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EXPERIMENTAL STUDIES ON THE MECHANICAL PROPERTIES OF CONCRETE USING COCONUT COIR FIBRES

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***Abstract*:-** Fiber Reinforced Concrete is a Composite material made of constituent materials consisting of Cement, Fine aggregate, Coarse aggregate and Fibers (i.e.: Natural, Steel and Glass Fibres).The fibres which are chosen for the up gradation of concrete should not pollute the environment and endanger the ecosystem. Fibers chosen must be easily accessible to the people and must be low in cost. As we know that the Plain or Conventional concrete has low tensile strength; by adding the fibres to the cement concrete matrix, we can overcome the problem of weakness of tensile force in the tension zone. Compressive strength, Tensile strength and Flexural strength of the materials can be improved by using fibres in concrete.

Coconut Coir fibre is abundant, renewable, cheap and has more resistant to thermal conductivity. The objective of this study is to use of coconut coir fibre in the concrete and to study the strength properties between Plain concrete and Coconut Coir Fibre reinforced Concrete.

In this study, M30 grade of concrete was produced by adding coconut coir in the mix proportion 1:1.89:2.9. The Aspect ratio was fixed as 50. Their Compressive strength and Tensile strength were evaluated at 7, 14 and 28 days. The coconut coir fibres were varied in different volume percentage by 0%, 1%, 2%, 3%, and 4%.

The result shows that the coir fibres gain strength up to 2% and decreases beyond. The Compressive strength and Tensile strength for 2% coir achieved good strength when compared to Plain Concrete.

Keywords:- Fibre Reinforced Concrete, Coir Fibres, Aspect ratio, Compressive Strength, Tensile Strength

I. INTRODUCTION

The Concrete is a very strong and versatile moldable construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel, which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the whole mix together. The initial hardening reaction usually occurs within a few hours. It takes some weeks for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many years.

Concrete containing a cement, water, aggregates and discontinous discrete fibres is called fibre reinforced concrete (FRC). FRC is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres each of which lend varying properties to the concrete. Fibres can be in the form of steel fibres, glass fibres, natural fibres and synthetic fibres. Main role of fibres is used to bridge the cracks that develop in concrete and increase the ductility of concrete elements. Improvement on post-cracking behaviour of concrete and Imparts more resistance to impact load and also Controls plastic shrinkage cracking and drying shrinkage cracking.

II. LITERATURE REVIEW

[1] D.M.Parbhane and S.B.Shinde, in this paper the Coir fibers are used in the concrete to minimize the construction cost. The rise in cost of material depends on the raw materials used in concrete. The coconut coir is used as a fiber material in concrete mix design. The study is done for an M20 grade of concrete by adding coconut fiber/coir. The workability and tensile strength are tested. Different percentages of coir are added to the mix. The mix was casted to cylinders. Specimens were done to test during the age of 7, 14 and 28 days. These molds were kept for curing and split tensile strength was done at the age of 7, 14 and 28 days. The results obtained in the split tensile test were noted for the different coconut fiber percentage used. After the results obtained for split tensile strength the fiber used must not be more than 5% because the strength decreases when more than 5% of fiber is used.

Coir increases the tensile strength, slump value and compaction factor value of concrete.

[2] Tara Sen and H.N.Jagannatha Reddy, This paper give us the information about the different types of natural fibers such as their properties, advantages and disadvantages. As there is a rapid growth in the field of construction due to material used and manufacturing sectors causing pollution in the environment. So as to reduce this to its minimum limit in construction field, here we are partially including these eco-friendly materials known as natural fibers. Development of plant fibers composites has begun. Among the various natural fibers such as Sisal fibers, bamboo fibers, coir fibers and jute fibers are of particular interest as these composites have high impact strength. These locally available materials are obtained easily and costs effective are less to use in the field of Civil Engineering.

[3] Jaspal Sing et al., This paper gives us the concept of reinforced concrete by using natural fibers such as jute, bamboo, wool, coir etc. This paper shows the limitations, which can be overcome by blending the concrete with fibrous material. The voids in the structure are closely spaced and fibers will improve the structural performance of the concrete. By use of required water-concrete ratio and super plasticizers we can obtain the bonding between the concrete and the natural fibers. Different mix design has done with different percentages of fibers and the tests conducted are compression strength, Tensile strength and flexural test. These tests are conducted for the age of 28 days.

But due to high moisture absorption by the natural fibers, compressive strength does not give durable result. However by the use of advanced chemical treatments to these fibers may help in modifying the natural fibers reinforced concrete performance.

[4] Majid Ali, This paper by Majid Ali, gives us the different property of coir such as physical properties, chemical properties and mechanical properties. In this paper the physical chemical and mechanical properties of coconut fiber are discussed by referring to series of journals. The Coconut fiber can be used in cement and mortar and in concrete. It can be also used in plaster, as roofing material, in slabs, in boards, in wall paneling systems and also in house construction. Other than in civil engineering applications the coconut fiber has other engineering applications like it can be used in bulletproof vest, motorcycle helmets and car parts and other general use. As this coconut fiber has a versatile and more applications in different fields have been detailed in this paper. The composition of fibers in concrete increases the strength of the concrete structure. The fibers can be used in reinforced concrete structural components like beams and components.

[5] Kshitija Nadgouda, in this paper the use of naturally obtained fibres in abundant quantity and low in cost is chosen for the advancement in the structural up gradation of the structure. Coir fibre is used in concrete to strengthen the mechanical properties of concrete. Workability, compressive strength, split tensile strength and flexural strength tests have been conducted to know the results. The aspect ratio are taken in varying lengths in fibre percentage has been taken as 3%, 5% and 7% by the weight of cement. The mix design was achieved for the M20 grade. The specimens were casted and tested for 28 days. Compressive strength split tensile strength and flexural strength gave maximum values for 3% of coir fibre, beyond 3% the strength decreases and shows it is not favorable to use fibre beyond 3%. In this paper, the future works includes the addition of super plasticizer or air entrapping agents to improve the flow characteristics of concrete matrix.

III. MATERIALS AND METHODOLOGY

MATERIALS USED

a. Cement

Here, in this present work the Ordinary Portland Cement - 53 Grade, confirming to IS: 12269-1987 has been used as shown in the Figure I.

FIGURE I. CEMENT

b. Fine Aggregates

Fine aggregate (crushed stone sand obtained from hard granite rocks) as shown in the Figure II passing through IS Sieve Designation of 4.75mm sieve has been used with water absorption of 1.5% .The sieve analysis conducted and it confirms to Zone I as per the specifications of IS: 383-1970.

FIGURE II. FINE AGGREGATES

c. Coarse Aggregates

Coarse Aggregate (obtained from hard granite rocks) as shown in the Figure III of size 20mm maximum and retained on IS Sieve Designation of 4.75 mm sieve has been used with water absorption of 1%. The sieve analysis of combined aggregates is conducted and it confirms to as per the specifications of IS: 383-1970 for graded aggregates.

FIGURE III. COARSE AGGREGATES

d. Coconut Coir Fibres

Coconut fibres were collected from factory in Arsikere. Brown coir as shown in the Figure IV was used in this study as it has good tensile strength than the white coir. Coir Fibres of effective length of 25mm and average diameter of 0.49mm, having the aspect ratio 50 has been used.

FIGURE IV. COIR FIBRES

e. Water

The water as shown in the Figure V used in mix is potable water from the supply network system. It was free from suspended solids and organic materials which otherwise might have affected the properties of the fresh and hardened concrete.

FIGURE V. WATER

f. Super Plasticizer

The 0.5% of Super Plasticizer Conplast-SP430 as shown in the Figure VI by the weight of cement is used as a chemical admixture.

FIGURE VI. SUPER PLASTICIZER

The objective of this study is to do the experimental investigation carried out on cubes, cylinders and beams for 7, 14 and 28 days respectively to understand the strength characteristics of varying percentages of Coir fibres by 0%, 1%, 2%, 3% and 4%.

This study is to determine the characteristics like

1. Compressive strength of coir fibre reinforced concrete.

2. Tensile strength of coir fibre reinforced concrete.

A. Concrete Mix Design

The Mix Design guidance for concrete mix is provided in accordance with Indian Codes of Practice IS: 10262-2009 for M30 grade concrete with water-cement ratio of 0.4 as shown in the Table I.

TABLE I. ADOPTED MIX PROPORTION

Cement	Fine Aggregate	Coarse Aggregate	Water	Super Plasticizer
1	1.89	2.90	0.4	0.5

B. Casting

The first layer of coarse aggregate was spread in the concrete mixer. Then the second layer of fine aggregate was added and the third layer of cement was added. During the dry mix, varying percentage of coir fibres was added. 0.5% Super plasticizer was mixed with water. Initially some quantity of water was added during the mix and remaining water was added so that the materials can blend properly.

Then 45 Cubes of 150mm x 150mm x 150mm sizes were casted by adding coir fibre of 0%, 1%, 2%, 3% and 4% by the weight of cement, 0.5% of super plasticizer Conplast-SP430 by the weight of cement is added for 7, 14 and 28 days strength and were demoulded after 24 hours then the specimens were kept for curing.

Then 45 Cylinders of 150mm x 300mm sizes were casted by adding coir fibre of 0%, 1%, 2%, 3% and 4% by the weight of cement, 0.5% of super plasticizer Conplast-SP430 by the weight of cement is added for 7, 14 and 28 days strength and were demoulded after 24 hours then the specimens were kept for curing.

IV. RESULT AND DISCUSSION

a. Compressive Strength

All the cubes were tested in a Compressive Testing Machine to determine the compressive strength.

The compressive strength of Coir Fibre reinforced concrete with the different percentage variations of 0%, 1%, 2%, 3% and 4% of coir fibres to the weight of cement are tested and the obtained results are tabulated in the Table II and their different variations are plotted in Figure VII for 7, 14 and 28 days respectively.

TABLE II. COMPRESSIVE STRENGTH (MPA) FOR VARYING % OF COIR FIBRE

Sl.no.	Coir fibers (%)	Compressive Strength (MPa)		
		7 days	14 days	28 days
1	0	33.11	37.30	41.16
2	1	35.70	47.87	51.82
3	2	40.53	48.63	52.35
4	3	38.46	40.49	41.91
5	4	34.16	34.68	35.22

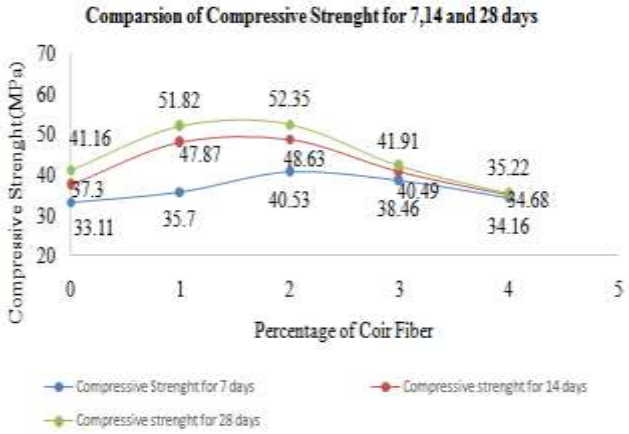

FIGURE VII VARIATION OF COMPRESSIVE STRENGTH (MPA) FOR 7, 14 & 28 DAYS OF FIBRE REINFORCED CONCRETE WITH VARYING % OF COIR FIBRE

The comparison between 7, 14 and 28 days compressive strength of Coir fibre reinforced concrete results with the different percentage variations of 0%, 1%, 2%, 3% and 4% of coir fibres to the weight of cement their variations are plotted as shown in above graph. Strength enhance with increases for 7, 14 and 28 days respectively in Coir Fibre quantity up to 2% and decreases beyond the increase in the coir fibre content. The maximum strength of coir fibre is 40.53 MPa for 7 days were observed, the maximum strength of coir fibre is 48.63 MPa for 14 days were observed and the maximum strength of coir fibre is 52.35 MPa for 28 days were observed.

b. Tensile strength

All the cylinders were tested in a Compressive Testing Machine to determine the tensile strength.

The tensile strength of Coir Fibre reinforced concrete with the different percentage variations of 0%, 1%, 2%, 3% and 4% of coir fibres to the weight of cement are tested and the obtained results are tabulated in the Table III and their different variations are plotted in Figure VII for 7, 14 and 28 days respectively.

TABLE III. TENSILE STRENGTH (MPA) FOR VARYING % OF COIR FIBRE

Sl.no.	Coir fibers (%)	Tensile Strength (MPa)		
		7 days	14 days	28 days
1	0	2.45	2.68	3.23
2	1	2.86	3.41	3.74
3	2	3.27	3.61	4.2
4	3	3.34	3.57	3.75
5	4	3.03	3.11	3.17

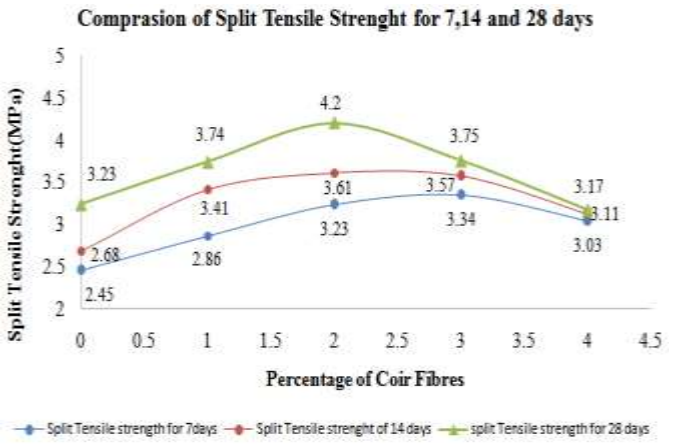

FIGURE VIII VARIATION OF TENSILE STRENGTH (MPA) FOR 7, 14 & 28 DAYS OF FIBRE REINFORCED CONCRETE WITH VARYING % OF COIR FIBRE

The comparison between 7, 14 and 28 days split tensile strength of Coir fibre reinforced concrete results with the different percentage variations of 0%, 1%, 2%, 3% and 4% of coir fibres to the weight of cement their variations are plotted as shown in the graph. Strength enhance with increases for 7, 14 and 28 days respectively in Coir fibre quantity up to 2% and decreases beyond the increase in the coir fibre content. The maximum strength of coir fibre is 3.23 MPa for 7 days were observed, the maximum strength of coir fibre is 3.61 MPa for 14 days were observed and the maximum strength of coir fibre is 4.2 MPa for 28 days were observed.

V. CONCLUSIONS

Based on the results obtained in the present study the experimental works carried out in the laboratory, the following conclusions can be drawn.

- *Compressive strength*

The results obtained were found optimum when 2% coir by the weight of cement was used; there was increase in the compressive strength. 40.53 MPa for 7 days, 48.63 MPa for 14 days and 52.53 MPa for 28 days and when compared to 0% of coir fibres it is increased by 22.4% for 7 days, 30.37% increased for 14 days and 27.18% increased for 28 days.

- *Split tensile strength*

The results obtained were found optimum when 2% coir by the weight of cement was used; there was increase in the split tensile strength. 3.27 MPa for 7 days, 3.61 MPa for 14 days and 4.20 MPa for 28 days and when compared to 0% of coir fibres it is increased by 33.47% for 7 days, 34.70% increased for 14 days and 30.03% increased for 28 days.

- Coir fibres have showed better structural up gradations in the mechanical properties of concrete when compared to plain concrete.
- Coir fibres act as bridging agents in the place of cracks.
- At higher percentage greater than 2%, there is a degradation of compressive strength and split tensile strength because the increase in weight of coir fibres results in loss of cohesiveness between the particles of the concrete.

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