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An Empirical Study of Sustainable Construction Methods using Expanded Polystyrene and Rice Husk Ash Concrete.

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ABSTRACT

Concrete is widely used in construction and has been found to have a significant environmental impact. This is mostly owing to its substantial carbon footprint and emissions, which can be linked to the energy-intensive manufacturing of Lime Stone Cement (LSC). This research investigates the feasibility of using expanded polystyrene (EPS) and rice husk ash (RHA) as sustainable construction materials. These materials are natural and environmentally friendly and can be partially substituted for traditional components in concrete mixtures, as EPS and RHA are two different types of agriculture and industrial waste materials. While Polystyrene, is widely used in packaging and insulation applications, is derived from petrochemical sources and commonly becomes trash after its utilization. Rice husk ash (RHA), is a byproduct of rice milling, is a readily accessible agricultural waste material that is frequently neglected in numerous places. Both materials offer opportunities for recycling and contributing to sustainable construction methods by reducing the environmental impact of their disposal. This study investigates how bio composite waste affects concrete's functionality, compressive strength, and water absorption characteristics. The compressive strength data obtained demonstrates a distinct pattern, wherein the concrete mixture containing 5% EPS and 5% RHA has the greatest strength, measuring 37.46 N/mm². A decline in the compressive strength was observed as the proportion of RHA and EPS increases, highlighting the inherent trade-off between sustainability and structural integrity. The assessment of workability in concrete placement is of utmost importance, and it was conducted using the slump test. The slump heights at 5-15% EPS ranged from 80-62mm, while at 20% EPS, the workability decreased to 62mm. A review was conducted to assess the durability of the concrete in terms of its ability to absorb water. The findings indicated that as the amount of EPS increases, the water absorption values exceed those of conventional concrete samples. This study establishes a significant basis for the use of RHA and EPS in the production of concrete, presenting an environmentally conscious approach towards promoting sustainable construction methods.

KEYWORDS: Ash, polystyrene, construction, agro-waste, concrete, Strength

INTRODUCTION

The construction industry stands as a cornerstone of modern society, providing the infrastructure and buildings upon which our lives depend. However, this industry has long faced the challenge of balancing the growing demand for construction materials with the imperative to reduce its environmental footprint. The aggressive consumption of resources and energy in the production of concrete, primarily due to the reliance on Ordinary Portland Cement (OPC), has spurred a quest for sustainable alternatives that can mitigate the environmental impact of this critical construction material.

Concrete is celebrated for its structural versatility and durability, but its production accounts for a substantial share of global carbon emissions. This environmental dilemma has catalyzed research endeavors that explore alternative materials to replace or supplement the conventional components of concrete. Notably, rice husk ash (RHA) and expanded polystyrene (EPS) have emerged as promising candidates for partial replacement of cement and coarse aggregate, respectively.

RHA, a byproduct of rice milling, is abundant and often underutilized, making it an attractive resource for sustainable construction practices. It is rich in amorphous silica and possesses pozzolanic properties, which can contribute to the strength and durability of concrete. Furthermore, EPS, a lightweight, thermoplastic material with well-established insulation properties, has shown potential in enhancing the thermal performance of concrete while reducing its weight.

This study delves into the effects of incorporating RHA and EPS as partial replacements for cement and coarse aggregate in concrete. It scrutinizes three crucial aspects of concrete performance: compressive strength, workability, and water absorption. Through rigorous testing and analysis, we aim to shed light on the trade-offs between sustainability and structural integrity, the influence of varying percentages of RHA and EPS on workability, and the implications for water resistance in RHA-EPS concrete.

As the global construction industry continues its shift towards more eco-conscious and sustainable practices, the findings of this research offer valuable insights into the potential of RHA and EPS to revolutionize the way concrete is produced. Striking a balance between sustainability and structural performance is imperative in this endeavor, and the outcomes of this study provide guidance for future efforts to foster greener construction practices and meet the demands of a rapidly evolving world.

In the subsequent sections of this research, we will present the results, discuss their implications, and offer recommendations for optimizing the use of RHA and EPS in concrete, further contributing to the growing body of knowledge on sustainable construction materials and practices.

[1] concluded that RHA is a super pozzolan material that may be applied to civil engineering projects. From the findings of [2], if RHA grains are ground to a certain degree, they can be used as a partial substitute for cement with a content of up to 70% without weakening the mortar after three and twenty-eight days.

Research conducted by [3] revealed that approximately one-fifth of the 300 million metric tons of rice produced annually comprises rice husk, an agricultural waste. They concluded that to address the environmental issues caused by this waste, attempts are being made to burn the rice husk at a regulated temperature and use the ash as a substitute cement. RHA has a high content of amorphous silica, which is required for the effective addicting reaction in cement as contained in the study of [4] and RHA has been found to contain impurities that reduce concrete's compressive strength. However, when rice husk is treated with hydrochloric (HCL) acid before it is burnt, it improves the compressive strength of concrete when partially replaced with cement.

[5] looked into how RHA variability affected the characteristics of the road subgrade. RHA was collected for their study from the states of Enugu, Ebonyi, and Cross River. The results showed that the highest concentration of silica (84.55%) was found in RHA from Ogoja, Cross River State. The next highest concentrations were found in RHA from Ebonyi and Enugu States, at 76.30% and 70.12%, respectively. They came to the conclusion that the soil type, temperature at which the rice was burned, and type of rice were the causes of the variability. When compared to the weak soil samples, they found that the RHA-Cement stabilized soil had a higher California Bearing Ratio (CBR). Furthermore, as demonstrated by the investigation's use of a variety of RHA specimens, the impact of RHA on the subgrade's geotechnical characteristics may be substantially influenced by its distinct chemical characteristics, particularly its silica concentration [6].

In the study by [7], the topic of expanded polystyrene (EPS) use in construction is covered. It draws attention to how EPS might improve building design and structural integrity. The consensus was that expanded polystyrene (EPS) is a well-known insulating material that is used in refilling, LWC, decorative molding, and panel applications for buildings, amongst other applications.

Applications for EPS encompass a wide range of materials, both flammable and non-flammable. EPS foam is lightweight but stiff, with great impact resistance, low weight load bearing capacity, full water and vapor barrier, airtightness for controlled conditions, extended lifespan, low maintenance, and easy, quick assembly. The benefits and feasibility of employing expanded polystyrene (EPS) as an insulator during the building design process that satisfies all insulation requirements, including fire safety, are illustrated in this article. Flame retardant grade EPS is necessary to address the flammability and flame spread on the surface of EPS products and to comply with fire safety rules. Consequently, EPS is combined with other fire-resistant materials in building design [8] and [9].

[10] investigated how the mechanical properties of concrete were affected when aggregate was substituted with polystyrene grains. 10% cement was swapped out for fly ash in the concrete composition. Mineral aggregates and cement are combined to make lightweight concrete. Creating lightweight flooring, walls with better thermal behavior, lightweight prefabricated parts, and other related advantages that can enhance construction characteristics and alter current concrete working techniques are just a few of the numerous advantages of using lightweight concrete.

[11] investigated how Expanded Polystyrene Beads (EPS) affected the mechanical characteristics of concrete. The results and analysis of the investigation showed that, although the tensile strength fluctuated (was not consistent), the workability, compressive strength, and flexural strength all reduced as the volume of EPS incorporated rose. It is clear from this that concrete that has expanded polystyrene instead of some of the coarse particles is weak and ought to be limited to low-strength structural elements, or elements that require little strength. The best applications for this kind of polystyrene-based concrete are non-structural components that don't need to have strong flexural and compressive strengths. There are many advantages to using EPS concrete due to its low density and thermal insulation. Investigating novel concrete materials and analyzing contemporary structural materials is therefore crucial for practical engineering [12]. Since the frame of the building will support both the dead and live loads, lightweight concrete made with expanded polystyrene beads can be utilized for concrete walls in frame constructions. Among many other advantages, this lowers costs, improves thermal insulation, and decreases the dead load—or weight—entering and exiting the structure.

Pozzolans are a distinct class of refractory materials, according to [13]. They are found naturally and are made up of extremely thin siliceous and aluminous material particles that react with lime (Ca(OH)2) in the presence of water to generate cementitious materials. The degree of reactivity of the finely dispersed pozzolan with lime and water is used to quantify the amount of pozzolanic activity. The very tiny silica or alumina particle size is the primary cause of the reaction. Portland cement typically has pozzolans added to it to raise its quality.

According to the study [14], the pozzolanic reaction of lime and silica in the presence of water forms calcium silicate hydrate (C-S-H), which is responsible for the quality enhancement. This fills up the pores in the cement, which lowers the number density of accessible pores, which lowers the permeability of the binder within the pores and lessens its interaction with the structural components. Lowering the binder permeability in pores lessens the amount of toxic ions like carbonates and chloride that are incorporated, which lessens the degree of corrosion. Because of this and the material's use of lime, sulfate attack is avoided. This activity is important because it prolongs the life of concrete structures by reducing iron corrosion in concrete mixtures.

According to [15], pozzolan reactivity is mostly determined by amorphousness, more so than by any other pozzolan feature. It also comes to the conclusion that the pozzolan's particular surface area controls the paste's water need, whilst its amorphousness controls the paste's strength. On the other hand, neither pozzolan strength nor reactivity are significantly impacted by the chemical makeup of the pozzolan [16].

[17] talked about the possible use of polymers based on pozzolanic acid to immobilize the concentration of soil polluted with heavy metals. Soil stabilization/solidification appears to be the most effective method for improving soft clay and other types of soil as well as cleaning up polluted soil. Pozzolanic materials are utilized to contain contaminants within a monolithic matrix and solidify them.

According to [18], the primary methods used by geopolymers to solidify heavy metals are chemical bonding and physical encapsulation. Furthermore, the pore size distribution and pore structure are altered by these pozzolanic reaction products that fill the pores. This thus reduces the binder's permeability. Alkali polysilicates and alumino-silicate oxides can also be polymerized to create Si-O-Al bonds. Then, it might be used to the geopolymer manufacturing process. The two primary constituents of geopolymer binder are alkali liquids and source materials. Usually, potassium or sodium solutions make up the alkali liquids. Byproducts or geologically formed materials with high silicon (Si) and aluminum content include clays, fly ash, metakaolin, slag bottom ash, and rice husk ash [19]. Thus, compared to traditional Portland cement, geopolymer is a more environmentally friendly binding material due to its reduced greenhouse gas output.

The density of the former is lower than the density of the latter, according to a study [20] on the properties of RHA concrete that uses periwinkle shell (PS) as coarse aggregate in partial replacement of granite. Additionally, the study demonstrated that when the periwinkle shell PS content increased, the compressive strength and split tensile test results declined. Beyond the financial benefits of swapping out traditional parts, a concrete mix with 30% PS and 20% RHA after 90 days has a minimum strength of 20N/mm^2.

II. MATERIALS AND METHODOLOGY

Expanded Polystyrene, or EPS (often referred to as cork in colloquial language), is extracted from various electronic packaging and physically broken into 6–15 mm granules. This is going to replace some of the coarse aggregate. The RHA sample was supplied through the rice mill located in Obubra, Cross River State, Nigeria. Fig. 1 shows the location of the rice mill. The finished product of the rice husk was air dried to produce rice husk ash (RHA).

OPC was acquired from the Lafarge cement factory located in the Nigerian state of Cross River, in the Akamkpa Local Government Area. For the experiment, coarse gravel with a size range of 15 to 22 mm will be obtained from a quarry owned by Faith Plant International Limited located in Akamkpa, Nigeria. For this investigation, naturally occurring fine aggregate from the Marina River will be used. In addition, this will sieve to make sure the sand is free of organic matter and to identify the grade zone for mix design purposes. Portable water that complied with the requirements set forth for water used in concrete mixtures was utilized for mixing and curing the concrete.

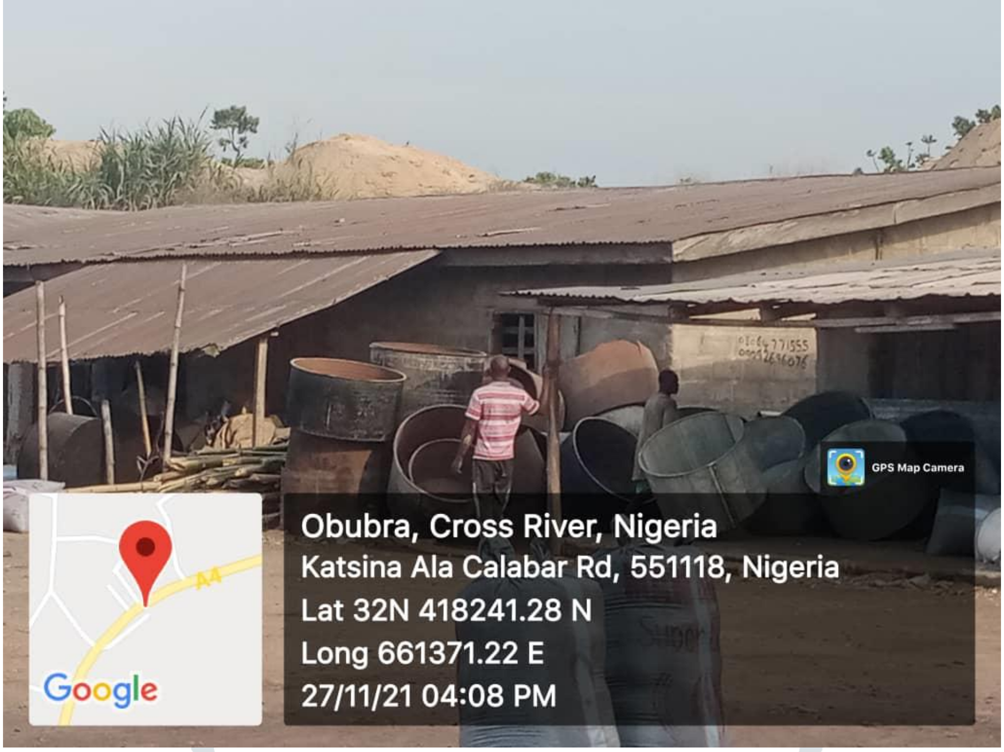

Fig 1: Rice Mill Location in Obubra, Cross River State, Nigeria

The first set of procedures included material preparation, material characterization, aggregate grading, material characterization, and concrete sample fabrication based on the calculated mixture proportions.

With the exception of using RHA and EPS in certain amounts to partially replace OPC and coarse aggregate, respectively, the process for making RHA-Polystyrene concrete was carried out just like regular concrete manufacture. For this study, a 1:2:4 concrete mix ratio was used. To account for OPC and RHA, the binder part of the concrete mix ratio was divided. For all samples, the RHA was kept at 20% partial replacement for OPC. In order to accept granite and EPS at partial replacement levels of 5, 10, 15, and 20%, the coarse aggregate fraction was also divided. Using a calibrated container, the volume of these percentages was determined. Five (5) separate batches of concrete total—normal concrete with 100% OPC was also created to act as the baseline for comparison.

The percentage of water absorption, compressive strength, and adaptability of the concrete were tested. Slump tests were performed on new batches of test and normal concrete in compliance with BS EN 12350-2:2009 to verify workability. After the freshly mixed concrete solidified, it was taken out of the molds and weighed to find the percentage of water absorption. It was then placed in a curing tank. To get an average value, 12 cubes were made from each batch of concrete, three for each of the four curing ages. The duration of the treatments was 7, 14, 21, and 28 days. Concrete is put through water absorption tests as a durability check to evaluate if it is susceptible to corrosion and deterioration from water or other harmful elements. It is the variation in the wet and dry weights of the concrete cubes just before and immediately following their curing.

Many people believe that the compressive strength of concrete is its most important feature. Testing for compressive strength is a helpful method for determining a material's response to a compression force. In 100 x 100 x 100 mm molds, three duplicate samples of concrete were made for each of the twelve (12) mix ratios.

Before applying layers of freshly mixed concrete, each around 50 mm thick, the interiors of the molds were thoroughly cleaned and lubricated. Each layer was crushed 35 times using a tamping rod that was 16 mm in diameter, 60 cm in length, and had a bullet tip at the bottom. The top surface of the concrete was always smoothed with a trowel before allowing it to set. After a day, the concrete samples were demolded and cured in a water bath. A Universal Testing Machine (UTM) was then used to assess the samples' compressive strength at 7, 14, 21, and 28 days. Each sample was added gradually at a rate of 140 kg/cm3 per minute until it failed. The following formula was used to determine each cube sample's compressive strength:

Strength of compression (kN/mm^2) Fcu = Wf / Ap

where Ap is the cube mold's cross-sectional area (mm^2) and Wf is the maximum applied load (N).

III RESULTS AND DISCUSSION

The following are the mixtures' laboratory results.

WORKABILTY

The results of the slump tests are shown in the Table 1 below:

Table 1: Results of Slump test showing varying percentages of OPC/RHA and GRANITE/EPS

S/No	W/C RATIO	% OPC	% RHA	% SAND	% GRANITE	% EPS	SLUMP(mm)
1	0.45	100	0	100	100	0	96
2	0.45	95	5	100	95	5	85
3	0.5	90	10	100	90	10	78
4	0.6	85	15	100	85	15	70
5	0.6	80	20	100	80	20	62

The results of the slump test indicate that there was a little 11mm variation in slump height between the first test value (95% OPC, 5% RHA, 5% EPS) and the control value (0% RHA, 0% EPS). Concrete has a stiffening effect when the degree of partial replacement of OPC and granite with RHA and EPS, respectively, increases with a steady increase in EPS content. Table 4.1's slump findings demonstrate that workability is high, with 5–15% EPS and a slump range of 85–70mm. Additionally, there is little workability for 20% EPS with a 62mm height. These demonstrate that a progressive increase in RHA and EPS increases the workability of RHA-Polystyrene concrete. A chart illustrating the difference in RHA-EPS concrete workability for various mix batches is presented in Figure 2.

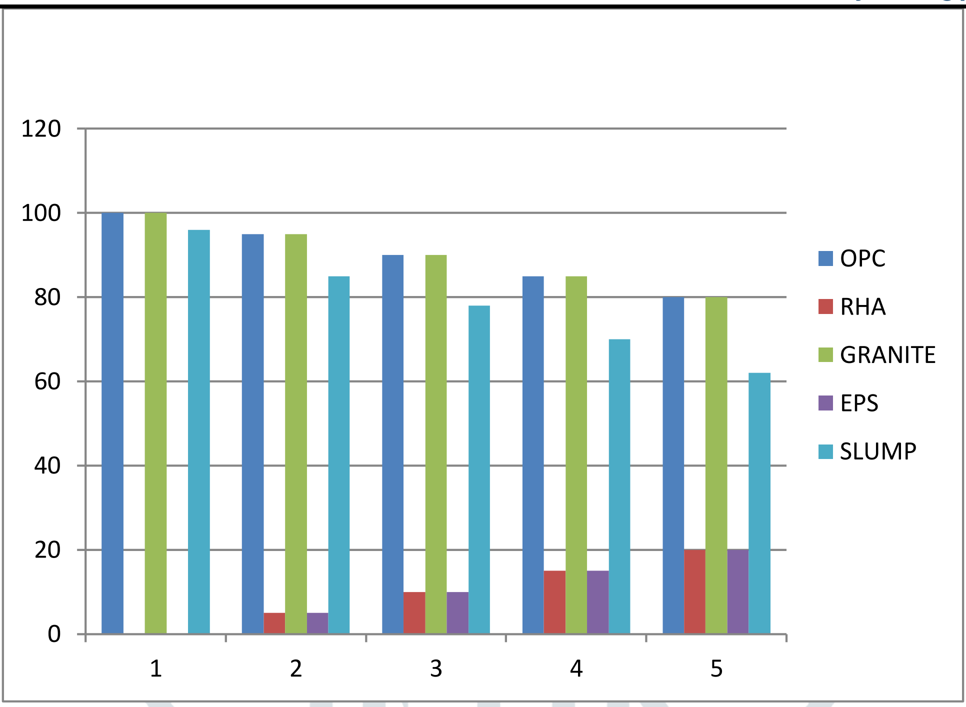

Fig 2: *Chart of Variation of RHA-EPS Concrete Workability*

WATER ABSORPTION TEST

The results of the water absorption test are as shown from table 2-6. Moisture absorption is a critical property in determining the durability and susceptibility of concrete to environmental conditions. 0.36% was obtained for 0% RHA, 0% EPS - Control Mix and this value serves as the baseline for moisture absorption. The low moisture absorption indicates that the conventional concrete mix without RHA and EPS has relatively good resistance to moisture penetration. 0.94% was obtained for 5% RHA and 5% EPS mix. The increase in moisture absorption compared to the control mix suggests that the inclusion of 5% RHA and 5% EPS has a notable impact on the moisture absorption characteristics of the concrete. This increase could be attributed to the porous nature of both RHA and EPS, which might allow more water absorption. 1.09% was obtained for 10% RHA and 10% EPS mix. This further increase in moisture absorption at this mixture indicates that the inclusion of 10% EPS contributes to higher moisture absorption. The lightweight nature of EPS might result in additional voids within the concrete, providing pathways for water ingress. 1.17% obtained at 15% RHA, 15% EPS mix shows the additional increase in moisture absorption at this mixture suggests that, beyond a certain point, the lightweight nature of EPS starts to dominate over the positive effects introduced by RHA in terms of reducing moisture absorption. 1.28% obtained at 20% RHA, 20% EPS mix shows the moisture absorption at this mixture suggests a further increase which emphasizes the need for careful consideration of the proportions of RHA and EPS to achieve a balance between moisture resistance and the desired properties introduced by these materials. The graph of durability base on water absorption is shown in fig. 3 which indicates decreased durability with increase in EPS percentages.

Table 2: Results of moisture absorption test with 0% RHA and 0% EPS

Curing Age	wet weight(g)	dry weight(g)	Avg dry weight(g)	Moisture absorption (%)	Avg Moisture absorption (%)
7 days	2822	2791	2798	0.31	0.28
	2801	2774		0.27	
	2855	2830		0.25	
14 days	2657	2613	2728	0.44	0.37
	2801	2782		0.19	
	2837	2789		0.48	
21 days	2848	2810	2773	0.38	0.43
	2781	2723		0.58	
	2817	2785		0.32	
28 days	2801	2759	2787	0.42	0.36
	2821	2792		0.29	
	2846	2810		0.36	

Table 3: Results of moisture absorption test with 5% RHA and 5% EPS

Curing Age	wet weight(g)	dry weight(g)	Avg dry weight(g)	Moisture absorption(%)	Avg Moisture absorption (%)
7 days	2581	2540	2536	0.41	0.47
	2678	2633		0.45	
	2489	2434		0.55	
14 days	2469	2401	2468	0.68	0.62
	2523	2465		0.58	
	2596	2537		0.59	
21 days	2407	2320	2442	0.87	0.85
	2694	2605		0.89	
	2481	2402		0.79	
28 days	2626	2530	2563	0.96	0.94
	2697	2609		0.88	
	2648	2550		0.98	

Table 4: Results of moisture absorption test with 10% RHA and 10% EPS

Curing Age	wet weight(g)	dry weight(g)	Avg dry weight(g)	Moisture absorption(%)	Avg Moisture absorption (%)
7 days	2528	2440	2467	0.88	0.81
	2551	2484		0.67	
	2563	2476		0.87	
14 days	2401	2302	2278	0.99	0.95
	2332	2235		0.97	
	2386	2297		0.89	
21 days	2411	2306	2343	1.05	0.99
	2481	2357		1.24	

	2432	2365		0.67	
28 days	2510	2408	2423	1.02	1.09
	2537	2428		1.09	
	2548	2432		1.16	

Table 5: Results of moisture absorption test with 15% RHA and 15% EPS

Curing Age	wet weight(g)	dry weight(g)	Avg dry weight(g)	Moisture absorption(%)	Avg Moisture absorption (%)
7 days	2385	2280	2287	1.05	0.97
	2441	2365		0.76	
	2328	2217		1.11	
14 days	2306	2214	2266	0.92	0.99
	2413	2289		1.24	
	2378	2296		0.82	
21 days	2388	2285	2217	1.03	1.12
	2453	2341		1.12	
	2147	2026		1.21	
28 days	2513	2409	2340	1.04	1.17
	2441	2295		1.46	
	2417	2315		1.02	

Table 6: Results of moisture absorption test with 20% RHA and 20% EPS

Curing Age	wet weight(g)	dry weight(g)	Avg dry weight(g)	Moisture absorption(%)	Avg Moisture absorption (%)
7 days	2296	2195	2226	1.01	1.02
	2351	2296		0.55	
	2338	2187		1.51	
14 days	2321	2212	2203	1.09	1.14
	2323	2192		1.31	
	2307	2204		1.03	
21 days	2233	2126	2133	1.07	1.06
	2197	2096		1.01	
	2289	2178		1.11	
28 days	2119	2016	1998	1.03	1.28
	2154	1991		1.63	
	2103	1986		1.17	

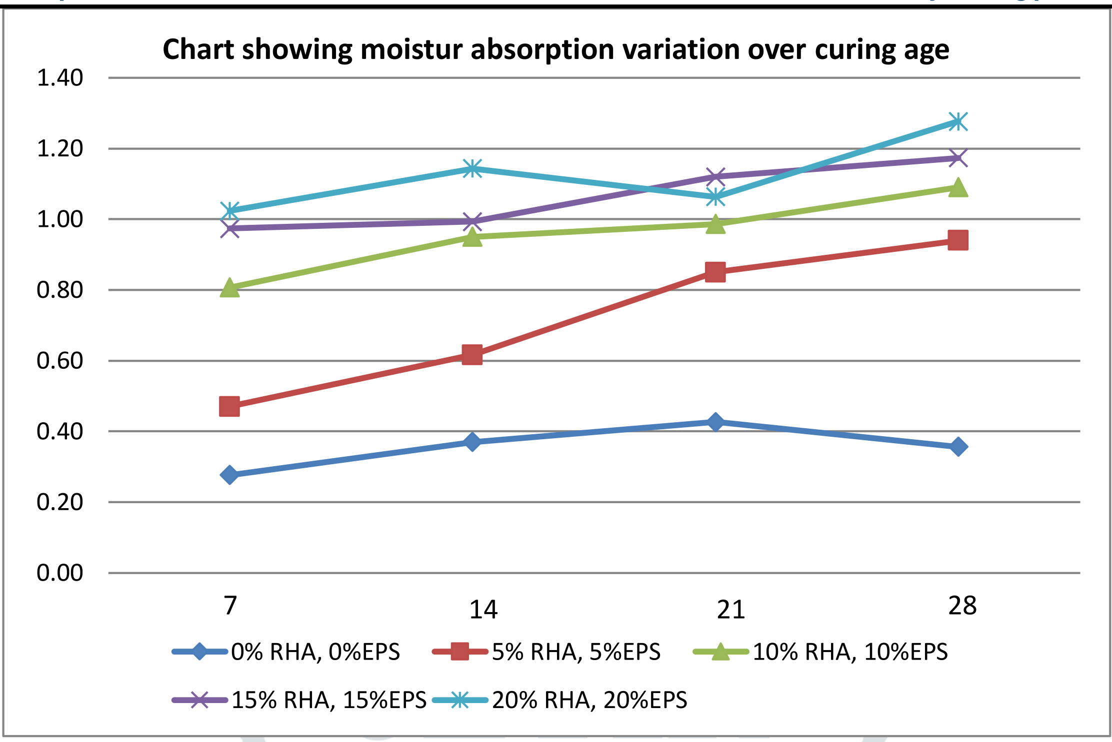

Fig 3: *Graph of Durability Base on Water Absorption*

COMPRESSIVE STRENGTH

One of the many important parameters that is altered by the addition of RHA and EPS is the concrete's compressive strength. The concrete's mechanical qualities are significantly impacted, as evidenced by the observed fall in compressive strength as the amount of RHA increases. Compressive strength increased by 37.46 kN/mm^2 in comparison to the control mix, indicating that adding 5% RHA and 5% EPS had a positive impact. Even if RHA's pozzolanic reaction aids in the development of strength, it may be sufficient to offset the reduction brought on by EPS's low weight. Generally speaking, the density of concrete has an inverse relationship with its compressive strength. Concrete's compressive strength is affected when lightweight components like EPS are added since they lower the material's overall density. The control mix's reduction in compressive strength suggests that 10% RHA and 10% EPS have a considerable effect. Because EPS is lightweight, the concrete's overall density is decreased, which lowers the concrete's compressive strength. This emphasizes the trade-off between preserving higher compressive strength and obtaining lower density (taking use of EPS's lightweight characteristic). The further decrease in compressive strength of 27.41 kN/mm^2 at 15% RHA and 15% EPS implies that, after a given amount of time, the pozzolanic reaction of RHA may not be as important due to EPS's lightweight nature. It suggests that in order to obtain the required strength properties, RHA and EPS must be carefully balanced. The findings of the compressive strength tests performed on the various batches of RHA-Polystyrene concrete mixes are displayed in Tables 7 through 11. Figure 4 displays the chart that illustrates how the compressive strength of RHA-Polysterne concrete changes with curing age.

Table 7: Results of compressive strength of control mixture

	crushing load(kN)	crushing load(kN)	fcu (N/mm^2)	Avg fcu (N/mm^2)
7 days	167.82	164.1567	16.782	16.42
	165.91		16.591	
	158.74		15.874	
14 days	213.87	223.6433	21.387	22.36
	226.21		22.621	
	230.85		23.085	
21 days	302.63	310.4767	30.263	31.05
	310.44		31.044	
	318.36		31.836	
28 days	334.12	357.69	33.412	35.77
	355.91		35.591	
	383.04		38.304	

Table 8: Results of compressive strength with 5% RHA and 5% EPS

	crushing load(kN)	Av crushing load(kN)	fcu (kN/mm^2)	Avg fcu (kN/mm^2)
7 days	182.92	183.82	18.29	18.38
	183.07		18.31	
	185.46		18.55	
14 days	253.16	251.67	25.32	25.17
	272.47		27.25	
	229.38		22.94	
21 days	307.34	312.7667	30.73	31.28
	311.32		31.13	
	319.64		31.96	
28 days	362.72	374.6433	36.27	37.46
	382.47		38.25	
	378.74		37.87	

Table 9: Results of compressive strength with 10% RHA and 10% EPS

	crushing load(kN)	Av crushing load(kN)	fcu (kN/mm^2)	Avg fcu (kN/mm^2)
7 days	164.88	163.85	16.49	16.39
	161.37		16.14	
	165.31		16.53	
14 days	214.73	219.1533	21.47	21.92
	212.84		21.28	
	229.89		22.99	
21 days	291.96	305.4933	29.20	30.55
	305.85		30.59	
	318.67		31.87	

28 days	336.84	343.7067	33.68	34.37
	341.97		34.20	
	352.31		35.23	

Table 10: Results of compressive strength with 15% RHA and 15% EPS

	crushing load(kN)	Av crushing load(kN)	fcu (kN/mm^2)	Avg fcu (kN/mm^2)
7 days	144.14	143.80	14.41	14.38
	141.31		14.13	
	145.94		14.59	
14 days	172.23	179.9867	17.22	18.00
	180.47		18.05	
	187.26		18.73	
21 days	226.61	237.04	22.66	23.70
	238.84		23.88	
	245.67		24.57	
28 days	261.88	274.0967	26.19	27.41
	272.07		27.21	
	288.34		28.83	

Table 11: Results of compressive strength with 20% RHA and 20% EPS

	crushing load(kN)	Av crushing load(kN)	fcu (kN/mm^2)	Avg fcu (kN/mm^2)
7 days	123.21	132.03	12.32	13.20
	135.37		13.54	
	137.52		13.75	
14 days	176.18	173.5133	17.62	17.35
	188.15		18.82	
	156.21		15.62	
21 days	191.84	190.17	19.18	19.02
	180.19		18.02	
	198.48		19.85	
28 days	221.11	224.5433	22.11	22.45
	217.37		21.74	
	235.15		23.52	

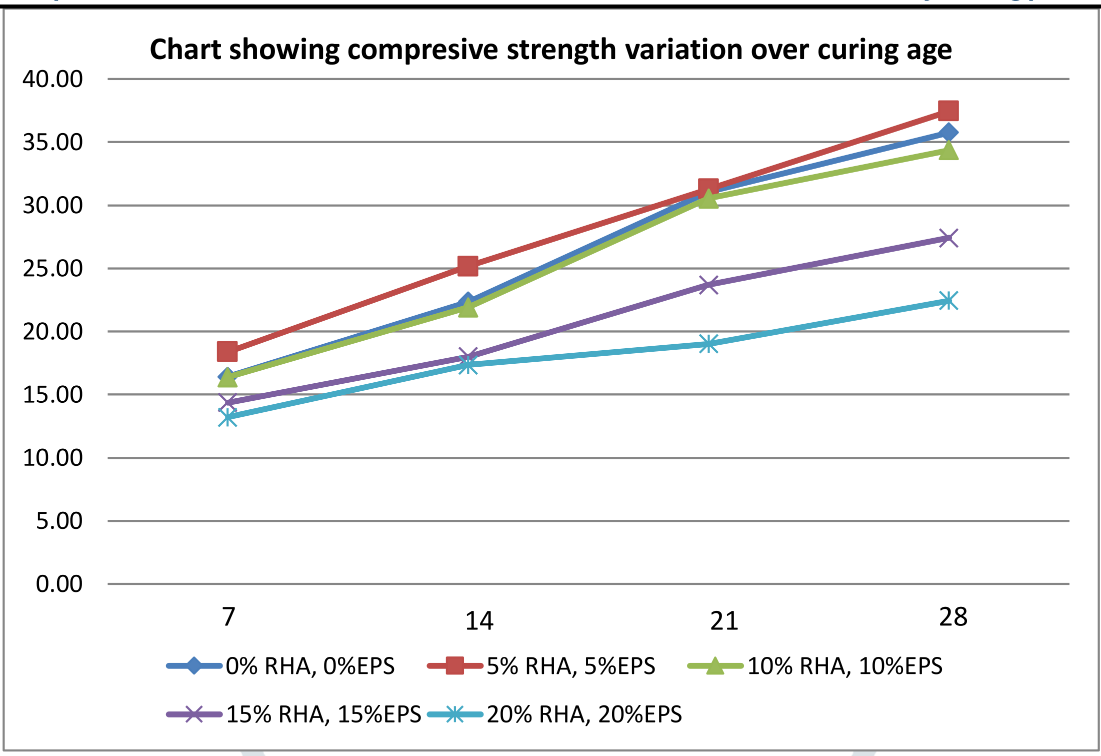

Fig 4: *Chart Showing Variation of Compressive Strength Variation over Curing Age*

IV CONCLUSIONS

The findings of this study clearly show that the compressive strength, workability, and water absorption properties of concrete are significantly impacted by the partial substitution of expanded polystyrene (EPS) and rice husk ash (RHA) for cement and coarse aggregate. The following are important findings and observations:

1. Strength of Compression:

- Compressive strength was 35.77 kN/mm² for the control sample made up of 100% Ordinary Portland Cement (OPC), while the maximum value was seen in the 5%RHA sample. Concrete with 5% EPS at 37.46 kN/mm²

- Compressive strength decreased noticeably as the fraction of RHA and EPS rose. This suggests that the compressive strength decreases when RHA and EPS are used in place of OPC and coarse aggregate.

2. Workability: The findings of the slump test show that the amount of RHA and EPS utilized affects the concrete's workability.

Workability remains relatively high when using 5-15% EPS with slump heights ranging from 80-70mm.

However, when 20% EPS is introduced, the workability decreases significantly, with a slump height of 62mm. This suggests that a higher percentage of EPS leads to reduced workability.

3. Water Absorption:

The water absorption test results demonstrate that the introduction of EPS materials increases the water absorption of RHA-EPS concrete.

As the percentage of EPS increases, the water absorption exceeds what is obtained with 0% RHA and 0% EPS, indicating a potential drawback in terms of water resistance.

ECOMMENDATIONS

1. Compressive Strength:

- It is crucial to find a balance between reducing the environmental impact through partial replacement and maintaining adequate compressive strength. Further research might focus on optimizing the mix proportions to enhance the strength of RHA-EPS concrete.

2. Workability:

- For applications where workability is critical, consider using lower percentages of EPS (5-15%) to maintain high workability. It may also be beneficial to explore additives or admixtures that could enhance workability without compromising other properties.

3. Water Absorption:

- If the concrete's resistance to water absorption is a priority, it's important to be cautious about higher percentages of EPS. Alternative methods or materials may need to be explored to reduce water absorption in RHA-EPS concrete.

In conclusion, this research shows that RHA and EPS can be viable partial replacements for cement and coarse aggregate, but careful consideration of the specific requirements of the construction project is needed when deciding on the percentage replacements to achieve the desired balance between environmental sustainability, strength, workability, and water resistance. Further studies may be necessary to fine-tune these mixtures for various applications.

LIST OF ABBREVIATIONS

1. RHA – Rice husk ash
2. EPS – Expanded polystyrene
3. OPC – Ordinary Portland cement
4. UTM - Universal Testing Machine

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