PERFORMANCE OF MECHANICAL BEHAVIOUR OF CONCRETE BY USING COCONUT FIBRES

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ABSTRACT

The standard goal of this task is to examine the properties of fibre strengthened cement and plan the most efficient method to accomplish high compressive and rigidity. It is seen from the worldwide supportable advancements that strands like glass, coconut, carbon and steel filaments improves in rigidity, strength, shrinkage, solidness, disintegration opposition, crack and exhaustion properties of fibre strengthened cement. This additionally manages the variety of crack vitality of cement with option of coconut strands in various volumes. The utilization of this sustainable cement structure is helpful for devouring less vitality, discharging less green house gases into the air and costing less to assemble Concrete is the most widely used construction material all over the world. Concrete is weak in tension flexural, most commonly, it is reinforced using steel reinforcing bars. However, usage of steel reinforcement is expensive. Many efforts have been made worldwide to add various types of fibres to concrete so to make it more strong, durable and economical. Natural fibre such as coconut fibre has certain physical and mechanical characteristics that can be utilized effectively in the development of reinforced concrete material. Sometimes, these coconut fibres are dumped as agricultural waste, so it can beeasily available in large quantity hence making them cheap.

This experiment describes the behavioural study of coconut fibre in concrete structure. The addition of coconut fibre in concrete improves various engineering properties of concrete. Coconut fibre is treated as natural fiber before using in concrete. Addition of coconut fibre improves the compressive strength, flexural strength and split tensile strength of concrete. The experiment was conducted on high strength concrete with the addition of fiber with 3 mix proportions (3%, 5%, and 7%) by the weight of cement. The compressive strength and split tensile strength of cured concrete evaluated for 7days, 28days.The study found the optimum fiber content to be at 5% (by the weight of the cement). These results show coconut fiber can be used in

construction.

INTRODUCTION

GENERAL

Concrete is the most widely used construction material all over the world. With innovations in science and technology in construction industry, the scope of concrete as a structural material, has widened. Since concrete is weak in tension and flexural, most commonly, it is reinforced using steel reinforcement bars. However, usage of steel reinforcement is expensive. Considerable efforts have been made worldwide to addvarious types of fibers to concrete so as to make it more strong, durable and economical. Natural fiber such as coconut fiber has certain physical andmechanical characteristics that can be utilized effectively in the development of reinforced concrete material. In most cases, these coconut fibers are dumped as agricultural waste can be easily available in large quantity hence making them cheap

The primary goal of this project is to conduct experimental studies for the enhancement studies for properties of concrete by reinforcing it with coconut fibers.

Coconut fiber is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fiber is coir. Cocos nucifera and Aceraceae (palm), respectively.

There are two types of coconut fibers , brown fiber extracted from matured coconutsand white fibers extracted from immature coconuts brown fibers are thick ,strong and have high abrasion resistance. White fibers are smoother and finer, but also weaker. Coconut fibers are commercial available in three forms, namely bristle (long fibers), matters (relatively short) and the requirement. In engineering, brown fibers are mostly used.

According to official website of international year for natural fibers 2009, approximately, 500000 tones of coconut fibers are produced annually worldwide, mainly in India and srilanka. Its total value is estimated at $100 million. India and srilanka are also the main exporters. Coconut fibers produced is exported in the form of raw fiber.

OBJECTIVES

1. To determine the improvement in flexural strength of concrete after addition ofcoconut fibers
2. To determine the improvement in tensile strength of concrete after addition ofcoconut fiber
3. To know the effect of addition of coconut fibers on compressive strength ofconcrete
4. To provide an alternative light weight material.
5. To evaluate the performance of coconut fiber reinforced concrete in reducingcracking

NEED FOR STUDY

- Coconut fibre with a tensile strength of 21.5 MPa is the toughest among all natural fibres (Munawar et al., 2003). They are capable of taking strains 4–6 times higher than other fibres (Munawar et al., 2003). Although it is a cheap and efficient a major hindrance towards its wide scale use is the high rate of water absorption, which can be reduced by coating it with oil.

- Compare with plain concrete, coconut fibre inclusion improves the compressive stress and strain and flexural strength, deflection of the concrete effectively. Since cement – based materials are well known insulator, another avenue for future research and product development would be the use of coconut fibre – cement composite for sound and heat insulation. The use of such fibres provides generally a low cost construction and the elimination of the need for waste disposal in landfills. The advantages of using coconut fibres are they are of low cost, low density, reasonable specific strength, good thermal insulation, reduce wear and availability to be recycled with minimal impact on environment.

The advantages of coconut fibre are: Low cost, reasonable specific strength, low density, ease of availability, enhanced energy recovery, biodegradability, and ability to be recycled in nature in a carbon neutral manner, resistance to fungi moth and rot, excellent insulation to sound, flame, moisture and dampness, toughness, durability, resilience.

LITERATURE REVIEW

(Bhatia, 2001) studied the usefulness of fibre reinforced concrete in various civil engineering applications. Fibres include steel fibre, natural fibres and synthetic fibres- each of which lends varying properties to the concrete. The study revealed that the fibrous material increases the structural integrity. These studies made us adopt natural fibres which are abundantly available and cheap.

(Chouw et al., 2012) studied the viability of using coconut-fibre ropes as vertical reinforcement in mortar-free low cost housing in earth quake prone regions. The rope anchorage is achieved by embedding it in the foundation and top tie-beams. The bond between the rope and the concrete plays an important role in the stability of the structureand the rope tensile strength is also found to be fairly high. The rope tension generated due to earthquake loading should be less than both the pull out force and the rope tensileload to avoid the structure collapse. The study concluded that the pull out energy increases with an increase in embedment length, rope diameter, cement and fibre content in the matrix.

(Liu et al., 2011) studied the influence of 1%, 2%, 3% and 5%

at fibre lengths of 2.5, 5 and 7.5 cm on properties of concrete. For a proper analysis the properties of plain cement concrete was used as reference. It was seen that damping of CFRC

beams increases with the increase in fibre content. It was observed that CFRC with a fibre length of 5 cm and fibre content of 5% produced the best results. In this study the optimum percent of coconut fibre added was 5%, which made us to adopt addition of 4%,5% and 6% coconut fibre by weight of cement in our research work.

(Kelleret al., 2005) investigated the shear behaviour of reinforced concrete beams strengthened by the attachment of different configurations and quantities of carbon fibres. The study revealed that the strengthening by using carbon fibres increased the resistance to shear and also spalling of concrete.

METHODOLOGY

PRINCIPLE

Concrete is a freshly mixed material which can be moulded into any shape. Concrete is a site made material unlike other material of construction such as can vary to a very great extent in its quality. Properties and performance owing to the use of natural material except cement. The properties of materials are important to make concrete workable and durable.

Materials used in this projects are- Cement (PPC), coarse aggregates (aggregates passing through 20mm sieve and retained on 4.75mm sieve), fine aggregates (Zone II sand), Coconut fibre, water(portable water).

EXPERIMENTAL WORK

TESTS ON MATERIALS

1. TESTS ON CEMENT

Cement is the important constituent in the concrete. The process of manufacture of cement consists of grinding the raw materials mixing them intimately in certain proportions and burning them in kiln at a temperature 1300 c to 1500 c. to determine thevarious properties of cement different tests are done. The test done are :

i. Standard consistency test
ii. Initial setting time
iii. Fineness of cement
iv. Specific gravity of cement

i. Standard consistency test

The standard consistency test of a cement paste is defined as that consistency which willpermit the Vicat plunger of 10 mm diameter and 50mm length to penetrate to a point 5 to 7 mm from the bottom of the Vicat mould FIG. The experiment was done as per IS 4031-part IV.

The experiment was done as per IS 4031-Part IV and the obtained value of standard consistency is 34%.

Initial Setting Time

Initial setting time is regarding as the time elapsed between the momemt that the water is added to the cement to the time that the paste starts losing its plasticity. Experiment was done as per IS-269:1989,clause 6.3.

Experiment was done as per IS -269:1989, clause 6.3 and the obtained value of initial setting time is 45 min. According to IS code initial setting time of cement shallnot be less than 30 minutes.

ii. Specific gravity of Cement

Specific gravity bottle is used to determine density of cement as shown in fig Kerosenewhich does not react with cement is used. Experiment was done as per IS 4031-Part I-1996 and the obtained value of finenessof cement is 6.58%.According to IS code the weight of residue should not exceed 10% for ordinary cement.

Experiment was done in the obtained value of density of cement is 3 g/ml.According toIS 4031-Part II-1988 density of cement is around 3.15 g/ml.

iii. Tests on Coarse Aggregate

Aggregates are important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. The aggregates occupy 70-80 percent of the volume of concrete; their impact on various characteristics and properties of concrete is considerable. To determine the various properties of aggregate different tests are done.

i. Bulk density of coarse aggregate
ii. Sieve analysis of coarse aggregates
iii. Specific gravity of coarse aggregate

SUMMARY OF MATERIAL PROPERTIES

The physical property of cement, fine aggregate, coarse aggregate and the compressive Strength test results of the concrete cube specimens are detailed below.

TESTS ON FRESH CONCRETE

1. WORKABILITY TEST

Workability is the ability of a fresh (plastic) concrete mix to fill the form/mold properly with the desired work (vibration) and without reducing the concrete's quality.Workability depends on water content, aggregate (shape and size distribution), cementitious content and age (level of hydration) and can be modified by adding chemical admixtures, like super plasticizer. Raising the water content or adding chemical admixtures increases concrete workability. Excessive water leads to increased bleeding orsegregation of aggregates (when the cement and aggregates start to separate), with the resulting concrete having reduced quality. The use of an aggregate blend with an undesirable gradation can result in a very harsh mix design with a very low slump, which cannot readily be made more workable by addition of reasonable amounts of water. An undesirable gradation can mean using a large aggregate that is too large for the size of the formwork, or which has too few smaller aggregate grades to serve to fill the gapsbetween the larger grades, or using too little or too much sand for the same reason, or using too little water, or too much cement, or even using jagged crushed stone instead of smoother round aggregate such as pebbles. Any combination of these factors and others may result in a mix which is too harsh, i.e., which does not flow or spread out smoothly, isdifficult to get into the formwork, and which is difficult to surface finish.

a. SLUMP TEST

Slump test is the most commonly used method of measuring consistency of concrete. It is used conveniently as a control test and gives an indication of the uniformity of concrete. Additional information on workability and quality of concrete can be obtained by observing the manner in which concrete slumps. The apparatus for conducting the slump test essentially consists of a metallic mould in the form of frustum of a cone having the internal dimensions of bottom diameter 20 cm, top diameter 10 cm and a height of 30 cm as shown in Figure 5.1.

b. COMPACTION FACTOR TEST

- The compaction factor test is performed to find out the workability pf concrete
- It is more accurate than slump test
- Compaction factor is defined as the ratio of weight pf partially compactedconcreteto the weight of fully compacted concrete.

TESTS ON HARDENED CONCRETE

1. COMPRESSIVE STRENGTH TEST

Compressive strength is the capacity of a material or structure to withstand axial loads tending to reduce the size. It is measured using the Universal Testing machine. Concrete can be made to have high compressive strength, e.g. many concrete structures have compressive strengths in excess of 50 MPa. Here the compressive strength of concrete cubes for the plain concrete and fibre reinforced concrete are found out using Compression testing machine. Three cubes were cast for each percentage of fibres and the average of the two compressive strength values was taken.

2. SPLIT TENSILE STRENGTH TEST

Tensile strength is the capacity of a material or structure to withstand tension. It is measured on concrete cylinders of standard dimensions using a Universal Testing machine. Both conventional and fibre reinforced specimens were tested at varying percentages of fibre and the average value was obtained.

3. FLEXURAL STRENGTH TEST

Flexural strength of concrete is considered as an index of tensile strength of concrete. Tensile stresses are likely to develop in concrete due to drying shrinkage, rusting of steel reinforcement, temperature gradients and many other reasons. Beam tests are conducted to determine flexural strength is obtained at bottom of beam and is called modulus of rupture , which depends on dimension of beam and position of loading .

EXPERIMENTAL PROCEDUREMIX DESIGN

Mix design is defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. The mix design

STIPULATIONS FOR PROPORTIONING MIX DESIGN FOR M30 GRADE CONCRETE

Grade concrete (designation)	= M30
Type of cement	= OPC 53 grade conforming to IS 8112
Minimum nominal size of aggregate	= 20 mm Minimum
cement content	= 300kg/m3
Maximum cement ratio	= 0.50
Workability	= 75 – 100 mm (slump)
Exposure condition	moderate
Method of concrete placing	= manual
Degree of supervision	= good
Type of aggregate	=crushed angular aggregate
Max cement content	=450kg/m3

Tests data for materials:

1) Cement used : OPC 53 grade conforming to IS 8112
2) Specific gravity of cement : 3.0
3) Specific gravity of
   1. Coarse aggregate : 2.69
   2. Fine aggregate : 2.63
4) Water absorption

1. Coarse aggregate : 2%
2. Fine aggregate : 1%

5) Free moisture

1. Coarse aggregate : Nil

Fine aggregate : Nil

6) Sieve analysis :

Fine aggregate: conforming to grading zone 1 of table 4 of IS 383

DESIGN

Step 1: Target strength for mix proportion

Fck= fck + 1.65s From Table 1 of IS 10262 : 2009

= 30 + 1.65 x 5standard deviation, s =5

= 38.25 N/mm^2

Step 2: Selection of water cement ratio

From Table 5 of IS 456, maximum cement ratio =0.50

Based on experience adopt water cement ratio =0.50-0.05=0.45

0.45<0.50,hence ok

Step 3: Selection of water content

From Table 2, of IS 10262-2009

Maximum water content for 20mm aggregate =186 liter (for 25-50mm slumprange)Estimated water content for 100 mm slump = 186+(3/100)x186

=191.58=192mm

Step 4: Calculation of cement content

Water cement ratio = 0.45

Cement content = 192/0.45=426.67kg/m3

=427kg/m3From Table 5, of IS 456

Minimum Cement Content for 'moderate 'exposure condition = 300kg/m3above calculate cement content valve is426.67>300kg/m3

Hence ok

Step 5: Volume of coarse aggregate &fine aggregate content

From table 3 of IS 10262-2009, volume of coarse aggregate corresponding to 20 mmsize aggregate and fine aggregate(zone 1)for w/c ratio of 0.50=0.60
In the present case water cement ratio is **0.45.**

Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water cement ratio is lower by 0.10. the proportion of volume of coarse aggregate is increased by 0.02.
Therefore, corrected proportion of volume of coarse aggregate for the w/c ratio of 0.45=0.60+0.01=0.61
Volume of fine aggregate content =1-0.61=0.39

Step 6: Mix calculations

Mix calculations percent volume of concrete shall as follows,

(a) Volume of concrete = 1 m3

(b) Volume of Cement (for w/c ratio 0.5) = $\frac{\text{mass of cement}}{\text{Specific gravity of cement}} \times \frac{1}{100}$ -

$= \frac{427}{3} \times \frac{1}{100}$

= 0.142 m3

(c) Volume of water = $\frac{\text{mass of water}}{\text{Specific gravity of water}} \times \frac{1}{1000}$

(d) Volume of all in aggregate = [a-(b+c)] = $\frac{192}{1} \times \frac{1}{100}$

= [1-(0.142+0.192)] = 0.192 m3

= 0.666 m3

(e) Mass of coarse aggregate = d X volume of coarse aggregate X specific gravity of coarse aggregate x 1000

= 0.666 X 0.61 X 2.69X1000

1092.83 kg =1093 kg

(f) Mass of fine aggregate = d X volume of fine aggregate X specific gravity of fine aggregate X 1000

= 0.666 X 0.39 X 2.63 X 1000

= 683.116 kg = 683 kg

Mix proportions:

Cement = 427 kg/m3

Water = 192 kg/m3

Coarse aggregate = 1093 kg/m3

Fine aggregate = 683 kg/m3

CASTING PROCEDURE

Casting of Plain Concrete Specimen

For casting, all the moulds were cleaned and oiled properly. There were securely tightened to correct dimension before casting. Care was taken that there are no gaps left, where there is any possibility of leakage of slurry. Careful procedure was adopted in the batching, mixing and casting operation. The coarse aggregate and fine aggregate were weighed first. The concrete mixture was prepared by hand mixing on a water tight platform. On the water tight platform cement and fine aggregates are mixed thoroughly until a uniform colour is obtained, to this mixture coarse aggregate was added and mixed thoroughly. Then water is added carefully making sure no water is lost during mixing. While adding water care should be taken to add it in stages so as to prevent bleeding which may affect the strength formation of concrete rising of water required for hydration to the surface.

Clean and oiled mould for each category was then placed on the vibrating table respectively and filled in three layers. Vibrations were stopped as soon as the cement slurry appeared on the top surface of the mould.

These specimens were allowed to remain in the steel mould for the first 24 hours at ambient condition. After that these were demoulded with care so that no edges were broken and were placed in the tank at the ambient temperature for curing. After demoulding the specimen by loosening the screws of the steel mould, the cubes were placed in the water for 7 days and 28 days.

Casting of Coconut Fiber Reinforced Concrete

The calculated amount of cement and fine aggregate are mixed together till a uniform mix is obtained. The amounts of fiber adopted are 3%, 5% and 7% of cement. Coir fibre strands are cut into a length of 5cm washed, oil coated with coconut oil and dried in sunlight for 24 hours.

It is then added to the mix until a uniform color is obtained. Coarse aggregates are then added to the same and mixed followed by addition of water. Care should be taken to add water slowly in stages so as to prevent bleeding which may affect the strength formation of concrete rising of water required for hydration to the surface. Admixture is added towards the last stage of addition of water so as to avail sufficient time for mixing before the concrete hardens. It is placed in the mould, compacted and finished is shown in Fig. 5.8. 6 cubes each of the same are prepared and cured. The compressive strength for 7day and 28 day is determined.

CURING OF CUBES, CYLINDERS AND BEAMS

The specimens were stripped from the mould after 24 hours of casting andsubmerged in water until testing.

RESULTS AND ANALYSIS

COMPRESSIVE STRENGTH TEST

COMPRESSIVE STRENGTH OF CONVENTIONAL CONCRETE CUBES

The compressive strength of ordinary concrete with different water cement ratiowas tested. The results are as shown

compressive strength of conventional concrete

Specimen	W/C ratio	slump value	7 days strength (N/mm2)	28 days strength(N/mm2)
1	0.45	80	22.22	34.18
2	0.45	80	23.10	36.53
3	0.45	80	22.67	34.87
		Average	**22.67**	**35.19**

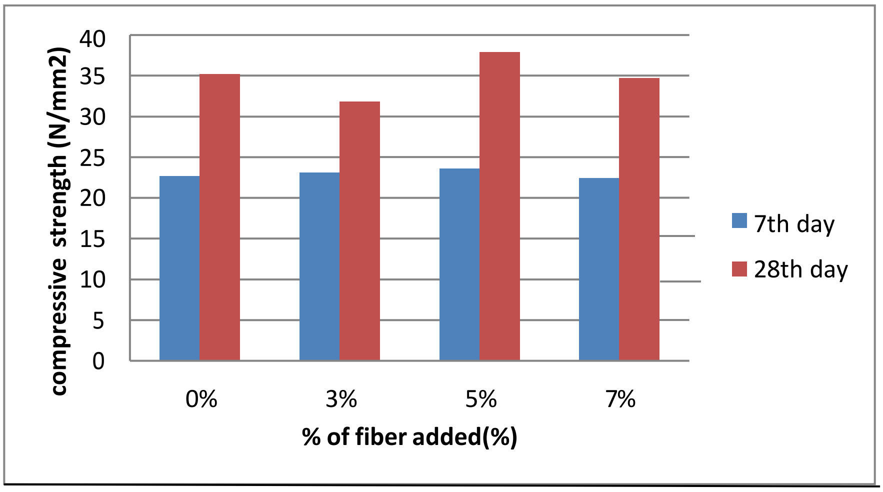
For the table the average of value from the 3 observations is **22.67 N/mm2**, is taken as compressive strength of plain concrete cube

COMPRESSIVE STRENGTH OF CFRC

Coconut fiber reinforced concrete was cast at a water cement ratio of 0.45 at which desired slump values and compressive strength were obtained for conventional concrete. However, when fiber is added the mix showed very low workability. Hence superplasticizer was added at different proportions of cement to get a concrete mix with suitable workability. The result of compressive strength of fiber reinforced concrete and slump test results are shown in Table 5.4.

Table 5.2. Compressive Strength of CFRC cubes

Specimen	W/C ratio	Percentage ofcoconut fiber added	slump valve	Compressive strength (N/mm2)	
				7 days	28 days
1	0.45	0%	80	22.66	35.19
2	0.45	3%	70	23.11	31.85
3	0.45	5%	65	23.50	37.90
4	0.45	7%	55	22.44	34.75



Graph 5.1. Graphs showing variation of compressive strength at varying percentages of fiber

The value obtained for 5% addition of coconut fiber water cement ratio **0.45** yielded highest results for compressive strength. However, the compressive strength decreased on the increase in fiber addition. This may be due to the fact when fibers are added initially the fiber sized fine aggregates enter into the surface pores in the fiber creating a better bonding between the fiber and mix, however further addition offiber causes formation of bulk fiber in the mix decreasing the bonding. Hence thereis an optimum value of fiber to cement ratio , beyond which the compressive strength decreases.

Hence **0.45** was taken as the optimum water cement ratio and optimum fiber content was taken as 5%.

SPLIT TENSILE STRENGTH TEST

SPILT TENSILE OF PLAIN CEMENT CONCRETE

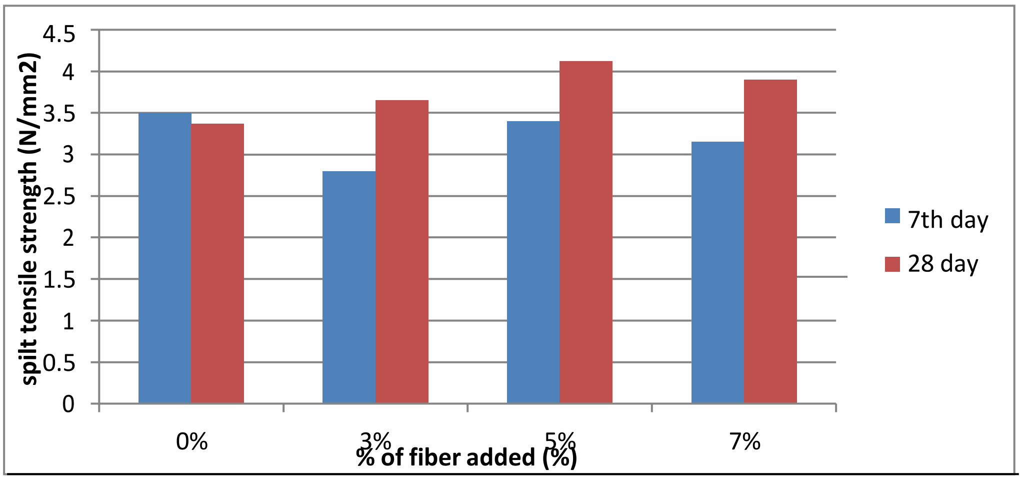
Split tensile strength tests were conducted on standard cylinders of dimension 15cm diameter and 30cm depth Fig 5.13 specimens each for plain concrete, coconut fiber reinforced concrete (both raw and processed fiber) were cast at varying percentages of fiber (3%, 5%, 7%). For each case 28day strength values were obtained by loading under a compression testing machine. The result of Split tensile strength of plain and processed fiber reinforced concrete and slump test results are shown in Table 5.5 and Table 5.6

Table 5.3. Spilt tensile strength of plain cement concrete cylinders

Specimen	W/Cratio	Slump value(mm)	Spilt tensile strength in N/mm2
1	0.45	80	2.50
2	0.45	80	2.75
3	0.45	80	2.60

Table 5.4. Spilt tensile strength for CFRC cylinders

Specimen	W/C ratio	Percentage ofcoconut fiber added	Slump value(mm)	Split tensile strength (N/mm2)	
				7 days	28 day
1	0.45	0 %	80	3.5	3.37
2	0.45	3 %	70	2.80	3.65
3	0.45	5 %	65	3.40	4.12
4	0.45	7 %	65	3.15	3.90



Graph 5.2. Graph showing the variation of spilt tensile strength at varyingpercentage of fiber

From the graph it is seen that when fiber content is increased there is an increase in spilt tensile with a maximum at 5% of fiber. However when the fiber content is increased beyond this value a downward slope of the graph is observed. This is dueto the fact that tensile failure occurs due to the atoms and molecules present in concrete. However when the fiber is added it acts as a binder holding them together.

FLEXURAL STRENGTH TEST

FLEXURAL STRENGTH FOR CONVENTIONAL CONCRETE

Flexural strength tests were conducted on standard beams of dimension 10cm x 10cm x 50cm Fig 5.19. 3 specimens each for plain concrete, coconut fibre reinforcedconcrete were cast at varying percentages of fibre (3%,5%, 7%). For each case the 28day strength values were obtained by loading under a apparatus for flexural strength. The result of Split tensile strength of plain and fibre reinforced concrete andslump test results are shown in Table 5.7 and Table 5.8 respectively and is shown graphically in Fig 5.20 and Fig 5.21.

Flexural strength for conventional concrete

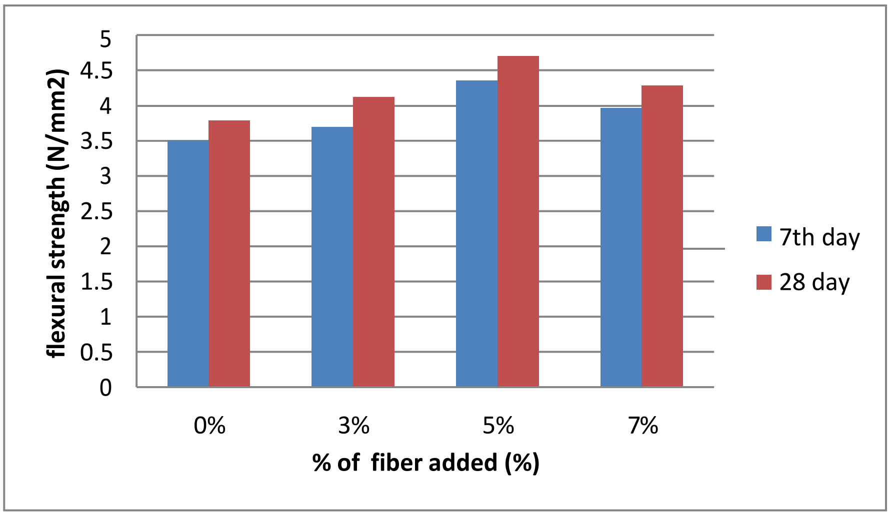
Specimen	**W/C ratio**	**Slump valve**	**Flexural strength(N/mm2)**	
			7 days	**28 days**
1	0.45	80	3.45	3.74
2	0.45	80	3.56	3.86
3	0.45	80	3.50	3.77
Average			**3.50**	**11.39**

FLEXURAL STRENGTH OF CFRC

The results for flexural strength of raw fibre reinforced concrete and slump testresultsare shown in Table 5.8 and is shown graphically in Fig 5.16

Flexural strength for CFRC beams

Specimen	W/C ratio	Percentage of coconut fiber added	Slump value(N/mm2)	Flexural strength (N/mm2)	
				7 days	28 days
1	0.45	0%	80	3.5	3.79
2	0.45	3%	70	3.70	4.12
3	0.45	5%	65	4.75	4.70
4	0.45	7%	55	3.96	4.22



Graph 5.3.Graph showing the variation of spilt tensile strength varying at percentage of fiber

From the graph it is seen that when fibre content is increased there is an increase in flexural strength with a maximum at 5% of fibre. However when the fibre content is increased beyond this value a downward slope of the graph is observed .

CONCLUSION

1. At 5% addition of coconut fibre with a water cement ratio of 0.45, compressive strength tests yielded best results. However, the compressive strength decreased on further fibre addition. This must be due to the fact that when the fibres are initially added to concrete, the finer sized fine aggregates enter into the surface pores in the fibrecreating a better bonding between the fibre and mix, however further addition of fibres resulted in formation of bulk fibre in the mix which will lead to decrease in bonding. Hence there is an optimum value of fibre to cement ratio, beyond which the compressive strength decreases. Hence **0.45** was taken as the optimum water cement ratio and optimum fibre content was taken as **5%**

2. When the fibre content is increased there is an increase in split tensile strength with a maximum at **5%**. However when the fibre content is increased beyond this value a reduction in tensile strength is observed. This is due to the fact that tensile failure occurs due to the dislocation of atoms and molecules present in concrete. However when the fibre is added it acts as a binder holding them together.

3. When fibre content is increased there is an increase in flexural strength with a maximum at **5%** of fibre. However when the fibre content is increased beyond this value a downward slope of the graph is observed. This is also due to the binding properties of coconut fibre owing to its high tensile strength of **21.5 MPa.**

4. The tensile properties and cracking pattern of CFRC shows that it can be particularly useful in construction activities in seismic zones due to its high tensile strength and post peak load behaviour, which offers sufficient warning to the inhabitants before complete collapse of the structure.

5 . Due to its relatively higher strength and ductility, It can be a good replacement for asbestos fibres in roofing sheets, which being natural in origin pose zero threat to theenvironment.

Since higher strength is attained at a lower design mix. It can be used to manufacture building blocks at relatively lower costs in comparison to plain concrete blocks thus making it suitable for rural residential buildings upto **10m** height or as protection walls around buildings.

6. It can also be used as the reinforcement material in cement fibre boards which can actas a good backing to tiles thereby improving its impact resistance and also in faux ceilings. The advantage of cement fibre boards is its ability to survive under moist environments unlike paper based gypsum boards

LIMITATIONS OF THE PROJECT

The limitations of this project are:

1) This study on coconut fibre reinforced concrete is limited to rural residentialconstructions
2) Mix design for concrete is done for mild exposure conditions and corrosionstudy isnot done

FUTURE SCOPE

1. The effect of coconut fibres on high strength concrete should be studied and thus the use of CFRC can be extended to industrial and commercial buildings. Since the corrosion study is not done, the applicability of CFRC in reinforced constructions could be tested.

2. Coconut fibre is a good insulator in itself and as such it can improve the thermal properties of concrete. This is particularly useful in a tropical country like India where the mercury levels are quite high for most part of the year, so as to maintain the room temperatures within comfort levels of its inhabitants. It can also reduce the load on air conditioning systems thus reducing the power consumption.

3. The acoustic properties of concrete reinforced with other natural fibres have been studied in the past using an impedance tube apparatus and the results are fair enoughto justify the use of coconut fibres as an alternative which is a good absorbent due tothe presence of surface pores.

REFERENCES

1. **Majid Ali, Nawawi Chouw (2012)**,"Experimental investigations on coconut-fibre rope tensile strength and pullout from coconut fibre reinforced concrete", Construction and Building Materials, 41, 681–690
2. **Reis J.M.L (2005)**,"Fracture and flexural characterization of naturalfiber- reinforced polymer concrete", Construction and Building Materials 20 (2005) 673–678

1. **Majid Ali, Anthony Liu, HouSou, Nawawi Chouw (2011)**,"Mechanical and dynamic properties of coconut fibre reinforced concrete" Construction and Building Materials 30 (2011) 814–825
3. **Noor Md. Sadiqul Hassan, Habibur Rahman Sobuz (2012)**, "Use of coconut fibre in production of structural light weight concrete", Journal of applied sciences 12(9) 831- 839, 2012
4. **Vijay Chavada, A.A Parikh (2013),** "An application review of coir fibre reinforced concrete", Vol. 2 Issue 4 ISSN: 2278-7844
5. **A Zuraida, H Zahurin, I Sopiyan (2011)**,"Effect of fibre length variation on physical and mechanical properties of coir fibre reinforced concrete", Materials Physics and Mechanics 16 (2013) 107-117
6. **P Nibasumba, X L Liu (2011)**,"Recent developments in fibre reinforced concrete and

their effect on concrete columns analysis", Construction and Building Materials 2011;18(7):549–58

7. **Joanna M Ferraz, Sabrina A Martins, Claudio H.S Del Menezzi (2013)**, "Effect of coir fibre treatment and coir-fibre ratio on properties of cement bonded composites", Bio Resources 6(3), 3481-3492
8. **Dr.M.Sivaraja (2009),** "Application of Coir Fibres as Concrete Composites for Disaster prone Structures" International Journal of Civil and Environmental Engineering Sci., Vol. 33, No. 6, December 2009, pp. 719– 729.
9. **Izad Amir Bin Abdul Karim (2012)**,"Effect of coconut waste on concrete structure component"ARPN Journal of Engineering and Applied Sciences, 30(2012). 2538 – 2547.
10. **Yalley, P. P. and Kwan, A.S K (2008),** "Use of coconut fibre as an enhancement of concrete", International Journal of Sustainable Construction Engineering &Technology, 27(5), 2008, pp. 575-582.