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Utilisation of Agriculture Waste in Concrete to Enhance Its Properties

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ABSTRACT

Concrete is the most extensively used man-made construction material in the world. Its most important quality is its versatility and the ability to design the concrete of any required properties according to the environment. Human development in today's scenario is impossible without the excessive use of concrete. Cement is the most important component of concrete. Unfortunately production of cement emits a very large amount of greenhouse gases and possess a very potential threat to the atmosphere. Thus it is inevitable for the sustainable development of human life that the dependency on cement to obtain strength in concrete should be lowered. This is the main reason to obtain a suitable replacement of cement to obtain high strength concrete at a low cost incurred. Also the modern constructions require very high strength in concrete which is only possible by mixing a suitable quantity of admixtures in the concrete.

The earth is abundant with two types of agricultural waste and sawdust. However, disposing of such large amounts of agricultural waste has become a major environmental threat. Research has shown that the byproducts of both materials have pozzolanic properties that allow them to be partially substituted for cement in the construction industry, creating environmentally friendly concrete and reducing the emission of harmful gases that are produced when cement reacts during concrete formation. Their disposal has gotten more expensive as a result of the most recent laws and regulations. Therefore, it's imperative to identify a suitable and beneficial application for these waste materials. Due to their high siliceous content and pozzolanic qualities, these materials can be added to concrete mixes as an additive to achieve high strength or utilized in place of cement. The two main factors that affect how well concrete performs in any field application are its flexural and compressive strengths. It is therefore important to find out how these admixtures affect the concrete's compressive and flexural strengths. One way to determine which admixture is best for a given case is to conduct a comparison research that evaluates the relative effects of these admixtures on concrete strength.

Keywords : Rice Husk Ash, Saw Dust Ash, Concrete, Environment Friendly.

I. INTRODUCTION

One of the most often used building materials is concrete. All things considered, it is a combination of water, additive, aggregate (filler materials), and cement (binding substance). It offers a broad range of design strength, is easy to work with, and can be shaped into any required shape. It is consequently used in almost all construction projects that have charitable purposes. For concrete to function as a binding substance, cement is essential. Nevertheless, there are a lot of natural hazards associated with producing concrete, including resource depletion due to the extraction of crude materials, noise pollution, air contamination, vibrations in the ground, and cement dust. Gases from cement factories mostly consist of CO2, N2, O2, SO2, water vapor, and microscopic components like CO and NOx.

One of the two largest industries in the world for carbon dioxide (CO2) production, accounting for up to 8% of the gas produced by humans, half of which comes from chemical reactions and the other 40% from fuel consumption. It is estimated that 410 kg/m3 of CO2 is created by structural concrete. For every metric ton of concrete produced, about 900 kg of CO2 emissions are released. A significant greenhouse gas is CO2. In this sense, the process of making cement releases greenhouse gases into the atmosphere through the simple breakdown of calcium carbonate and the additional expenditure of energy, particularly from the burning of fossil fuels.

Therefore, it is anticipated that we will find alternative optional materials for concrete in place of cement. Should we be prepared to replace a little percentage of cement in concrete, it will help reduce carbon dioxide emissions. From various investigation projects, certain mechanical wastes are found that can reduce the amount of concrete in cement without compromising its important qualities (e.g. durability). A variety of industrial wastes can be used as reinforcing cementitious materials, including fly ash, silica fume, granulated blast furnace slag, and rice husk ash.

An agricultural byproduct known as rich husk ash is extracted from rice mills and burned at a very high temperature to make fuel. This, when added to cement, has some additional benefits. Prior to further discussion of RHA, let's take a brief look at concrete.

Advancement in concrete technology is growing day by day, researchers has found many things that can replace cement, sand and aggregate so that a better concrete can be formed with a better performance, but cement is the most costliest and harmful material for our environment, as construction sector is growing use of cement is also increasing which is resulting in damaging our environment so we have found an agricultural waste i.e. Rice Husk Ash and Saw Dust Ash has a pozzolanic property and can be replaced with cement. Rice Husk Ash and Saw Dust Ash is also an agricultural waste which has became a threat to our environment, 20 million tons of RHA is produced only in India from boilers so that ash can be used in concrete as a partial replacement of cement, it will help our environment in reducing the agricultural waste and also reduce the emission of harmful gases generated from cement. Concrete can be made for less money in the long run by substituting agricultural waste for cement because both resources are readily available and inexpensive. This allows us to make strong, affordable, and environmentally friendly concrete.

II. LITERATURE REVIEW

K. Rakesh and Dr. A. V. Rao (2023) The author's main area of interest is the partial substitution of rice husk ash (RHA) for cement in the manufacturing of geopolymer concrete. An agricultural waste product that is widely accessible and frequently thrown away as waste is rice husk ash. The goal of adding RHA to geopolymer concrete M40 was to assess how well it performed as a cement substitute in geopolymer concrete prepared with varying ratios of rice husk ash.

Results indicated a significant enhancement in the physical and mechanical properties of concrete with a maximum replacement of 8% by weight with rice husk ash. This substitution leads to a 30% reduction in construction costs, particularly advantageous when cement availability is limited or distant. Moreover, the utilization of rice husk ash as a replacement material reduces the need for waste disposal, thereby mitigating environmental pollution.

Md Munazirul Haque et.al (2023) in the research paper, synthetic hydrocarbon polymer called polypropylene fibre (PPF) used as partial replacement of fine aggregate was added to the concrete to increase its compressive and split tensile strength. A variety of specimens using different amounts of polypropylene waste, including (0%, 0.25%, 0.5%, 0.75%, and 1.00%) was created. The compressive strength and split tensile strength of the fiber reinforced concrete (FRC) were measured after 7 and 28 days of curing, whereas the density of the FRC was assessed right away after the preparation of the concrete mix.

Results stated that adding polypropylene fibre causes the density of new fiber-reinforced concrete (FRC) to slightly or barely decrease from 2397 kg/cm3 to 2393 kg/cm3. For all curing ages up to a specific point, adding discarded polypropylene fibre increases the strength of fibre reinforced concrete (FRC). The strength of the Fibre Reinforced Concrete (FRC) suddenly decreases after that. For maximal strength with a low coefficient of brittleness, 0.5% polypropylene fibre addition was advised. The Fibre Reinforced Concrete (FRC)'s compressive strength increases by 10% and its split tensile strength by 17% with the addition of 0.5% waste polypropylene fibre.

Objectives of the Research

The objective of this research is to analyse the characteristics of RHA and Saw Dust and investigate its behaviour in concrete, compared to the literature. The following aspects are investigated in this research:

- To investigate the physical properties and chemical composition of RHA and Saw Dust to analyze its concrete performance, and relate that to the contradiction published results.
- To investigate the optimum replacement percentages of RHA and SawDust without compromising on the concrete parameters
- Increasing the amount of replacement cement by RHA and SD to more than 25% by weight of cement was considered, if necessary, by using the two additives.

MIX PROPORTION

A mix M30 grade was designed as per Indian Standard method (IS 10262-2009) and the same was used to prepare the test samples with water cement ratio w/c 0.43.

Table 1 Mix Ratio

	W (Ltr)	C (Kg/m3)	F.A. (Kg/m3)	C.A. (Kg/m3		Chemical Admixture
				20mm	10mm	
By Weight (kg)	183.5	422.45	644.25	728.25	485.5	3.4
By Volume (m3)	0.43	1	1.48	1.7	1.11	-

W- Water

C- Cement

F.A - Fine Aggregate

C.A- Coarse Aggregate

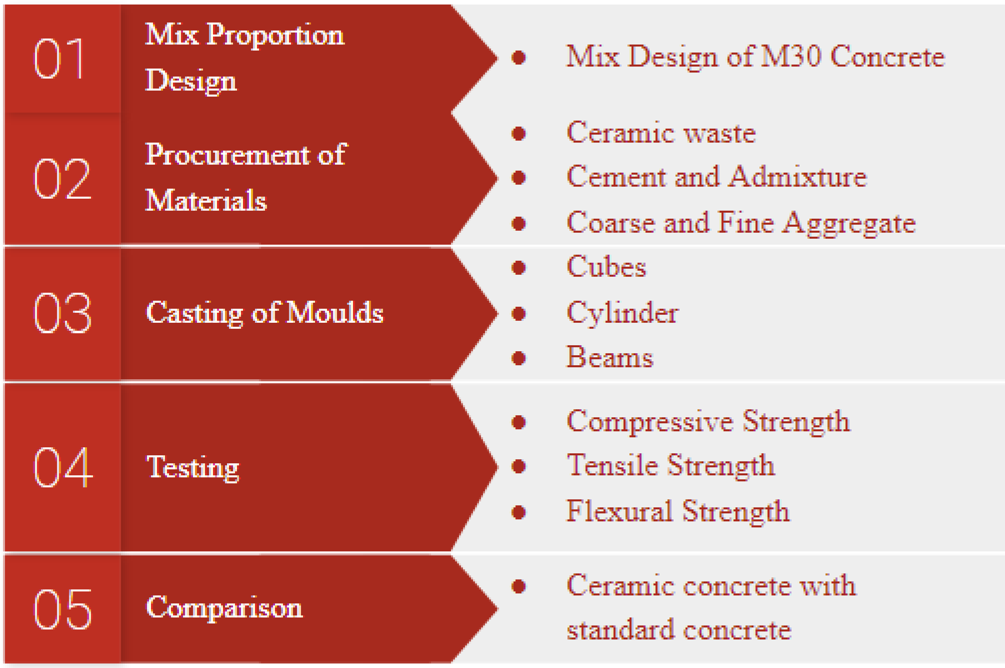
Table 2 Concrete design mix proportions.

Partial Replacement	Cement	Fine aggregate	Coarse Aggregate	W/C	Water	Partial Replacement Quantity
Conventional Concrete	9.759	17.506	22.694	0.45	4.391	0
05% RHA	9.271	17.506	22.694	0.45	4.391	0.487
10% RHA	8.783	17.506	22.694	0.45	4.391	0.975
15% RHA	8.295	17.506	22.694	0.45	4.391	1.463
20% RHA	7.807	17.506	22.694	0.45	4.391	1.951
25% RHA	7.319	17.506	22.694	0.45	4.391	2.439
05% SDA	9.271	17.506	22.694	0.45	4.391	0.487
10% SDA	8.783	17.506	22.694	0.45	4.391	0.975
15% SDA	8.295	17.506	22.694	0.45	4.391	1.463
20% SDA	7.807	17.506	22.694	0.45	4.391	1.951
25% SDA	7.319	17.506	22.694	0.45	4.391	2.439
5%	7.807	17.506	22.694	0.45	4.391	1.467

RHA+15%SDA						
10% RHA+10%SDA	7.807	17.506	22.694	0.45	4.391	0.975
15% RHA+5%SDA	7.807	17.506	22.694	0.45	4.391	0.489

In total 42 samples were prepared to investigate the material strength on the parameters of compressive strength, flexural strength and split tensile strength.

III. METHODOLOGY



IV. RESULTS AND DISCUSSION

Compressive Strength

The cube size of 150mm x 150mm x150mm is used in this experimental study to identify the compressive strength of concrete. For each type of mix cubes were casted for 7days and 28 days. 14 Cubes were casted for two different waste materials and its combination and placed in curing tank up to testing date.

Table 3 Compressive Strength in N/mm2

Compressive Strength in N/mm2		
Concrete Mix	7 Days	28 Days
0%	18.94	34.51
5% RHA	17.55	36.24

10% RHA	15.18	34.81
15% RHA	9.91	27.23
20% RHA	9.12	19.15
25% RHA	8.24	14.49
5% SD	18.7	34.57
10% SD	21.49	37.1
15% SD	19.76	34.1
20% SD	17.21	31.02
25% SD	14.41	27.73
5% RHA+15%SDA	15.18	31.67
10% RHA+10%SDA	18.59	36.66
15% RHA+5%SDA	13.17	28.42

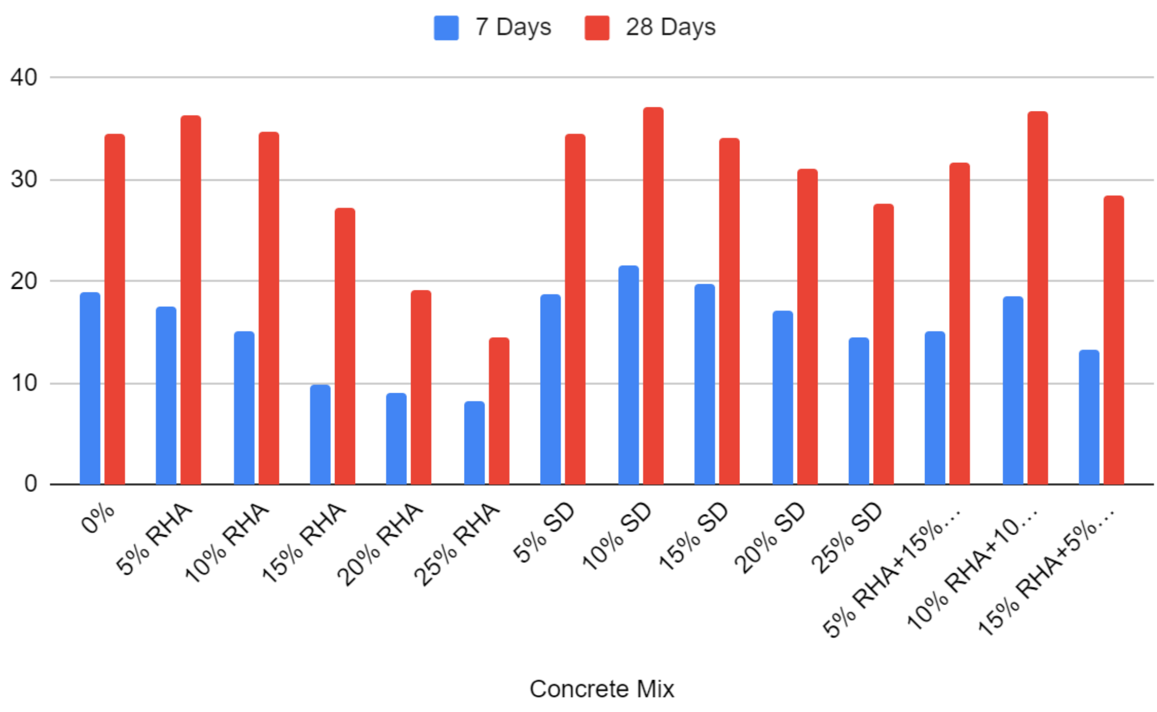


Fig Compressive Strength in N/mm2.

Inference- .With an increase in the percentage of rice husk ash in the concrete mixes, the compaction factor value falls. The fact that the compacting factor value has decreased indicates that the concrete is less workable. The fact that the percentage of rice husk ash has increased indicates that the mixture is becoming more workable as additional water is added. Because there is more silica in the mixture, rice husk ash concrete requires more water. Up to a 10% replacement of rice husk ash in the concrete mix boosts the mix's compression strength; after that, a progressive decline in compressive strength is observed. Test results shows that the compressive strength of the material is increased by the addition of sawdust ash.

Flexural Strength

The unreinforced beam of 100 x 100mm x 500mm is used. Because of the concrete brittleness, the failure occur suddenly and single crack will be obtained at the time of failure of a beam .This test is conducted under Universal Testing Machine. The average load carrying capacities of unreinforced sawdust ash concrete with conventional is little bit high at different mix.

Table 4 Flexural Strength in N/mm2

Flexural Strength in N/mm2		
Concrete Mix	7 Days	28 Days
0%	2.38	4.45
5% RHA	2.95	4.61
10% RHA	2.15	4.53
15% RHA	1.65	3.48
20% RHA	1.36	2.23
25% RHA	1.2	1.8
5% SD	2.58	3.87
10% SD	2.58	3.92
15% SD	2.671	4.407
20% SD	2.5	3.8
25% SD	2.1	3.4
5% RHA+15%SDA	2.21	3.4
10% RHA+10%SDA	2.8	3.9
15% RHA+5%SDA	2.5	3.4

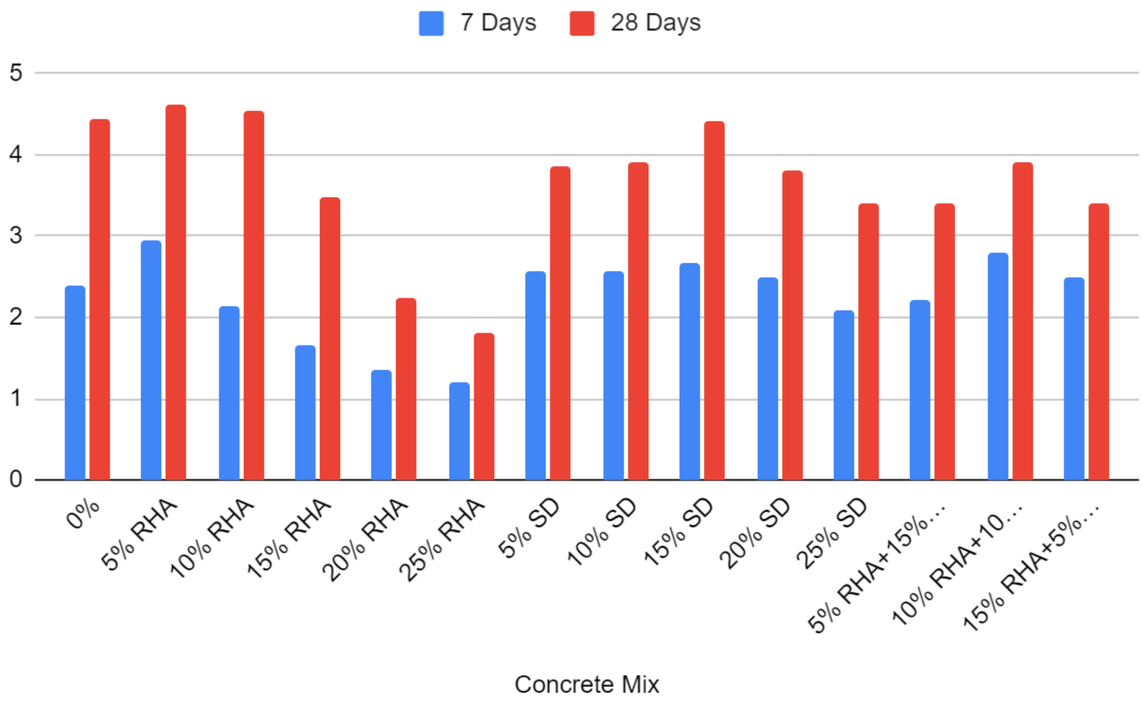


Fig Flexural Strength in N/mm2

Inference- The rice husk ash concrete's flexural strength indicates an increase in RHA concrete's strength. The conventional mix's flexure strength after seven days is 2.38, but the addition of 5% rice husk ash results in a 2.95 strength increase. All other mixes then exhibit a decrease in flexural strength and a linear down of the curve. And the flexural strength after 28 days yields good results. The strength, or the replacement of 5% and 10% of rice husk ash, increases the concrete mix's strength as compared to the conventional mixture's strength of 4.45. For 5 and 10% replacement, the two mixes' flexural strengths increase to 4.61 and 4.53, respectively, while the other mixes' flexure strength decreases after the 10% replacement. Therefore, up to 10% of the concrete mix can be replaced with rice husk ash as a replacement martial. Furthermore, adding more rice husk ash than 10% of the original mix tends to reduce the concrete's flexural strength.

Split Tensile Strength

Tensile strength of concrete was determined by using UTM. The split tensile strength of concrete was tested using 100mm x 300mm cylinder specimens are carried out by placing a specimen between the loading surfaces of UTM and the load was applied until the failure of the specimen .The average value of specimens for each mix at the age of 7 days and 28 days

Table Split Tensile Strength

Split Tensile Strength in N/mm2		
Concrete Mix	7 Days	28 Days
0%	2.23	2.85
5% RHA	2.97	3.39
10% RHA	2.25	2.95

15% RHA	2.07	2.44
20% RHA	1.81	2.02
25% RHA	1.11	1.85
5% SD	1.74	2.61
10% SD	1.69	2.57
15% SD	1.848	2.87
20% SD	1.8	2.7
25% SD	1.73	2.64
5% RHA+15%SDA	1.97	2.84
10% RHA+10%SDA	2.07	3.1
15% RHA+5%SDA	2.03	2.87

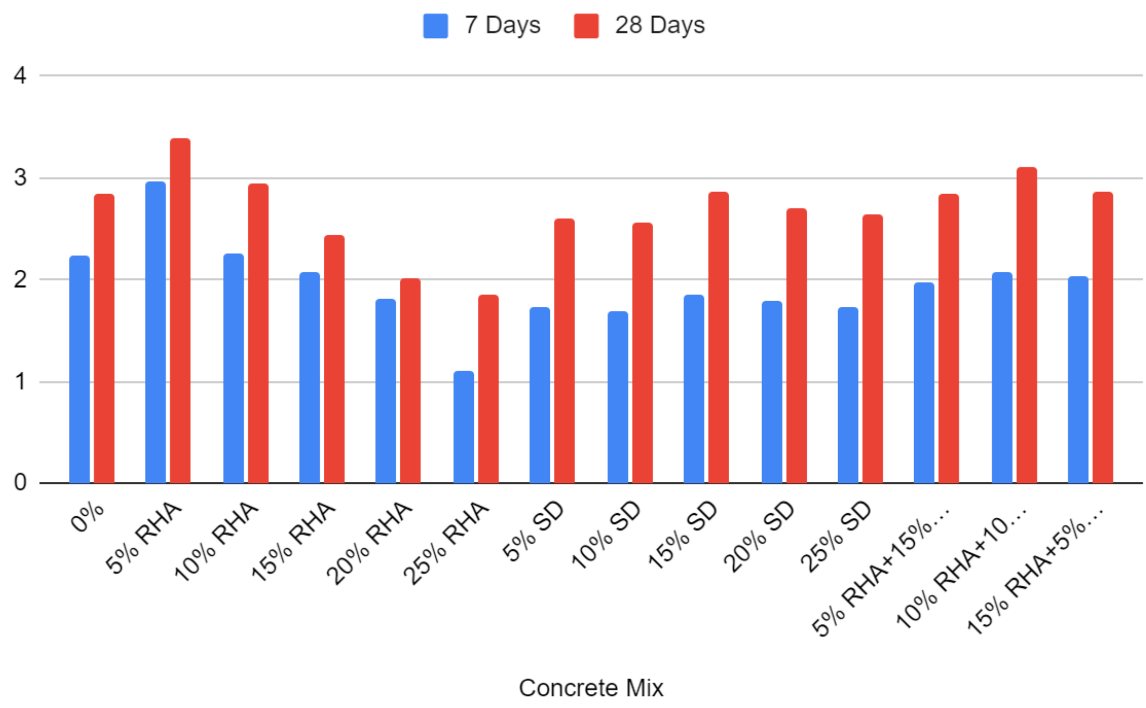


Fig : SPlit Tensile Strength in N/mm2

Inference- the concrete with 15% Saw Dust showed maximum strength as 2.87 N/mm2 and 10% Rice Husk Ash as 2.95 N/mm2.

V. CONCLUSION AND FUTURE SCOPE

The utilization of saw dust ash and rice hush ash in concrete was found to be economical and free of cost

It was recognized that the workability of concrete was decreased by the addition of the alternative materials which has increased the demand of water while mixing concrete when compared to conventional concrete. The use of such materials in concrete conserves resources, notably cement, and thereby ensures the long-term sustainability of the concrete construction sector.

Up to a certain point, cement can be used to partially replace agricultural waste like RHA and SDA, according to the study. In the case of RHA, cement replacement is allowed up to 20%, but for optimal strength, it should only be changed up to 5%. In contrast, SDA cement replacement is allowed up to 10%, but only up to 5% for good strength. Concrete's strength may diminish if certain limits are exceeded. Because RHA provides good strength, it is preferable than SDA when it comes to partial replacement with cement.

In addition to forming more environmentally friendly concrete, substituting these agricultural waste for cement can benefit our environment by reducing the toxic gasses released during the cement-water reaction.

Compressive Strength

With an increase in the percentage of rice husk ash in the concrete mixes, the compaction factor value falls. The fact that the compacting factor value has decreased indicates that the concrete is less workable. The fact that the percentage of rice husk ash has increased indicates that the mixture is becoming more workable as additional water is added. Because there is more silica in the mixture, rice husk ash concrete requires more water. Up to a 10% replacement of rice husk ash in the concrete mix boosts the mix's compression strength; after that, a progressive decline in compressive strength is observed. Test results shows that the compressive strength of the material is increased by the addition of sawdust ash.

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RECOMMENDATION FOR FUTURE STUDY

The findings of this research suggest a number of potential topics for future studies. Some open questions are pointed out as follows:

- The effects of various curing conditions on the hardened properties of OPC mortar and concrete, including the drying shrinkage, should be examined. I
- The impact of RHA properties on the fresh and hardened properties of OPC concrete should be investigated for different types and sizes of coarse aggregate.

- The effects of unburnt carbon content and the internal water curing of RHA on the hydration and microstructure development of cement paste should be evaluated.
- Chloride diffusion resistance of RHA concrete may be studied for a different type of cement rather than one type of cement (high strength cement).
- The effect of RHA on the durability of OPC concrete at low water to binder ratio (w/b), should be investigated.
- The effect of mineral admixtures may also have a positive impact on the durability of concrete should be evaluated.
- Effect of combustion temperature on the time of the silica structure transformation needs more investigation to produce ash with ultimate reactivity

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