparatively thinner than the remaining fibres such as plastic, tyre and sugarcane. For constant volume fraction, decreasing the length of thinner fibres increases the air content.

There are two parameters that strongly influence the degree of damage to concrete workability caused by fibres. These are fibre volume fraction and aspect ratio. Generally increasing volume fraction and/or increasing aspect ratio of fibres results in further reduction of fresh concrete workability.

it is observed that increase in fibre reinforcing index increases the vee bee time also for all the types of mixes. Tyre fibre mix possess the highest vee-bee seconds value which denotes it will create more damage in workability of concrete.

At specific fibre reinforcing index value, tyre fibre seems to give higher slump value. Next to tyre, sugarcane, plastic, steel and coir have given the higher slumps respectively. Among all the fibres, nylon possessed higher workability by having less water absorption capability as well as less surface area.

datas obtained indicates that the coir fibre concrete has the good workability.

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