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A Comprehensive Analysis of the Influence of Rice Husk Ash Content on Concrete Strength

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ABSTRACT

The study explores the strength of ordinary Portland cement (OPC) concrete when blended with rice husk ash (RHA). The research uses laboratory experimentation, specimen preparation, curing regimes, and mechanical testing to evaluate the effects of RHA on concrete's mechanical properties. Results show that RHA influences the strength development of OPC concrete, with variations in early-age and long-term strengths. The study uses rice husk ashes, which have a bulk density of 770kg/m3, specific gravity of 1.85, and fineness modulus of 1.45. The research also focuses on determining compressive strength, and workability of the Portland cement in concrete. Three concrete mixes were designed using specific characteristic concrete strength of 30N/mm², standard deviation of 6N/mm² and slump ranges of 30-60mm. A constant water/cement ratio of 0.57 was used throughout the mix and the batching was by weight. Mix 1 was cast with cement only [100% OPC] which serves as the control mix, then sample another two mix was casted with some percentage replacement of 30% and 40% of cement with RHA respectively. Based on the findings the following compressive strength was determined for the three-mix design 30.51, 23.88 and 19.19 N/mm² respectively. In addition, the durability test was conducted after 56 days and the following strength was gotten 33.30, 28.99 and 22.10N/mm² respectively.

Keywords: characteristics strength, Portland cement, Rice husk, Concrete.

INTRODUCTION

The building industry in Nigeria is currently experiencing an unparalleled ascent to its pinnacle. The prominence and growing use of concrete is one of the technological effects of this growth [1]. These days, it is rare to find a building project where some component is either transitory or part of the permanent work. Because cement is still the most expensive element in the manufacturing of concrete, its market value (price) will always be on the high side. As a result, the total cost of producing concrete will depend on the availability and cost of its constituent [2]. These days, there is a global movement to find alternative materials to replace well-known materials like cement in nations where those resources are not readily available for purchase. Given this, it's necessary to use less cement when making concrete [3]. Replacing a portion of the cement used in the manufacturing of concrete with extra cementitious materials (Pozzolans), such as Rice Husk Ash (RHA) is a workable way to reduce the amount of cement used in a particular work, in order to lower the high cost of structural concrete [4]. Cement is an expensive building material; this much cannot be stressed. The solid waste that the rice milling industry produces from rice husk. It is predicated on the current excessive cost of building materials, namely cement, which has led to those in the construction sector. Based on the current excessive cost of building materials (cement), it is said that individuals in the construction industry have been manipulating or reducing the amount of cement required to reach the maximum strength in concrete structures [5]. The aim of optimizing the rice husk ash (RHA) content in blended concrete for enhanced characteristics strength is to maximize the beneficial properties of RHA while maintaining or improving the overall strength and durability of the concrete mixture [6]. In addition to identify Optimal RHA Proportion by determining the specific percentage of RHA that maximizes the strength and other desired characteristics of the concrete mix, such as durability and workability. To enhance Compressive Strength by investigating how different levels of RHA incorporation influence the compressive strength of the concrete, aiming to increase this strength while maintaining other essential properties [6]. To improve durability and performance by assessing the impact of varying RHA content on the durability of the concrete, including resistance to factors such as chemical corrosion, abrasion, and environmental conditions, with the goal of enhancing overall performance and longevity. Finally, to optimize cost-effectiveness by evaluating the cost-effectiveness of using RHA in concrete production by considering factors such as material availability, production costs, and long-term benefits, aiming to develop a blend that balances performance with economic feasibility [8].

LITERATURE REVIEW

Concrete is a composite material made mostly of binding medium with embedded fragments of filler material that is relatively inert. [1], defined concrete as any product or mass formed through the application of cementing medium. Aggregates, water, and Portland cement make up its composition. Portland cement is a hydraulic cement that forms a compound that is resistant to water by hardening in water [8]. In order to produce concrete, the hydration products serve as a binding agent for the aggregates. Any substance having cohesive and adhesive qualities that can join material fragments to form a whole is generally referred to as cement. Choosing the right cement and using it correctly are crucial to getting the necessary balance of qualities for any given concrete mixture at the best possible price [9]. Following the current trend of performance-oriented requirements, BSCN 197-1 provides minimal information regarding this substance's chemical makeup. It just states that it contains 95–100% Portland cement clinker and 0–5% minor ingredients, which could be fillers to increase workability or water retention or cementitious materials [10]. When sulphates are not present in the soil or groundwater, ordinary Portland cement is by far the most often utilized cement in conventional concrete building. [1] the term "aggregates" refers to inert, granular, and inorganic materials, most commonly composed of solids that resemble stone or stone [11]. Aggregates for a good concrete mix should be robust, clean particles devoid of coatings of clay and other fine impurities that could cause the concrete to deteriorate or absorb pollutants [7]. The majority of the particles in fine aggregates typically pass through a 3/8-inch screen and are composed of either sand or crushed stone [1]. Any particles larger than 4.75 mm are considered coarse aggregates. Crushed stone makes up the majority of the remaining coarse aggregate in concrete, with gravel making up the majority of it [2]. The process of determining the aggregate's particle-size distribution is known as grading. Because these characteristics have an impact on the quantity of aggregate used, the amount of cement and water needed, the workability and durability of concrete, grading limitations and maximum aggregate size are specified [3]. Because it actively engages in the chemical reaction in concrete, water is an essential component reaction with cement and it helps to form the strength giving cement gel [12].

The water is required for preparation of mortar, mixing the amount of water should be enough for complete hydration of cement and to provide workability for the mix [13]. The water used for mixing and curing should be clean and free from injurious quantities (impurities) of sulphate, organic acids, oils, alkalis, salt, sugar, organic materials and other substances that may be deleterious to concrete [3]. Potable water is generously considered satisfactory for mixing. The impurities must be limited to a given volume. Water from questionable sources can be tested to establish the quantity of impurities before use. It has been observed that certain common impurities in water affect the quality of water. Many times, in spite of using best materials – cement, sand and coarse aggregate in cement concrete, required results are not achieved. Most of contractors think that there is something wrong in cement, but they do not consider quality of water being used. Some bad effects of water containing impurities include: According to [1], it was explained that in many specifications, that quality of water is covered by a clause saying that water should be fit for drinking. And it's absolute because drinking water may be unsuitable as mixing water when the water has a high concentration of sodium or potassium and there is a danger of alkali–aggregate.

According to American Society for Testing Materials [4], Pozzolana is a siliceous or a siliceous aluminous material which contains little or no cementitious value, but in finely divided form and in the presence of moisture or water, chemically reacts with calcium of moisture at ordinary temperature to form compound possessing cementitious properties [15]. Such material commonly includes fly ash, Rice husk Ash (RHA), Saw dust ash (SDA), oil palm bunch ash silica (OPBA), cassava waste ash (CWA), coconut husk ash (CHA), corn cob ash (CCA), plantain leaf ash (PLA), and paw-paw leaf ash (PLA). Many researchers are being done on the possible use of locally available materials (pozzolanic materials) to partially replace cement in concrete as cement is widely noted to be most expensive constituents of concrete. [16] have shown that partial replacement of cement by fly ash can also reduce heat of hydration. Use of Pozzolana can also reduce alkali aggregate's reaction. According to [9, 20], cement is composed primarily of silica and lime which form the essential commentary components tricalcium (C_3S) and dicalcium silicate (C_2S). Any alternation in silica content will invariably affect the strength characteristics of cement, which is expected when pozzolanic material is used to partially replace any grades of cement for making concrete [21,22, 23]. Various naturally occurring materials possess, or can be processed to possess pozzolanic properties. Natural Pozzolans are generally derived from volcanic origins as these siliceous materials tend to be reactive if they are cooled rapidly. Available natural Pozzolans include volcanic glass, zeolite trass or tuffs, rice husk ash and diamaceous earth. Artificial pozzolans is made by calcining fire clay and adding lime, sand, and water, with fine brick dust. [18] Artificial pozzolans used today are mostly from by-product materials. Rice is one of the agricultural plants that contain a large amount of silicate especially in the husk. The controlled combustion of rice husk makes the resulting ash highly pozzolanic [19]. A combustion temperature below 800^0C is adequate to provide ash containing silica in amorphous pozzolanic state. The production of one tone of rice paddy generates about 200kg of rice husk, which in turn produces 40kg of ash. Usually, the colour of RHA is light grey to black depending on the burning conditions as shown in plate 1. A state-of-the-art report on RHA was published by [14] that contains a review of physical and chemical characteristics of RHA, the effect of incineration conditions on the pozzolanic properties of the ash, and a summary of the research findings from several countries on the use of RHA as a supplementary cementing material [17].

MATERIALS AND METHODOLOGY

The basic materials used in the course of this research includes; Ordinary Portland Cement, Crushed granite (coarse aggregate 20mm size), Sand (fine aggregate), Pozzolan (Rice Husk Ash (RHA)), Water. These materials were collected from different locations in two states basically Enugu and Ebonyi State. For this research work IBETO brand of ordinary Portland cement (OPC) which is used in general construction and building purpose which conforms to BS 812 (1978) requirement was used. The cement was obtained from Kenyetta market in Enugu state. The fine aggregate (FA) used for this research work was sharp river sand collected from Nyama River here in Enugu State. The fine aggregate conforms to zone 3 of the aggregate zoning chart after being washed, surface dried and sieved. The coarse aggregate used for the work was crushed aggregate obtained from Isiagu in Abakaliki, Ebonyi. The maintained after collection, was sieved, washed and surface dried. The coarse aggregate size was limited to 20mm. Pozzolan (RHA) Used for the course of this research work was obtained from Rice mill in Ani-nri in Enugu State. The Rice husk after collection was burnt in an incinerator at a temperature between 650^0C and 800^0C to produce the rice husk Ash (RHA). After burning and allowing to cool inside the incinerator for about 24 hours, the resultant RHA were taken out and sieved using 600Um sieve to obtain the main RHA to be used for the work.

The large particles retained on the sieve were discarded while those that passed through the sieve were used for the work. A simple form of pozzolanity test was carried out for the RHA to know if the RHA acts as Pozzolana. The water used for mixing and using the concrete was clean, odourless and free from visible impurities. It was sourced from a borehole in Enugu. The various test carried out in the course of this project work, were done in accordance to appropriate [3] BS codes specification such as; determination of particle size distribution for coarse and fine aggregate (sieve analysis). This helps to determine the various zones into which the aggregate fall and to remove materials that fall outside the range of sizes required for the test. Determination of specific gravity of aggregate (fine and coarse) The samples for this test were taken in conformity with clause 5 of part 2 of BS 812:1995. The essence of the relative density is to be able to determine the quantity of cement required for the mix. pozzolanicity test on the RHA obtained to determine whether or otherwise RHA act as pozzolana [5].

DATA ANALYSIS AND RESULTS

Table 1 is the result of sieve analysis of fine aggregates; from the result it can be shown that the finess modulus is 3.13 and it fell within zone 3. Figure 1 is the graph of fine aggregates showing the grading curve.

Table 1 Sieve Analysis result for fine aggregate

Sieve Size	Weight Retained (g)	% Weight Retained (g)	Cumulative % Retained (g)	Cumulative % Passing (g)
9.5mm	0	0	0	100
4.75mm	0	0	0	100
2.36mm	13.5	1.91	1.91	98.09
1.18mm	44.5	6.31	8.22	91.78
600μm	152.5	21.62	29.84	70.16
300μm	340	48.20	78.04	21.96
150μm	124.5	17.65	95.69	4.31
75μm	28.5	4.04	99.73	0.27
Pan	1.9	0.27	–	–
Σ	705.4	100	313.43	

$$\text{Finess Modulus} = \frac{313.43}{100} = 3.13$$

Percentage passing sieve 600μm sieve is 70.16%, the aggregate falls under zone 3.

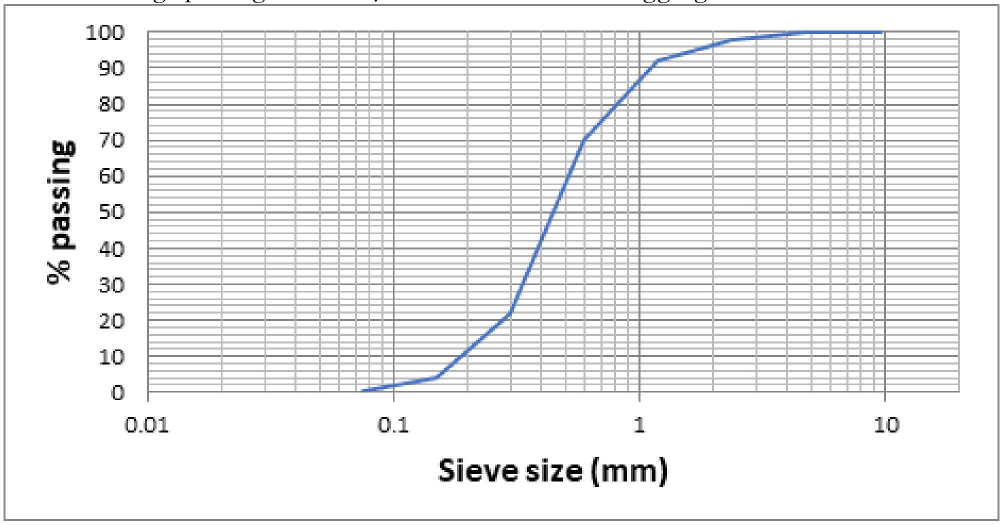

Figure 1. Sieve Analysis Graph (Fine Aggregate)

Table 2 is the result of sieve analysis of coarse aggregates. Figure 2 is the graph of coarse aggregates showing the grading curve.

Table 2 Sieve Analysis for coarse aggregate

Sieve Size	Weight Retained (g)	% Weight Retained (g)	Cumulative % Retained (g)	Cumulative % Passing (g)
40mm	0	0	0	100
20mm	440	22.62	22.62	77.38
9.5mm	1334	68.59	91.21	8.79
4.75mm	171	8.79	100	0
2.36mm	0	0	–	0
Pan	0	0	–	0
Σ	1945	100	213.83	

Figure 2 Sieve Analysis Graph (Coarse Aggregate)

From this result it was observed that the coarse aggregate had 23% content of aggregate size larger than 20mm and 91% content of aggregate size larger than 9.5mm.

Specific Gravity

Specific gravity is a very important parameter in concrete technology as it can be used in various areas such as mix design, and calculation of computation factor during workability measurement. specific gravity of both the coarse and fine aggregate was conducted and the results are shown below.

Specific Gravity Results

$$\text{Weight of Empty Bottle} = \text{A}$$

$$\text{Weight of Empty Bottle} + \text{Sample} = \text{B}$$

$$\text{Weight of Sample} = \text{B} - \text{A} =$$

$$\text{Weight of Bottle} + \text{Sample} + \text{Water} = \text{D}$$

$$\text{Weight of Bottle} + \text{Water} = \text{E}$$

$$\text{Specific Gravity Value} = \frac{\text{C}}{\text{C} - (\text{D} - \text{E})}$$

Specific Gravity Results for Fine Aggregate

Table 3 is the result of specific gravity of fine aggregate, it indicates that the fine aggregates has specific gravity of 2.67 which is according to the recommendation.

Table 3 Specific Gravity Data for Fine Aggregate

Sample ID	Weight (kg) Sample 1	Weight (kg) Sample 2
A	0.460	0.460
B	1.440	1.335
C	0.98	0.875
D	2.220	2.145
E	1.600	1.600

Specific Gravity on SSD Basis

$$\text{Sample 1} = \frac{0.98}{0.98 - (2.220 - 1.600)} = \frac{0.98}{0.36} = 2.722$$

$$\text{Sample 2} = \frac{0.875}{0.875 - (2.145 - 1.600)} = 2.652$$

$$\text{Average} = \frac{2.722 + 2.652}{2} = \frac{5.374}{2}$$

$$\text{S.G} = 2.687$$

Specific Gravity Result for Coarse Aggregate

Table 4 is the result of specific gravity of coarse aggregate, it indicates that the coarse aggregates have specific gravity of 2.77.

Table 4 Specific Gravity Data for Coarse Aggregate

Sample ID	Weight (kg) Sample 1	Weight (kg) Sample 2
A	0.460	0.460
B	1.330	1.350
C	0.87	0.89
D	2.155	2.170
E	1.600	1.60

Specific Gravity on SSD Basis

$$\text{Sample 1} = \frac{0.87}{0.87 - (2.155 - 1.600)} = 2.762$$

$$\text{Sample 2} = \frac{0.89}{0.89 - (2.170 - 1.600)} = 2.78$$

$$\text{Average} = \frac{2.762 + 2.78}{2} = \frac{5.542}{2}$$

$$\text{S.G} = 2.77$$

Pozzolanicity Test

Calculations and Result

Reacting Solution $H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$

Determining of Molar Mass $H_2SO_4 = 2 + 32 + 64 = 98g$

$$Ca(OH)_2 = 40 + (16 + 1) \times 2 = 74g$$

Concentration in mol/dm^3 $= \frac{\textit{Reacting Mass}}{\textit{Molar Mass}}$

Determination of Reacting Mass For H_2SO_4

$$\text{Weight of Beaker} = 103.4\text{g}$$
$$\text{Weight of Beaker} + \text{Acid} = 155.6\text{g}$$
$$\text{Reacting Mass} = (155.6 - 103.4)\text{g} = 52.2\text{g/dm}^3$$

For $Ca(OH)_2$

$$\text{Weight of Beaker} = 103.4\text{g}$$
$$\text{Weight of Beaker} + \text{Base} = 120.8\text{g}$$
$$\text{Reacting Mass} = (120.8 - 103.4)\text{g} = 17.4\text{g}/dm^3$$

Concentration of Acid, H_2SO_4 in mol/dm^3 (Molar Concentration)

$$\text{Molar Concentration} = \frac{\text{Reacting Mass}}{\text{Molar Mass}} \text{ in mol/dm}^3$$
$$\text{Molar Mass of } H_2SO_4 = (2 \times 1) + (32) + (4 \times 16) = 98\text{g}$$
$$\text{Reacting Mass} = 52.2\text{g/dm}^3$$
$$\text{Molar Concentration} = \frac{52.2}{98} = 0.53\text{mol}/dm^3$$

Concentration of Base, $Ca(OH_2)$ in mol/dm^3

$$\text{Molar Concentration} = \frac{\text{Reacting Mass}}{\text{Molar Mass}} \text{ in mol/dm}^3$$
$$\text{Molar Mass of } Ca(OH)_2 = 40 + (16 + 1)_2 = 74\text{g}$$
$$\text{Reacting Mass} = 17.4\text{g}$$
$$\text{Molar Concentration} = \frac{17.4}{74} = 0.24\text{mol/dm}^3$$

For RHA Solution

$$\text{Weight of plate pam} = 40.8\text{g}$$
$$\text{Weight of plate pam} + \text{RHA} = 53.6\text{g}$$
$$\text{Reacting Mass} = (53.6 - 40.8)\text{g} = 12.8\text{g}$$
$$\text{Volume of water used} = 25cm^3$$

Table 5 is the result of the RHA mix showing the values at each interval of titration

Table 5 Experiment Timing Table for Rha Mix

	30 minutes		**60 minutes**		**90 minutes**		**120 minutes**	
	1st titration	**2nd titration**	**1st titration**	**2nd titration**	**1st titration**	**2nd titration**	**1st titration**	**2nd titrati**
Final burette reading (cm^3)	21.4	12.5	11.3	23.40	5.20	5.20	43.8	48.0
Initial burette reading	10.5	1.00	0.8	13.0	0.00	0.00	38.5	43.8
Volume of acid used (cm^3)	10.9	11.50	10.50	10.40	5.20	5.20	5.30	4.20
Average	11.2cm^3		10.45cm^3		5.20cm^3		4.75cm^3	

Determination of the Concentration of the Mixture

$$\frac{C_AV_A}{C_BV_B} = \frac{nA}{nB}$$

Where
C_A = concentration of Acid
C_B = concentration of Base
V_A = volume of Acid
V_B = volume of Base
nA = number of moles of Acid
nB = number of moles of Base
For 30 minutes

$C_A = 0.533 mol/dm^3$, $C_B = ?$

$V_A = 11.2 cm^3$, $V_B = 25 cm^3$

$nA = 1$, $nB = 1$

$$C_B = \frac{C_A V_A nB}{V_B nA} = \frac{0.533 \times 11.2 \times 1}{25 \times 1} = 0.239 mol/dm^3$$

For 60 minutes

$V_A = 10.45 cm^3$

$$C_B = \frac{0.533 \times 10.45 \times 1}{25 \times 1} = 0.22 mol/dm^3$$

For 90 minutes

$V_A = 5.20 cm^3$

$$C_B = \frac{0.533 \times 5.20 \times 1}{25 \times 1} = 0.11 mol/dm^3$$

For 120 minutes

$V_A = 7.45 cm^3$

$$C_B = \frac{0.533 \times 4.75 \times 1}{25 \times 1} = 0.10 mol/dm^3$$

The titre values were reduced with time and fixing more of calcium hydroxide in the mixture. The alkalinity content of the mixture was reduced with increase in time thereby confirming the pozzolanicity of the Rice Husk Ash (RHA).

Plate 1: Burnt pozzalanic (Source: 21)

Mix Design, Casting and Curing

Mix design involves the calculation of various materials needed to produce a given volume of concrete. In this research, 3 cubes of dimensions 150mm x 150mm x 150mm were used in other to produce a good concrete. A consideration of the design is therefore necessary in order to come up with the appropriate mix in accordance with [6]. The concrete was produced with each zone. Several concrete mixes were designed using specific characteristic concrete strength of $30N/mm^2$, standard deviation of $6N/mm^2$ and slump ranges of 30-60mm. the mix design was done manually and confirmed with the acid of scale 149 software. mix proportion designed to be a normal strength concrete which will attain $30N/mm^2$ strength after crushing. A constant water/cement ratio of 0.57 was used throughout the mix and the batching was by weight. Five samples of 150mm x 300mm cylinder each were casted. The mix 1 was cast with cement only [100% OPC] which serves as the control mix, then sample another two mix was casted with some percentage replacement of 30% and 40% of cement with RHA respectively. Table 5 is the sample summary of the properties mixed.

Table 5: Sample summary of properties

Mix	Cement (kg/m^3)	RHA (kg/m^3)	Water (kg/m^3)	Fine (kg/m^3)	Coarse (kg/m^3)	Slump (mm)	% RHA	W/C Ratio
1	62.14	0	35.23	125.21	231.88	35	0	0.57
2	43.50	18.64	35.23	125.21	231.88	20	30	0.57
3	37.28	24.86	35.23	125.21	231.88	20	40	0.57

As a result of rate of hydration of concrete made with RHA, adjustment was made particularly on water on mix 2, and 3 to obtain a normal slump range (Workability) [2]. Here, the constituent of the concrete were measure in correct proportion by weight before the mixing of the concrete constituent together. For the course of this project, manual mixing was used throughout the mixing in each percentage replacement. The aggregate (coarse and fine) and cement were first mixed until a homogenous mix was achieved before water was added. Total of 60 pieces cylinder concrete of 150mm x 300mm was casted. The slump test was carried out on each mix in order to check the workability of the concrete (fresh concrete) as shown in plate 2. The test was performed in accordance with [5] Capping was done on the casted sample after 3 hours of casting for the smoothness of the surface using water/cement ratio of 0.3. The curing of the samples was done in the methods: By the use of curing tank (immersion in water), Damp curing (Wet covering). The samples were water-cured for 7,14,21,28 and 56 days.

Plate 2: Slump test (Source: 21)

Compressive Strength

The three specimens of the samples (each set labelled by date of the cast, mix number, group number and mould number) were air-dried, weighed and placed in the crushing machine at the end of each curing age. Once the sample is air-dried, it will be crushed to obtain the crushing load of the sample as can be seen in plate 3. Three samples were crushed for each curing age for each mix. A strength test will be used after curing for 56 days for durability studies on the concrete.

Plate 3. Crushing machine (Source: 21)

Compressive Strength Test Results

Table 6 is the summary of the mean strength of compressive strength at the different crushing ages. Figures 3 and 4 show the graph and the bar chart of mean strength Vs age at crushing for 0%, 30 & 40% RHA replacement.

Table 6: Summary of Mean Strength (for 0%, 30% & 40% replacements) @ Age of Crushing for the 5 Mix Proportions

% RHA	Mean Strength at Age of Crushing (N/mm^2)				
	7 days	14 days	21 days	28 days	56 days
0	16.74	22.34	24.55	29.51	32.30
30	13.69	20.56	21.33	22.88	27.99
40	11.36	13.79	15.46	18.19	21.10

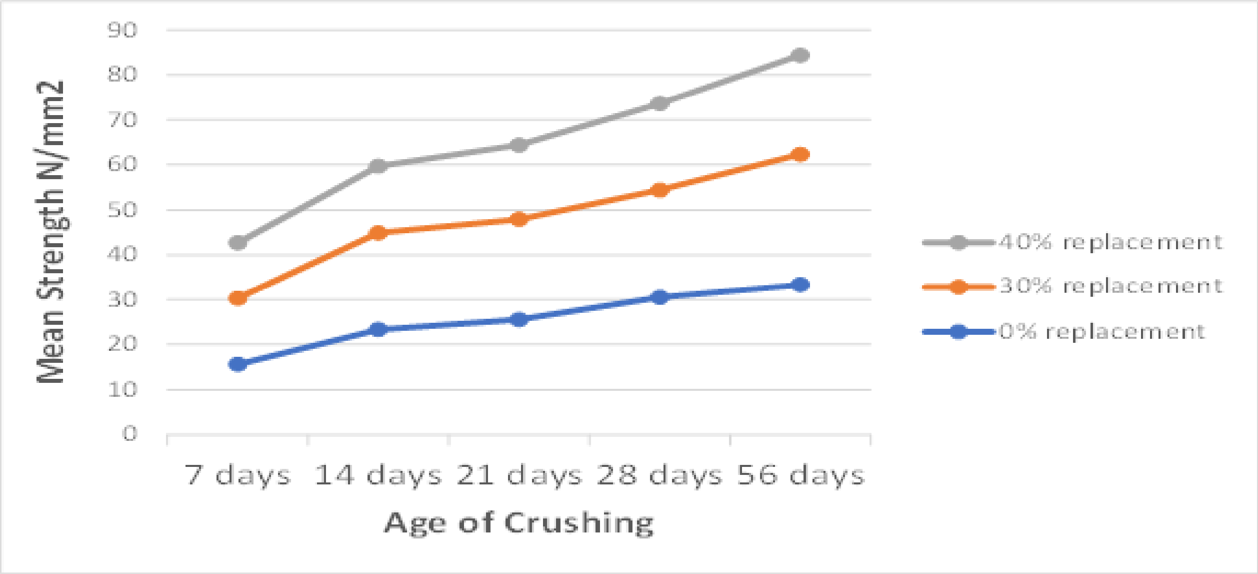

Figure 3: Mean Strength Vs Age at Crushing for 0% - 40% Replacement.

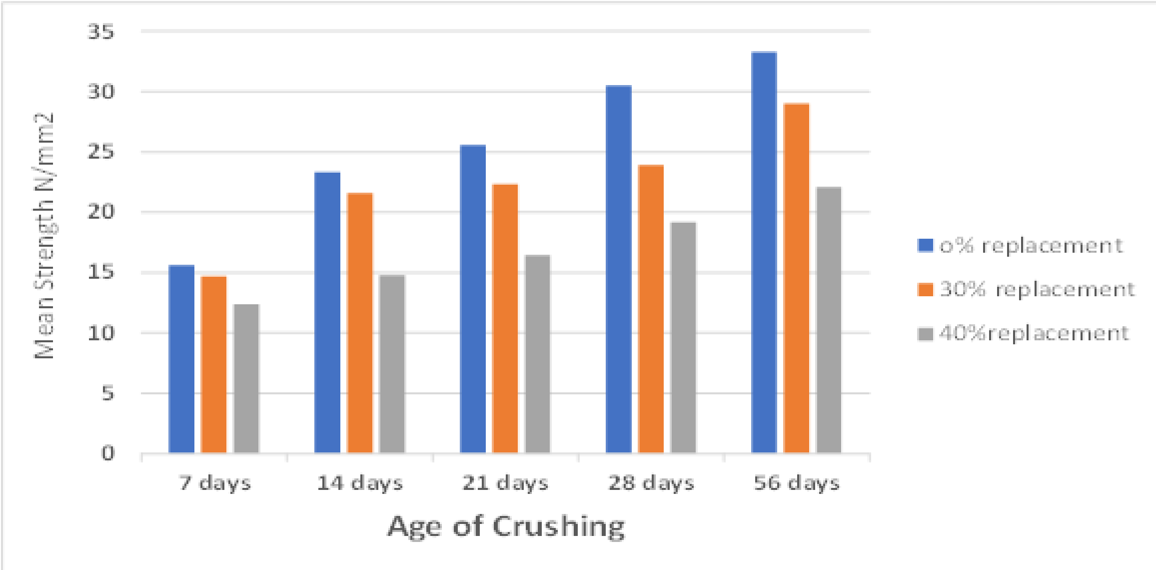

Figure 4: Group Bar Chart for Mean Strength Vs. Age at Crushing for 0% - 40% Replacement

DISCUSSION OF RESULTS

The particle size analysis showed that Rice Husk Ash (RHA) is coarser than Ordinary Portland Cement, the reason been that the ashes were not ground to finer particles. Therefore, the compressive strength values obtained with them can still be improved upon when the ashes are ground to finer particles [4,24]. The pozzolanicity test confirmed the ash as a pozzolana since it fixed some quantities of lime over time, thereby reducing the alkalinity of the calcium hydroxide-ash mixture as reflected in the smaller titre value over time compared to the blank titre. The variation of the compressive strength and mean strength of OPC – RHA blended cement composites with percentage RHA are shows that the compressive strength values of the OPC – RHA blended cement composites are higher than the control at 7 days of curing. All other replacement percentages were lower than the control at first, but they increased to become comparable to the control values at 56 days. This demonstrates that the compressive strength of the concrete increases as the curing age of the OPC-RHA mixed cement grows. The OPC-RHA blended cement will have an even greater compressive strength than the control after an extended curing period of approximately ninety days. These results imply that replacement of OPC with 30% and 40% could be appropriate for typical reinforced concrete works, provided that the concreting process was of high quality.

CONCLUSION AND RECOMMENDATION

The following conclusion may be drawn from the findings of this study on the strength properties of concrete prepared using Ordinary Portland Cement and Rice Husk Ash (RHA) pozzolanic cement: Rice husk was once discarded as waste after rice production and was thought to be a pollutant to the environment. However, due to its enrichment with silica above 75%, it is now proven to be helpful in the building sector and may be used as an additive and super-pozzalan. Materials classified as super-pozzalan have a silica concentration of more than 75%. RHA typically has a higher ash content—roughly 25%. The ash has a high porosity, is light, and contains between 90 and 93 percent silica. This indicates that RHA concrete requires more water. In general, the compressive strength rises with the length of the curing period and falls with the amount of RHA added. The pore structure of concrete is altered when RHA is added to the cement content. Fine and discontinuous pores are formed, and the combination of RHA and hydration products blocks the pores, increasing the concrete's durability. RHA is advised for use because it increases the compressive strength of concrete after a prolonged curing period. Additionally, results have shown that RHA improves the properties of concrete mixes by improving their resistance to acidic attack and reducing the penetration of chloride, both of which can extend the life of concrete, particularly in marine environments. Rice Husk It is also advised to utilize ash to make lightweight concrete mixes and building blocks, which are helpful in the construction of tall buildings since they are lighter when a portion of the cement in the concrete mix is replaced with ash.

Contribution to knowledge

This study explores the impact of rice husk ash (RHA) content on concrete strength, providing insights for optimal blending ratios, performance evaluation, and sustainability considerations. Emerging trends like AI, machine learning, and IoT sensors are also discussed.

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