

EXPERIMENTAL STUDY ON COIR FIBRE MIXED CONCRETE

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ABSTRACT

This paper presents the versatility of coconut fibre is one of the natural fibers abundantly available in tropical regions, and is extracted from the husk of coconut fruit the properties of composites of concrete in which coconut fibers are used as reinforcement, are discussed. The research carried out and the conclusions drawn by different researchers in last few decades are also briefly presented. Coconut fibers reinforced composites have been used as cheap and durable non-structural elements. The aim of this project is to spread awareness of coconut fibers as a construction material in Civil Engineering.

Keywords:

1. Fibre
2. Concrete
3. Cement

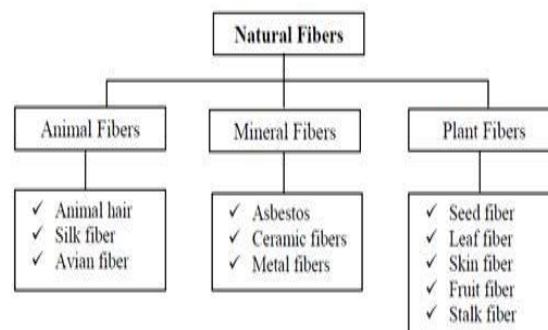
I. INTRODUCTION

1.1 General

Concrete is most widely-used Man made construction material and studies indicate that it will continue to be so in the years and decades to come. Such versatility of concrete is due to the fact the common ingredients, namely cement, sand, coarse aggregate and water. Concrete is good in compression and also it is very strong in carrying flexural force. A Reinforced concrete section, where the concrete resists compression and the steel resists the tension.

1.2 Natural fiber

Natural fibers include those made from plant, animal and mineral sources. Natural fibers can be classified according to their origin.



II. BACKGROUND OF COIR FIBER

2.1 COIR FIBER

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 Arecaceae (Palm), respectively.

There are two types of coconut fibers, brown fiber extracted from matured coconuts and 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.

However, steel reinforcement is still expensive for many people who want to build earthquake resistant houses. To overcome the difficulty, an economical but safe constructional material is needed. Natural fibers can be one possible material, as they are cheap and locally available in many countries. In this present work, the natural Coir fiber using in concrete.



Fig. 2.1 Coconut Tree, Coconut and Coconut fibers

Natural fibers such as jute, sisal, pineapple, abaca and coir have been studied as a reinforcement and filler in composites. Growing attention is nowadays being paid to coconut fiber due to its availability. The coconut husk is available in large quantities as residue from coconut production in many areas, which is yielding the coarse

Coir fiber. Coir is a lingo-cellulose natural fiber. It is a seed-hair fiber obtained from the outer shell, or husk, of the coconut. It is resistant to abrasion and can be dyed.

Total world Coir fiber Production is 250,000 tonnes. The Coir fiber industry is particularly important in some areas of the developing world. Over 50% of the Coir fiber produced annually throughout the world is consumed in the countries of origin, mainly India. Because of its hard-wearing quality, durability and other advantages, it is used for making a wide variety of floor furnishing materials, yarn, rope etc. However, these traditional coir products consume only a small percentage of the potential total world production of coconut husk.



Fig. 2.2 Coir fiber

2.2 APPLICATIONS IN CIVIL ENGINEERING TECHNOLOGY

2.2.1 Plaster

John et al. (2005) studied the coir fiber reinforced low alkaline cement taken from the internal and external walls of a 12 year old house. The panel of the house were produced using 1:1.5:0.504 (binder: sand: water, by mass) mortar reinforced with 2% of coconut fibers by volume.

Fibers removed from the old samples were reported to be undamaged. No significant difference was found in the lignin content of fibers removed from external and those removed from internal walls.

2.2.2 Roofing material

Cook et al. (1978) reported the use of randomly distributed coir fiber reinforced cement composites as low cost materials for roofing. The studied parameters were fiber lengths (2.5 cm, 3.75 cm and 6.35 cm), fiber volumes (2.5, 5, 7.5, 10 and 15%) and casting pressure (from 1 to 2 MPa with an increment of 0.33 MPa). Different properties like bending, impact, shrinkage, water absorption, permeability and fire resistance were investigated. They concluded that the optimum composite was a composite with a fiber length of 3.75 cm, a fiber volume fraction of 7.5 % and cast at pressure of 1.67 MPa. Cost comparison revealed that this composite was substantially cheaper than the locally available roofing materials.

Agopyan et al. (2005) studied coir and sisal fibers as replacement for asbestos in roofing tiles. Coir fibers were more suitable among studied fibers.

2.2.3 Slabs

Paramasivam et al. (1984) conducted a feasibility study of making coir fiber reinforced corrugated slabs for use in low cost housing particularly for developing countries. They gave recommendations for the production of coconut fiber reinforced corrugated slabs along with casting technique.

Tests for flexural strength, thermal and acoustic properties were performed. For producing required slabs having a flexural strength of 22 MPa, a volume fraction of 3 %, a fiber length of 2.5 cm and a casting pressure of 0.15 MPa (1.5 atmosphere) were recommended. The thermal conductivity and sound absorption coefficient for low frequency were comparable with those of locally available asbestos boards.

Ramakrishna and Sandararajan (2005) performed the experimental investigations of the resistance to impact loading were carried out on cement sand mortar (1:3) slabs. The slab specimens (300 mm x 300 mm x 20 mm) were reinforced with natural fibers (coconut, sisal, jute and hibiscus cannabinus fibers) having four different fiber contents (0.5, 1.0, 1.5 and 2.5% by weight of cement) and three fiber lengths (20, 30 and 40 mm).

A fiber content of 2% and a fiber length of 40mm of coconut fibers showed best performance by absorbing 253.5J impact energy among all tested fibers. All fibers, except coconut fibers, showed fiber fracture, at ultimate failure where as coconut fiber showed fiber pull out failure.

Li et al. (2007) studied fiber volume fraction and fiber surface treatment with a wetting agent for coir mesh reinforced mortar using nonwoven coir mesh matting. They performed a four-point bending test on a slab specimen.

They concluded that cementitious composites, reinforced by three layers of coir mesh (with a low fiber content of 1.8 %) resulted in a 40 % improvement in the maximum flexural stress, were 25 times stronger in flexural toughness, and about 20 times higher in flexural ductility.

2.2.4 Boards

Asasutjarit et al. (2007) determined the physical, mechanical and thermal properties of coconut coir-based light weight cement board after 28 days of hydration. The parameters studied were fiber length, coir pre-treatment and mixture ratio. Boiled and washed fibers with 6cm fiber length gave better results. On the other hand, optimum mixture ratio by weight for cement: fiber: water was 2:1: 2. Also, tested board had lower thermal conductivity than commercial flake board composite.

2.2.5 Wall paneling system

Mohammad Hisbany Bin Mohammad Hashim (2005) tested wall panels made of gypsum and cement as binder and coconut fiber as the reinforcement. Bending strength, compressive strength, moisture content, density, and absorption were investigated.

Coconut fibers did not contribute to bending strength of the tested wall panels. Compressive strength increased with the addition of coconut fibers, but the compressive strength decreased with an increase in water content and density was increased. There was no significant change of moisture content with coconut fibers. However, moisture content increased with time. There was also no significant effect to water absorption on increasing coconut fiber content

2.2.6 House construction

Some researchers (Luisito J Peramora, Neil J Melencion and RolendioN Palomar) of PCA-Zamboanga Research Center, San Ramon, Zamboanga city invented coconut fiber boards (CFB) for different applications.

According to them, CFB can replace construction materials such as tiles, bricks, plywood, and asbestos and cement hollow blocks. It is used for internal and exterior walls, partitions and ceiling. It can also be used as a component in the fabrication of furniture, cabinets, boxes and vases, among others.

2.2.7 Slope stabilization

Coir erosion fabrics provide firm support on slopes and unlike other natural fiber alternatives like cotton or jute, do not degrade until 5 years. They have the necessary strength and come in a number of forms such as matting, rolls and logs and are used for soil stabilization.

Coconut fiber finds applications in slope stabilization in railway cutting and embankments, protection of water courses, reinforcement of temporary walls and rural unpaved roads, providing a sub base layer in road pavements, land reclamation and filtration in road drains, containment of soil and concrete as temporary seeding etc, highway cut and fill slopes, control of gully erosion and shallow mass waste.

III. LITERATURE REVIEW

3.1 General

This chapter outlines some of the recent reports published in literature Mechanical behaviour of natural fiber.

Anthony liu et al. (2012) has studied the mechanical and dynamic properties of coconut fibre reinforced concrete and also they have potential to be used as reinforcement in low cost structures. The influence of 1%, 2%, 3% and 5% fibre contents by mass of cement and fibre lengths of 2.5, 5 and 7.5 cm is investigated. They concluded that by adding 5% fibre content by mass of cement and fibre length 5 cm improving the properties of concrete.

Sivaraja M. et al. (2012) has studied contribution of coir, steel , nylon and plastic fibres in mechanical strength was found more than that of other fibres. Optimum volume fraction of fibres was 0.5-1% will be increasing in strength of fibrous concrete.

Cheul shin U., et al. (2007) has compared physical, mechanical and thermal properties of manufactured coconut coir cement boards to the normal boards. Coconut coir has additional property of being light in weight with low thermal conductivity. The coconut coir –based light weight cement board could be used as insulating building material for energy conservation in buildings.

Huang gu (2009) have investigated tensile behavior of the coir fibre and related composites after NaOH treatment. Brown coir fibres were treated by NaOH solution with concentrations from 2% to 10% separately. In the case of NaOH density with 10%, lower tensile strength of the composite was noticed compared to the cases of 2%, 4%, 6% and 8%. They concluded after alkali treatment the elongation at break of the composites. This implied that the ductility of the alkali-treated coir fibre had been improved.

Majid Ali et al. (2009) has studied the dynamic behaviour and load carrying capacity of CFRC beams as structural members without and with coconut rope. Natural coir fibres having a length of 7.5 cm and a fibre content of 3 % by weight of cement are used to prepare CFRC beams. Coconut rope having a diameter of 1cm and tensile strength of 7.8 MPa is added as the main reinforcement. They concluded that CFRC with coir rope rebars has the potential to be used as main structural members due to its increased damping and ductility.

John V.M. et al (2005) have studied durability of slag mortar reinforced with coconut fibre. The ratio of mortar reinforcement using 1:1.5:0.5(binder: sand: water) with 2% coir fibre volume of mortar. The binder was blast furnace activated by 2% of lime and 10%of gypsum. They are concluded finally increasing durability at the presence of coir with using binder.

Ramakrishna G. and Sundarajan T. (2004) have experimentally investigated the resistance to impact loading, using a simple projectile test, on cement mortar slabs (1:3,size: 300mm*300mm*20mm) reinforced with four natural fibers, coir, sisal, jute, hibiscus cannebinus. four different fiber contents (0.5%,1.0%,1.5%,and 2.5% by weight of cement) They used three fiber lengths (20mm,30mm,and 40mm) and obtained increased impact resistance by 3-18 times than that reference mortar slab. They have concluded that, out of the four fibers, Coir fiber reinforced mortar slab specimen have shown the best performance based on the set of chosen indicators, i.e. the impact resistance (R_u), residual impact strength ratio(I_{rs}), impact crack resistance ratio(Cr) and the condition of fiber at ultimate failure.

Ramakrishna G. and Sundarajan T. (2005) investigated the variation in chemical composition and tensile strength of four natural fibers (coconut, sisal, jute and hibiscus cannabibus fibers), when subjected to alternate wetting and drying and continuous immersion for 60 days in three mediums (water, saturated lime and sodium hydroxide). Chemical composition of all fibers changed for tested conditions (continuous immersion was found to be critical), and fibers lost their strength. But coconut fibers were reported best for retaining a good percentage of its original tensile strength for all tested conditions. Fibers content was 0.08, 0.16 and 0.32% by total weight of cement, sand and water. The mortars for both design mixes without any fibers were also tested as reference. Cylinders having size of 50mm diameter and 100mm height and beams having size of 50mm width, 50mm depth and 200mm length were tested for compressive and flexural strength. The curing was done for 8 days only. It was found that all strengths were increased in case of fiber reinforced mortar as compared to that of plain mortar for both mix design with all fiber contents. However, a decrease in strength of mortar was also observed with an increase in fiber content.

Geethamma et al. (2005) have studied the dynamic mechanical behavior of natural rubber and its composites reinforced with short Coir fibers. volume fraction ranging from 10% to 30%, show better properties than composites with untreated fibers, A maximum value of 42.3MPa is reported against a value of 48.5MPa for the neat polyester. Acetylating of Coir fibers increases the hydrophobic behavior, increases the resistance to fungi attack and also

increases the tensile strength of coir– polyester composites. However, the fiber loading has to be fairly high, 45 wt% or even higher, to attain a significant reinforcing effect when the composite is tested in tension.

Laly et al. (2006) have investigated banana fiber reinforced polyester composites and found that the optimum content of banana fiber is 40%. Mechanical properties of banana fiber cement composites were investigated physically and mechanically finally, reported that kraft pulped banana fiber composite has good flexural strength.

Mansur and Aziz (2006) studied bamboo-mesh reinforced cement composites, and found that this reinforcing material could enhance the ductility and toughness of the cement matrix, and increase significantly its tensile, flexural, and impact strengths. On the other hand, jute fabric-reinforced polyester composites were tested for the evaluation of mechanical properties and compared with wood composite, and it was found that the jute fiber composite has better strengths than wood composites. A pulp fiber reinforced

thermo plastic composite was investigated and found to have a combination of stiffness increased by a factor of 5.2 and strength increased by a factor of 2.3 relative to the virgin polymer . Information on the usage of banana fibers in reinforcing polymers is limited in the literature.

Yuhazri M.Y. and Dan M.M.P. (2007) utilized coconut fibers in the manufacturing of motor cycle helmet. They used epoxy resins from thermo set polymer as the matrix materials and coconut fibers as the reinforcement. After the development of helmet shells fabrication method, mechanical testing (dynamic penetration) was performed on this composite material to determine its performance. The result in the mechanical performance showed that coconut fibers performed well as a suitable reinforcement to the epoxy resin matrix.

Paramasivam et al. (1984) conducted a feasibility study of making Coir fiber reinforced corrugated slabs for use in low cost housing particularly for developing countries. They gave recommendations for the production of coconut fiber reinforced corrugated slabs along with casting technique. Tests for flexural strength, thermal and acoustic properties were performed. For producing required slabs having a flexural strength of 22 MPa, a volume fraction of 3 %, a fiber length of 2.5 cm and a casting pressure of 0.15 MPa (1.5 atmosphere) were recommended. The thermal conductivity and sound absorption coefficient for low frequency were comparable with those of locally available asbestos boards.

Li et al. (2007) studied fiber volume fraction and fiber surface treatment with a wetting agent for coir mesh reinforced mortar using nonwoven coir mesh matting. They performed a four-point bending test on a slab specimen. They concluded that cementitious composites, reinforced by three layers of coir mesh (with a low fiber content of 1.8 %) resulted in a 40 % improvement in the maximum flexural stress, were 25 times stronger in flexural toughness, and about 20 times higher in flexural ductility. Cook et al. (1978) reported the use of randomly distributed Coir fiber reinforced cement composites as low cost materials for roofing. The studied parameters were fiber lengths (2.5 cm, 3.75 cm and 6.35 cm), fiber volumes (2.5, 5, 7.5, 10 and 15%) and casting pressure (from 1 to 2 MPa with an increment of 0.33 MPa). Different properties like bending, impact, shrinkage, water absorption, permeability and fire resistance were investigated. They concluded that the 7.5 % and cast at pressure of 1.67 MPa. Cost comparison revealed that this composite was substantially cheaper than the locally available roofing mat.

IV. MATERIALS PROPERTIES

4.1 MATERIALS USED IN CONCRETE

4.1.1 Cement

The cement used should confirm to IS specifications. There are several types of cements are available commercially in the market of which Portland cement Specific Gravity is 3.15 the most known and available everywhere. OPC 53 grade confirms to IS 8112:1989 is used for this study.

4.1.2 Fine Aggregate

Naturally available fine aggregate is used for casting specimens. The fine aggregate was passing through 4.75mm sieve and had a specific gravity of 2.68. The grading zone of fine aggregate was zone II as per Indian Standard Specification (IS 383).

4.1.3 Coarse Aggregate

Coarse aggregate are the crushed stone is used for making concrete. The maximum size of coarse aggregate used for this investigation is 20mm and the specific gravity is 2.78.

4.1.4 Water

Water is an important ingredient of concrete as it chemically participates in the reactions with cement to form the hydration product C-S-H gel. The strength of cement concrete depends mainly from the binding action of the hydrated cement paste gel. A higher water-binder ratio will decrease the strength, durability, water-tightness and other related properties of concrete. As per Neville, the quantity of water added should be the minimum required for chemical reaction of hydrated cement, as any excess of water would lead end up only in the formation of undesirable voids (capillary pores) in the hardened cement concrete paste. Hence, it is essential to use a little paste as possible consistent with the requirements of workability and chemical combination with cement

From HSC mix considerations, it is important to have the compatibility between the given cement and the chemical and mineral admixtures along with the water used cement and mineral admixtures along with the water used for mixing. HSC with its high content of cementitious materials is susceptible to a rapid loss of workability on account of high amount of heat of hydration generated. Therefore attention is required to see that the initial hydration rate of cement should not be significantly affected. Quality and quantity of water is required to be looked very carefully.

The water used for making concrete should be free from undesirable salts that may react with cement and admixture and reduce their efficiency. Silts and suspended particles and undesirable as they interfere with setting, hardening and bond characteristics. Algae in mixing water may cause a marked reduction in strength of concrete either by combining with cement to reduce the bond or by causing large amount of air entrainment in concrete.

Water conforming to the requirements of BIS:456-2000 is found to be suitable for making concrete. It is generally stated that water fit for drinking is fit for making concrete.

4.1.5 Coir Fibers

Locally available waste materials were collected from different and properly shaped in the form of fibers. Uniform length of fibers was obtained by using cutting machine. Typical properties of fiber shown in table 4.1.

Table 4.1 Properties of fiber

Properties of fiber	
Diameter in mm	0.48
Aspect ratio	104.2
Specific gravity	0.87
Water absorption in %	104.2
Density in kg/m ³	2057

V. EXPERIMENTAL INVESTIGATION

5.1 MATERIALS AND MIX PROPORTIONS

Materials used include ordinary Portland cement (53 grade, conforming to IS 8112-1989), coarse aggregate of crushed rock (max. size, 20mm), fine aggregate of clean river sand (zone II of IS 383-1970) and portable water. Locally available rural materials were taken from waste stream and converted into fibers of required length and diameter. Diameter of coir fiber was measured by microscope and uniform length of coir was obtained by cutting machine. diameter is 0.48mm and aspect ratio is 104.8 fiber sample (5g each) was accurately weighted in an electronic balance and water absorbed after 24h of continuous immersion was determined. A mix was designed as per IS 10262-1982 to achieve a concrete grade of M20. A sieve analysis conforming to IS 383-1970 was carried out for both fine and coarse aggregates. The concrete mix was designed so as to achieve cube strength of 20 MPa (28 days). Coir fiber of volume 1%, 2% & 3% percent of concrete was mixed in concrete homogeneously. The fiber of longer size was chosen to reduce the number of fibers per kg to avoid workability problem.

5.2 MIXING AND CASTING

Hand mixing was used for convenient handling of coir fiber. Sand and cement were mixed dry and kept

separately. Then coarse aggregates, coir fibers and dry mix of cement and sand were kept in three layers and approximate amount of water was sprinkled on each layer and mixed thoroughly. Mixing procedure was felt to be extremely tedious due to formation of small lumps. In order to avoid the formation of lumps the fibers were randomly oriented in the mix. The cubes (150mm x 150mm), cylinders (150mm dia & 300mm deep) and flexure beams (100mm x 100mm x 500mm) of both conventional and fiber reinforced concrete specimens were casted. Each layer was compacted with 25 blows with 16 mm diameter steel rod.

Conventional concrete

1% of coir fiber

2% of coir fiber

3% of coir fiber

5.3 MIX PROPORTION OF M20 GRADE CONCRETE

5.3.1 Conventional and fibre reinforced concrete (M20)

M20 grade of concrete has been designed as per IS code and the mix proportions is given in the table 5.1

Table 5.1 mix proportions

Cement	Fine Aggregate	Coarse Aggregate	W/C Ratio
1	1.5	3	0.5

5.4 WORKABILITY PROPERTIES

5.4.1 Slump Cone Test

This test is used to determine the workability of concrete. The apparatus is a cone of 10cm top diameter, 20cm bottom diameter and 30cm height. It has two handles for lifting purposes. Initially, the cone is cleaned and oil is applied on the inner surface. Then, the concrete to be tested is placed into the cone in three layers. Each layer is compacted 20 times by a standard tamping rod. After filling the cone, it is lifted slowly and carefully in the vertical direction. Concrete is allowed to subside and this subsidence is called slump.

If the slump is even, then it is termed as true slump. If one half of cone slides, it is called shear. If entire concrete slides, it is called collapse. Shear slump indicates that concrete is non-cohesive and shows a tendency for segregation. Generally, the slump value is measured as the difference between the height of the mould and the average height after subsidence. Slump test is found to be the simple test and is widely used.

5.4.2 Compaction Factor Test

The compaction factor test was developed at the Road Research Laboratory, UK and it is one of the most efficient tests for measuring the workability of concrete. This test is more precise and sensitive than the slump test and is particularly useful for concrete mixes of low workability as are normally encountered when concrete is to be compact by vibration. The compaction factor test is designed primarily for use in the laboratory. The apparatus consists of upper hopper, lower hopper and a bottom cylinder. The concrete to be tested is filled in the upper hopper to the brim. The trap door is opened so that the concrete falls in to the lower hopper. Then the trap of the lower hopper is opened and the concrete is allowed to fall into the cylinder. In the case of a dry mix, it is likely that the concrete may not fall on opening the trap door. In such a case, a slight poking by a rod may be required to set the concrete in motion. The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades supplied along with the apparatus.

The concrete is weighed to the nearest 10 grams. This is known as weight of partial compacted concrete. The cylinder is emptied and then refilled with the concrete for four (or) five layers compacting each layer fully. The top surface of the fully compacted concrete is then struck off in level with the top of cylinder and weighed to the nearest 10 grams. This is known as weight of fully compacted concrete. The test set up for the compaction factor is in photo.

Compaction factor is the ratio obtained when the weight of partially compacted concrete is divided by the weight of fully compacted concrete. The weight of fully compacted concrete can also be calculated by knowing proportions of materials, their respective specific gravities and the volume of the cylinder.

5.5 FORM WORK

Fresh concrete, being plastic requires some kind of form work to mould it to the required shape and also to hold it till it sets. The form work has, therefore, got to be suitably designed. It should be strong enough to take the dead load and live load, during construction and also it must be rigid enough so that any bulging, twisting or sagging due to the load is minimized. Wooden beams, mild steel sheets, wood, and several other materials can also be used. Formwork should be capable of supporting safely all vertical and lateral loads that might be applied to it until such loads can be supported by the ground, the concrete structure, or other construction with adequate strength and stability. Dead loads on formwork consist of the weight of the forms and the weight of and pressures from freshly placed concrete. Live loads include weights of workers, equipment, material storage, and runways, and accelerating and braking forces from buggies and other placement equipment. Impact from concrete placement also should be considered in formwork design. Horizontal or slightly inclined forms often are supported on vertical or inclined support members, called shores, which must be left in place until the concrete placed in the forms has gained sufficient strength to be self-supporting. The shores may be removed temporarily to permit the forms to be stripped for reuse elsewhere, if the concrete has sufficient strength to support dead loads, but the concrete should then be restored immediately.

5.6 MIXING

Mixing of concrete should be done thoroughly to ensure that concrete of uniform quantity is obtained. Hand mixing is done in small works, while machine mixing is done for all big and important works. Although a machine generally does the mixing, hand mixing sometimes may be necessary. A clean surface is needed for this purpose, such as a clean, even, paved surface or a wood platform having tight joints to prevent paste loss. Moisten the surface and level the platform, spread cement over the sand, and then spread the coarse aggregate over the cement. Use either a hoe or a square-pointed D-handled shovel to mix the materials. Turn the dry materials at least three times until the colour of the mixture is uniform. Add water slowly while you turn the mixture again at least three times, or until you obtain the proper consistency. Usually 10% extra cement is added in case of hand mixing to account for inadequacy in mixing.

5.7 CASTING

Before casting the cubes the entire mould is oiled. So the cube can be easily removed from the mould after 24 hours. The concrete is filled in the cube three layers and each layer tamped evenly by tamping rod.

5.8 COMPACTION

All specimens were compacted by using needle vibrator for good compaction of concrete. Sufficient care was taken to avoid displacement of the reinforcement cage inside the form work. Finally the surface of the concrete was levelled and finished and smoothened by metal trowel and wooden float.

5.9 CURING OF CONCRETE

The concrete is cured to prevent or replenish the loss of water which is essential for the process of hydration and hence for hardening. Also curing prevents the exposure of concrete to a hot atmosphere and to drying winds which may lead to quick drying out of moisture in the concrete and thereby subject it to contraction stresses at a stage when the concrete would not be strong enough to resist them. Concrete is usually cured by water although scaling compounds are also used. It makes the concrete stronger, more durable, more impermeable and more resistant to abrasion and to frost. Curing is done by spraying water or by spreading wet hessian cloth over the surface. Usually, curing starts as soon as the concrete is sufficiently hard. Normally 14 or more days (28 days) of curing for ordinary concrete is the requirement. However, the rate of hardening of concrete is very much reduced with the reduction of ambient temperature.

5.10 STRENGTH RELATED PROPERTIES

The strength related tests were carried out on hardened conventional cement concrete 28 days to ascertain the strength related properties such as cube compressive strength, cylinder compressive strength.

5.10.1 Compressive Strength Test

The process involved in the determination of compressive strength of concrete is as follows.

5.10.2 Preparation of Concrete Cubes

For this study, experimental work involves casting of concrete cubes of size 150mm X 150mm X 150mm for determination of compressive strength for 7 days, 28 days. Cubes were casted for various percentage of addition of cement with Coir fibre addition made for 0%,1%,2% and 3%. For the study the water cement ratio of 0.5 is maintained uniform.

5.10.3 Testing of Concrete Cubes

For cube compression tests on concrete, cube of size 150mm were employed. All the cubes were tested in saturated condition after wiping out the surface moisture from the specimen. For each trial mix combination, two cubes were tested at the age of 7 and 28 days. The tests were carried out at a uniform stress after the specimen has been centered in the testing machine. Loading was continued till the dial gauge needle just reserves its direction of motion. The reversal in the directions of motion of the needle indicates that the specimen has failed. The dial reading at the instant was noted, which is the ultimate load. The ultimate load divided by the cross section area of the specimen is equal to the ultimate cube compressive strength.

5.10.4 Split Tensile Strength Test

It is impossible to apply truly axial tensile on concrete specimen due to additional stresses induced by eccentricity, grip, etc. There is also a tendency for the specimen to break near the ends. The splitting tests are well known indirect tests for determining the tensile strength of concrete sometimes referred as split tensile strength of concrete. This tests are carried out in accordance with IS 516-1999 standards conducted on concrete cylinders of 150 mm diameter and 300 mm length.

5.10.5 Preparation of Concrete Cylinder

For this study, experimental work involves casting of concrete cylinder of size diameter 150 mm and height of 300 mm for determination of split tensile strength for 7 days, 28 days. Cylinders are casted for various percentage of addition of cement with Coir fibre addition made for 0%, 1%, 2% and 3%. For the study the water cement ratio of 0.5 is maintained uniform.

5.10.6 Split Tensile Tests for Cylinders

This is an indirect test to determine the tensile strength of the specimen. Splitting tensile tests were carried out on 150mm x 300mm sized cylinder specimens at an age of 7 days using 400 Tonne capacity Heico compression testing machine as per IS: 5816 – 1970. The load was applied till the specimen split and readings were noted.

5.11. FLEXURAL STRENGTH TEST

5.11.1 Experimental Setup

All the specimens were tested in the Universal Testing Machine (UTM) of 1000 kN. The testing procedure for the entire specimen was same. After the curing period of 28 days was over, the beam as washed and its surface was cleaned for clear visibility of cracks. The most commonly used load arrangement for testing of beams will consist of two-point loading. This has the advantage of a substantial region of nearly uniform moment coupled with very small shears, enabling the bending capacity of the central portion to be assessed. If the shear capacity of the member is to be assessed, the load will normally be concentrated at a suitable shorter distance from a support.

Two-point loading can be conveniently provided by the arrangement. The load is transmitted through a load cell and spherical seating on to a spreader beam. This beam bears on rollers seated on steel plates bedded on the test member with mortar, high-strength plaster or some similar material. The test member is supported on roller bearings acting on similar spreader plates.

The UTM must be capable of carrying the expected test loads without significant distortion. Ease of access to the middle third for crack observations, deflection readings and possibly strain measurements is an important consideration, as is safety when failure occurs.

The specimen was placed over the two steel rollers bearing leaving 50 mm from the ends of the beam. The remaining 1000 mm was divided into three equal parts of 330

and two point loading arrangement was done. Loading was done by hydraulic jack of capacity 100 KN. Dial gauges of least count 0.01mm were used for recording the mid span deflection of the beams. The dial gauge was placed just below the centre of the beam.

5.11.2 Preparation of Reinforced Concrete Beam

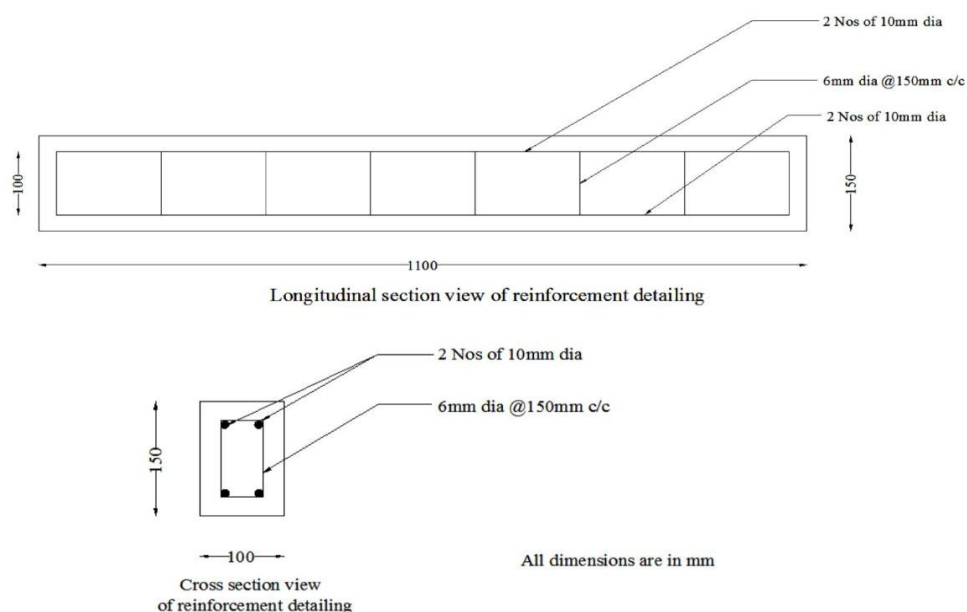
Tests were carried out on reinforced concrete beam specimens of size 1100mm x 100mm x 150mm flexural strength for 28 days. Beams are casted for various percentage of replacement of cement with coir fiber addition made for 0%, 1%, 2% and 3%. For the study the water cement ratio of 0.5 is maintained uniform.

5.11.3 Flexural Strength of Reinforced Concrete Beams

Reinforced concrete beams are typically used in framed structures. Tests were carried out on reinforced concrete beam specimens of size 1100mm x 100mm x 150mm shown in fig 5.1. Testing was carried out in the UTM (Universal Testing Machine). The tested beams were instrumented to measure the applied load, deflection along the beam span, strains at the mid span. Both side surfaces of the beam were painted in white colour with the objective of observing the crack development during testing. The load was kept constant while cracks were marked and photographed. The inclined crack width at load points or supports and corners of the opening was monitored.

The deflections were measured using dial gauge in mid span and under the load point. Dial gauge having sensitivity of 0.01mm was used to trace the deflection profile of the beam by placing along the centre line of the beam.

Fig 5.1 Reinforcement details



VI. RESULTS AND DISCUSSION

6.1 COMPRESSION TEST RESULTS

The specimens are tested for their strength properties. The cube specimen (15*15*15cm) where placed over the compression testing machine and the load was gradually applied till the failure of the specimen. The ultimate load was noted down as collapse load and crushing strength was calculated as (load/area). The results are given table 6.1

Table 6.1 Test Results and Evaluation Table for Compressive Strength of Concrete (M20)

% of fiber	Compressive Strength of cubes at 28th day (N/mm ²)
0	22.73
1	23.25
2	23.84
3	24.44

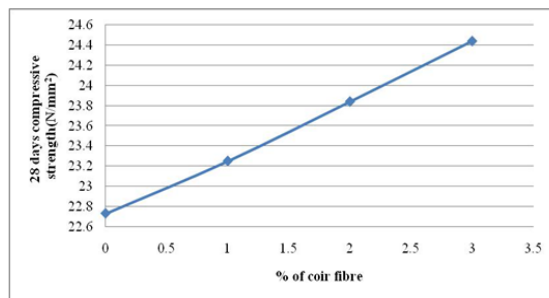


Fig.6.1 28 Days Compressive Strength (N/mm²)



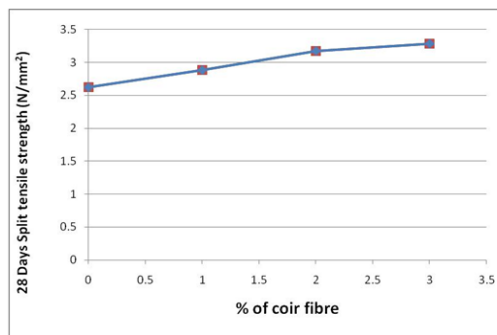
Fig. 6.2 Compression Testing of Cubes

6.2 SPLIT TENSILE TEST RESULTS

The cylinder specimen (15cm diameter & 30cm height) were tested in compression testing machine with horizontal position to determine the split tensile strength of concrete. The results are given table 6.2

Table 6.2 Test Results and Evaluation Table for Split Tensile Strength of Concrete (M20)

% of fibre	28 Days Split Tensile Strength (N/mm ²)
0	2.62
1	2.88
2	3.17
3	3.28

**Fig. 6.3** Split Tensile Strength Test on Coir Fiber Reinforced Concrete**Fig 6.4** Split Tensile Strength of Cylinder

6.3 FLEXURAL TEST RESULTS

Concrete beams (10*12*110cm) were tested with the span of 100cm in the universal testing machine to determine the flexural strength of concrete. The failure load was noted down and the modulus of rupture on 28 days flexural strength was determined as $f = pl/bd^2$. The results are given table 6.3

Table 6.3 Test Results and Evaluation Table for Flexural Strength of Concrete (M20)

S.No	% of Fibre	Load at initial crack days in 28 days(kN)	Ultimate load in 28 days(kN)	Nature of failure
1	0	20	30	Flexural failure
2	1	15	24	Flexural failure
3	2	12	16	Flexural failure
4	3	10	12	Flexural failure

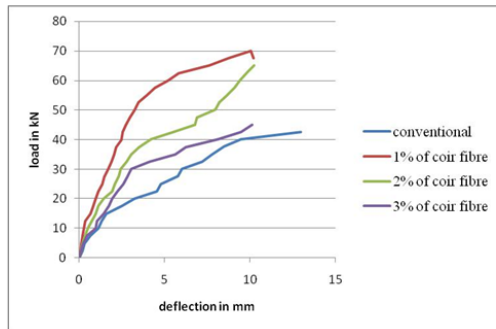


Fig.6.5 Load vs Deflection Curve Conventional and Fibre Reinforced Concrete



Fig 6.6 Flexural test on coir fiber reinforced concrete

6.4 COMPARISION OF TEST RESULTS

The compressive strength and split tensile strength of coir fiber reinforced concrete have been tested and the tested results have shown that when compared with conventional concrete the strength increase gradually when we increase the percentage of fiber adding in a regular interval basis. It has been clear that by adding fiber by 1% coir fibre by adding in a regular manner the strength get increased linearly. The flexural strength of coir fiber reinforced concrete will get increased in all the criteria when we compared with conventional concrete values.

6.5 DISCUSSION ON TEST RESULTS:

When Fibers are added in the concrete, the results in marginal increase in compressive strength property. A better performance can be archived for 3% coir fiber reinforced concretes. Similarly the split tensile strength and flexural strength properties are improved by adding coir fiber along the concrete. Addition of coir fiber results in good strength properties as compared to conventional concrete.

VII. CONCLUSION

The compressive strength and split tensile strength of coir fiber reinforced concrete has been tested and the tested results shown that the strength of coir fiber reinforced concrete is increased gradually when we increase the percentage of fiber. It has been clearly noted that adding fiber upto 3% slightly increases the strength.

The flexural strength of coir fiber reinforced concrete increases for 1%, 2%, 3% of fiber used for M20 grade when compared with conventional concrete.

So finally, it is concluded that coir fiber reinforced concrete is more effective than conventional concrete.

VII. REFERENCES

- Asasutjarit C., Hirunlabh J., Khedari J., S. Charoenvai, B. Zeghmati, U. CheulShin (2007), "Development of coconut coir-based lightweight cementboard", *Construction and Building Materials* vol.21, pp.277–288
- Majid Ali, Anthony Liu, Hou Sou, Nawawi Chouw (2012), "Mechanical and dynamic properties of coconut fibre reinforced concrete", *Construction and Building Materials* vol.30 pp.814–825.
- John V.M., Cincotto M.A., Sjostrom C., Agopyan V., Oliveira C.T.A, (2005),
- "Durability of slag mortar reinforced with coconut fibre", *Cement & Concrete Composites* vol.27 pp. 565–574.
- Romildo D. Toledo Filho, Karen Scrivener, George L. England, Khosrow
- Ghavami (2000), "Durability of alkali-sensitive sisal and coconut fibres in cement mortar composites", *Cement & Concrete Composites* vol.22 pp.127-143.
- Majid Ali and Nawawi Chouw (2009) "Coir Fibre and Rope Reinforced Concrete Beam Under Dynamic Loading"
- Majid Ali (2010) "Coconut Fibre – A Versatile Material and its Applications in Engineering", second international conference on sustainable construction materials and technologies.
- Agopyan, V., Savastano Jr, H., John, V. M., and Cincotto, M. A. (2005). "Developments on vegetable fibre-cement based materials in Sao Paulo, Brazil: An overview." *Cement and Concrete Composites*, 27(5), 527-536.
- Das Gupta, N. C., Paramasivam, P., and Lee, S. L. (1979). "Coir reinforced cement pastes composites". *Conference Proceedings of Our World in Concrete*
- Li, Z., Wang, L., and Wang, X. (2006). "Flexural characteristics of coir fiber reinforced cementitious composites". *Fibers and Polymers*. 7(3), 286-294
- Mansur M. A and Aziz M. A, "Study of Bamboo-Mesh Reinforced Cement Composites" *Int. Cement Composites and Lightweight Concrete*, 5(3), 1983, pp. 165–171.
- Ramakrishna, G., and Sundararajan, T. (2005). "Studies on the durability of natural fibres and the effect of corroded fibres on the strength of mortar." *Cement and Concrete Composites*, 27(5), 575-582
- Yuhazri M.Y., and Dan M.M.P., (2007) *Helmet Shell Using Coconut Fibr (Deco- Helmet)*. *Journal of Advanced Manufacturing Technology*, Vol. 1 (No.1 pp. 23-30. ISSN 1985-3157.

