iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** V **Month of publication:** May 2021

DOI: https://doi.org/10.22214/ijraset.2021.34766

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue V May 2021- Available at www.ijraset.com

Experimental Investigation on Compressive Strength of Cement Mortar by Rice Husk Ash and Jute Fiber

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Abstract: ***The primary objective of this study to investigate the strength of cement mortar. Cement is part replaced by Rice Husk Ash up to 30%. Jute fiber were added in the percentage of 0.5%, 1%, 1.5%, and 2% by total weight of cement mortar. Jute fiber enhances the mechanical properties of cement mortar and also avoid crack propagation. The mixed specimen is cured for 7, and 28 days for observing compressive strength test results.***
Addition of small closely spaced, uniformly distributed fibers act as crack arrester, substantially increase static and dynamic properties with increasing water content. This paper results in the experimental study on the behavior of plain and fiber reinforced cement mortars with jute fiber. It has been resulted that the tested fiber reinforced mortars had no greater static and impact strength compared to plain mortar.
Keywords: Jute fiber, Cement mortar, Rice husk ash, Compressive strength, Fiber reinforced

I. INTRODUCTION

Cement mortar is widely used in various building construction material to attain its structural strength and durability. In Indian construction, cement mortar is used in large scale. Cement mortar is a material composed of sand (fine aggregate) and hydrated cement (binder) and water.

In this study natural fiber is used as an additive material with cement mortar such as jute fiber and it is easily available from the local market. India plays a vital role in the field of agriculture production of food grains and natural fibers. In this agricultural production, every year Rice mills turns a million tonnes of rice husk, which is extracted from the paddy grains. Combustion of rice husk wastes will turned in to rice husk ash and it contains highest silica content. Rice husk ash and jute fiber were renewable materials and easily available.

Construction industry can be user of all wastes such as Rice husk Ash and Jute fiber in this way can contribute to solve this environmental problem. In this project, Rice Husk Ash is partially replaced by cement by the total weight of cement mortar and it is used to improve workability, good stability and reduces plastic shrinkage. Jute fiber is used to reduce crack, freezing and thawing. It helps to increases impact strength, Durability and mechanical properties of cement mortar. This research paper is mainly carries, for using cement mortar in construction work efficiently with available wastes. In this way wastes can be reduced and it is used in eco-friendly building construction to reduce cost.

A. Scope

1) The fiber reinforced mortar improves the structural strength.
2) Reduce crack widths and control the crack widths tightly, thus improves durability.
3) Improves impact and abrasion resistance.
4) Mix design of cement sand ratio is 1:4
5) It is ideal for improving the durability and toughness performance of mortar
6) The natural jute fiber can be effective material to reinforce mortar strength which will not only explore a way to improve the properties of mortar

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II. METHODOLOGY

The methodology has followed to complete this project is represented in the below flowchart,

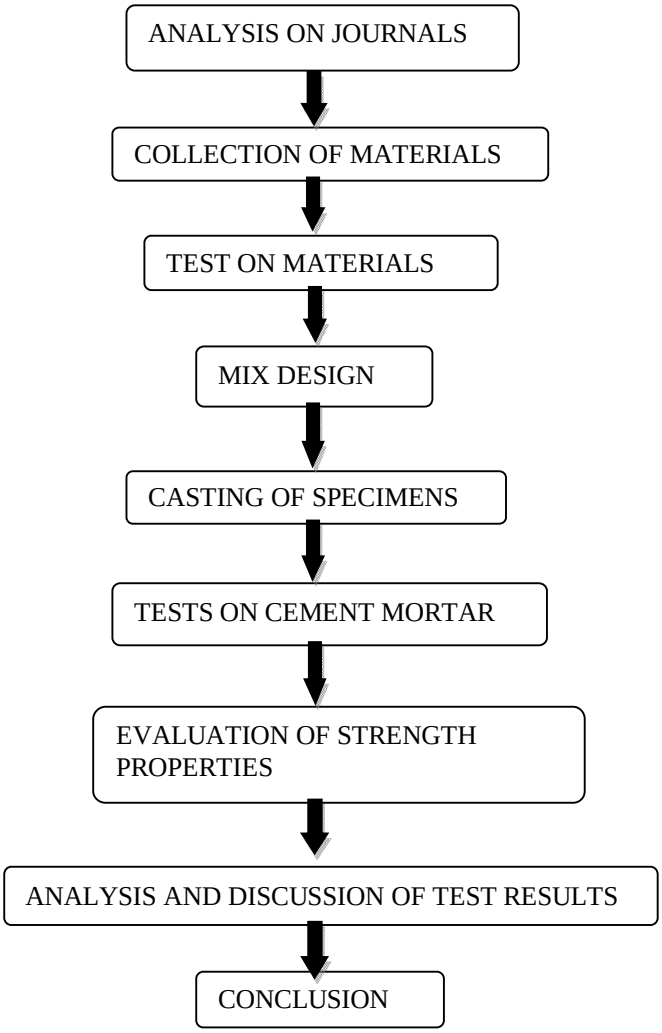

Fig. 1. Methodology

III.MATERIAL COLLECTION AND PROPERTIES

A. Cement

Ordinary Portland cement of 43 grades conforming to the IS: 12296- 1987 was used for the present experimental investigation. The cement was tested as per the procedure given in (Indian standards) IS 4031-1988.

B. Fine aggregate

The river sand conforming to zone-3 as per IS 383-1987 was used

C. Rice husk ash (RHA)

RHA is very rich in silicon dioxide and it is a super pozzolan.Also very suitable as a partial replacement of ordinary Portland cement.RHA shows better bond as well as reduce permeability to water and aggressive chemicals.

D. Jute fiber

Jute is obtained by low level of energy using manpower and technology. It is low modulus of elasticity and impact higher strength. It improves post cracking behaviour of structure. Easily available with less cost.

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E. Water

Water is an important ingredients of concrete as it actively participates in chemical reactions with cement. Clean potable water conforming to IS 456-2000 was used for the preparation of concrete mixture.

Table: 1 Physical properties of rice husk ash

S.NO	Property	Experimental value
1	Specific gravity	2.06
2	Fineness modulus	Fineness passing through 45 micron sieve 96%
3	Water absorption	12.90%
4	Bulk density	0.675kg/cc

Table 2: Chemical properties of rice husk ash

S.NO	PARAMETER	VALUES
1	Sulphur trioxide(SO_3)	0.24%
2	Carbon (C)	5.91%
3	Loss on ignition	5.44%
4	Silicon dioxide(SiO_2)	87.20%
5	Aluminium Oxide (Al_2O_3)	0.15%
6	Ferric oxide(Fe_2O_3)	0.16%
7	calcium oxide (CaO)	0.55%
8	Magnesium oxide (MgO)	0.35%

Table 3: Physical properties of jute fiber

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

Table 4: Chemical properties of jute fiber

S.NO	CHEMICAL PROPERTY	VALUES
1	Alpha cellulose	60-63
2	Hemicellulose	21-24
3	Lignin	12-13
4	Fats and Waxes	0.4-1.0
5	Pectin	0.2-1.5
6	Protein	0.80-1.9
7	Ash	0.7-1.2

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IV. EXPERIMENTAL DETAILS

A. Mixing

Table 5: Mix proportion of mortar

SI.NO	% OF MATERIALS REPLACEMENT
1	Plain cement mortar[without replacement]
2	Cement90% +RHA10% +Sand
3	Cement80% +RHA20% +Sand
4	Cement70% +RHA30% +Sand
5	Cement90% +RHA10% +Sand +1% Jute
6	Cement80% +RHA20% +Sand + 2% Jute
7	Cement70% +RHA30% +Sand +3% Jute

Figure-2 Mixing of Specimens

B. Casting

A total of 16 cubes were casted on different mix proportion inclusion of conventional mortar, replacement of cement by rice husk ash by 10%, 20%, 30% and addition of jute fiber in 1%, 2%, and 3%. For each percentage rice husk ash addition, mortar cubes were cast mix as per the specification design mix given in Indian standards. For determining the compressive strength, cube specimens of 7cm × 7cm × 7cm were casted.

Figure-3 Casting of Specimens in Moulds

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V. COMPRESSIVE STRENGTH TEST RESULTS

Steel moulds of size 70×70×70 mm were used for casting the specimens. Mortar mix was prepared and specimens were prepared. Specimens were allowed for curing for a period of 7days & 28 days. Area of the specimen (A) was calculated from its dimensions. Then specimen was placed in the universal testing machine in such a manner that the load is applied to opposite side of cubes as caste. The load is applied at the rate of 100 kg/cm2 /minute till the cube breaks. Maximum load (W) is recorded at the time of mortar failure. Same procedure was adopted for all the mixes and compressive stress was calculated from equation.

Compressive Stress = W/A

Table 6: 7 days and 28 days test results

% OF REPLACEMENT MATERIALS	COMPRESSIVE STRENGH AFTER 7 DAYS(N/mm^2)	COMPRESSIVE STRENGH AFTER 28 DAYS(N/mm^2)
Conventional cement mortar	6.12	13.26
Cemant90%+RHA10%+Sand	5.10	9.591
Cement80%+RHA20%+Sand	4.081	7.959
Cement70%+RHA30%+Sand	3.673	3.673
Cemant90%+RHA10%+Sand+Jute1%	1.428	4.897
Cement80%+RHA20%+Sand+Jute2%	4.89	2.55
Cement70%+RHA30%+Sand+Jute3%	2.857	3.632

Figure-4 Testing specimens in UTM

VI. RESULTS AND DISCUSSION

1) The comparative study shows only a considerable difference in compressive strength of mortar through addition of rice husk ash and jute fiber.
2) The normal mortar results in 7 days and 28days are respectively 6.12 N/mm2 and 13.26 N/mm2.
3) The volume fraction of 10 % of rice husk ash replaced with cement shows considerable increase in compressive strength for 7 days and 28 days are 5.102 N/mm2 and 9.519N/mm2 respectively.
4) As same 20%and 30% rice husk ash replaced instead of cement results in considerable increase in compressive strength for 7 days and 28 days respectively 4.081N/mm2 and 7.959N/mm2 ,3.673 N/mm2 and 5.51 N/mm2.There is slight variation in strength

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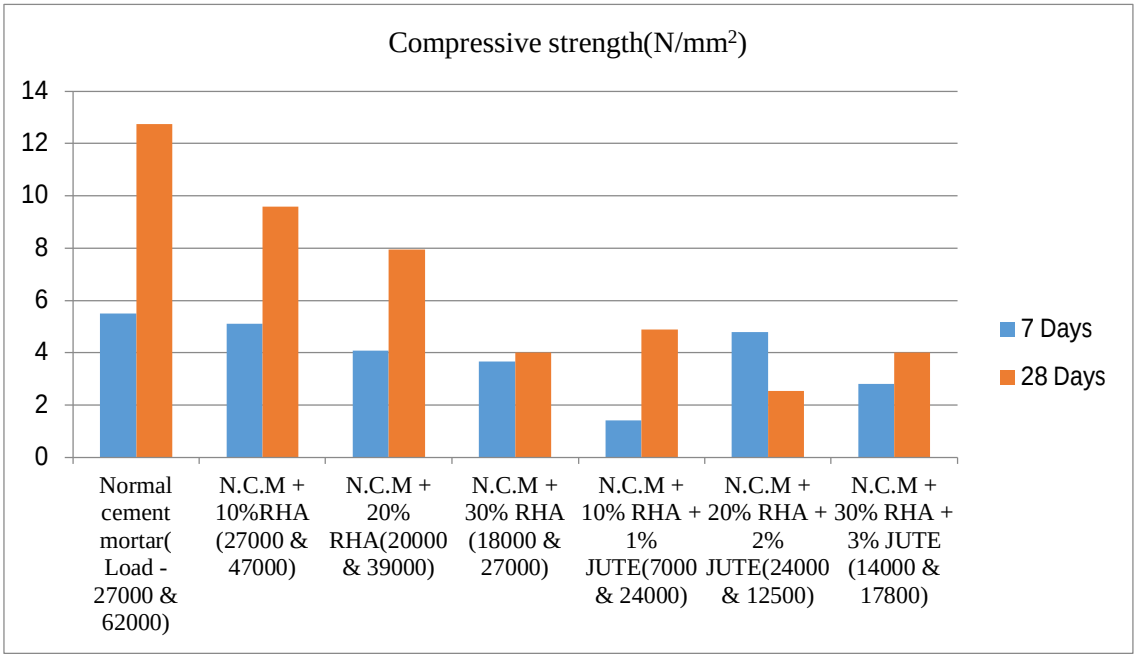
A. Comparison Between 7 Days and 28 Days Test Results



VII. CONCLUSION

Rice husk Wastes can be used to partially replace by cement in a cement mortar. This is compensated while curing in sun light. During curing, compressive strength increases. The effect of water-cement ratio of strength development is prominent in the case of RHA cement mortar. It is because of the fact that the jute fiber reduce the plastic shrinkage of cement mortar. Therefore, the compressive strength test results of cement mortar with Rice Husk Ash for 7 days and 28 days is slightly Decreases. Due to these reasons jute fiber is added along with Rice Husk Ash and cement mortar. This prominently increases the compressive strength of cement mortar for 7 days and 28 days. Introduction of jute fiber in cement mortar tends to make durability. Hence it increasing the stability of cement mortar. The Addition of Rice Husk Ash and jute fiber in the cement mortar of under investigation has been shown to be advantageous and Eco-Friendly.

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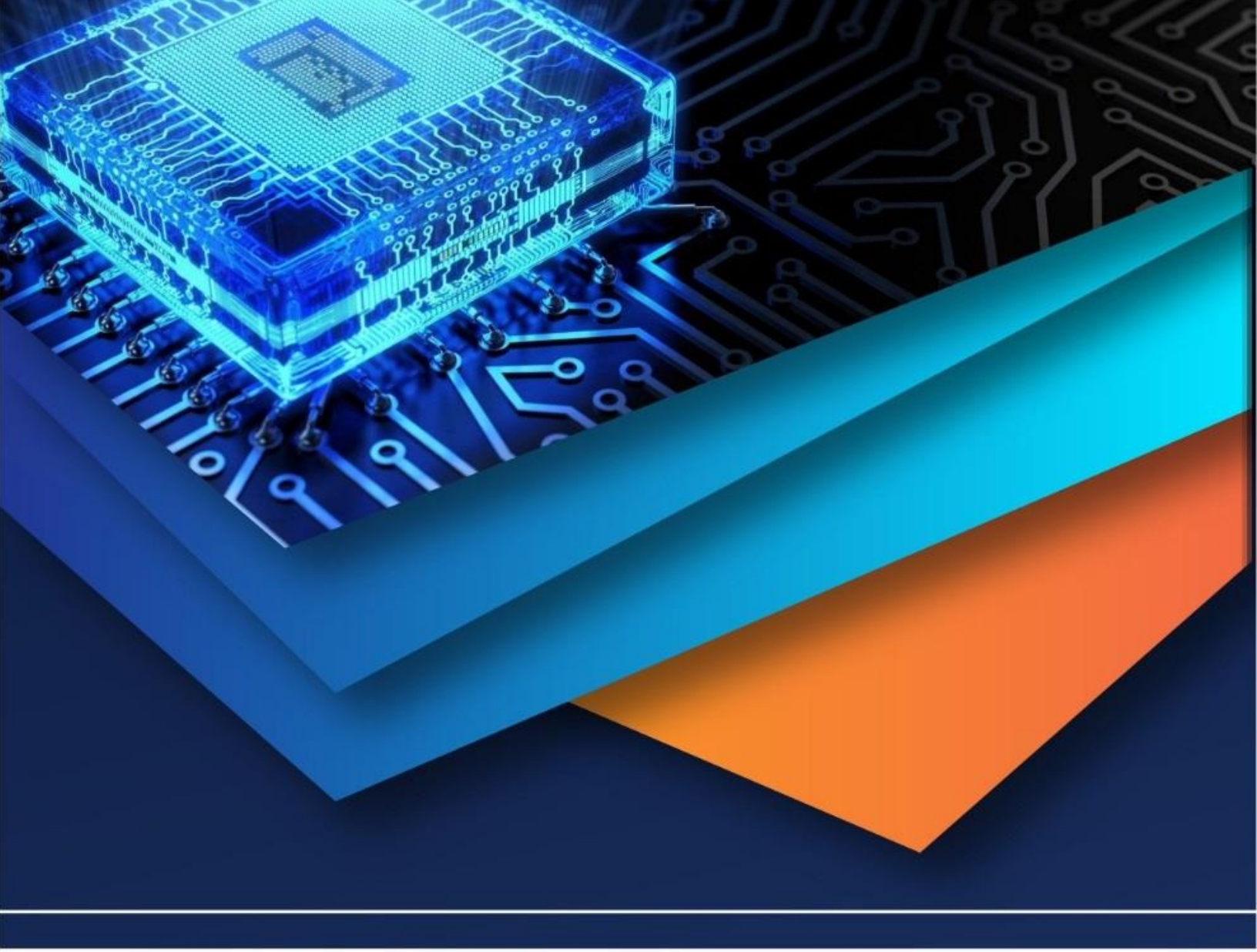

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