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Mechanical properties and economical feasibility of RHA modified concrete

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Abstract **-----Improper disposal of rice husk ash (RHA) leads to air pollution and landfilling problem. To reduce these issues, investigations were undertaken to produce low-cost concrete by various ratios of Rice husk ash. In this project, mix deisgn M20 was adopted. Rice Husk Ash (RHA) is used as partial replacement of Ordinary Portland Cement. Rice husk ash was varied as 0%,10%,20%, and 30% by weight of cement. Tests were conducted on workability i.e slump test and mechanical property such as compressive strength was determined for 100mm concrete cubes and compared it with normal concrete. The above tests mentioned were carried out for curing periods of 7, and 28, days. It is observed that concrete with 20% replacement of cement with RHA showed a better results in both fresh and hardened state and it is also economical when compared to conventional concrete.**

Key Words: workability, slump test, compressive strength, rice husk ash, concrete.

I. INTRODUCTION

The concrete of today has transformed itself into advanced type with new ingredients added either singularly or in combination. The traditional four ingredients mix of cement, water, fine aggregate, coarse aggregate done in the past, but a new ingredient material like filler materials has been growing rapidly to improve the quality of concrete. In this filler material, rice husk ash is used. Rice husk ash is produced by controlled burning of the rice husk, is used as highly reactive pozzolanic material. RHA represents a significant improvement on the properties of both fresh and hardened concretes.

II. LITERATURE REVIEW

I.O.Obilade (2014) observed that the compressive strength reduced as the percentage of RHA increased. The addition of RHA as a partial replacement for cement is in the range of 0-20%. The fresh properties of concrete values reduced as the RHA percentage increases. The compacting values reduced from 0.91 to 0.88 as the percentage RHA replacement increased from 0% to 25%. Compressive strength rapidly decreased from 29.15N/mm^2 to 13.29N/mm^2 as the RHA content increases.

Nishant & Vinod (2015**)** studied the effect of the partial replacement of rice husk ash with cement by 0%,10%,20% and 30% of weight on the properties of concrete i.e., compressive strength, initial and final setting time, workability and durability. It observed that 5-20% replacement of cement with RHA helps the concrete in possessing desirable properties of concrete.

Josephin et al (2016) conducted experimental work to study the effect of the RHA dosage in concrete strength. It is found that 10% by weight of cement replacement showed a remarkable percentage of strength gain (7.8%) as compared to normal concrete. The strength increases are due to the higher content of calcium silicate in the RHA. However, 20% of RHA also performed better compared to the normal concrete.

Harshit Varshney(2008) Investigated about the concrete in which ordinary Portland cement (OPC) cement was replaced by Rice husk ash (RHA). Partial replacement of OPC cement was carried out at 0% to 20% and is compared with 0% replacement. In this work, different tests were performed as slump test, compaction factor, compression test. Compression tests were performed for 7days and 28 days of curing and result shows some variation in both tests in every proportion. It concluded that up to 15% replacement of RHA for cement is suitable for making concrete.

III EXPERIMENTAL STUDY

A. Materials Used

Ordinary Portland Cement of 53 grade conforming to IS 8112 was used. Coarse and fine aggregate available at the local area. Potable water was used for mixing and curing of concrete. Rice husk ash is also available from local area sesali.

B. Cement

The chemical analysis of cement was carried out as per IS 4032 and results are presented in the below table.

TABLE I

CHEMICAL COMPOSTION OF CEMENT

Parameter	**Results**	**Specifications(upper limit)**
MgO	0.84	6
SO_3	2.24	3.5
Chloride	0.02	0.1
Loss of Ignition	2.74	4

(Source: www.anjanicement.com)

C. Fine Aggregate

The fine aggregate conforming to zone II according to the IS 383:1970 was used. The fine aggregate used was obtained from nearby river course. The sand used for this work is free of silt and foreign matter.

D. Coarse Aggregate

The crushed stone aggregate of 20mm obtained from local quarry site was used for this research work. The water absorption values obtained for the aggregates is 0.5%.

E. Water

The water is the most important constituent of a concrete product which enables bonding between cement and the aggregates and also helps in the hydration of cement which is the most important phenomenon in gaining strength. Potable water which is free from salts and impurities is used for mixing and also curing purposes.

F. Rice Husk Ash

Rice husk ash is collected from nexus feed limited production company where rice husk is burnt under controlled conditions. The raw RHA was ground in ball mill to reduce the particle size less then 90 microns.

Fig.1 Rice Husk Ash

IV. FRESH PROPERTIES

The water to cement ratio was fixed for normal and cementitious material as 0.5. The fresh concrete mixtures were tested for workability through slump cone test, test results are shown in table 3 and graphical variation is shown in Fig 3. From results it is observed that as the RHA increases, workability decreases.

TABLE II

SLUMP CONE VALUES FOR VARIOUS MIXES

Mix	Slump cone value(mm)
0% RHA	42
10% RHA	30
20% RHA	18
30% RHA	5

Fig.2 Slump cone test

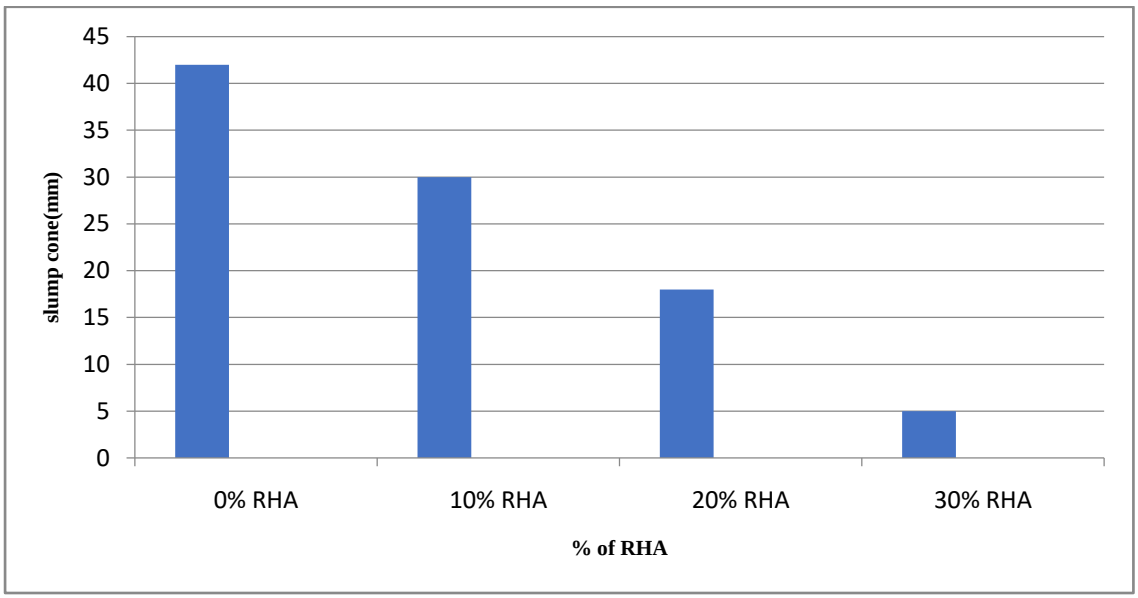

Fig.3 Effect of RHA on slump cone

V. HARDENED PROPERTIES

The cube specimen of size 100×100×100 were cast and tested for a curing period of 7, 28 days for compressive strength as per IS 516: 1999. The capacity of the compression testing machine used was 2000kN. The table 4 illustrates the average 7,28 days compressive strength results of mixes with 0% of RHA to 30% RHA. The compressive strength variation with increase of RHA content for 7 and 28 days of curing was shown in figures 4 and 5 respectively.

TABLE III

COMPRESSIVE STRENGTH ON HARDENED CONCRETE

RHA (%)	Compressive strength(7 days) N/mm^2	Compressive strength(28 days) N/mm^2
0	26.33	40.33
10	23.5	34.33
20	25.83	41.17
30	10.67	22.33

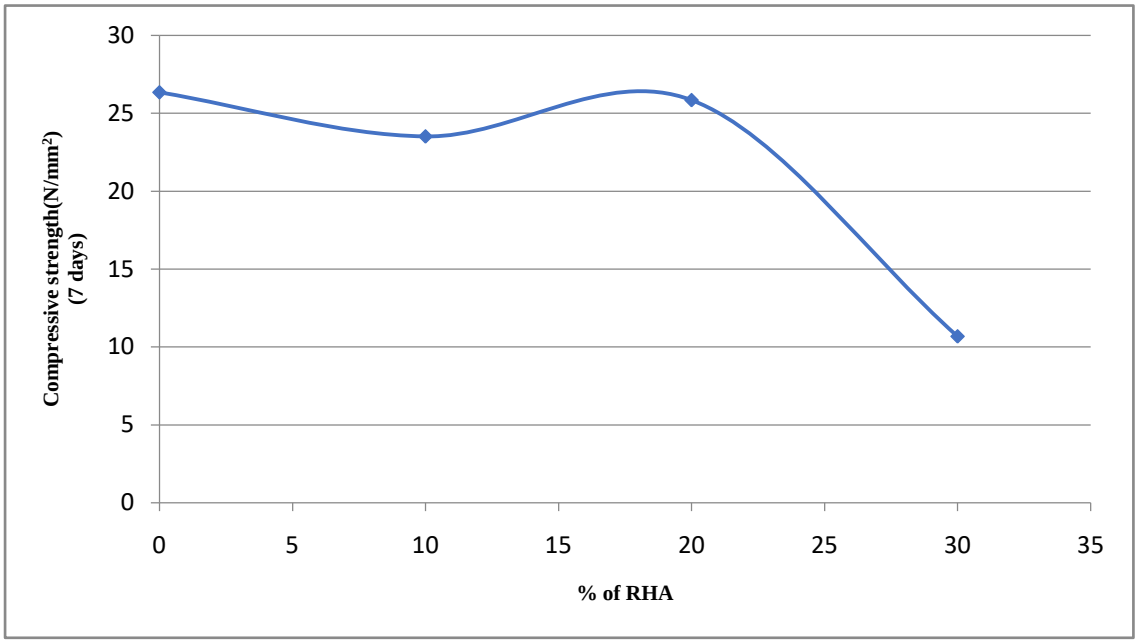

Fig.4 Effect of RHA on compressive strength (7 days)

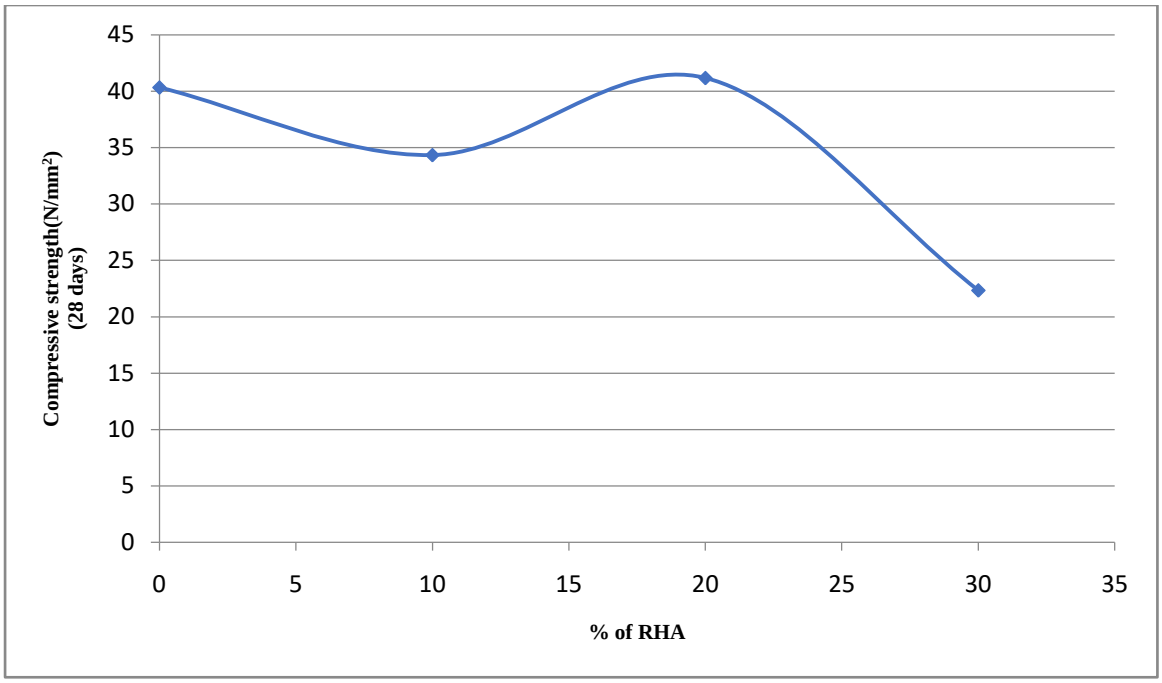

Fig. 5 Effect of RHA on compressive strength (28 days)

Fig .6 Compressive strength test

VI.COST ANALYSIS

Cost analysis is carried out for optimum percentage of rice husk ash in concrete and is compared with conventional concrete.

TABLE IV

COST ANALYSIS OF NORMAL CONCRETE/M^3

Item	**Quantity (Kg/m^3)**	**Rate (Rs.)**	**Cost of Material (Rs.)**
Cement	372	6/kg	2232
RHA	-	0/kg	-
Sand	689.99	886.52/m^3	437.05
Coarse Aggregate	1219.94	1063.83/m^3	772.51
Total Cost			3441.51

TABLE V

COST ANALYSIS OF 20% RHA REPLACED CONCRETE/M^3

Item	**Quantity (Kg/m^3)**	**Rate (Rs.)**	**Cost of Material (Rs.)**
Cement	297.6	6/kg	1785.6
RHA	74.4	0/kg	-
Sand	675.1	886.52/m^3	427.3
Coarse Aggregate	1193.66	1063.83/m^3	756.38
Total Cost			2969.28

Table 5 shows the cost analysis of conventional concrete and table 6 shows the cost analysis of concrete with 20% replacement of RHA. From the above tables it is clear that total cost of the concrete per cubic metre decreases with increase of RHA content.

VII. CONCLUSIONS

Afte sucessful completion of experimental study the following conclusions are made.

- As the percentage of RHA increases workability increases.
- It was observed that the compressive strength shows better results with Rice husk ash upto 20% replacement by weight of cement.
- The cost analysis results showed a decrease in cost of per cubic meter of concrete and the differenece in cost from normal concrete to RHA partially replaced concrete was Rs. 472.23.
- Based on the above, it can be recommended that 20% of RHA by weight can be effectively used as a replacement in cement which showed better results in fresh and hardened state than normal concrete and also cost effective.

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