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Study on Strength and Durability of Concrete Made of Natural Fibers

Gouti Vamshi[1] | Rapolu Nishith Sai[2] | B. Sai Charan Reddy[2] | Bhukya Srikanth[2]

[1]Civil Engineering, Intitute of Aeronautical Engineering,
[2]Civil Engineering, Jawaharlal Nehru Technological University Hyderabad,

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ABSTRACT

Concrete is the best material used in construction due to its versatile nature, but even then concrete has some limitations like cracking, lesser fatigue strength, lesser tensile strength, shrinkage etc. Natural fibers are used in concrete to improve the properties of the concrete and are also used to control cracking and improve the strength. Natural fibers are used due to their low cost, high availability and are renewable source materials. There are several treatment processes to enhance the durability of concrete by natural fibers. In the present study coconut coir is used as a natural fiber in M30 concrete to study the mechanical properties of concrete. The fibers are added at the proportions of 1%,3%,5%,7%. The specimens are cured to their predetermined time and their compressive, split tensile strengths will be determined. Durability test will also be conducted using dilute H2SO4 for a period of 28 days. In this research Comparative study is conducted between conventional concrete and natural fiber concrete.

KEYWORDS:Natural Fibers, Concrete, Composites, Durability, Mechanical Properties.

1. INTRODUCTION

Concrete is best material used in the construction. Concrete has versatile nature. Generally concrete is used in construction field widely. Concrete is the material mixture of cement, aggregates, sand, and water, also mixed to get harden with time. Concrete has some limitations like cracking, lesser tensile strength etc. It is known that concrete is very good in compression and weak in tension. Reinforcement is provided to improve the tensile nature of the concrete. In order to reduce cracking, permeability, bleeding and improve strength fibers are used. Fibers are added into the concrete changes its mechanical properties and compared from normal conventional concrete. Ordinary Portland Cement (OPC) is largely used in these project and construction. Cement is a binding material having cohesive and adhesive properties. It is generally used for construction purpose and reinforced concrete buildings, bridges, and pavements etc. Ordinary Portland cement is used where the soil is normal. It has great resistances towards shrinkage and cracking. The initial setting time of the Ordinary Portland cement is faster. Treatment period of Ordinary Portland cement is shorter. Fibers are made of naturally or manmade substance. Fibers are significantly longer and wide. Fibers look like threads like structure and used for

different purposes. The natural fibers are coconut coir, sugarcane bagasses, silk, jute, sisal etc. There are different types of fibers are used in concrete to get more durable, strong and economical. A fiber is used to improve durability and strength properties of concrete. Use of fibers in concrete is to reduce cracking, due to plastic shrinkage and due to drying shrinkage. A fiber makes a greater impact, shatter resistance and abrasion in concrete. Natural Fiber is used in this project. Natural fibers are acquired from plants, geological process and animals. Natural fibers are available at low cost and cheaply available. Natural fibers have achieved greater specific stiffness and specific strength. It also have large fatigue strength, more resistance to corrosion, better recyclability, renewable source materials and lower life cycle cost. By adding natural fibers in concrete improves the tensile, bending strength and greater resistance. It also gets ability to sustain loads. Natural fibers change the strength properties of concrete. A natural fiber improves mechanical performance, strength, stiffness. These are environmental friendly composite material. In this experimental study coconut coir fiber is the natural fiber used. The coconut coir fiber is removing from the shell of coconut. Coconut coir is the best natural fiber, low cost, low density and reasonable specific strength. The objective of this experimental study is to identify, improvement in strength properties of concrete in addition to coconut coir. In this research paper, comparative study is conducted between the conventional concrete and natural fiber concrete. To find the variations in strength properties like compression, split tensile and durability. Addition of fiber to enhances the physical properties of concrete. Addition of fiber into concrete reduces such issues as they help in arresting the cracks in plastic as well as hardened state which eventually results in durable concrete. Besides enhancing the strength properties and controlling cracks. The following tests are to be performed on concrete block made of natural fibers.

1. Compressive Strength
2. Split Tensile Strength
3. Durability.

Need of the study

In this study, the comparative study is conducted between the conventional concrete and concrete made of natural fibers. Natural fibers are used to improve the strength and durability properties. Natural fibers are generally used in concrete to enhance some special characters to the concrete. Fibers are used in concrete mainly influences the bending behavior of concrete. Fibers are get mixed in concrete to improve the bending nature of concrete without cracking. It is also able to sustain loads in various conditions. Investigation is carried to improve durability of concrete by addition of natural fibers. Natural fibers are used in concrete to enhance the tensile property of concrete. Due to proper homogeneous mix, leads to reduce segregation, reduce permeability and bleeding. Also leads to improves durability and better strength. Fibers are used since many days in the field of construction. Fibers are added in the concrete to get required properties and characteristics to the concrete to withstand the loads and to get more strength. Experiments on natural fiber reinforced 3 concrete have proven that leads to increases compressive strength, tensile strength, and durability to great extent. Natural fibers are used to overcome the difficulty, economical and safe construction material. Natural fibers are cheaply and locally available in many places. The natural coir fiber using in concrete and coir is a lingo-cellulose natural fiber. Natural fibers are mixed in concrete to produce materials with improved strength, durability and toughness. Natural fibers are cheap compared to synthetic fibers. Natural fibers are easy to handle and flexible. Natural fibers are used in large quantities and these have highest toughness among all the natural fibers. By addition of coconut coir natural fiber in concrete workability increases. So coconut coir is best natural fiber among other fibers.

OBJECTIVES

1. To determine the variation in compression strength between conventional concrete (CC) and natural fiber reinforced concrete (NFRC).
2. To determine the variation in split tensile strength between conventional concrete (CC) and natural fiber reinforced concrete (NFRC).
3. To determine the variation in durability between conventional concrete (CC) and natural fiber reinforced concrete (NFRC).

2. PRELIMINARY STUDY

Natural Fiber Reinforced Concrete

Fibers are consolidating into concrete to get required properties. Fibers are used for this type of fiber reinforced concrete. Each fiber has its own characteristics and to improve the properties of the concrete to desired value. Coconut coir fiber is one among them such fibers. Coconut coir fiber changes the properties of the concrete. Coconut coir is widely used in the construction field. Coconut coir can be chopped into different lengths for different proportions. Coconut coir fibers are generally mixed with ingredient of the concrete in the required percentages during dry mix. There are two methods of adding fibers into the concrete. One is natural fibers are added to concrete by spraying them, uniformly on the surface of concrete. To reinforce the concrete with natural fibers get more strength nature to the concrete. Second is natural fibers are added while concrete is mixing instantly. By adding the natural fibers in concrete enhance compression strength and tensile strength. Also improves the durability of the natural fiber reinforced concrete. Coconut coir has high abrasion resistance, but also smoother and finer. After adding the coconut coir in the concrete it leads to improves the physical, mechanical properties of concrete.

Natural fiber (Coconut coir)

Natural fibers are generally extracted from the plants, animals and geological process. Natural fiber used in this project is coconut coir. Coconut coir are very thin fibers of coconut outer most shell. The natural fiber reinforced concrete (NFRC) changes in physical properties, strength properties of the concrete. Addition of the coconut coir into concrete improves the compressive and tensile strengths. Also enhances durability of natural fiber reinforced concrete. Coconut coir (CC) is more strong compared to other fibers. Coconut coir is cheap compared to all fibers, safe and economical. Coconut coir is added with different fiber proportions of 1%, 3%, 5%, and 7% with respective lengths 2.5cm, 5cm and 7.5cm. Coconut coir has two types of fibers they are brown color fibers and white color fibers. Brown color fibers have more tensile nature compared to white fibers. Coconut fibers contain lignin as major portion, cellulose, and hemi-cellulose. So coconut coir is better compared to all the fibers. Fiber is incorporated with concrete is known as natural fiber reinforced concrete.

Preliminary Tests on the materials

1. Fineness of cement

The cement is produced from crushing different raw materials after calcinations. Degree to which cement is crushes to smaller and smaller particles is known as fineness of cement. The fineness of cement has important on rate of hydration. Hence, the rate acquires strength and also on rate of evolution on heat. The fineness of cement offers a greater surface area for the rate of hydration and hence the faster development of strength occurs. An increase in fineness of cement increases dry shrinkage and cracking of cement. The fineness of cement is tested either by sieving or by a calculation of the specific surface by air permeability apparatus. The total surface area has of all the particles in 1 gram of cement known as a specific surface.

Observations:

The following table shows fineness of cement values

Trail no.	1	2	3
Weight of cement (grams)	90	90	90
Weight of residue On sieve (grams)	2.8	2.4	2.5

Results:

Fineness of cement = 2.6%

2. Specific gravity of cement

Specific gravity is normally describes as the ratio between the weight of given the volume of material and the weight of equal volume of water. The Portland cement has specific gravity value is around 3.15. Kerosene is used to determine the specific gravity of cement because kerosene does not react with cement. Density is obtained by measuring the mass of a cement sample and its volume by measuring the liquid which is replaced by the cement sample.

Formula:

Specific gravity = weight of cement/volume of cement.

Observations:

Cement: PENNA OPC 53 grade

Weight of cement taken (W): 60 grams

Liquid used: Kerosene

Results:

Specific gravity of the cement: 3.15.

3. Normal consistency of cement

Normal consistency test was conducted to calculate the amount of water added to cement to get cement paste of normal consistency. Normal consistency is which will permit the vicat plunger to penetrate up to 5 - 7mm from bottom of vicatMould. Time taken between water added to cement and fill the mould with paste in vicat apparatus is called gauging time. The time taken for this is 3 - 5min. The Standard or Normal consistency for OPC varies from 25-35%. Standard consistency 25-35% of water is used to prepare a mix of cement paste. To know about the normal consistency. Let us assume that standard consistency of cement is up to 30%.

Observations:

Weight of cement=300 grams.

% of water	Initial values (mm)	Final values (mm)	Height not Penetrated (mm)
26%	50	31	19
28%	50	22	28
30%	50	15	35
32%	50	7	43

Results:

Normal consistency of the cement = 32%.

4. Initial setting time of cement

The setting of cement is nothing but to become fine and hard. It is the process in which the constituents changes from a semi-liquid state to a plastic state. Then it changes from a plastic state to a solid state. Concrete is in a state of semi-liquid, when it is mixed. Then chemical reactions take place between cement, water and the mixture goes into a plastic state. Initial setting time is the time in which the cement can be cast in any desired shape without losing its strength characteristics. When water is added to the cement to then the time it loses its plasticity. The needle of initial setting shows the penetration of 5 - 7mm from the bottom of the Vicatmould.

Observations:

Weight of cement = 300grams

Time (min)	10	20	30	40	50	60
Initial Reading (mm)	50	50	50	50	50	50
Final Reading (mm)	1	2	3	3.5	4.5	6
Height not penetrated (mm)	49	48	47	46.5	45.5	44

Result:

Initial setting time of cement = 30 minutes

5. Specific gravity of fine aggregate

The value of specific gravity (SG) of fine aggregates will be calculated to find the ratio of weight of a given volume of aggregate to the weight of an equal volume of water. Then specific gravity of the aggregates is observed to measure the strength or quality of material. Aggregates having low specific gravity (SG) is generally weaker compared to aggregates has high SG. Specific gravity property helps in identification of any type of aggregate neither coarse nor fine aggregates.

Observations:

S.No	Description	Sample 1	Sample 2
1	Weight of pycnometer in air (W1 g)	450	450
2	Weight of pycnometer + F.A (W2g)	1409	1409
3	Weight of pycnometer + F A + water(W3g)	1799	1798
4	Weight of pycnometer + water(W4g)	1202	1202
5	Specific gravity=(W2-W1)/(W4-W1) -(W3-W2)	2.65	2.645

Results:

The SG of fine aggregate = 2.65.

6. Specific gravity of coarse aggregate (C.A)

The C.A specific gravity is used to calculate by determining the ratio of weight of a given volume of aggregates to the weight of equal volume of water. It is similar in nature to the F.A specific gravity test.

Observations:

Table: SG of 12 mm Coarse aggregates

S.No	Description	Trail 1	Trail 2
1	Weight of empty specific gravity bottle (W1) Grams	465	465
2	Weight of bottle + aggregate (W2) grams	1415	1415
3	Weight of bottle + aggregate + water (W3) Grams	1817	1815
4	Weight of bottle + Water (W4)	1222	1222
5	Specific gravity	2.67	2.66

Table: SG of 10 mm Coarse aggregates

S.No	Description	Trail 1	Trail 2
1	Weight of empty specific gravity bottle (W1) Grams	450	450
2	Weight of bottle + aggregate (W2) grams	1231	1221
3	Weight of bottle + aggregate + water (W3) grams	1691	1681
4	Weight of bottle + Water (W4)	1211	1211
5	Specific gravity	2.6	2.594

Results:

The SG of 12 mm coarse aggregate = 2.67.

The SG of 10 mm coarse aggregate = 2.60.

7. Slump Cone Test

A Concrete slump test is used to control the workability of fresh concrete before it sets. The Concrete slump test is also known as the slump cone test. It is used to find the consistency of fresh concrete mix prepared at the laboratory during the progress of the work. A Slump cone test is carried out from batch to batch to check the uniform quality of concrete. The Slump cone test is a simple test to check the workability of concrete involves at a low cost and provide immediate results. The Process involved batching, mixing and placing.

Results:

The slump obtained in this experimental study is 10 mm.

3. METHODOLOGY

Materials and properties

This includes the Raw materials used for the concrete for this project.

- Cement
- Fine Aggregates
- Coarse Aggregates
- Natural Fibre
- Water

Cement

The cement has used in this study is ordinary port land cement of 53 Grade. Cement was tested according to IS 10262:2009 and It was confirmed to IS 12269. Cement is a binding material mostly used in the construction field it sets, hardens and combines other materials. Cement is widely used in the construction. A mixture of cement, aggregates, sand and water make concrete. Manufacture of a cement takes place in two methods. Those are dry process and wet process. Cement is made by the lime stone and other materials. Calcinations process takes place then quick lime is formed. Quick lime combines chemically with other materials is mixed to form calcium silicates and cementitious compounds. Then hard substance is formed known as clinker. Then gypsum is added to clinker finally ordinary Portland cement is formed. Basic ingredient in concrete is ordinary Portland cement (OPC). Ordinary Portland cement is hydraulic cements. Composition of OPC is lime (Cao)-60 to 67%, silica (SiO2)-17 to 25%, alumina (Al2O3)-3 to 8%, iron oxide (Fe2O3)-0.5 to 6%, magnesia (Mg0)-0.1 to 4%, sulfur trioxide (So3)-1 to 3%, soda (Na2O+K2O)-0.5 to 1.3%. There are four main compounds in the cement are also called as Bogue Compounds. They are C3S, C2S, C3A and C4AF. These four compounds vary in the various ordinary Portland cements.

Cement properties

S.No.	Property	Test results
1.	Initial setting time	30 minutes
2.	Final setting time	600 minutes
3.	Normal consistency	30%
4.	Specific gravity (SG)	3.15
5.	Compressive strength at (CC) 7 days 14 days 28 days	 23.25 N/mm^2. 28.26 N/mm^2. 37.24 N/mm^2.

Aggregates

Aggregates can be natural, manufactured or recycled. Aggregates occupy major portion in the concrete mix. Aggregates are granular materials such as sand, gravel, and crushed stone. Aggregates can inhabited around up to 60-80% of concrete mix. Aggregates are the main elements and concrete strength depends on aggregates. An aggregate provides physical properties and mechanical properties. According to the sizes aggregates are classified into two types. Those are coarse and fine aggregates. If the sizes of granite rocks are 10mm and 20mm those are coarse aggregates. If the size of the aggregates is between 4.75 to 75 microns those are fine aggregates. Tests on fine aggregates and coarse aggregates are conducted in this project. Aggregates effects in durability, strength, workability and bulk to concrete etc.

Fine aggregates:

Fine aggregates are generally used to make the concrete mix. Fine aggregates fill all the gaps and occupy the spaces between the aggregates. Fine aggregates such as sand, crushed stone and fine rock material. Sand is available near river and seas etc. Fine aggregates are naturally available and it is obtain from different places. Fine aggregate also deals with mechanical properties like strength etc. concrete depends up on the quantity and quality of the fine aggregates. For this project the sand which is passing from the 2.36 sieve size. In these studies river sand is used as fine aggregate (FA).

Table: Properties of F.A

Properties	Test values
Specific gravity (SG)	2.65
Fineness modulus	2.52
Water absorption	2.5%

Coarse aggregates:

Coarse aggregates can be obtained from the crushed stone, gravel, from rock quarry from ground deposits. If the size of the aggregates is greater than 4.75mm then those are called as coarse aggregates. Coarse aggregates are used as building materials. Coarse aggregates are massively and most important used as building material in construction industry. Coarse aggregates occupy more than 70% in the concrete mix. Coarse aggregates majorly deals with mechanical properties of the concrete. Coarse aggregates should be durable, hard and strong. Coarse aggregates helps to increase volume of the concrete and also used to reduce the cost. Coarse are responsible for strength and brittleness of the concrete. Coarse aggregates make concrete stronger.

Table: Properties of C.A

Property	Test values
Specific gravity (SG)	2.67
Aggregates size(mm)	10mm&20mm
Fineness modulus	2.61
Water absorption	0.5%

Water

Water is most important material in concrete mix. The quality and quantity of the water has been carefully chosen in this study. Water is the material used to mix all the materials used to make concrete including cement. Be careful while adding water to make concrete. By the standard consistency test the amount of water required must be calculated and that water content must be used throughout the experiment. Through mix design we will calculate water-cement ratio.

In this research, water cement ratio used was 0.45.

Mix Design

The Concrete mix design is primary step for doing project. Mix design used to find the correct proportions of cement, sand, water, and aggregates for to get achieved target strength of the concrete. Mix design has various steps, calculations and laboratory testing to get correct mix design.

All materials test data:

1. Cement used: OPC 53 Grade conforming IS 12269.
2. Specific gravity of cement: 3.15
3. Chemical admixture: super plasticizer
4. Specific gravity of Coarse aggregates 12mm: 2.67
5. Specific gravity of Fine aggregates: 2.65
6. Water absorption of Coarse aggregates = 0.5%.
7. Water absorption of Fine aggregates= 2.5%.

Target Strength:

From IS 10262:2009

Target strength $f^{1}_{ck} = f_{ck} + 1.65xS$

$= 30 + 1.65x5 = 38.25$ N/mm^2.

Selection of w/c ratio:

Adopted w/c ratio = 0.45 (max w/c ratio = 0.45)

Selection of water content:

From the table 2 of IS 10262:2009

Max. Water content (WC) for aggregates is 186 liters for slump range up to 25 to 50mm.

Estimated water content (WC) for 100 mm slump = 186+ (6/186) = 197 liters.

Based on trails with super plasticizer added. WC (Water content) is reduced up to 20% has been reached.

Hence the achieved water content (WC) = 197- [197 x (20/ 100) = 158 litres.

Calculation of cement content:

Adopted W/C ratio = 0.45

Cement content = 158/0.45 = 351 kg/m^3.

From table 5 of IS 456, Minimum cement content for "severe" exposure conditions 320 kg/ m3.

351 kg/m^3> 340 kg/ m^3 hence ok.

Proportion of volume of CA and FA content:

From the table 3 of (IS 10262:2009) volume of coarse aggregates (CA) corresponding to 20mm size aggregates and fine aggregates (zone ii) for the w/c ratio of 0.50 = 0.62.

Therefore corrected proportion of volume of coarse aggregates for the w/c ratio of 0.45 = 0.63.

For pumpable concrete 10% is reduced. Volume of coarse aggregates content = 0.63 x 0.9 = 0.567.

Volume of FA content = 1-0.567 = 0.433.

Mix calculations:

Mix calculations per unit volume of concrete shall be as follows:

a) Volume of Concrete = 1m^3

b) Volume of cement = 0.114m^3

c) Volume of water = 0.158m^3

d) Volume of chemical admixture = 1.75 liters / m^3. (0.4% is used by the weight of cement by trial and error method).

e) Volume of all aggregates = [1-(0.114 + 0.158 + 0.004)] = 1- 0.276 = 0.724 m^3.

f) Mass of CA = e x volume of CA x SG of coarse aggregate x 1000 = 0.724 x 0.567 x 2.67 x 1000 = 1096 kg/m^3.

g) Mass of FA = e x volume of FA x SG of fine aggregate x 1000 = 0.724 x 0.433 x 2.65 x 1000 = 830.75 kg/m^3.

Mix proportions:

- Cement = 351 kg/m^3.
- Water = 158 liters/m^3.
- Fine aggregates (FA) = 830.75 kg/m^3.
- Coarse aggregates (CA) = 1096 kg/m^3.
- Chemical admixture = 1.75 liters/m^3.
- Concrete Density = 2430 kg/m^3.
- Water/cement ratio = 0.45.

Adjustment on water:

By water absorption both FA and CA are reduced.

- Fine Aggregates (dry) = 810.48 kg/m^3
- Coarse Aggregates (dry) = 1090.54 kg/m^3

Extra water is added for absorption by fine aggregates and coarse aggregates.

- Fine aggregates = 1096 – 1090.54 = 5.45 kg.
- Coarse aggregates = 830.75 – 810.48 = 20.47 kg.
- Water content = 5.45 + 20.47 = 25.72 kg.
- Total water content = 158 + 25.72 = 183.72 kg.

Batching details:

- Cement = 351 kg.
- Water = 183.72 liters.
- Fine aggregates = 810.48kg/m^3.
- Coarse aggregates = 1090.54 kg/m^3.
- Chemical admixture = 1.75 liters/m^3.
- Water/cement (W/C) ratio = 0.45
- Mix proportion by weight = 1: 2.30: 3.10.

Mix proportions:

Table: Quantity of Materials for various trails

Constituents	CC	CCRC 1	CCRC 2	CCRC 3	CCRC 4
Cement (kgs.)	351	351	351	351	351
Water (ltrs.)	183.72	183.72	183.72	183.72	183.72
Fine aggregate (kgs.)	810.48	810.48	810.48	810.48	810.48
Coarse aggregate (kgs.)	1090.54	1090.54	1090.54	1090.54	1090.54
Coconut coir Fibers (%)	0	1	3	5	7

Process of mixing concrete

Batching

Batching means it is the process of taking all the required ingredients for concrete mix by Volume or mass. Batching is the main process before any tests are to be performed. Batching is should done carefully and all the calculations should accurate. All the ingredients for concrete mix are weighed accurately and are added in correct proportions. Batching ingredients are cement, water, aggregates, and other required materials. Proper batching should be done. Mix proportions are 1:1.75:2.36.

Mixing

Mixing is the process where all the materials incorporated with water for a homogenous concrete. Mixing is done properly in a good manner then the concrete will achieve the desired objectives. Uniform mix should be done and if good mixing takes place then while adding ingredients or materials with water then we will achieve good uniformity of the concrete. The concrete must show good workability and must have good plasticity. Concrete should mix for 2 minutes thoroughly and placing is done. Mixing depends upon the requirement, quality, quantity, etc. Method of mixing takes place for this project is hand mixing.

Concrete specimens casting

After batching is done and mixes all materials in a required proportion, then concrete is placed in the moulds. Moulds are in different shapes they are cubes, cylinders, beams. Then clean the mouldsand fix the bolts correctly to the moulds. Apply the grease to the moulds before placing of concrete mix in the moulds. Transfer the concrete to the moulds in layers and for each layer tamping should be done for good compaction. Then moulds are free from voids and casting is done.

Procedure of casting specimens

Specimens are needed for these projects were 70 cubes to be casted for compression test, tensile strength test and durability. In this present study M30 concrete is used to study concrete properties like physical, mechanical properties. Total conventional concrete cubes were casted are 14 specimens and total natural fiber reinforced concrete were casted are 54 specimens. Arrange all the required materials as per quantity required for the cubes and cylinders. The CA, FA and cement thoroughly mixed for 5 minutes. Then slowly add water while mixing the materials to make concrete. Again add fibers to the concrete and mix thoroughly to make natural fiber reinforced concrete. Continue mixing from uniform dispersion of fibers. Before mixing prepare the moulds and apply grease to the moulds. Then place the concrete mixes in the moulds for three layers and for each layer give 25 blows. Fill all the moulds and after that keep the moulds as it is for 24 hours. Remove the moulds after 24 hours and place the cubes and cylinders and cure for 7, 14 and 28 days. After curing tests are performed the cubes and cylinders.

Curing

After casting all the cubes and cylinders in the moulds. Keep the moulds as it is for 24 hours. Then after completion of the 24 hours de-mould all the cubes and cylinders. Then place the total casted cubes and cylinders in the curing tank. Before you should check the curing tank should be cleaned and with good water which are chemically inert. Now all the cubes are placed in curing tank and cure the specimens for required duration with ambient temperature.

Compressive Strength Test

The capacity of the material or the structure to resist under the action of compression loads is called compressive strength. The compressive strength is the important parameter for concrete. Compressive strength is the engineering property. Concrete specimens like cubes were casted and tested in a compression testing machine (CTM) by apply compressive loads to find out the strength of concrete. compressive strength of concrete depending upon the ingredients like cement, coarse and fine aggregates and mainly on water content and other various admixtures. It is also depends upon the water cement ratio, mix proportion, quality and quantity of materials used. Water cement ratio is chief factor for determining the strength of concrete and lower the water cement ratio gives higher compression strength. Compressive strength is conducted on both cubes and cylinders.

Compressive strength test is conducted according to IS 456:2000. Calculation of compressive strength of concretes is very important part as the capacity of concrete to resist under compressive stress among the structure. Reinforcement is provided to protect from the stresses applied by the loads. The compressive strength varies by adding additional fibers. The compressive strength values vary between conventional concrete and natural fiber reinforced concrete at 7 days, 14 days and 28 days with M30 concrete are given in results.

Split Tensile Strength Test:

Split tensile strength test is used to find out the tensile strength of concrete. Tensile strength is the important property of concrete among all the properties. It is also important property for many concrete structures like pre-stressed concrete structures, roadways, liquid retaining walls, etc. tensile strength value is required. Both compressive strength and tensile strength cannot decided directly. So, split tensile test is used, it is an indirect method to find the tensile strength value for the concrete. The split tensile strength test is conducted on the coconut coir reinforced concrete cylinder. The tensile strength values are acquired by all the concretes. The tensile strength values are obtained by conventional concrete are shown in results.

Durability test

Durability test is the laboratory which is used to find out the durability of the concrete made of natural fibers and conventional concrete. Durability of the concrete means capability of concrete resist to weathering conditions and chemical attack. There are many tests to find out the durability of concrete. Many of the concrete structures exposed to environmental conditions. So concrete must should be durable that means it should resist from external environmental conditions. To find out the durability of the concrete acid test has been chosen for this project. Durability is main property of the concrete and durability cannot find easily. The setup is prepared in the artificial environment and to cast the specimens to know how it is durable between conventional concrete and natural fiber reinforced concrete. Then prepare the cubes both conventional concrete cubes and natural fiber concrete cubes. Pour the dilute H2SO4 in the tank. Then place the conventional and natural fiber concrete cubes in tank for 28 days.

4. RESULTS AND DISCUSSIONS

Compressive strength

In this experimental study compressive strength values calculated for conventional concrete and natural fiber reinforced concrete. Early strength is observed at 7days of conventional concrete and coconut coir fiber reinforced concrete has shown. Later strength is observed at 28 days has shown of both conventional concrete and coconut coir reinforced concrete. Therefore increase in compressive strength is noticed between conventional concrete and coconut coir fiber reinforced concrete. This result shows that addition of fiber in concrete has shown increment in compressive strength. Compared to conventional concrete and coconut coir reinforced concrete early strength shown when 1% and 3% addition of fibers in concrete and shows little variation compared to conventional concrete. At 5% more or highest compressive strength shown. Fibers are added into concrete plays a major role in compressive strength increment and great control on reducing cracks.

Conventional concrete:

Compressive strength values for 7, 14 and 28 days. The Compressive strength values for CC shown in table below

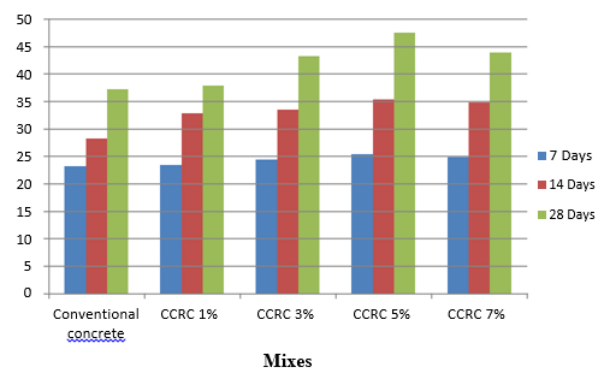
Duration Period	Sample 1 (N/mm^2)	Sample 2 (N/mm^2)	Sample 3 (N/mm^2)	Average compressive strength(N/mm^2)
7 days	23.20	23.12	23.43	23.25
14 days	28.35	27.99	28.45	28.26
28 days	37.12	37.28	37.33	37.24

Natural fiber reinforced concrete:

Natural fiber used coconut coir. Compressive strength values for 7days, 14 and 28 days. Then Compressive strength values of CCRC shown in table below

Trail	Strength for 7 Days (N/mm^2)	Strength for 14 Days (N/mm^2)	Strength for 28 Days (N/mm^2)
1%	23.47	32.81	37.87
3%	24.36	33.43	43.19
5%	25.43	35.30	47.48
7%	24.78	34.85	44.92

This experiment study says about the comparative study on compressive strengths between the conventional concrete and coconut coir reinforced concrete. Variations compressive strength values shown in figure below



Split tensile strength

This is the comparative study on tensile strength between conventional concrete (CC) and coconut coir fiber reinforced concrete (CCRC). These results shows increase in tensile strength by addition of natural fiber in the concrete compared to CC. M30 concrete grade is used.

In this study early strength was obtained at 7 days of coconut coir reinforced concrete. Later strength was obtained at 28 days of coconut coir fiber reinforced concrete. This results shows early strength is observed at 1% and 3% of fiber added to the concrete and later strength was observed at 5% of fiber added and also at

5% highest tensile strength is observed. After 5% strength is decreasing due excess amount fiber is added at 7% fiber is exposed outside of the concrete.

Conventional concrete:

Tensile strength values for 7, 14 and 28 days. Tensile strength values for CC shown in table below

Duration period	Sample 1 (N/mm^2)	Sample 2 (N/mm^2)	Sample 3 (N/mm^2)	Average compressive strength(N/mm^2)
7 days	2.58	2.56	2.60	2.58
14 days	2.95	2.98	2.96	2.96
28 days	3.42	3.49	3.51	3.47

Natural fiber reinforced concrete:

Natural fiber used coconut coir. Tensile strength values for 7, 14 and 28 days. Tensile strength values shown in table below

Trail	Strength for 7 Days (N/mm^2)	Strength for 14 Days (N/mm^2)	Strength for 28 Days (N/mm^2)
1%	2.73	3.48	4.17
3%	2.97	3.60	4.59
5%	3.08	3.73	4.92
7%	3.18	3.66	4.65

This experiment study says about the comparative study on tensile strengths between the conventional concrete and coconut coir reinforced concrete.

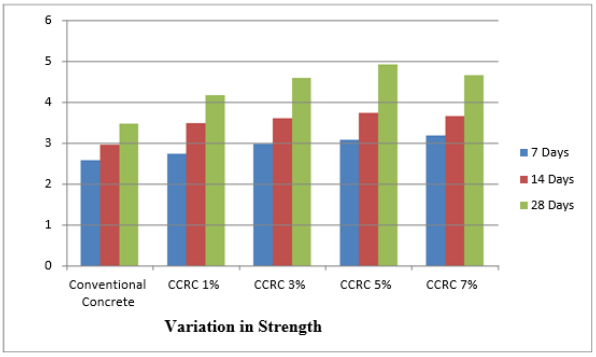


Figure: Bar diagram showing Tensile strength values at 7, 14 and 28 days of between conventional concrete and coconut coir fiber reinforced concrete.

Durability test

Durability of concrete is the most important property. Because durability is capable of resisting the conditions for which it has been designed throughout the life of structure. Durability is defined as its ability or capacity of the concrete to resisting towards weathering action, abrasion and chemical attack. If the workability of the concrete increase then durability increase. In this study durability is the main test has been conducted. To find the durability there are many tests we selected acid test with water absorption method for this project.

Prepare the concrete and place in the moulds. Keep the moulds as it is for 24 hours and demould it after 24 hours. Clean the cubes with Absorbent sheet and weigh the cubes. Fill the Curing tank with clean water and add of 10% of dilute H2So4 in the total volume of water. Then place the cubes in curing for 28 days and cure it. After 28 days of curing then test the cubes and note down the obtained results.

In this experimental study comparison has done between normal conventional concrete and coconut coir fiber reinforced concrete. This shows the results that the coconut coir fiber reinforced concrete has achieved at 5% and 7% more durability compared to conventional concrete. So, we conclude that coconut coir fiber reinforced concrete has more durability.

Conventional concrete:

Durability test values of Conventional Concrete

Samples	Mix	Initial weight of cube (kg)	Weight after curing of 28 days with 10% H2SO4 (kg)	Reduction (%)
Cube 1	M30	8.437	7.347	13%
Cube 2	M30	8.437	7.387	12.5%
Cube 3	M30	8.437	7.357	12.8%

Natural fiber reinforced concrete:

Natural fiber used coconut coir. Durability test values of Coconut fiber reinforced concrete

percentage of fiber Added	Initial Reading (kg)	Weight after curing of 28 days with 10% H2SO4 (kg)	Reduction (%)
CCRC 1%	8.437	7.80	7.5
CCRC 3%	8.437	8.03	4.8
CCRC 5%	8.437	8.26	2
CCRC 7%	8.437	8.14	3.5

5. CONCLUSIONS

From this experimental study, the comparative study is conducted between conventional concrete and coconut

coir reinforced concrete. In this experimental study it stated that addition of fiber to conventional concrete has improved in compressive strength, tensile strength and durability properties of concrete to great extent. Addition of fibers enhances the mechanical properties of the conventional concrete. In this study, concrete reinforced with coconut coir shows increase in durability property when compared to conventional concrete (CC). Addition of coconut coir fibers in concrete states that reduces cracks, increase in strength and reduces small water pores.

From this experiment at 5% of addition of fibers in concrete has achieved greater strengths and durability. Different percentages of fibers added in concrete different variations were observed in strength properties and durability properties.

Compressive strength:

According to this experimental study, compressive strength of CCRC has achieved greater strength compared CC. At 5% addition of coconut coir fiber with water cement ratio of 0.45 highest or maximum compressive strength was observed. At 7% addition of coconut coir fiber the value of compressive strength is decreased. The compressive strength has been decreased when more than 5% of fiber is added to concrete. Compressive strength is decreased due lack of bonding and workability of concrete.

So, this experimental study concludes that maximum compressive strength is observed at 5% of coconut coir reinforced concrete (CCRC). By adding natural fibers compressive strength is improved compared to conventional concrete.

Tensile strength:

According to this experimental study, tensile strength of CCRC has achieved greater strength compared CC. At 5% addition of coconut coir fiber with water cement ratio of 0.45 maximum tensile strength is observed. At 7% addition of coconut coir fiber the value of tensile strength is decreased. The tensile strength is decreased when more than 5% of fiber is added to concrete.

So, this experimental study concludes that maximum tensile strength is observed at 5% of coconut coir reinforced concrete (CCRC).

Durability test:

In this experimental study, comparative study is conducted on conventional concrete and coconut coir reinforced concrete. The results on durability of the concrete are obtained by the acid test with water absorption test.

By this study durability is obtained more in coconut coir reinforced concrete compared to conventional concrete. Durability is obtained at 5% of fiber added to the concrete is increased. At 7% of fiber added to the concrete durability is decreased. Durability is decreased if more than 5% fiber is added in the concrete because of workability and more content of fiber is added.

So, this experimental study concludes that maximum durability is obtained at 5% of coconut coir fiber is added. By adding natural fibers durability properties is improved compared to conventional concrete.

6. FUTURE SCOPE OF STUDY

As per this study, strength decreases by adding more amount of coconut coir fiber. So that, we can also do research by using other natural fibers for better improvement of strength and durability parameters of concrete. To get accurate durability results we can use another methods to improve the durability of concrete.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Sheeja, M.K and Sam N, "Durability study on coir fibre reinforced concrete. International Journal of Civil Engineering and Technology", 9(1), 416-422, 2016.

[2] Kandasamy, Sivaraja, Sudhakaran Pillai and Velmani. "Study on durability of natural concrete composites using mechanical strength and microstructural properties", Bull. Mater. Sci, vol. 33, no. 6, pp.719-729, 2009.

[3] Sundararajan T and Ramakrishna G, "Impact strength of a few natural fibre reinforced cement mortar slabs: A comparative study", Cement Conc. Comp, 27(5): 547-553, 2005b.

[4] P.P.Yalley, and A.S.K, Kwan, "Use of coconut fibres as an enhancement of concrete", J. Engineering Technology, 2012, 2, 54-69.

[5] M Sivaraja, "Application of coir fibres as concrete composites for Disaster prone structures" International Journal of Civil and Environmental Engineering Sci., Vol.33, No.5, pp.719-729, December 2009.

[6] Sher Bahadur Budha and Ravikant Sharma, "A review study on the use of coir fiber, recron fiber and steel slag in the concrete", Journal of Emerging Technologies and Innovative Research, vol 7 issue 10, October 2020.

[7] Adewumi, John Temiyope K and Oladimeji Benedict, "Mechanical and durability properties of coir fiber reinforced concrete", Journal of Engineering Science and Technology, vol. 14, no. 3, 1482-1498, 2019.

[8] Anoopsingh Chandel, Tanmay Shah, Tarak Shah and Dixit Varde, "A comparative strength study of coir fiber reinforced concrete (CRFC) over plain cement concrete (PCC)", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), vol 13, pp 101-103, 2016.

[9] Shiva Balaji C.C.R, Shinde Rahul Ramesh and Vijay Samuel G, "Coir based sustainable concrete-a review", International Journal of Recent Scientific Research, vol. 8, issue, 9, pp.19696-19699, 2017.

[10] Majid Ali, "Natural fibers as construction materials", Journal of Civil Engineering and Construction Technology, vol. 3(3), pp. 80-89, 2012.

[11] Kavitha S, Felix Kala T, "A review on natural fibers in the concrete", International Journal of Advanced Engineering and Technology, vol. 1, issue 1, pp.01-04, 2017.

[12] Prakash P, Anandh S, Sindhu Nachair S, and Gilssy Mary Gilbert, " A Study on mechanical and durability properties of coconut shell concrete using coconut fiber and saw dust", IOP publishing ltd, 2020.

[13] Hasan Ali, Senthamizh Sankar, Achudhan and Saikumar K, "Experimental study on coir fibre mixed concrete", International Journal of Pure and Applied Mathematics, vol. 118, no. 20, 2913-2929, 2018.

[14] AnandhSekar and Gunasekaran Kandasamy, "Optimization of coconut fiber in coconut shell concrete and it's mechanical and bond properties", MDPI, 2018.

[15] Ali Majid, Anthony Liu, "Mechanical and Dynamic Properties of Coconut Fiber Reinforced Concrete." Construction and Building Materials. Reed Business Information, vol. 30, pp. 814-825, 2012.

[16] Atul K Desai and Ardeshana, "Durability of fiber reinforced concrete of marine structures", International Journal of Engineering Research and Applications", vol. 2, issue 4, pp.215-219, 2012.

[17] Pravin V Domke and Rajiv Gandhi, "Improvement in the strength of concrete by using industrial and agricultural waste", IOSR Journal of Engineering, 2012