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RICE HUSK ASH AS A PARTIAL REPLACEMENT FOR CEMENT IN CONCRETE

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Abstract: Availability of conventional materials for concrete is cause for concern worldwide. In recent years significant global initiatives to use both local and waste materials in concrete has taken place. One of these materials is rice husk, which when incinerated under regulated conditions and if finely pulverized may be utilized as a substitution for cement in concrete. In order to understand the impact of Rice Husk Ash (RHA) on the mechanical and durability characteristics of concrete when used as a partial cement replacement, a thorough assessment of the relevant literature on Rice Husk Ash (RHA) is conducted. Due to its significant pozzolanic qualities, RHA has the ability to replace cement upto 30% without affecting the structural integrity of concrete. The main objective of this study is to find the optimum percentage of replacement of Rice Husk Ash based on compressive strength and flexural strength of concrete. Thus, the use of RHA as a partial alternative to cement in concrete can offer additional environmental benefits, such resource saving and the management of agricultural waste, while simultaneously encouraging a circular economy in the construction sector.

Index Terms - Rice Husk Ash, Partial replacement, Optimum Percentage

I. INTRODUCTION

Concrete is one of the most used construction materials due to its strength and durability. However, while producing cement which is a major part of concrete, contributes greatly to the emissions of carbon dioxide and other greenhouse gases which is a threat to environment [1]. For this very reason it is a need of the day to find a substitute material which can replace cement partially while keeping the performance of concrete unchanged [2]. It will be a very practical and economical solution for the reduction of carbon dioxide in environment if the cement in concrete can be replaced with any cementitious material which can be found from any agricultural by products or any waste materials from industry[3]. It is observed that agricultural by-products when used as a partial replacement of concrete, enhance the strength of concrete and simultaneously increase the sustainability properties as the total costs reduces and improving environmental protection[4].

Rice husk is an agricultural by-product which can be found in all the rice producing countries around the world. It is generally not fit for human consumption and not as the nutritional value is very low it is not recommended for animal feed also[5]. Along with that the natural degradation of rice husks is very low because its surface is uneven and abrasive and having high silica content, making it a potential pollution material [6].

Rice husk ash (RHA) can be utilised for partial replacement of cement with a color range of white, grey, and black in relation to raw material source, mode of incineration, and duration and temperature of burning [7]. For this reason in this study rice husk ash is used as a partial replacement of cement. Several studies are made with different percentage of RHA starting from 10% replacement to 30% replacement and Compression Strength and Flexural Strength were carried out after 7 days and 28 days. Comparisons

were made and optimum percentages of RHA were found out. This study investigates utilization of RHA as a substitute for cement in the manufacture of concrete blocks to increase sustainability and stability.

II. OBJECTIVE OF THE STUDY

The objective of the current study includes:

- To examine the possibility of replacing cement in concrete samples partially with rice husk ash (RHA).
- To find out the effects of RHA on the stability, compressive strength, and durability of concrete sample in an effort to discover environmentally friendly solutions that retain or enhance the functionality of conventional concrete.
- To use rice husk ash as a partial replacement for cement and utilise a waste material to save environment

III. MATERIALS AND METHODOLOGY

The materials used is coarse aggregates, fine aggregates, water, cement and rice husk ash. The properties of the materials are listed below. Table 3.1 shows the properties of fine aggregates, Table 2 shows Properties of Coarse Aggregate and Table 3 Physical properties of cement. Table 3.4 details the Chemical composition of cement.

Table 3.1: Properties of Fine Aggregate

Properties of Fine Aggregate	**Values**
Specific gravity	2.72
Bulk density in loose state	1525.4 kg/m^3
Bulk density in compacted state	1768.7 kg/m3
Partial size Distribution zone	Zone 2 (IS 383 Table 4)

Table 3.2: Properties of Coarse Aggregate

Properties of Coarse Aggregate	**Values**
Specific gravity	2.78
Bulk density in loose state	1398 kg/m^3
Partial size	20 mm (IS 383 Table 2)

Table 3.3: Physical properties of cement

Properties of Cement	Values
Fineness	2.8%
Soundness	1.0 mm
Initial Setting Time	40 mins
Final Setting Time	365mins

Table 3.4: Chemical composition of cement

CaO	60 to 65%
SiO2	19 to 26%
Al2O3	4 to 10%
Fe2O3	0.5 to 4%
MgO	0.1 to 5%
SO3	1 to 3%
Na2O+K2O	0.5 to 1.5%

RHA is the result of burning of rice husk. RHA is a byproduct of rice milling, generated when husks is combusted at high temperatures. Husks is the outer protective covering of rice grains, and they are detained from the grains during the milling process. Traditionally, rice husks were considered agricultural waste and were often discarded or used as fuel.

Rice husk ash is primarily composed of amorphous silica (silicon dioxide) and may also have other elements like carbon, potassium, calcium, magnesium, and other trace elements, depending on the burning conditions. The specific gravity of RHA is found to be 2.05 and the colour is Greyish black .Table 3.5 shows the chemical composition of RHA

Table 3.5: Chemical composition of Rice Husk Ash

Characteristics	RHA (%Wt)
SiO_2	87.00 - 97.50
K_2O	0.60 - 2.45
Na_2O	0 - 1.80
CaO	0.25 - 1.50
MgO	0.15 - 1.95
Fe_2O3	0 - 0.55
P_2O_5	0.20 - 2.85
SO_3	0.15 - 1.15
CI	0 - 0.45

To find out the mix proportion of various materials in concrete, mix design was carried out and the materials required for 1 cube of M_{20} concrete is Cement was taken as 1.331 kg, Fine aggregate was found to be 2.35 kg, Coarse aggregate was taken as 3.98 kg and water as 667ml.

Similarly materials required for casting 1 beam of M_{20} concrete Cement was 1.972 kg, Fine aggregate was taken as 3.476 kg, Coarse aggregate was 5.88 kg and water was taken as 986ml.

After mixing the fresh concrete has been casted into the moulds of size 150*150*150mm. The mould were casted immediately after mixing.

Figure 3.1: Casting of Rice Husk Ash concrete cubes

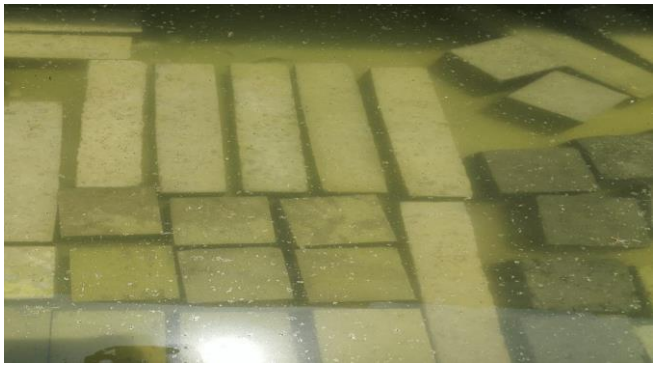

Figure 3.2: Curing of Rice Husk Ash Concrete cubes

Fig 3.1 shows Casting of Rice Husk Ash concrete cubes and Fig 3.2 shows Curing of Rice Husk Ash Concrete cubes.

IV. RESULTS AND DISCUSSIONS

Compression Strength:

The compression test was done on the 150*150*150mm size cube specimen after curing for 7days and 28days. All the moulds were tested by using CTM of 2000KN capacity undergoes uniform rate of loading until failure occurs and also the final loading in failure was taken for the estimation of compressive strength.

Below results are Compression strength results

Table 4.1: Average results of 7 days compressive strength

% Rice Husk Ash	Compressive strength (N/mm^2)
0	13.6
10	19.9
17.5	12.5
20	18.1
22.5	20.9
25	10.0
30	5.2

This RHA concrete will gain the strength of around 80-90% within 7days itself and the percentage of cement replacement with RHA was 0%, 10%, 17.5%, 20%, 22.5%, 25% & 30% has been showed in the Table 4.1. Table 4.2 shows the compression strength after 28days.

Table 4.2: Average results of 28 days compressive strength

% Rice Husk Ash	Compressive strength (N/mm^2)
0	27.8
10	33.3
17.5	28.23
20	31.26
22.5	34.12
25	18.7
30	14.6

Table 4.3 shows the Comparison of compression test results of 7days & 28days

Table 4.3: Comparison of compression test results of 7days & 28days

Description of varying mix proportions	**7 days Compression strength(N/mm^2)**	**28 days Compression strength (N/mm^2)**
Normal concrete of M 20 grade	13.6	27.8
10%RHA replacement with cement	19.9	33.3
17.5% RHA replacement with cement	12.5	28.23
20% RHA replacement with cement	18.1	31.26
22.5% RHA replacement with cement	20.9	34.12
25% RHA replacement with cement	10.0	18.7
30% RHA replacement with cement	5.2	14.6

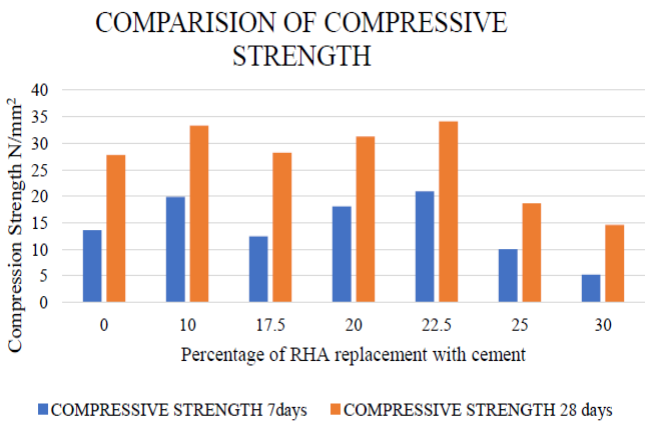

Figure 4.1: Comparison of compression test results of 7days & 28days

From the compression strength test results obtained for M_{20} grade of concrete, with varying percentages of RHA from the table 4.3, it is observed that an increasing strength value of 20.9 N/mm^2 and 34.12 N/mm^2 strength for 7 days and 28 days respectively with 22.5% RHA replacement was obtained. With decrease in strength on 25% and 30 % RHA replacement observed. Hence 22.5% of RHA replacement with cement in M_{20} grade concrete is considered as the optimum percentage of replacement.

Flexural Strength:

Flexure test is done to determine the bending properties of the material. To check the specimen how it acts under the influence of bending loads. This test usually conducted on the wood, steel, concrete beams, etc. In this study RHA concrete beam is subjected to the flexure test. Table 4.4 shows the Flexural test results of 28days.

Table 4.4: Flexural test results of 28days

Description of varying mix proportions	28 days flexural strength test (KN/mm^2)
Normal concrete of M_{20} grade	3.18
10% RHA replacement with cement	4.97
17.5% SCBA replacement with cement	4.33
20% RHA replacement with cement	4.9
22.5% RHA replacement with cement	5.7
25% RHA replacement with cement	3.7
30% RHA replacement with cement	2.99

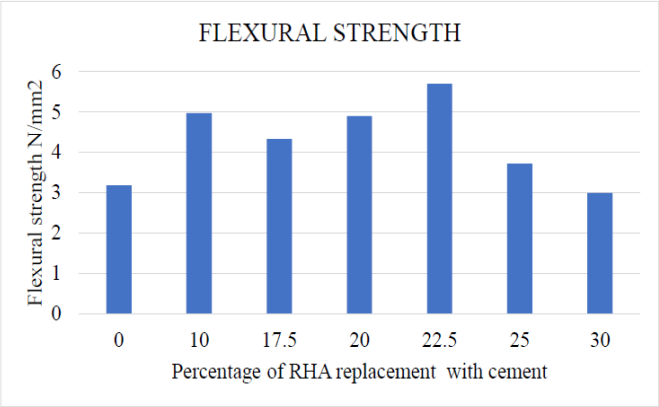

Figure 4.2: Flexural test results of 28 days

V. CONCLUSION

The conclusions made from the study on partial substitution of cement with RHA in M_{20} grade concrete

- The cement is replaced by RHA in incremental percentage of 10% , 17.5% , 20% , 22.5% , 25% and 30% with cement in M_{20} Grade Concrete.
- The normal concrete of M_{20} Grade shows compression strength value of 20.9 N/mm^2 and 34.12 N/mm^2 strength for 7 & 28 days respectively with 22.5% RHA replacement was obtained. With decreasing strength on 25% and 30 % RHA replacement observed.
- The maximum strength is achieved for flexural test at 22.5% replacement of RHA with cement.
- At 22.5 % of RHA substitution with cement in the concrete sample it is observed to attain the highest strength and with additional percentage of RHA the compression strength gradually decreases.
- Hence the optimal percentage of RHA with cement replacement in concrete sample is observed to be 22.5%.
- Thus partial substitution of cement with RHA in concrete shows promising potential for improving the sustainability and durability of concrete.

VI. REFERENCES

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