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Rice Husk as Partial Replacement of Cement with Natural Fiber (Jute Fiber)

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Abstract
The release of GHG, radioactive metals and other chemicals is detrimental to the environmental impact of cement manufacturing. The use of natural pozzolan (raw rice husk) as a partial substitute of cement in concrete may not only serve to increase compressive strength but also be environmentally sustainable. This paper manages the idea of utilizing Rice Husk as a partial substitution of cement and non-metallic natural fibers (Jute fiber) in concrete to develop an FRC material to study the possible improvement in the 28-day strength and also to reduce the plastic shrinkage crack. Different compositions of 13mm jute fiber (0.1%, 0.2%, and 0.3%) and Rice Husk (5%, 10%, and 15%) were added to concrete with a water-cement ratio of 0.38 in this study. It depicts that the compressive strength improves by up to 2.03% relative to plain concrete after using both jute fibers and rice husk. Further addition of fiber and rice husk prompts a diminishing pattern in strength as the two substances increased, the compressive strength gets diminished, causing low workability of concrete. Moreover, Shrinkage tests were performed to assess the existence of shrinkage cracks; it indicates that when applying jute fiber, the shrinkage crack region decreases. The optimum content of jute fiber is 0.2% (13mm) and rice husk is 10% for the maximum increment of compressive strength. However, the incorporation of 0.3% jute fibers with 13 mm concrete length was found to be very effective in suppressing shrinkage cracks to near zero.

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I. Introduction

Rice husk is an agricultural residue widely available in major rice producing countries. The husk surrounds the paddy grain. During milling process of paddy grains about 78 % of weight is obtained as rice, broken rice and bran. Remaining 22 % of the weight of paddy is obtained as husk. This husk is used as fuel in the various mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the rest 25 % of the weight of this husk is converted into ash during the firing process, this Ash is known as rice husk ash. This RHA contains around 85 % - 90% amorphous silica. Rice husk is generated from the rice processing industries as a major agricultural by product in many parts of the world especially in developing countries. About 500 million tons of paddies are produced in the world annually after incineration only about 20% of rice husk is transformed to RHA. Still now there is no useful application of RHA and is usually dumped into water streams or as landfills causing environmental pollution of air, water and soil. RHA consists of non-crystalline silicon dioxide with high specific Surface area and high pozzolanic reactivity, thus due to growing environmental concern and the need to conserve energy and resources, utilization of industrial and biogenic waste as supplementary cementing material has become an integral part of concrete construction. Pozzolonas improve strength because they are smaller than the cement particles, and can pack in between the cement particles and provide a finer pore structure. RHA has two roles in concrete manufacture, as a substitute for Portland cement, reducing the cost of concrete in the production of low cost building blocks, and as an admixture in the production of high strength concrete.Therefore, using those two natural wastes (rice husk and jute fiber) for increasing compressive and tensile strength in concrete is economical and productive. The primary goal of this research is to determine the feasibility of using rice husk and jute fiber in concrete and to identify a proper method for minimizing environmental contamination by using these agricultural wastes.

II. MATERIAL USED

Cement

Cement is the fine grey powder that acts as a binding materials which is used for the construction. The cement that was used during experiment was Ordinary Portland Cement 43 grade confirming to IS 8112 impurities were removed before the process.

Rice Husk Ash (RHA)
Rice Husk Ash is the ash that is obtained by burning the rice husk until it gets reduced by 25%. The Rice Husk for the research was obtained locally. These Husk then were deliberated until fine ash is being produced. These ashes were sieved by the 600 micron where further impurities are being minimized.

Chemical Properties of Rice Husk Ash

S. No	Chemical properties	Value
1	Silicon dioxide(SiO2)	88.32
2	Ferric oxide(Fe2O3)	0.67
3	Calcium oxide(CaO)	0.51
4	Magnesium oxide(MgO)	0.44
5	Sodium oxide(Na2O3)	0.12
6	Potassium oxide(K2O)	2.91

Physical Properties of Rice Husk Ash

S. No	Particular properties	
1	Colour	Gray
2	Shape Texture	Irregular
3	Mineralogy	Non crystalline
4	Particle Size	<45micron
5	Specific Gravity	2.37
6	Odour	Odourless

Water
The water that is used for the research work was obtained locally that fulfill the requirement provided by Indian Standard. The water was clean and free from any visible impurities. Water is being supplied partially deliberating the proportionate ratio.

Fine Aggregate
The sand that was used for the research work was obtained locally that fulfills the requirement provided by Indian Standard 383 1970.The purity of the sand was analysed glancing the code provided by Indian Standard.

Fine aggregates

Coarse Aggregates

The aggregates that are used for this research work are taken from the locally available natural rocks that get retained on 4.75micron sieve after being crushed. These granite passes the requirement provided by Indian Standard 383 1970.

Coarse aggregates

Aggregate physical properties.

Physical Property	FA (Sand)	CA (Stone Chips)
Bulk Specific Gravity (OD Basis)	2.50	2.66
Absorption Capacity (%)	1.36	0.69
Fineness Modulus (FM)	2.61	-
Dry Rodded Unit Weight (kg/m^3)	1585	1550

Jute fiber

(JF) Jute fiber is mainly made up of cellulose, hemi cellulose, and lignin. It is more resilient than cotton and other natural fibers. Jute fiber shows high tensile strength and low extensibility. It is also reinforcing and crack resisting material for concrete.


Jute fiber

Characteristics of the jute fiber used in the research (textile engineering study, 2012).

Length of fiber (mm)	**13**
Diameter of Fiber (mm)	0.05
Aspect Ratio (l/d)	260
Density (kg/m^3)	1395
Tensile Strength (MPa)	400
Color	Off-white to brown
Specific Gravity	1.5
Elongation at break %	1.7

Method Adoptade

Concrete mixing and casting -:A machine mixer was used to mix the concrete. A 50-liter volume was considered for each trial mixer. Adequate quantity of fine aggregates (FA), coarse aggregate (CA) and cement were taken and dry mixing applied for two minutes. Water was then applied to the mix. To achieve a uniform distribution in the concrete, fibers were spread by hand in the mixture for an extent of 4 minutes. Concrete workability was measured using a slump cone after it had been mixed. The concrete was poured into the cube, and it was tamped with a tamping rod. The new concrete was finished with a smooth steel trowel. These molds are removed after 24 hours, and tests pecimen sare cured in water.

Compressive strength testing -: Compressive strength test for cubic specimen serves as an indicator of all the properties of concrete. This test can also be used to assess whether the concrete work was properly done. The compressive strength of concrete ranges between 15 MPa and 30 MPa. in industrial and commercial structures (4400 psi). Concrete's compressive strength is determined by a variety of factors, including the water-cement ratio, strength of cement, quality of concrete material, quality control during manufacturing, and so on. Compressive strength is measured using either a cube or a cylinder. In this experiment cube has been used.At first mold was taken volume of 150×150×150 mm. In the cubes, three layers of concrete were poured. Each layer was compacted with 32 tamping rod strokes, and the top surface was finished with a trowel after the last layer was compacted. The specimen was taken out of the mold after 24 hours with proper care. To determine the compressive strength after 7 days and 28 days of curing, three specimens were tested in every case.

Testing at compressive testing machine.

III. Result

Effect of jute fiber and rice husk on compressive strength

The concrete goal strength was set to 35 MPa in this analysis using ACI 211. (2009). The compressive strength of concrete made with the rice husk (Partial substitution of cement) and jute fiber, it is seen that the addition of 10% rice husk with 0.2 % jute fiber (13mm) gives a significant improvement in compressive strength up to 1.10% in 7 day). With this same combination of jute fiber (13mm) and rice husk, the compressive strength can be improved up to 2.03% at 28 days. Because of the higher amount of reactive silica in rice husk that contributes in the pozzolanic reaction by producing calcium silicate hydrate which enhances the compressive strength. Further addition of rice husk tends to show a decreasing pattern of compressive strength due to the higher requirement of water which affects the workability of the mix as well as the hydration reaction. Bawankule et al. found that the compressive strength reduction ranges from 7.11 % to 41.35 % for 2.5 to 15% replacement of cement by rice husk ash (RHA). Furthermore, Krishna et al. [14] also reported the reduction of compressive strength with an extent of 8.15% to 40.62% for 5% to 20% replacement of cement by RHA. Patil et al. [21] narrated that, 15% RHA in concrete is obtained as an indication of maximum increment of compressive strength. Use of 1% Coconut Fiber (CF) and 9% RHA in concrete as a replacement of cement shows a great increment of compressive strength at 7 days but at 28 days no increment was found .Moreover, addition of distinct jute fibers in concrete, the crack expansion is bridled, and the brittle mode of failure is changed to a more ductile pattern. The more fibers in the mix, the more porosity in the matrix and interference with the concrete matrix's cohesiveness, resulting in the balling effect and a loss in compressive strength. In this study, 10% replacement of cement with rice husk and 0.2% jute fiber as reinforcing material is found to be more effective not only for strength improvement but also for reducing failure pattern.

IV. Conclusion

The chemical composition of rice husk indicates that it could be used as pozzolanic material for the improvement of the compressive strength of concrete. However, the inclusion of jute fiber in concrete not only enhances the compressive strength but also diminishes the shrinkage cracks. Furthermore, the incorporation of natural wastes (rice husk) as a replacement material and natural fiber (jute fiber reinforcing material) can reduce the construction cost and production of greenhouse gas. After completion of the tests and analysis of the results regarding compressive strength and shrinkage crack of rice husk and jute fiber reinforced concrete, following are the conclusionsthat can be deduced:

- Addition of 0.1% to 0.3% jute fiber (13mm) and 5% to 15% rice husk the compressive strength increases from 0.14% to 2.03% with respect to plain concrete.
- The combination of 10% rice husk with 0.2 % jute fiber (13mm) gives a maximum improvement in compressive strength up to 1.10% in 7 days and 2.03% at 28 days.
- Concrete with larger percentages of jute fiber (>0.2%) and rice husk (>10%) has a small reduction in compressive strength. However, it is still comparable with plain concrete.
- Plastic shrinkage cracks were minimized by 56%–99% when 0.1%-0.3% jute fiber (13mm) was applied to the concrete, relative to the control concrete.
- Incorporation of 0.3% jute fiber in concrete mix expurgates the shrinkage cracks.

- Furthermore, 15% rice husk as cement replacement results in a cost savings of up to 7%.

However, considering compressive strength and shrinkage cracks 10% rice husk as cement substitution will be the most promising mix content with cost-saving up to 4.7%.

- Using RHA as replacement of OPC in concrete, the emission of greenhouse gases can be reduced up to a greater extent.

References

[1]. ACI 211.1-91. Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete (Reapproved 2009). Am Concr Institute, Farmingt Hills, MI, 48331-3439 USA 2009.

[2]. ASTM C143/143 M. Standard Test Method for Slump of Hydraulic-Cement Concrete. ASTM Int West Conshohocken, PA, USA 2010.

[3]. ASTM C192/C192M-19. Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory. ASTM Int West Conshohocken, PA, USA 2019.

[4]. P. Bawankule S, D. Hiwase P, S. Balwani M. Effect of Partial Replacement of Cement by Rice Husk Ash in Concrete. Int J Res Eng Sci an Technol 2015;1:310–3.

[5]. Patil V, Paliwal MC. Partial Replacement of Cement with Rice Husk Ash in Cement Concrete. Int J Eng Res Technol 2020;9:322–5.

[6]. Tutur N, Noor RNHRM. The potential of rice husk ash (Rha) and coconut fiber (Cf) as partial replacement of cement. AIP Conf Proc 2018;2020. doi:10.1063/1.5062687.