Strength Characteristics of Jute Fiber Composite Concrete

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***Abstract*— In this study deals with the concept of fiber reinforced concrete using jute fiber. The incorporation of fiber in concrete is an aboriginal subject. Concrete made of cement is strong in compression but weak in tension and also this concrete has little resistance to cracking which limits its use. These restrictions can be overcome by blending the concrete with fibrous material, which is termed as fiber reinforced concrete. With the modern technology, natural fibers like jute, bamboo, wool etc. can be economically extracted from various vegetables and animals. The addition of little strictly spaced and consistently dispersed fibers will improve the overall structural performance of the concrete. Due to ever increasing quantities of waste materials from industrial, solid waste management is the major fear in the world. Lack of land-filling space and because of its ever increasing cost, recycling and utilization of industrial by-products and waste materials has become an attractive proposition to disposal. One such industrial by-product is Rice Husk Ash (RHA). RHA is a major by-product of rice mills and successfully used as a land filling material for many years. Also the waste disposal has become one of the major problems in modern period. Either burning or land filling techniques is used to dispose the waste. Both of these techniques are hazardous to the environment. So adding of these waste fibers and RHA in concrete could help to save the environment. In this study, Jute fibers are added 0.5% volume fraction of concrete and rice husk ash is replaced by cement at various dosages like 0, 10%, 20% and 30% in concrete. This study includes the strength characteristics of the jute fiber and rice husk ash concrete investigate the mechanical properties like compressive strength, split tensile strength.**

Keywords— ***Natural Fiber, Jute Fiber, Rice Husk Ash, Compressive strength, Split tensile strength,***

I. INTRODUCTION

Concrete is considered as one of the most versatile building material. Concrete has a relatively low tensile strength and low ductility when compared to other building materials. And also it is susceptible to cracking. The production of concrete leads to many environmental issues related to the significant release of CO_2 and other greenhouse gases. Mainly, steel reinforcement in the form of bars, mesh or wires, is always used to meet tensile strength and ductility demands of concrete structures. The corrosive nature of steel under certain conditions limits its uses. Thus, it is essential to utilize the sustainable concrete and structures to reduce the harmful impact on the environment. The fusion of concrete with fibers is a conventional technique. Straw and asbestos are the few fibers that are being used in making of mud bricks and clay pots respectively since from the early ages. Natural fibers have the potential to be used as reinforcement to overcome the deficiencies in concrete material composites. In the recent times glass, steel and synthetic fibers like polypropylene plays a vital role in concrete industry. But the most sustainable and durable type of fiber which can be used in concrete with the less harmful effects on nature is natural fiber. These are extracted from various living beings and plants, with the help of modern technology. With use of natural fibers, the cost-effective and sustainable building construction is possible. It is found that natural fibers of different structure can be used to alter conventional steel rebar as reinforcement of concrete structures. By Adding of these natural fibers to concrete helps to improves various types of mechanical performances such as flexural properties, fracture toughness and impact resistance. More over the application of these natural fibers is beneficial for consuming less energy, releasing less greenhouse gases into the atmosphere, and costs less to build and to maintain over time. Fiber reinforced concrete (FRC) is another technology which yields similar properties as that of usual conventional concrete. Basically the Conventional concrete is brittle and has poor resistance to crack opening. Many journals showed that use of Jute fibers in lower strength concretes increase the compressive strength significantly when it is compared to plain un-reinforced matrices and is irectly related to volume fraction of Jute fiber used. This study provides in-depth look into the jute fiber reinforced concrete properties like durability, tensile strength, compressive strength and flexural strength.

II. MATERIAL PROPERTIES

A. Jute Fiber

Jute fiber is produced from genus Corchorus, family Tiliaceae. It is a long, soft and shiny vegetable fiber having off-white to brown color. High tensile strength and low extensibility are some key properties of jute fiber.

Figure I. Treated Jute Fiber

TABLE I. PHYSICAL PROPERTIES OF JUTE FIBER

S.NO	PHYSICAL PROPERTY	
1	Density (g/cm^3)	1.4
2	Length (mm)	30
3	Diameter (mm)	0.15 – 0.20
4	Aspect Ratio	150 - 300
4	Elongation at break (%)	1.7
5	Cellulose content (%)	50 – 57
6	Lignin content (%)	8 – 10
7	Young's Modulus (GPa)	30

B. Rice Husk Ash

Rice husk was burnt approximately 48 hours under uncontrolled combustion process. The ash so obtained was ground in a ball mill by box-behnken methodology and its appearance was grey. From the chemical composition it is clear that the principal material contained in RHA is SiO_2 and it contains 7.27% loss on ignition which is an indication of its carbon content. The RHA also contains high K_2O content which is due to fertilizers. For normal RHA, silica content is about 82.89% and loss on ignition is 7.27.

C. Cement

Ordinary Portland cement of 53 grade conforming to IS: 8112 – 1989 was used. Its specific gravity was 3.15.

III. METHODOLOGY

Concept of using jute fiber in concrete was conceived. Based on the concept, various papers where referred and a knowledge about the natural fiber known as the jute fiber being used in concrete was obtained. The knowledge on fiber reinforced concrete was also found by referring various journals. Literature review was done and the concept was finalized. Various tests on Binding Material, fine and coarse aggregates were carried out and the results were achieved. In order to do find the value or drawback of any special concrete, it has to be related with conventional concrete. Therefore, a set of conventional concrete mix specimen is required. In order to cast a set of conventional concrete mix, primarily the mix design for M40 grade of concrete has to be done. Tests on fresh concrete were carried out. Workability was tested by slump test. The water binder ratio and the percentage of super plasticizer to be added was also firm based on three altered designs of trail mix. The mix with optimum results were considered for casting conventional concrete mix. The similar mix ratio which was used to cast conventional concrete mix specimen, was used to cast special concrete mix specimens. Special concrete mix specimens are fiber reinforced specimens. Fiber was cut for aspect ratio. For the aspect ratio, 0.5 percentage of amount of fiber were added to concrete mix. Special concrete specimens consist of cubes, cylinders and prisms. OPC grade 53 cement was used in casting. The coarse aggregate added to the mix was divided into two portions. 50% of 20mm aggregate and 50% of 12.5mm aggregate was used. Jute Fiber reinforced Concrete were cast and cured. 3, 7 and 28 days testing were carried out to find the compressive, split tensile and flexural strengths for the concrete.

A. Mix Proportion

The work on M40 grade of concrete as per IS:456-2000 for fiber-cement ratio 0.5% are carried out with fiber length of 25mm – 30mm chopped. The conventional mix proportion concrete composed of cement (350 kg/m3), fine aggregate (717 kg/m3), coarse aggregates (1356 kg/m3) and water to cement ratio is 0.4. The addition of jute fiber into conventional mix concrete is 0.5% of concrete volume fraction. The addition of Rice Husk Ash into conventional mix concrete is 10%, 20%, 30% of cement volume fraction. The curing period of all the concrete mixes was 3, 7, 28 days. The Mix ID for corresponding conventional mix, 0.5% jute fiber + conventional mix, 0.5%JF + 10%RHA replace with cement, 0.5%JF + 20%RHA replace with cement, 0.5%JF + 30%RHA replace with cement are CC, JFC, RJ1, RJ2, RJ3 respectively.

IV. EXPERIMENTAL STUDY

The cubes, cylinders and Prisms were casted and after completion of 3,7 and 28 days curing the following tests have been conducted.

A. Compressive Strength

The standard cube mould of 150 x 150 x 150mm which are thoroughly fitted and oiled are used. They are set for 3, 7 and 28 days curing and then tested in a Compression Testing Machine.

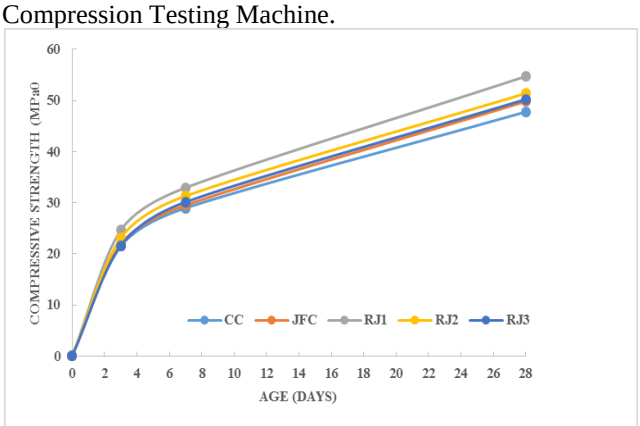

Figure. Ii Compressive Strength For Various % Of Rha Replaced By Cement In Jfrc

B. Split Tensile Strength

The standard cylinder mould of diameter 150mm and height 300mm which are thoroughly fitted and oiled are used. They are set for 28 days curing and then tested in a Compression Testing Machine.

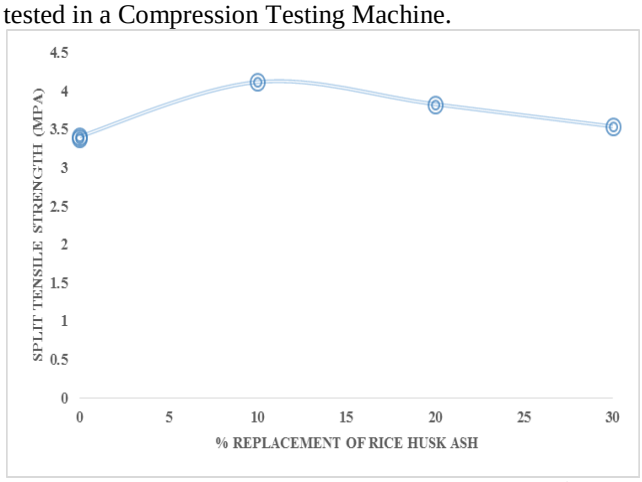

Figure.Iii. Split Tensile Strength For Various % Of Rha Replaced By Cement In Jfrc

C. Flexural Strength

The standard prism mould of 500 x 100 x 100mm which are thoroughly fitted and oiled are used. They are set for 3, 7 and 28 days curing and then tested in a Universal Testing Machine.

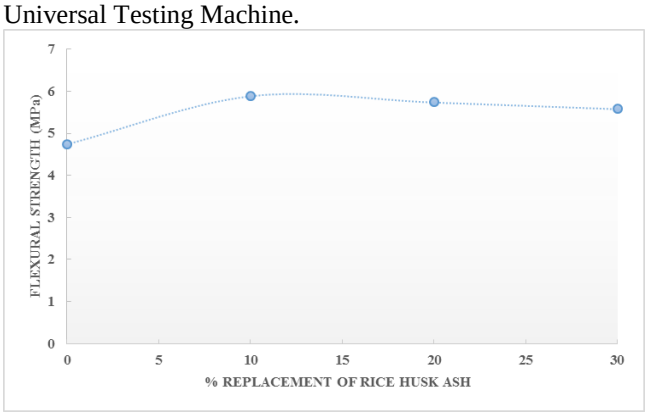

Figure.Iv. Flexural Strength For Various % Of Rha Replaced By Cement In Jfrc

V. CONCLUSION

Use of RHA in concrete reduces the production of waste through industries. RHA is an eco-friendly building material. The problems of disposal and maintenance cost of land filling also reduced. RHA is much cheaper, therefore it is very economical. Based on the experimental results the following observations are made:

- The compressive strength is increased by 14.56% for 10% RHA replacement when compared to control mix at 28 days. The maximum compressive strength is obtained at 10% replacement of cement by RHA. Further replacement reduces the strength.
- Similarly at 10% RHA replacement, split tensile strength and flexural strength are increased by 21.89 % and 24.26 % than the control mix respectively.
- However, for all the replacement percentages the strength values are greater than the control mix which means that even 30% replacement of cement by RHA has no adverse effect on the strength aspect.
- RHA has a fine binding nature. Higher dosages of super plasticizer are required to maintain a good workability.
- Solving of disposal problems thereby by reducing the land pollution.

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