The Influence of Rice Husk Ash on Concrete

Rohit chaurasia[1], Sheela Malik[2], Ravinder[3]

[1](M.Tech Scholar, Department of Civil Engineering, Ganga Institute of techbology & management , jhajjar haryana)
2(Assistant Professor, Department of Civil Engineering, Ganga Institute of techbology & management , jhajjar haryana)
[1](M.Tech Scholar, Department of Civil Engineering, Ganga Institute of techbology & management , jhajjar haryana

---

Abstract *In recent decades, the use of residue in civil construction, particularly in addition concrete, has been the subject of numerous studies because, in addition to reducing environmental polluters, it may lead to several improvements in concrete properties. The annual global rice harvest is estimated to be 500 million tons. If 20% of the grain is husk and 20% of the husk after combustion is converted into ash, a total of 20 million tonnes of ash can be obtained. This report examines how different levels of rice husk ash (RHA) in concrete affect its physical and mechanical properties. Samples with dimensions of 15 X 15 cm were tested, with 12.5, 25, & 37.5% of RHA, replacing in mass the cement. Properties like simple compressive strength, splitting tensile strength, water absorption and modulus of elasticity were evaluated. The results were compared to controlled sample and the viability ofadding RHA to concrete was verified.*

Keywords - Rice husk ash, compressive strength, splitting tensile strength, water absorption and modulus of elasticity…

1. INTRODUCTION

Rice husk is an agro-waste material which is produced in about 100 million of tons. Approximately, 20 Kg of rice husk are obtained for 100 Kg of rice. Rice husks contain organic substances and 20% of inorganic material. Rice husk ash (RHA) is obtained by the combustion of rice husk. The amorphous phase content of RHA is the most important property that determines pozzolanic activity. RHA is a highly reactive pozzolanic material that can be used to replace Portland cement in lime-pozzolana mixes. RHA contains a high concentration of silicon dioxide, and its reactivity to lime is determined by a combination of two factors: non-crystalline silica content and specific surface.

Research on producing rice husk ash (RHA) that can be incorporated to concrete and mortars are not recent. In 1973, researchers investigated the effect of pyro processing on the pozzolanic reactivity of RHA. Since then, a lot of studies have been developed to improve the mechanical and durability properties of concrete. The potential reactivity of aggregate was investigated, and the results show that adding more than 12% RHA reduces the expansion to acceptable levels. RHA obtained through uncontrolled combustion was added to concrete in this report. Mechanical properties such as compressive strength, splitting tensile strength, water absorption, and elasticity modulus were determined. The samples were tested at seven and twenty-eight days of age.

The Effect of RHA Average Particle Size on Mechanical Properties-

This paper describes an experimental study that looked at the effect of Rice Husk Ash Average Particle Size (APS) on the mechanical properties and drying shrinkage of RHA blended concrete. Locally produced RHA with three different APS (i.e., 31.3, 18.3, and 11.5 m) were used to replace cement by 12.5 percent, 25%, and 37.5 percent of its weight, respectively. The mixture was proportioned to produce a high workability RHA mixture (200-240 mm slump) with target strength of 40MPa. Incorporation of RHA in concrete increased water demands while inclusion of RHA provided similar or enhanced mechanical properties when compared to the control. Ordinary Portland Cement (OPC) mixture with finer RHA provides better improvement. Fine RHA had the highest shrinkage value due to the effect of micro fine particles, which significantly increased its shrinkage values.

2. MATERIALS USED

Rice Husk Ash:

The Rice Husk Ash used in this work was created in the laboratory by burning the husk in a Ferro cement furnace at a temperature not exceeding 7000 degrees Celsius. The ash was ground in a Los Angeles mill for 180, 270, and 360 minutes before undergoing XRD analysis to determine the silica form of the RHA Powder samples. RHA samples were scanned by electron microscope to show the RHA's multi layered and micro porous surface.

Other Materials:

Portland cement, coarse aggregate with a maximum size of 20 mm, and mining sand with a maximum size of 5 mm were also used in the concrete mixture. The coarse and fine aggregate fineness moduli were 2.43 and 4.61, respectively. The Sp used is sulphonated naphthalene formaldehyde condensed polymer based admixture.

Mix proportion:

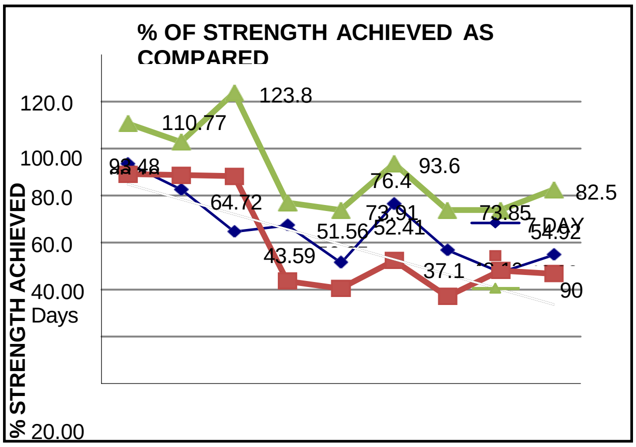
The goal of this investigation was to create concrete with 28-day compressive strength targets of at least 40 MPa. The proportion of mixtures was chosen based on these goals. The RHA was tested to replace cement in a variety of ratios, including 0, 12.5, 25, and 37.5 percent by mass of cement. Ratio of water per total cement binder (cement plus RHAs) was fixed at 0.48.

3. EFFECTS OF RHA

Effect of RHA APS on Workability & Density of concrete

All of the concrete mixtures' fresh propertie are given. The slump was in the (210-230 mm) range, and bleeding was negligible for the control mixture. There was no bleeding or segregation in concretes containing RHA. The fresh density ranged from (2253-2347 kg/m3), with the mixture having the lowest density values due to the low specific gravity of RHA, which resulted in a reduction in mass per unit volume. The concrete incorporating finer RHA resulted in denser concrete matrix.

The SP content had to be increased along with the RHA fineness and percentage, this due to the high specific surface area of RHA which would increase the water demand therefore, to maintain high workability, Sp content rose up to 2.00 % for the mixture.



Water absorption

The results reveal that higher substitutionamounts results in lower water absorption values, it occurs due to the RHA is finer than cement. Adding 10% of RHA to the concrete, a reduction of 38.7% in water absorption is observed when compared controlled mixture.

Static Modulus of Elasticity:

The values of the static modulus of elasticity were in the range of 29.6 - 32.9 GPa. It can be noted that the addition of RHA to concrete exhibited marginal increase on the elastic properties, the highest value was recorded for mixture due to the increased reactivity of the RHA. Concretes incorporating pozzolanic materials usually show comparable values for the elastic modulus compared to the OPC concrete.

Splitting tensile strength

All the replacement degrees of RHA researched, achieve similar results in splitting tensile strength. According to the results, may be realized that there is no interference of adding RHA in the splitting tensile strength.

Drying Shrinkage

The results demonstrated that the RHA average particle size had a significant effect on drying shrinkage, with the 37.5 percent concrete Mixture having a higher shrinkage value than the control. The shrinkage for 25% concrete was comparable, while shrinkage for 12.5 percent was lower when compared to the control. The reduction in RHA particle size increased pozzolanic activity and helped to refine the pore structure of the RHA concrete paste matrix. Thus, it can be concluded that the addition of micro fine particles to concrete would increase the drying shrinkage. Many researchers showed that concretes incorporating pore refinement additives will usually show higher shrinkage and creep values. On the other hand, others showed that using pozzolanic materials as cement replacement will reduce the shrinkage.

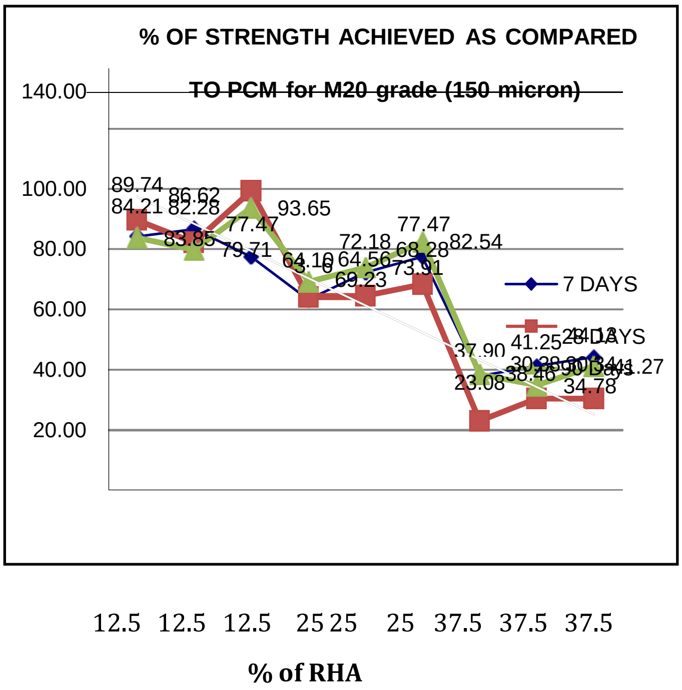
Compressive Strength:

The development of strength at various ages is shown below. It should be noted that the strength was comparable at early ages, but at 28 days, finer RHA exhibited greater strength than the sample with coarser RHA. This is due to the finer RHA particles, which may have increased the reaction with Ca(OH)2 to produce more calcium silicate hydrate(C-S-H) resulted in higher compressive strength.

4. RESULTS AND DISCUSSION

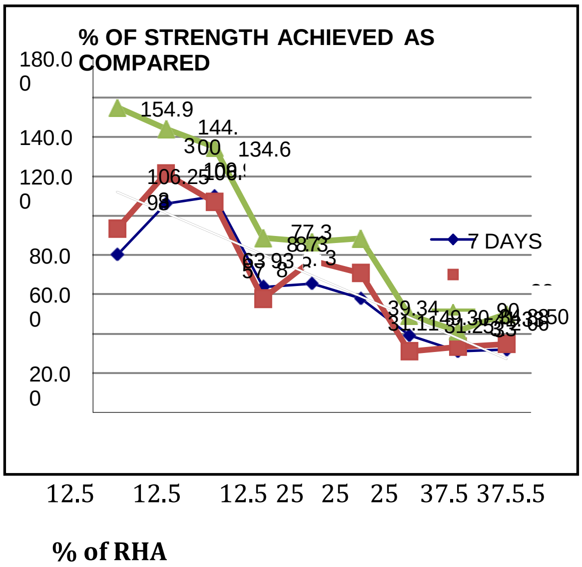
Following results shows the effect of percentage and fineness of RHA on the compressive strength of concrete,

4.1 % Strength achieved for M20 grade concrete with 12.5%, 25% & 37.5% RHA:



The average achieved strength is higher for 90 days, but lower for 28 days and 7 days when using 75 micron RHA. The average strength achieved is greater for 12.5 percent RHA than for other proportions. When compared to PCC, one of the samples achieved 123.81 percent strength after 90 days of curing.

Days	RHA	% strength achieved(In the avg. range of)	
		75µ	150µ
7 days	12.5%	75-80%	77-80%
7 days	25%	64-68%	65-70%
7 days	37.5%	50-52%	38-41%
28 days	12.5%	88-89%	87-92%
28 days	25%	44-46%	64-68%
28 days	37.5%	40-44%	25-30%
90 days	12.5%	110-114%	82-85%
90 days	25%	80-85%	70-74%
90 days	37.5%	75-77%	39-42%



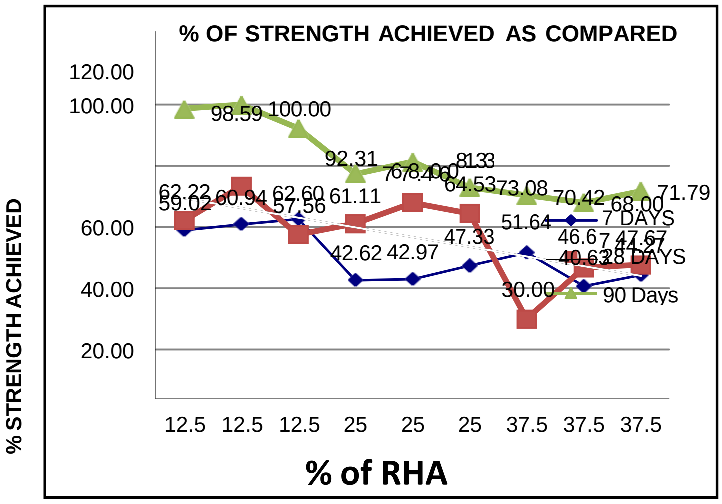
When 150 micron RHA is used, the average achieved strength is higher for 90 days and lower for 28 days and 7 days. When compared to PCC, the percent strength achieved was in the 85-90 percent range for 7 days. Then, after 28 and 90 days of Curing, it decreased significantly.

At the very least, the minimum achieved strength was for 25% RHA using 75 micron. It was 67.37 percent after 90 days of curing. The minimum achieved strength for 150 micron was 37.5 percent RHA. It was 34.78 percent after 90 days of curing.

From the above discussion it is observed that, when 75 micron RHA is used, the percentage of strength achieved for 90 days is higher as that of PCC, whereas it is found lesser in case of 28 days & 7 days.

Therefore from all above discussion it can be interpreted that concrete tends to achieve 85-100 % for 12.5 % RHA, and 65-90% for 25% and 37.5% of RHA.

It is observed that strength gain becomes slow when RHA is used and strength is reduced for higher % of RHA for both 75 micron and 150 micron of RHA.



Days	RHA	% strength achieved (In the avg. range of)	
		75µ	150µ
7 days	12.5%	94-98%	57-59%
7 days	25%	59-62%	43-46%
7 days	37.5%	30-32%	44-47%
28 days	12.5%	105-110%	62-66%
28 days	25%	65-70%	63-65%
28 days	37.5%	30-32%	39-44%
90 days	12.5%	138-142%	95-98%
90 days	25%	86-88%	75-78%
90 days	37.5%	86-88%	75-78%

The % strength achieved can be interpreted as follows:

The average achieved strength is higher for 90 days, but lower for 28 days and 7 days when using 75 micron RHA. The average strength achieved is greater for 12.5 percent RHA than for other proportions. When compared to PCC, one of the samples achieved 154.93 percent strength after 90 days of curing.

When 150 micron RHA is used, the average achieved strength is higher for 90 days and lower for 28 days and 7 days. When compared to PCC, one of the samples achieved 100 percent strength after 90 days of curing.

At the least, the minimum achieved strength was for 37.5% of RHA using 75 micron. After complete 90

days of curing it was 33.33%. For 150 micron the minimum achieved strength was for 25% of RHA. After complete 90 days of curing it was 64.53%.

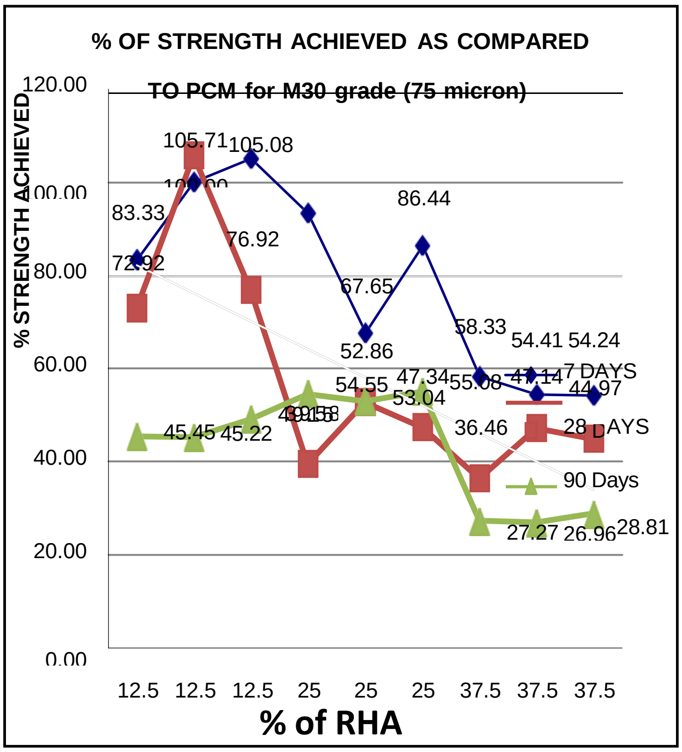
It can also be seen that when finer RHA (75 micron) was used, the percent strength achieved was higher than when RHA of 150 micron was used. It did, however, show a steep decline for higher percentages of RHA.

According to the discussion above, when 75 micron RHA is used, the percentage of strength achieved for 90 days is higher than that of PCC, whereas it is lower in the case of 28 days and 7 days.

Therefore from all above discussion it can be interpreted that concrete tends to achieve 75-85% for 12.5 % RHA, and 90-110% for 25% and 37.5% of RHA.

It is observed that strength gain becomes slow when RHA is used and strength is reduced for higher % of RHA for both 75 micron and 150 micron of RHA.

% Strength achieved for M30 grade concrete with 12.5%, 25% & 37.5% RHA:



Days	RHA	% strength achieved (In the avg. range of)	
		75µ	150µ
7 days	12.5%	90-95%	50-55%
7 days	25%	75-80%	45-48%
7 days	37.5%	53-56%	15-18%
28 days	12.5%	80-85%	85-90%
28 days	25%	80-85%	85-90%
28 days	37.5%	80-85%	85-90%
90 days	12.5%	45-47%	54-56%
90 days	25%	45-50%	34-36%
90 days	37.5%	45-50%	34-36%

The % strength achieved can be interpreted as follows:

The average achieved strength is higher after 7 days and 28 days, but lower after 90 days when using 75 micron RHA. When 25 percent RHA is used, the average strength achieved is higher than when other proportions are used. When compared to PCC, one of the samples achieved a maximum strength of 55.08 percent after 90 days of curing.

When 150 micron RHA is used, the average achieved strength is higher for 7 days and 28 days, but lower for 90 days. The average strength achieved is greater for 12.5 percent RHA than for other proportions. One of the samples recorded a maximum strength of 57.2 percent after curing for 90 days of curing as compared to PCC.

The minimum achieved strength was 37.5 percent RHA using 75 micron. It was 26.96 percent after 90 days of curing. The minimum achievable strength for 150 micron was 25% RHA. It was 34.75 percent after 90 days of curing.

It can also be seen that when finer RHA (75 micron) was used, the percent strength achieved was slightly lower for this grade when compared to RHA size of 150 micron.

According to the discussion above, when 75 micron RHA is used, the percentage of strength achieved for 90 days is much lower than that of PCC, whereas it is higher in the case of 28 days and 7 days.

It is observed that strength gain becomes slow when RHA is used and strength is reduced for higher % of RHA for both 75 micron and 150 micron of RHA.

CONCLUSION

Based on above results of concrete mixes, the following conclusions can be drawn,

- Mixes have a higher compressive strength than standard concrete.
- The replacement of 12.5 percent of cement in the matrix with rice husk ash reduces cement utilisation and expenditures. Concrete quality can also be improved after 90 days.
- The results show that pozzolanic reactions of rice husk ash in the matrix composite were low at early ages, but ageing the specimens to 90 days had a significant effect on strength.
- According to research, adding pozzolans to concrete, such as rice husk ash, can improve the mechanical properties of specimens.

REFERENCES

1. Concrete technology – M.S. Shetty All India seminar on concrete for infrastructural developments.
2. Concrete microstructure, property and material –KUMAR MEHTA AND J.M.MONTEIRO.
3. Romualdi, J.P. and Batson, G.B., "Mechanics of Crack Arrest in Concrete", Proceedings of ASCE, Vol.89, June 1963, pp.147-168.
4. Ramaswamy, "Behaviour of Fibre Concrete ", M.Tech. thesis ,IIT-Delhi,1978
5. Khan, T.A.H, Laid, S.M. and Ramakrishnan,B. “Experimental Study of SFRe under Compression and Pure bending ", Journal of ACI, Vol.89, pp.96100, Feb.1972.
6. Gabbler and Krieger, “Abrasion. Resistance of High Strength Concrete made with Class- C Flash ", ACI Journal, Nov.-Dec. 1995,pp.650- 655
7. Étagère Rao.M.V. "Study of rice husk ash cement concrete as a structural material ", PhD thesis, JNTU, Hyderabad, 1992.
8. "Malhotra, V.M. ed. (1980) Progress in Concrete Technology, CANMET, Ottawa, pp 367-419.
9. Mehta P.K. and Monteiro, Paul J.M. (1997) Concrete: Microstructure, Properties, and Materials. Indian Concrete Institute, Chennai
10. Mindess, S. and Young, J.F. (1981) Concrete. Prentice Hall Inc.; Englewood Cliffs, NJ
11. MOR, A. (1992) Concrete Construction, Vol37, No.5.
12. Moreno, J. (1990) Concrete International, Vol. 12, No.1, pp 35-39
13. Ngab, A.S. , Slate, F.O. and Nilson, A.H. (1981) ACI Materials Journal, Proc. , Vol. 78, No.4, pp 262-68.
14. Oliverson, J.E. and Richardson, A.T. (1984) Concrete International, Vol. 6, No.5, pp 20- 28
15. Polivka, M. and Davis, H.S. (1979) ASTM STP 169B, pp 420-34
16. Report of ACI Committee 213 (1987) ACI Materials Journal. , Vol. 87, No.3, pp 638-51
17. Report of ACI Committee 223 (1991) Manual of Concrete Practice, Part 1

BIOGRAPHIES

Rohit Chaurasia
M.Tech Scholar. Ganga Institute of Technology and Management

Sheela Malik
Assist. Professor Ganga Institute of Technology and Management

Ravinder
Assist. Professor Ganga Institute of Technology and Management

Shivender
Junior Engineer ,CADA Haryana