Analysis of Pervious Concrete by Partial Replacement of Cement with Rice Husk

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Abstract - *Rice companies are under pressure to find a method for disposing of "rice husk ash", which is rapidly accumulating. It is critical to increase the amount of green concrete produced by rice husk ash. it can be added to concrete to improve its energy efficiency and other sturdiness properties. As a result, we can employ rice husk ash in pervious concrete as a partial cement substitute. As a result, the study's purpose is to track pervious concrete behaviour while altering rice husk ash within concrete proportions. According to test results, compressive energy achieved as much as 10% as an alternative to cement with rice husk ash can be most effective without altering the properties of sparkling as well as cured concrete.*

Key Words: Rice Husk Ash, Compressive Strength, Flexural Strength, Eco-Friendly, Pervious Concrete, Industrial Waste, Low Cost, O.P.C. Cement, Rice Husk Ash.

1. INTRODUCTION

One-of-a-kind and powerful alternative for decreasing runoff and replenishing floor water from paved areas. Traditional concrete is more capable of uprooting hurricane water than pervious concrete. In order to compensate for the lack of a retention pond, swales, and hurricane water control measures, it is presently recharging floor water. It is likewise put off luxurious hurricane water detention vaults as well as piping systems. Thus lessen creation expenses, protection troubles as well as preservation cost. Waste control hassle has already end up intense with inside world. Hassle is compounded via way of means of unexpectedly growing quantity's of business wastes of a complicated nature as well as composition. Energy performs a vital position with inside increase of rising nations. In the environment of poor non-renewable resource availability electricity sources coupled with necessity's of huge portions of electricity for constructing substances like cement, significance of usage of business waste can not be underestimated. As a result, the fundamental purpose substances increase aggregate share as well as compressive and flexural electricity. Within 2010 India produces round one hundred twenty million heaps of rice paddy, giving round 24 million heaps of rice husk as well as six million heaps of "rice husk ash". Authors discovered that incorporating silica fume and superplasticizer into pervious concrete improves its strength significantly. By using smaller parts, the strength of porous concrete can be improved [1]. Adding small volumes of superplasticizer to silica fume-containing mixtures improved both permeability and compressive strength of pervious concrete [2]. Permeability of pervious concrete is determined by water cement ratio, aggregate shape, and size [3]. For all types of aggregates, pervasive concrete mixes generated with smaller aggregate sizes resulted in improved compressive strength. Permeability and compressive strength of pervious concrete are affected by particle sizes as well as the A/C ratio. They employed an A/C ratio of 6:1, 8:1, and 10:1. When compared to A/C ratios of 8:1 and 10:1, they discovered that a 6:1 A/C ratio generated the highest compressive strength. Mixtures with a higher A/C ratio, such as 8:1 or 10:1, are regarded to be appropriate for pavements with low compressive strength but high permeability. They concluded that coarse aggregate with a smaller particle size should have a higher compressive strength and permeably rate [4].

2. MATERIAL

2.1 Rice husk ash (RHA)

Rice Husk Ash (R.H.A.) disposing of it, it has the potential to become an environmental disaster in resource- rich countries. The cultivation of rice paddy is linked to the production of rice husk and rice bran, which are essentially two byproducts. The outer shell that protects the R.C.E. kernel is termed as the husk, often known as hulls. About 220 kilograms (22 percent) of husk is produced for every 1000 kg of paddy milled. The majority of rice husk is used as a fuel in paddy processing boilers. When the husk is burned with bolers, about 55 kg (or 25%) of R.H.A. is generated. Chart 1 depicts rice husk ash collected by Guru Metachem Pvt. Ltd., Ahmedabad, from R.C.E. fields. Table 1 represents the chemical properties of RHA. Table 2 represents the physical properties of RHA.

Chart-1: Rice husk ash

Table -1: Chemical properties of RHA

Sr. No.	Particulars	Proportion
1.	Silicon dioxide (SiO_2)	85.5-95.5%
2.	Aluminum oxide (Al_2O_3)	0.0-2.5%
3.	Iron oxide (Fe_2O_3)	0.0-1.5%
4.	Calcium oxide (CaO)	0.0-1.0%
5.	Carbon (c)	2.0-4.0%
6.	Sodium oxide (Na_2O)	0.0-1.0%
7.	Potassium oxide (K_2O)	0.0-3.0%

Table -2: Physical properties of RHA

Sr. No.	Particulars	Proportion
1.	Color	Gray
2.	Shape	Irregular
3.	Particle size	<45 micron
4.	Specific gravity	2.3
5.	Appearance	Very fine

2.2 Cement

Grade 53 Portland Cement is a common type of Portland cement. Hathi Cement was used in accordance with IS: 12269 – 1987 [5]. Tables 3 and 4 demonstrate the physical and chemical properties of cement respectively.

Table -3: Physical properties of ordinary Portland cement

Sr. No.	Property	Value for Cement	IS Code: 12269-1987
1.	Specific Gravity	3.15	3.10-3.15
2.	Consistency	28%	30-35%
3.	Initial setting time	35 min	30 minimum minutes
4.	Final setting time	178 min	600 maximum minutes

Table -4: Chemical properties of ordinary Portland cement

Sr. No.	Particulars	Proportion
1.	Silicon dioxide (SiO_2)	21.77%
2.	Aluminum oxide (Al_2O_3)	2.59%
3.	Sulphur trioxide (SO_3)	2.41%
4.	Calcium oxide (CaO)	57.02%
5.	Magnesium oxide (MgO)	2.71%
6.	Ferric oxide (Fe_2O_3)	.65%

2.3 Aggregate

Aggregate makes up majority of volume of concrete, indicating that it is one of most significant components. They give concrete body, reduce shrinkage, as well as save money. within this study, two sizes of aggregate were used. To reach needed range, coarse material utilised within investigation was sieved. Table 5 lists aggregate's physical characteristics. The following are two sizes available:

a. Aggregate that passes 20 mm filter 100 percent of time as well as is retained 100 percent of time on 10 mm sieve.

b. For each concrete mix, use aggregate that passes a 10 mm screen 100% of time as well as measures 100*100*500 mm ratio of 0.30-0.35-0.40.

After around 24 hours, specimens were demoulded, as well as water curing was maintained until corresponding specimens were tested for compressive as well as flexural strength after 7, 14, as well as 28 days.

Table -5: Aggregate property

Sr. No.	Property	Aggregate	
		20 mm	10 mm
1.	Fineness Modulus	7.52	3.19
2.	Specific Gravity	2.75	2.65
3.	Water Absorption	1.82	1.30

2.4 Water

Because it facilitates in the chemical interaction between cement and water, water is an important component of concrete. Water quantity and quality must be carefully evaluated because they both contribute to the strength of cement gel.

3. METHODOLOGY

Table 6 shows RHA-adjusted mix proportion. Table 7 shows pervious concrete design mix utilising RHA. aggregate composition of design mix is 1500 kg/m3, with a Cement: Aggregate ratio of 1:4 maintained.

Table -6: Mix proportions of rice husk ash

Mix	Aggregate content	Cement content	W/C ratio	Cementitious material
Mix0.30	1500 kg/m3	375 kg/m3	0.30	0% RHA
R Mix 1				10% RHA
R Mix 2				20% RHA
Mix0.35	1500 kg/m3	375 kg/m3	0.35	0% RHA
R Mix 1				10% RHA
R Mix 2				20% RHA
Mix0.40	1500 kg/m3	375 kg/m3	0.40	0% RHA
R Mix 1				10% RHA
R Mix 2				20% RHA

Table -7: Mix design having rice husk

Concrete Design Mix Proportions (kg/m³)						
Mix	W/C ratio	Quantity Requirements				
		Cement (kg)	Rice Husk Ash (kg)	Aggregate 10 mm (kg)	Aggregate 20 mm (kg)	Water (Liter)
$Mix_{0.30}$	0.30	375.00	00.00	750.00	750.00	112.50
R Mix 1		337.50	37.50	750.00	750.00	
R Mix 2		300.00	75.00	750.00	750.00	
$Mix_{0.35}$	0.35	375.00	00.00	750.00	750.00	131.25
R Mix 1		337.50	37.50	750.00	750.00	
R Mix 2		300.00	75.00	750.00	750.00	
$Mix_{0.4}$	0.40	375.00	00.00	750.00	750.00	150.00
R Mix 1		337.50	37.50	750.00	750.00	
R Mix 2		300.00	75.00	750.00	750.00	

3. RESULT & DISCUSSION

Concrete testing is first step within determining whether R.H.A. may be used the same as cement substitute. Cement, water, coarse aggregate, as well as R.H.A. make up pervious concrete. R.H.A. is used to replace between 10% as well as 20% of cement within pervious concrete. For each concrete mix, a 150*150*150 mm mould with with a w/c ratio of 0.30, 0.35, a partial substitution of cement, 0.40, 0.50 as well as 0.40. On size mould, three beam samples were cast.

For each concrete mix, dimensions are 100*100*500 mm, with partial cement substitution at w/c ratios of 0.30, 0.35, as well as 0.40. Following around 24 hours, specimens be de-molded, as well as water curative maintained until corresponding specimens were tested for compressive as well as flexural strength after 7, 14, as well as 28 days.

3.1 Compressive Strength (IS:516-1959) [6]

Using cube samples, compression strength tests were done on a compression testing equipment. average strength values provided within this research were determined by testing three samples each batch. On each concrete mix, comparative experiments were conducted for 0.30, 0.35, as well as 0.40 W/C ratios of partial substitution cemented R.H.A. at 10% as well as 20%.

The pervous concrete compressive strength is described within Table 8. Table as well as Charts 2, 3, as well as 4 demonstrate experimental outcomes.

Table -8: Compressive strength

Concrete Mix	W/C ratio	% Replacement of Cement	Average Compressive Strength (N/mm²)		
			7 Days	14 Days	28 Days
$Mix_{0.30}$	0.30	0	6.72	7.40	8.02
R Mix 1		10	7.29	8.00	8.83
R Mix 2		20	6.42	7.10	7.86
$Mix_{0.35}$	0.35	0	7.13	8.20	9.42
R Mix 1		10	8.38	9.20	10.05
R Mix 2		20	6.82	8.10	9.19
$Mix_{0.4}$	0.40	0	8.57	9.40	10.35
R Mix 1		10	9.11	10.05	10.98
R Mix 2		20	7.91	8.50	9.78

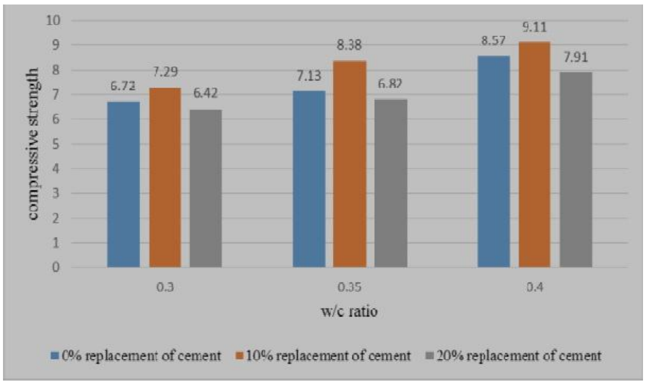

Chart-2: 7th day compressive strength vs W/c ratio

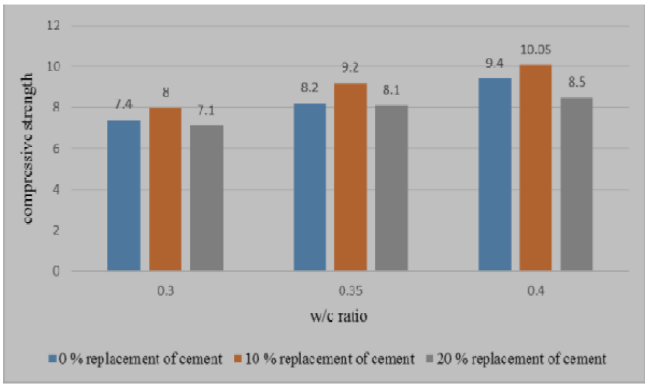

Chart-3: 14th day compressive strength vs W/c ratio

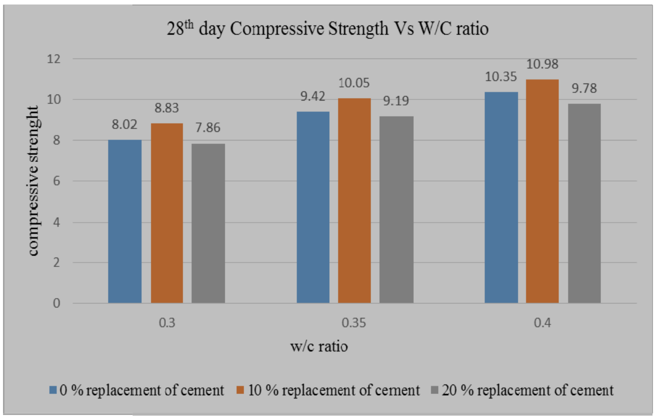

Chart-4: 28th day compressive strength vs W/c ratio

3.2 Flexural Strength (IS:516-1959)

Using beam samples, On a flexural testing table, flexural strength tests were performed equipment. average strength values provided within this research were determined by testing three samples each batch. Flexural tests were performed on each concrete mix using 0.30, 0.35, as well as 0.40 W/C ratios of partial cement substitution with R.H.A. at 10% as well as 20%, respectively. pervious concrete flexural strength is described within Table 9. Table 9 as well as charts 5, 6, as well as 7 demonstrate experimental outcomes.

Table -9: Flexural strength

Concrete Mix	W/C ratio	% Replacement of Cement	Average Flexural Strength (N/mm²)		
			7 Days	14 Days	28 Days
Mix0.30	0.30	0	1.14	1.30	1.49
R Mix 1		10	1.55	1.65	1.87
R Mix 2		20	1.10	1.15	1.32
Mix0.35	0.35	0	1.40	1.58	1.85
R Mix 1		10	1.88	2.02	2.38
R Mix 2		20	1.31	1.55	1.75
Mix0.4	0.40	0	1.89	2.15	2.43
R Mix 1		10	2.41	2.70	3.05
R Mix 2		20	1.80	2.20	2.40

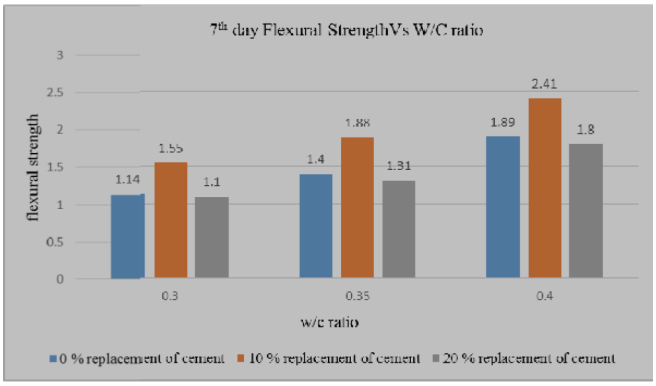

Chart-5: 7th day flexural strength vs W/c ratio

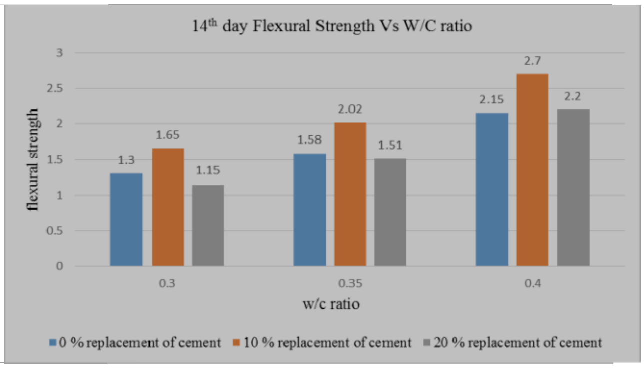

Chart-6: 14th day flexural strength vs W/c ratio

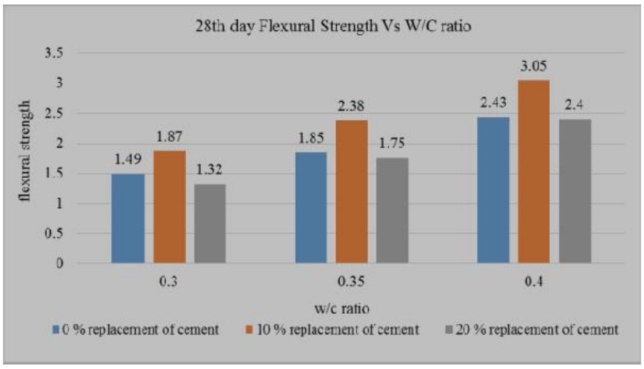

Chart-7: 28th day flexural strength vs W/c ratio

3. CONCLUSIONS

Observations made examinations into as well as flexural strengths of concrete. W/C ratio of pervious concrete increases, resulting within increased compressive as well as flexural strength. When Cement is substituted with RHA, the compressive strength of porous concrete increases by up to 10%, after which it begins to decline. It is a feasible alternative approach for safe R.H.A. disposal.

4. REFERENCES

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