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Partial Replacement Of Binder Material With Rice Husk Ash (RHA) In Concrete

Abhijith C S, Anjali J S, Baheeja Badusha,Manu Krishnan R, M Niveditha, Nisha Ubaid, Tejal Tilak Bekar

Abstract— This project was aimed at determining the effects of replacing Rice Husk Ash (RHA) with Ordinary Portland Cement (OPC) in concrete as partial replacemen of binder material on compressive strength, tensile strength and workability on concrete.OPC was replaced with RHA by weight at 0%,5%,10%,15%,20%,25%.material properties were studied and Mix design was prepared for M20 grade concrete. Fresh concrete and hardened concrete test were carried out. On fresh concrete, compacting factor test and slump test and for hardened concrete compressive strength and split tensile strength were done .Strength of concrete increases upto optimum value ,after that it decreases.

Index Terms- compressive strength,concrete,ordinary Portland cement,rice husk ash,split tensile strength,workability.

1 INTRODUCTION

Concrete is a composite material composed mainly of water, aggregate, and cement. Often, additives and reinforcements (such as rebar) are included in the mixture to achieve the desired physical properties of the finished material. When these ingredients are mixed together, they form a fluid mass that is easily molded into shape. In its simplest form, concrete is a mixture of paste and aggregates. Through a chemical reaction called hydration, the paste hardens and gains strength to form the rock-like mass known as concrete. Within this process lies the key to a remarkable trait of concrete: it's plastic and malleable when newly mixed, strong and durable when hardened .Concrete’s durability and strength make it the backbone of buildings and infrastructure worldwide—houses, schools and hospitals as well as airports, bridges, highways and rail systems.

This research work examined and involved the determination of workability,tensile strength and compressive strength of the concrete at different level using Rice Husk Ash as partial replacement for Ordinary Portland Cement in concreteyour paper.

2 RHA IN CONCRETE

The use of rice husk ash with ordinary Portland cement increases the compressive strength of concrete at 28 days and the concrete produced is resistant to acid attack. The increase in strength is attributed to the water absorption capability of the rice husk ash.chemical composition of RHA shows that the high silica and alumina contents are responsible for the pozzolanic activity of RHA.

- *Abhijith C S ,Anjali J S , Baheeja Badusha,Manukrishnan R M.Niveditha,Nisha Ubaid are currently pursuing bachelors degree program in civil lengineering in UKF college of engineering & technology.*
- *Thejal is assistant professor in department of civil engineering at UKF college of engineering &technology*

When added to laterite with very high clay particles, It increases its plasticity with fairly insignificant increase in the soil strength owing perhaps to the traces of sulphates present.

The addition of RHA to laterite soil increases its porosity and permeability.

In very small percentage, RHA acts as a binding agent while in very high percentages it makes the mix more brittle and prickly. So far RHA is used in combination with either cement or lime. The pozzolanic effect of RHA is attributed to the ability of silica to combine with calcium hydroxide to produce cementations compound of calcium silicate hydrates. In comparison, reaction of RHA in the presence of mixture is very percentages of silica,which accounts for the decrease inthe initial strength of cement- RHA mixture as the percentages of RHA values increases .

Rice husk is productively used in various forms for construction when it is burnt into ash.

Use of RHA with cement improves workability and stability, reduces heat evolution, thermal cracking and plastic shrinkage.

This increases strength development, impermeability and durability by strengthening transition zone, modifying the pore-structure, blocking the large voids in the hydrated cement paste through pozzolanic reaction. RHA minimizes alkali-aggregate reaction, reduces expansion, refines pore structure and hinders diffusion of alkali ions to the surface of aggregate by micro porous structure.

RHA replacing 10% Portland cement resists chloride penetration, improves capillary suction and accelerated chloride diffusivity . Highly micro porous structure RHA mixed concrete provides escape paths for the freezing water inside the concrete, relieving internal stresses, reducing micro cracking and improving freeze-thaw resistance.The Rice Husk obtained, was burnt under guided or enclosed place to limit the amount of ash that will be blown off.. The ash was ground to the required level of fineness and sieved through 60 μm sieve in order to remove any impurity and larger size particles. Batching was done by volume at replacement percentages of 0, 5, 10, 15, 20, and 25%.

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2.1 PROPERTIES OF RHA

Rice husk ash is a pozzolanic material.It is having different physical and chemical properties.The product obtained from RHA is identified by trade name silpoz which is much finer than cement.The RHA used in this study is efficient as a pozzolanic material; it is rich in amorphous silica (88.32%). The loss on ignition was relatively high (5.81%). Increasing RHA fineness increases its reactivity.

Physical properties of RHA

SL NO:	PARTICULARS	PROPERTIES
1	COLOUR	GREY
2	SHAPE TEXTURE	IRREGULAR
3	MINERALOLOGY	NON CRYSTALLINE
4	PARTICLE SIZE	>15 MICRON
5	ODOUR	ODOURLESS
6	SPECIFIC GRAVITY	2.3

Chemical properties of RHA

SL NO:	PARTICULARS	PROPERTIES
1	Silicon di oxide	86.94 %
2	Aluminium oxide	0.2 %
3	Iron oxide	0.1 %
4	Calcium oxide	0.3-2.2 %
5	Magnesium oxide	0.2 0.6 %
6	Sodium oxide	0.1 0.8 %
7	Pottasium oxide	2.15 – 2.30%

2.2 CHEMICAL COMPOSITION OF RHA

SL NO:	CONTENTS	PERCENTAGE
1	CaO	60-67
2	SiO_2	17-25
3	Al_{2O}	2.3-8
4	Fe2O	30.5-6.0
5	MgO	0.5-4
6	ALKALI	0.3-1.2
7	SO	32-3.5

3 EFFECT OF RHA IN CONCRETE

The use of rice husk ash with ordinary Portland cement increases the compressive strength of concrete at 28 days and the concrete produced isresistant to acid attack. The increase in strength is attributed to the water absorption capability of the rice husk ash.chemical composition of RHA shows that the high silica and alumina contents are responsible for the pozzolanic activity of RHA.

When added to laterite with very high clay particles, It increases its plasticity with fairly insignificant increase in the soil strength owing perhaps to the traces of sulphates present. The addition of RHA to laterite soil increases its porosity and permeability.In very small percentage, RHA acts as a binding agent while in very high percentages it makes the mix more brittle and prickly.

So far RHA is used in combination with either cement or lime. The pozzolanic effect of RHA is attributed to the ability of silica to combine with calcium hydroxide to produce cementations compound of calcium silicate hydrates. In comparison, reaction of RHA in the presence of mixture is very percentages of silica,which accounts for the decrease inthe initial strength of cement- RHA mixture as the percentages of RHA values increases.

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RHA replacing 10% Portland cement resists chloride penetration, improves capillary suction and accelerated chloride diffusivity .

Highly micro porous structure RHA mixed concrete provides escape paths for the freezing water inside the concrete, relieving internal stresses, reducing micro cracking and improving freeze-thaw resistance..

4 EXPERIMENTAL STUDY ON STRENGTH OF CONCRETE DUE TO VARIATION IN RHA

4.1 MATERIALS

CEMENT

Ordinary Portland cement of grade 53 was used in the concrete mixture.finess of cement obtained was0.83%.percentage water for standard consistencywas 34% and initial setting time of cement obtained was 45 minutes.

FINE AGGREGATE

Fine aggregates used in concrete have the function of a filler material which fills the voids in concrete generated by coarse aggregates. The filler materialused is natural river sand.Pycnometer test was used to determine the specific gravity of fine aggregate.specific gravity of fine aggregate was 2.56 and the finess modulus of fine aggregates was 4.95.

COARSE AGGREGATE

They are materials when mixed with other stuffs like sand and cement, provide strength to the structure. They are responsible for the stability of concrete. Here we used aggregates having size less than 20 mm.specific gravity of coarse aggregate obtained was 2.77 and the finess modulus was 2.8.

RICE HUSK ASH

Rice Husk Ash (RHA) is an agricultural by-product and a good pozzolans. The Rice Husk obtained, was burnt under guided or enclosed place to limit the amount of ash that will be blown off.. The ash was ground to the required level of fineness and sieved
through 90 μm sieve in order to remove any impurity and larger size particles. Batching was done by volume at replacement percentages of 0, 5, 10, 15, 20, and 25%.Finess of RHA obtained was 0.8%.

WATER

The water used for the study was obtained from a free flowing stream. The water was clean and free from any visible impurities.

QUANTITIES OF MATERIALS REQUIRED

WATER (l)	**CEMENT** (kg/m^3)	**F.A** (kg/m^3)	**C.A** (kg/m^3)
197	**394**	**530**	**1247**

4.2 MIX PROPORTION

W/C	**CEMENT**	**F.A**	**C.A**
0.50	**1**	**1.34**	**3.16**

4.3 CASTING AND CURING

In this investigation,casting is done for 0%,5%,10%,15%20%&25% of replacement of cement by RHA.Casting is first done for control mix.According to our mix proportion materials required for our concrete is collected and mixed.The concrete mixture was then tested for slump. Then, the mixture was filled into the specified moulds. The moulds were tamped to eliminate entrapped air. The moulds were kept in the laboratory condition for one day and then placed into curing tanks. The temperature of water in the curing tanks was the normal temperature of water available in the laboratory. The cubes were taken out from the tanks before the testing date. Tests on hardened concrete were carried out at 28 day .

4.4.TESTING

. The concrete mixture was tested for slump in its fresh state, as well as compressive strength and split tensile strength at hardened state. The workability and consistency quality of concrete mix can be determined using the slump test. The slump apparatus was a mould of 1.18mm thick galvanized metal in the form of frustrum of a cone with the base 200mm in diameter. The top was 100mm in diameter and the height 300mm. The taping end was a hemisphere 16mm in diameter.This test was carried out to determine the slump value of the concrete mix as an indicator of its workability and quality.

The compressive strength of concrete was tested on the compression testing machine in the laboratory. The test was carried out on specified cubes . The compression machine used in this research was Automatic Compression Tester having a loading capacity of 2000 kN. Loading on test specimen was applied at a constant rate of stress equal to 0.2 to 0.4 MPa/s.

5 RESULT AND DISCUSSIONS

This section describes the experiments conducted on fresh stage and hardened stage of concrete.

5.1 SLUMP TEST

Figure 1 shows the graph of slump (mm) at various percentages of rha. The slump value decreased from control mix to25% addition of rha.

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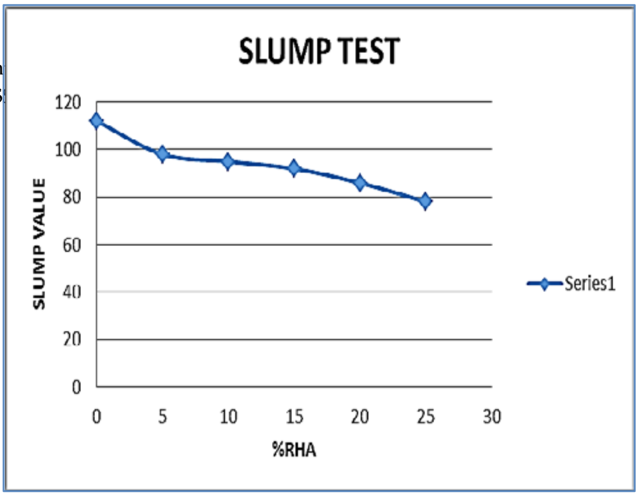
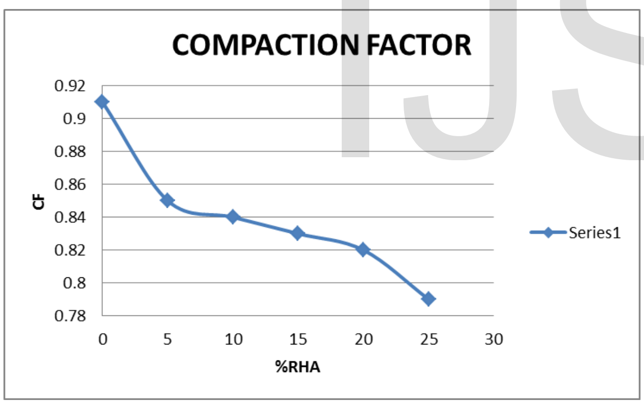
SL.NO	%RHA ADDED	SLUMP VALUE
1	0	112
2	5	98
3	10	95
4	15	92
5	20	86
6	25	82

5.2 COMPACTING FACTOR TEST



The results obtained from the compacting factor test on fresh concrete samples are given in Table

SL.NO	%RHA ADDED	COMPACTION FACTOR VALUE
1	0	0.91
2	5	0.85
3	10	0.84
4	15	0.83
5	20	0.82
6	25	0.79

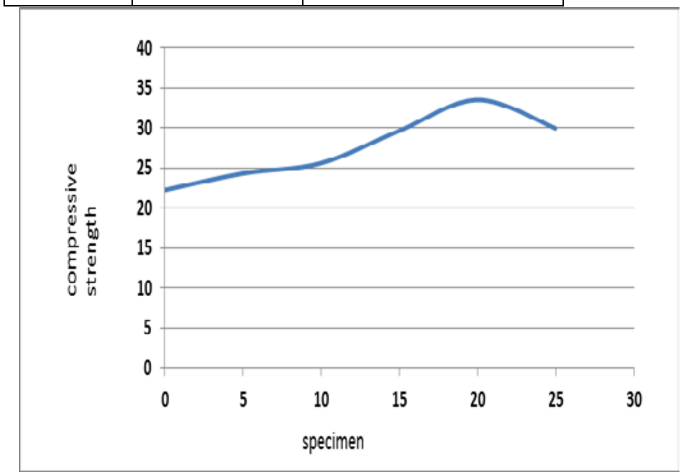


The table indicates that the compacting factor values get reduced on increasing the RHA content. The compacting factor values reduced from 0.91 to 0.79 as the percentage RHA replacement increased from 0% to 25%. These results indicate that the concrete becomes less workable asthe RHA percentage increases meaning that more water is required to make the mixes more workable. The high demand for water as the RHA content increases is due to increased amount of silica in the mixture.

5.3 COMPRESSIVE STRENGTH TEST

The results of the compressive strength tests on concrete are shown in Table 3 as well as graphically explained in Figure

SL NO:	%RHA ADDED	COMPRESSIVE STRENGTH(N/mm2)
1	0	22.22
2	5	24.29
3	10	28.59
4	15	29.63
5	20	33.48
6	25	29.93



The results of the compressive strength of concrete cubes shown in Table 3 conclude that, as the percentage RHA increased, the compressive strengths get reduced. Despite, the compressive strengths increased as the number of days of curing increased for each percentage RHA replacement.

It is noted from Table 3 that for the control mix, the compressive strength increased from 22.2 N/mm^2 at 28 days to 29.93 N/mm^2.The strength of the 5% replacement by rice husk ash showed increase in compressive strength from 22.22 N/mm^2 to 24.29 N/mm^2 at 28 days. The strength of the 10% replacement by rice husk ash showed increase in compressive strength from 24.29 N/mm2 to 28.59 N/mm^2 at 28 days. The strength of the 15% replacement by rice husk ash showed increase in compressive strength from 28.59N/mm^2 a to 29.63N/mm^2 at 28 days.. The strength of the 20% replacement by rice husk ash showed increase in compressive strength from 29.63 N/mm^2 to 33.48 N/mm^2 at 28 days. .. The strength of the 25% replacement by rice husk ash showed increase in compressive strength from 33.48 N/mm^2 to 29.93 N/mm^2 at 28 days.

5.4 TENSILE STRENGTH TEST

The results of the compressive strength tests on concrete cubes are shown in Table 3 as well as graphically explained in Figure.

SL NO:	% RHA ADDED	TENSILE STRENGTH (N/mm^2)
1	0	3.18
2	5	3.32
3	10	3.43

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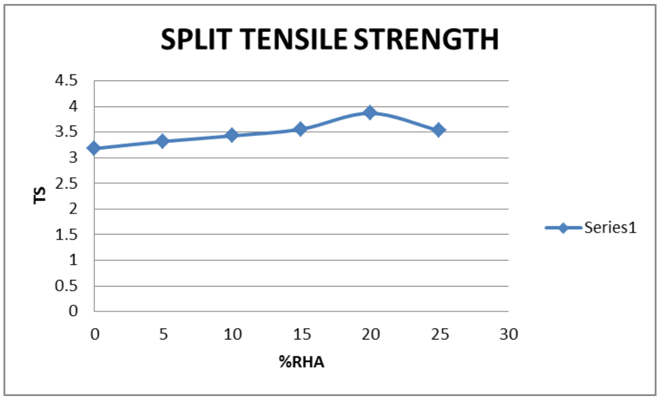
4	15	3.56
5	20	3.87
6	25	3.53



It is noted from Table 3 that for the control mix, the split tensile strength increased from 3.18N/mm^2 at 28 days to 3.53 N/mm^2.The strength of the 5% replacement by rice husk ash showed increase in compressive strength from 3.18N/mm^2 to 3.32 N/mm^2 at 28 days. The strength of the 10% replacement by rice husk ash showed increase in compressive strength from 3.32 N/mm^2 to 3.43 N/mm^2 at 28 days. The strength of the 15% replacement by rice husk ash showed increase in compressive strength from 3.43N/mm^{2}a to 3.56N/mm^2 at 28 days. The strength of the 20% replacement by rice husk ash showed increase in compressive strength from 3.56 N/mm^2 to 3.87 N/mm^2 at 28 days.The strength of the 25% replacement by rice husk ash showed increase in compressive strength from 3.87 N/mm^2 to 3.53 N/mm^2 at 28 days.

6 CONCLUSION

- The optimum addition of RHA as partial replacement for cement for better performance is between the range of 0-20%.
- The compacting factor values and slump values of the concrete reduced as the percentage of RHA increased.
- The Compressive Strengths, split tensile strength of concrete reduced as the percentage RHA replacement increased.

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