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Effect of Rice Husk Ash on the Properties of Concrete

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Abstract: ***As a binder for infrastructure development, conventional Portland cement is currently the primary material that is used. However, cement production has a substantial impact on the environment, and many pozzolanic materials can reduce their carbon footprint with conventional Portland cement. In this experimental study, replacement of OPC (ordinary portland cement) is replaced with the ash produced from rice husk (An agricultural waste) and analyzed for durability and strength performance in concrete samples and mortar as well as chemical composition analysis and microstructure observation of rice hull ash according to X-ray differential test data were also conducted in the research analysis. it is produced by burning of husk (produced by rice barley waste) of oxygen for the production of rice husk ash. Its chemical composition is rich in silicates and aluminates which promotes the binding property of ordinary Portland cement and does not affect the IST(Initial setting time), FST(Final setting time) and does not increase the fineness of the cement particles hence it gives significant results with cement replacement. It was determined that 10% rice husk ash replacement was the optimum value for rice husk ash replacement based on the strength and workability criteria of the concrete quality assurance system.***

Keywords: RHA(Rice husk ash); Pozzolanic material; Mechanical Properties of recycled concrete ; Cement Replacement; Durability analysis of the concrete.

I. INTRODUCTION

Present world is the world of the development of infrastructure and society is growing in very fast manner very fast-growing manner and concrete is the back bone of the present infrastructure it is second largest using material in construction after essential water , concrete is made of four basic elements as water, cement fine and coarse aggregate where mortar (cement and water) is a major source of increment of carbon footprint in the environment, in the other hand the use of cheaper, locally produced materials may slow the growth in construction costs. Recycled products from manufacturing and agriculture can be used in construction. You can find the right type of waste in the right amount in a landfill and use it to make concrete. A good example is rice husk. For example, after grinding rice, the hulls remain and are considered agricultural waste. It was determined that the rice accounted for 80% of the total mass of the rice and the hulls accounted for the remaining 20%. Manufacturing plants burn the shells to generate steam and electricity. (Naveen, 2015) About 75% of rice hulls are biological material and the remaining 25% is ash, commonly known as rice hull (RHA). At the turn of the century, cement and concrete manufacturers increased their spending on mineral additives. In some cases, cement is being replaced as an alternative to keep up with the sky rocketing need of concrete say cement because need of concrete organicaly raise demand of the cement. Significant cost savings can be achieved by replacing Portland cement with ligno-cellulosic. While landfilling or incinerating large amounts of trash are both bad for the environment, using by-products found to be a promising choice. RHA is composed of amorphous silica (80-90%), potassium oxide (K2O) (1-2%), and sunburn carbon (the rest). Mixing RHA with Portland cement is the same as using any other type of concrete. (Akeke, 2012) To know the peak value or optimum alteration of the rice husk ash in the concrete at the place of the conventional Portland cement, we measured the concrete's strength, fracture toughness, flexural modulus, and ultrasonic beam velocity. In its place, we used a range of percentages of Cement Concrete (Grade 43) in place of ash from rice husks (2.5%, 5%, 7.5%, and 10%). The cement content, aggregates, or cement that were incorporated into the design mix were subjected to a battery of biological and mechanical testing. Plasticizers (Polymer base, 1% by weight) make 0.45 water/cement concrete more manageable. Hardened concrete compression tests were performed after 7 and 28 days, according to the requirements of the relevant ARE standard. (Javed, 2018).

II. INDIAN RICE HUSK ASH

India is a big producer of good quality rice therefore it also generate high amount of waste through rice paddy, in the world and consequently generates large amounts of paddy waste. Paddy waste can be divided into two categories, straw, and husk, which have serious environmental impacts.

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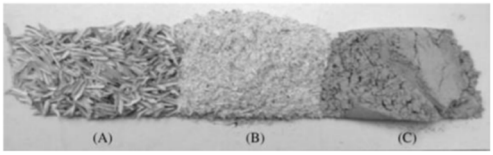


Image (A) Paddy (B) Rice husk (C) Rice husk ash

Straw and husk are the most important by-products of rice cultivation in India. Rice straw is the stems, leaves, and hulls of rice plants, which are often burned resulting in significant greenhouse gas emissions and air pollution. The burning of rice straw also causes soil degradation, organic matter loss, and soil quality degradation. In addition, when the rice straw is burned, harmful pollutants such as carbon monoxide, nitrogen oxide, and sulfurous acid gas are emitted, causing health problems such as difficulty breathing.

On the other way , it is a protective coating on grain and is usually burned for energy. However, burning the shells releases large amounts of carbon dioxide, a greenhouse gas that contributes to global warming. Additionally, the ash from burning rice hulls is difficult to dispose of and poses a serious health and environmental hazard.

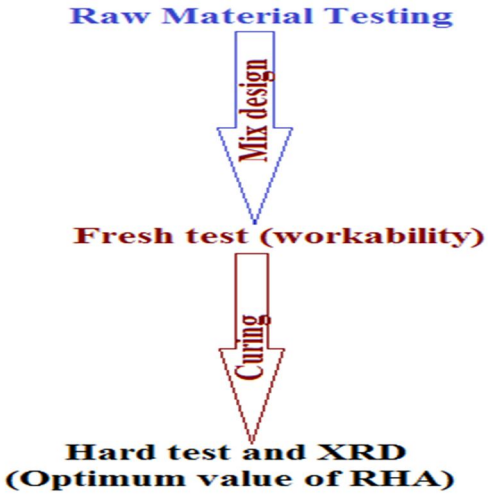
Therefore, it is urgent to turn waste from rice fields into valuable resources instead of burning them. Several innovative methods have been proposed to achieve this objective, such as using rice straw as animal feed, composting, and generating electricity from rice husks. For instance, rice straw can be used as fodder and feed for livestock, which can help farmers earn an additional income. Farmers can also convert waste into valuable fertilizer by composting rice straw, which can help improve soil fertility.

In conclusion, waste from paddy fields in India leads to significant environmental and health implications, particularly through the burning of straw and husk. However, if treated as a valuable resource, it can be used to generate income and improve farming practices. Governments and stakeholders must invest in innovative methods and technologies for efficient waste management to create a sustainable agricultural system in India. Rice paady and rice husk ratio is 5:1 , and rice husk to the ash produced by rice husk is in the ration of the 5:1 hence 1kg paddy produce 40gm of rice husk ash. Rice husks are rice husks that might be grown to become over for the duration of the rice husking process. a thousand kg of rice produces approximately two hundred kg of rice husk, which whilst burned produces approximately forty kg of ash. Rice husks account for approximately one 5th of three hundred million lots of rice produced with inside the international every year. I believe Mehta's report8, the modern annual manufacturing of rice is ready 500 million lots, of which approximately one hundred million lots of rice husk is used as mill waste rice Rice husks also are now no longer used as animal feed due to the fact they have got low dietary homes and their strangely hard floor is actually undamaged and might motive actual melting problems. Short-time period combustion of rice husks at 500-600°C for two hours produces a combustion residue containing unborn carbon and denatured silica

III. THE OBJECTIVE OF THE RESEARCH

The objective of this qualitative research work is to determine the peak value of the cement replacement with conventional Indian rice husk ash.

IS 10262:2019 code of concrete design is adopted for the design the concrete mix.



Raw material tested for designing of concrete samples and verification of permissible criteria as per codal provision.

1) Cement- OPC 53 -grade cement is used for the blending point of view in this research work.

The following results are observed from the cement as-

Table 1 Mechanical parameters of the OPC53

PROPERTY	TEST RESULTS
Normal consistency	29%
Initial Setting Time	68 minutes
Final Setting Time	160 minutes
Fitness of cement (Air permeability)	2800 cm2/ gm
Soundness of cement (Lee- chastely)	2mm
(Autoclave expansion)	0.76%
Specific gravity	2.96%
Compressive Strength	
7 days	33MPa
28 days	54 MPa

2) Rice Husk Ash- Ordinary rice husk ash is produced by incineration of the paddy (rice husk) in the presence of oxygen, RHA sample is distributed in 5 subclasses on the basis of the particle size, the average density of the RHA is 1.58, 2.16, 1.76, 2.03,0.79 respectively.

Rice husk ash sample.

X-ray diffraction test(XRD) is conducted to determine the chemical know the properties of the materia(Rice husk ash)

Table-02 Chemical characters of the material

Chemical analyses, at %	Average of all samples
Silicondioxide (SiO_2)	89.1120
Aluminiumoxide (Al_2O_3)	00
Ferricoxide (Fe_2O_3)	0.4140
Calciumoxide (CaO)	1.6080
Magnesiumoxide(MgO)	0.0
Manganeseoxide (MnO)	0.7680
Sodiumoxide (Na_2O)	0.0
Potassiumoxide (K_2O)	4.568.0
Other	3.740

Table 3 Physical Analysis of RHA

Parameters	Values
Fineness	95%
S.G	2.060
Bulk Density	718 Kg/m^3

This value excludes large KCI crystals dispersed in the sample.
In this study, we employed rice husk ashes with a silica content of 84%-92%. Potassium, present at levels between 3% and 7%, was the second most prevalent element in these swatches. The silica content of RHA is measured at anywhere from 79% to 94%.
Mix Proportions- Concrete of 20MPa is prepared for this analysis work, the mix proportion of Mix of 20MPa Grade concrete is 1:1.50:3.0 as per IS10262:2019 recommendation.
target mean strength of the concrete is 27MPa (M20 concrete)
Preparation of test specimen- Concrete specimen made of partially replaced OPC of 53 grade with RHA as 10.0%, 15.0%, 20.0%, 25.0%, and 30.0%.
The concrete specimen is prepared in the size of cubes of 15x15x15 cubic centimeters for justification of compressive strength and beam for justification of tensile strength.
The nomenclature of the test specimen on the basis of the replacement of binding material is done as follows-

Table 4 Specimen sample nomenclature

Percentage of replacement	Code symbol
0% replacement	Control
10% replacement	C10
15% replacement	C15
20% replacement	C20
25% replacement	C25
30% replacement	C30

Workability- Workability is depend on the following factors as particle size of RHA and absorption and adsorption percentage of water.
Rice husk ash has great water absorption hence workability indicating a falling trend with empirical relationship y = -2.114x + 38.4 (almost linearly).

Table 5 workability results of the specimen

Sample	Workability (Slump cone value in mm)
Control	39
C10	32
C15	31
C20	29
C25	28
C30	27

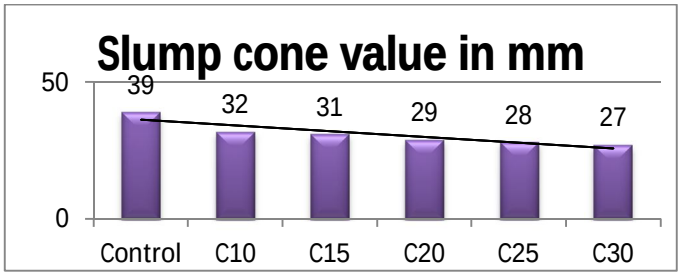


Figure 1 Workability results of samples

Compressive strength- Concrete is enough strong to with stand in compression and but can weak in tension stress therefore concrete is mainly used for wearing compressive stress of the structure, therefore the optimum value of the RHA adulteration is depend on the compressive strength behavior of the concrete, the concrete gives upward trend up to the optimum adulteration then lowering the strength values as follows-

Table-6 Compressive strength results of the sample

	7-days	14-days	28-days
Control	17.955	25.91	28.5
C10	18.9	27.27	30
C15	20.16	29.09	32
C20	20.79	30.00	33
C25	20.79	30.00	33
C30	18.27	26.36	29

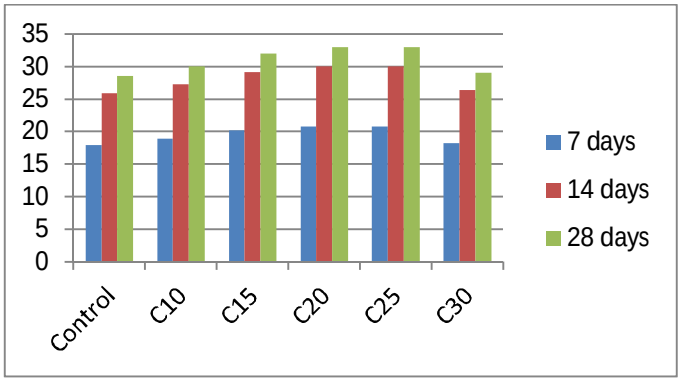


Figure 2 Compressive strength of 7days, 14 days and 28days

Flexural strength- The flexural strength is a direct indicator of the tensile strength behavior which is conducted after 4 weeks as follows

Table-7 Tensile strength results

	flexural strength (MPa)	Split tensile strength (MPa)
Control	4.2	3.1
C10	4.27	3.1
C15	4.34	3.2
C20	4.34	3.2
C25	4.25	3.3
C30	4.2	3.1

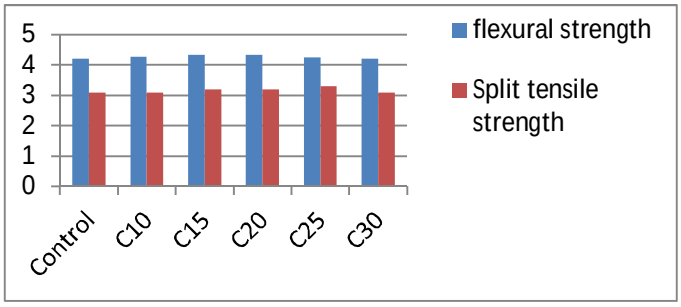


Figure 3 Tensile strength results

IV. CONCLUSION

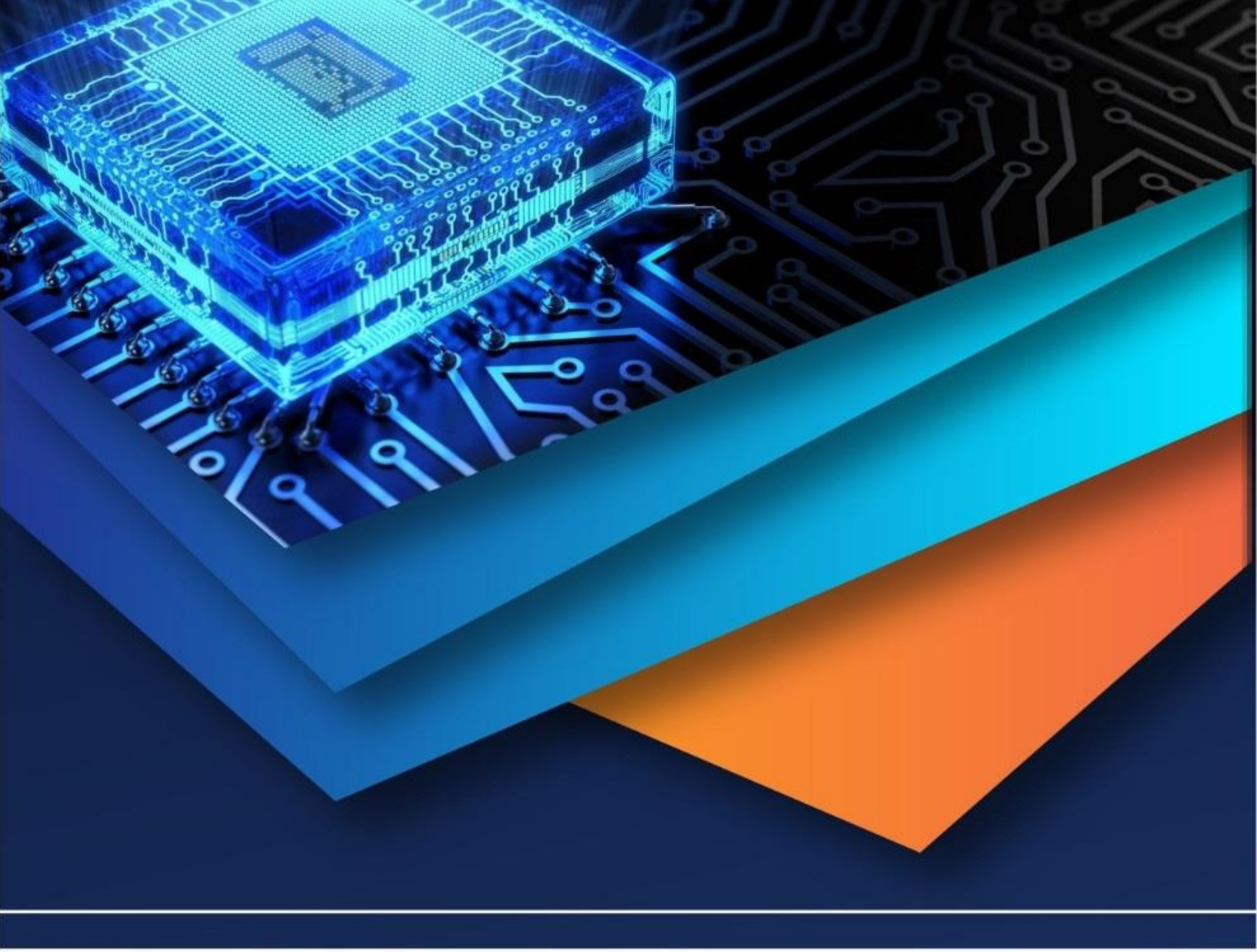
1) There are Significant results are observed by applying rice husk ash in the concrete as fresh results and hard strength tests as well.
2) Workability is decreasing linearly with respect to rice husk ash adulteration due to high water absorption and porosity of rice husk ash, but workability results are under the range of the permissible value according to Indian standards.
3) Significant change in compressive quality is watched up to 25% substitution of cement with rice husk ash, ideal increment in quality is +25.26% in 4 week quality.
4) Flexural strength and split tensile strength also give significant positive changes up to 20% adulteration of the cement with rice husk ash.
5) An optimum value of rice husk utilization in this research analysis is 25% observed on the basis of compressive strength results.

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