ANALYSIS OF PERVIOUS CONCRETE PROPERTIES WITH RICE HUSK ASH AND POLYPROPYLENE FIBERS: AN EXPERIMENTAL INVESTIGATION

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ABSTRACT

A unique variety of concrete called pervious concrete has little-no fine aggregate. It is a solution to problems with water logging and to lessen runoff from paved surfaces. Its strength is less than that of conventional concrete, hence admixtures are required to boost strength and durability without lowering permeability. In this study, experimental research was done to examine the effects of replacing a portion of the cement with ricehusk ash at percentages of 0%,5%,10%,15%, and 20% and the optimum Percentage of RiceHusk Ash is the varied the addition of Polypropylene Fibres with certain percentages of 0.5%,1%,1.5%. The ACI Method was used to create the mixes.Water Cement ratio of 0.35 was adopted based on the Trial Method. Flexural strength Test, Compression Test, Split Tensile Test, Permeability, Porosity, Sorptivity, Acidity Alkalinity test and RCPT are among those conducted. The results indicated that for the compressive strength test, split tensile test and flexural test 10% of rice husk ash provides the Optimum results. Addition of Polypropylene Fibres at 1% by weight of cement Gives the Optimum Result in Mechanical tests and Acceptable durability were obtained based on ACI-522.

INTRODUCTION

Cement, water, coarse aggregate, and little to no fine aggregate make up pervious concrete. Rapid population increase may encourage the use of pervious surfaces like parking lots and sidewalks. The ground water table rises as a result of pervious surfaces. By allowing rainwater to seep into the earth, it is an eco-friendly way to satisfy demands. The vacancy content of pervious concrete ranges from 15% to 35%.Floods can be avoided by allowing runoff water to escape via the pores in pervious pavement, which also makes the problem of water logging simple to resolve. Although it has a higher permeability value than traditional concrete, its strength is lower. Long-term use of pervious concrete is a difficult undertaking since performance may decline. Pozzolanic materials are utilised to boost strength without affecting permeability. The w/c ratio and other parameters of concrete are impacted by the pozzolanic ingredient. The pervious concrete mechanical and durability characteristics are determined by the bond between the particles and the pores. It is typically utilised in places with frequent heavy rains so that the pervious surface can help with water logging issues.

To strengthen the contact area in this experimental inquiry, ricehusk ash (RHA) was used as artificial pozzolana. Rice husk, which has a comparatively high silica content, is one of the pozzolanic materials used in the constituent parts of agricultural waste. A significant amount of rice husk is produced each year in Iran's north and other parts of the country due to the abundance of rice fields in these regions. These husks have little to no use right now. Additionally, getting rid of will cause significant environmental problems because they are burned, which releases a lot of smoke and pollutants. Husk is a valuable agricultural product and a raw material with a variety of uses, it should be emphasised.

A by-product of the paddy business is RHA. Ricehusk is burned under regulated conditions to yield ricehusk ash, a highly reactive-pozzolanic substance FA is produced by coal-fired power plants and is finely split. Like naturally pozzolanic material, fly ash has pozzolanic characteristics. RHA is a by-product of the paddy industry. Under controlled settings, ricehusk is burned to produce ricehusk ash, a highly reactive pozzolanic material. Rice husk ash is a significant agricultural waste produced during the paddy rice husk removal cycle.

Concrete. Because of its abundance and ease of processing, rice is one of the most widely consumed foods in the world. The husk, which makes up around 20–23% of the weight of the paddy, must be eliminated during the milling process before the rice can be consumed. Ricehusk ash (RHA) is created by burning ricehusk at a temperature of less than 750 C in an oven(under regulated temperature and humidity)or outdoors (uncontrolled) to create amorphous ash that can be utilised as an extra-cementitious ingredient in concrete.

Polypropylene fibres are useful for improving soil drainage and rebound, releasing gases from refractory applications, and strengthening and reinforcing cementitious materials. Polypore created utilizing components derived from hydrocarbon fuels, such as petroleum oil, as is the case with the majority of plastics.The process of converting the monomer propylene, which is initially derived from crude oil gas form, into the polymer polypropylene is known as chain growth polymerization.

It was decided to substitute 5%, 10%, 15%, and 20% of the Portland cement with calcium carbide waste (CCW) and ricehusk ash (RHA), correspondingly. The tests and models for determining the permeability, water absorption of PC was created using the response surface methodology. between the variables and the outcomes was revealed by the built-in RSM models. The variable that was optimized had the characteristics: water permeability between 0.96 cm/s and water absorption of 4.3382%.**[1]**

The effects of replacing a portion of the cement in concrete with Flash (FA) and Rice Husk Ash (RHA) in a combined proportion of 30%FA and 0%RHA while gradually increasing RHA by 2.5% and decreasing FA by 2.5% were investigated in this study through a thorough experimental investigation. The Ultimate percentage was set at 15%FA and 15%RHA.

The research showed that at 28 days, compressive strength had increased by 30.15% compared to the goal strength and had dropped by 8.73% compared to control concrete. Split tensile strength fell by 9.58% compared to the intended strength, tensile strength declined by 8.73% compared to the targeted strength, and flexural strength rose by 4.5% compared to control concrete**[2]**

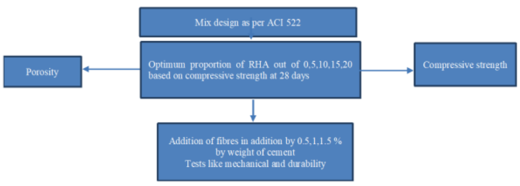
The mechanical characteristics of concrete mixtures containing cement replacements at weight percentages of 0%, 2%, 4%, 6%, 8%, 10%, and 12% were investigated in this study. The pozzolanic cement paste was strengthened using rice husk ash (RHA). 0.2%Vf of glass, 0.5%Vf of steel, and 0.3%Vf of Polyphenylene sulphide (PPS) fibres were added to the pervious concrete to further improve its mechanical properties, where "Vf" is the volume ratio of the fibre to the volume of the concrete . The compressive, tensile, and flexural strengths of concrete containing RHA and fibres displayed a similar pattern for all w/c ratios, although the optimum % of RHA varied, rising quickly up until the optimisation point and then progressively declining after it. The mechanical qualities of the pervious-concrete were greatly improved with w/c ratio of 0.33 while voids and permeability were simultaneously decreased.**[3]**

Kevlar, PVA, and ultra high molecular weight polyethylene are three distinct types of fibers that are used to assess the mechanical performance of PC paving bricks.. The permeability values, which are good by ACI standards and related to the material's porosity, range from 0.15 cm/s-0.39 cm/s. The pressure compaction method and the inclusion of fibre have a detrimental effect on the compressive. Splitting tensile strengths, although the flexural strength is slightly boosted. A distinct method of moulding or forming that fully makes use of fibre inclusion.**[4]**

The permeability and strength of pervious concrete are being examined in this study in relation to how adding glass fibre and rice husk ash in various ratios affects them. It is discovered that the compressive strength of pervious concrete for RHA 10% is higher than it is for RHA 8%.By adding fibres, pervious concrete retains its compressive strength. Because it fills part of the holes in the concrete, glass fibre lessens the permeability of pervious concrete. The permeability of pervious concrete has no impact on RHA.**[5]**

In this analysis, mix designs like M30 and PC30 are considered. The coarse aggregate is used instead of the fine aggregate by adjusting the ratios to 0%, 5%, 10%, or 15%. By adding a variety of pozzolanic elements, including GGBS, silica fume, and glass fibres. When compared to the original grade of M30, the strength of all replacement levels of PC with other combinations continues to decline. When comparing PC with Pozzolanic materials, a change is apparent after 7 days for the same replacement, and the strength continues to decline after 28 days for 25% pozzolanic concrete. Compared to the parent grade of M30, PC with pozzolana's strength decreases with each replacement.**[6]**

METHODOLOGY



MATERIAL PROPERTIES

A. **Portland Cement concrete:** Pervious Concrete is made from constituent materials that must be suitable for the intended use in concrete and free of harmful ingredients in concentrations that could compromise the concrete's quality Sor durability or speed up the corrosion of the reinforcement.

B. **Aggregates:** the aggregates' maximum size varies depending on the specific application but is often restricted to 16mm. The powder content is primarily made up of particles smaller than 0.125 mm. To manufacture SCC of consistent quality, the moisture content must be continuously controlled and considered.

C.Super plasticizer: Conplast SP430 is a sulphonated naphthalene 4 based super plasticizing admixture that is devoid of chloride. It is offered as a murky solution that readily dissolves in water. The performance of the concrete's water content is enhanced by conplast SP430, which disperses the microscopic particles in the concrete mix. Significant strength increases are possible at extremely high levels of water reduction. To identify the optimal SP dose, trial mixtures should be employed.

Table 1. Material properties

Material Properties	Ranges
Fineness of cement	7.5%
Grade of cement	53
Sp.Gravity	3
Initial-setting time	35min
Final-setting time	355min
Sp.Gravity of coarse aggregate	2.62
Sp.Gravity of fine aggregate	2.688

D. Admixtures

The admixture used in the concrete mix is Rice husk ash. The specific gravity of RHA is found to be 2.04.

Table 2. Chemical compositions

Oxide	RHA (%)
SiO_2	87.30
Al_2O_3	0.15
Fe_2O_3	0.16
CaO	1.40
MgO	0.57
K_2O	3.68
Na_2O	1.12
SO_3	0.24

MIX PROPORTIONS

The mix proportion is designed to determine correct proportions of materials cement, coarse aggregate, water, and RHA to satisfy the workability, durability of concrete. The design mix was based on requirements of ACI-522R;water cement ratio of 0.5,cement -aggregate ratio of 1:4.5,and target porosity of 20% adopted on the cement content

Conventional Mix

Cement: 455kg/m^3

Fine-Aggregate: 1650kg/m^3

Coarse-Aggregate: 177 kg/m^3

Super Plasticizer: 2.76 kg/m^3

Water: 159 kg/m^3

EXPERIMENTAL INVESTIGATION

Compressive strength of Cubes at 7 and 28 days

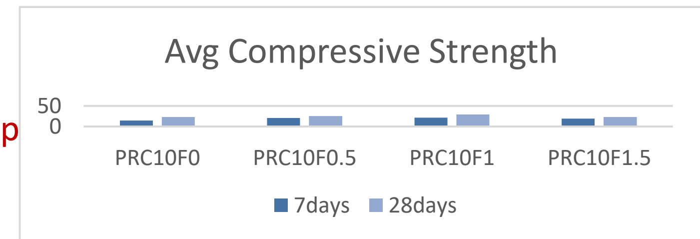
Percentage of RHA Added	Average Compressive Strength MPa for 7 days	Average Compressive Strength MPa for 28 days
PRC0	6.80	18.48
PRC5	9.30	21.80
PRC10	14.84	27.06
PRC15	8.06	22.46
PRC20	5.45	18.34

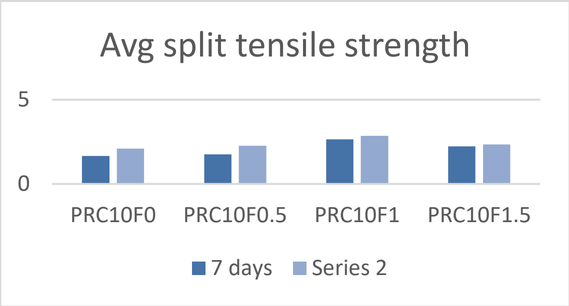
From the above table, the optimum amount of RHA to be replaced was opted as 10% based on the obtained average compressive strength. To the obtained value of RHA, polypropylene fibres are added and mix proportions are designed. The tests are conducted for the hardened and durability properties of concrete.

Mechanical properties of Pervious concrete with addition of 10 % RHA and varying Polypropylene fibres at 7 and 28 days

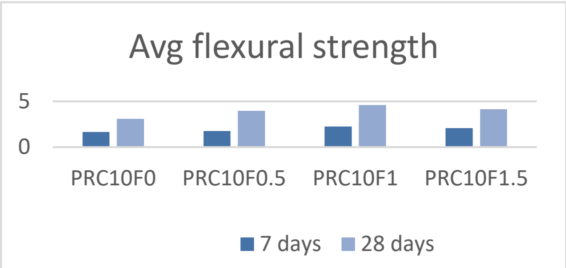
The tests on hardened concrete includes the compressive strength, split tensile strength and flexural strength from which the strengths are determined as follows:

Graph 1: Avg compressive strength vs mix proportions





Graph 2: Avg split tensile strength vs mix proportions



Graph 3: Avg flexural strength vs mix proportions

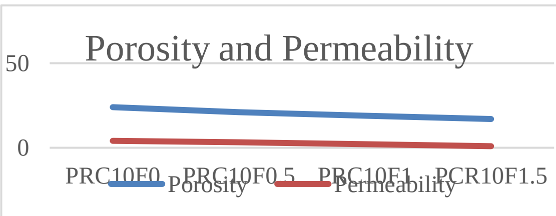
DURABILITY TESTS ON CONCRETE

Tests on durability includes porosity, permeability, acidity, alkalinity, RCPT and sorptivity whose test results are as follows:

POROSITY AND PERMEABILITY TESTS

Table 6: Porosity and Permeability at 28 days

% of fibres added	Porosity (%)	Permeability (cm/s)
PRC10F0	24	4.09
PRC10F0.5	21	3.17
PRC10F1	19	2.14
PRC10F1.5	17	0.92



Graph 4: Porosity vs Permeability

ACIDITY AND ALKALINITY TESTS:

Table 7: Acidity and Alkalinity at 28 days

Mix Proportion	% of weight loss (H2SO4)	% of weight loss (NaOH)
PRC10F0	3.34	0.40
PRC10F0.5	0.93	0.72
PRC10F1	1.30	0.81
PRC10F1.5	3.12	0

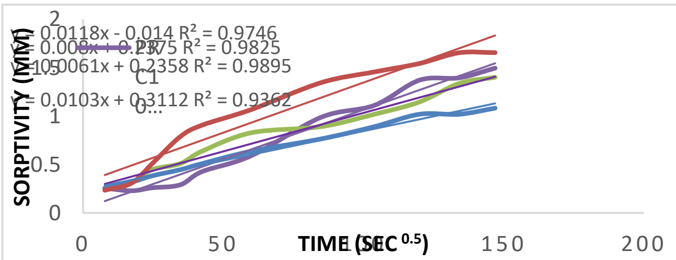
RCPT TEST:

Table 8: RCPT at 28 days

% of fibres added	Chloride ion permeability (Coulombs)
PRC10F0	Short Circuit
PRC10F0.5	Short Circuit
PRC10F1	Short Circuit
PRC10F1.5	Short Circuit

SORPTIVITY TEST:

MIX PROPORTIONS	Initial Absorption (mm/√s) at 28 days	Final Absorp at 28 days
PRC10F0	0.0118	0.00384
PRC10F0.5	0.00801	0.00221
PRC10F1	0.00610	0.00193
PRC10F1.5	0.0103	0.00223



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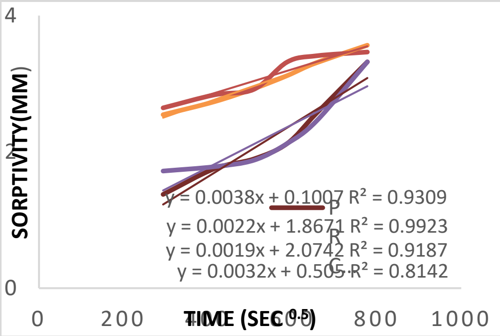

Graph 5: Sorptivity vs root of time

CONCLUSION

In this study, the properties of pervious-concrete are experimentally investigated using Rice husk ash as a replacement of cement. The following conclusions are made:

- The **10%** replacement of cement with Rice husk ash gives the Optimum result in Compressive Strength Test at 28days with the percentage increase of **46.43%.**
- Addition of **1%** of polypropylene fibres by weight of cement to the Optimum of RHA Percentage gives the Optimum result in Compressive strength test, Split Tensile test, and Flexural test. Percentage increase due to **1%** addition of Fibres in Compressive Strength at 28days is about **7.84%.**
- The range of Permeability Along with addition of fibres was observed to in the range of 2 to 6 mm/s for 1% and 1.5% addition of fibres. (As per ACI 2mm/s to 14.4mm/s). In which the Permeability is high in **1.5%** of fibres i.e., **3.17mm/s**
- From the Experimental Studies conducted using RHA and Fibres, exhibited accepted Porosity which is in the range of **15%-25%** (as per Limitations of ACI-522R 10).
- In case of Acid resistance test and Alkaline resistance test, the Percentage loss of strength due Acid is **26.87%**, and due to alkaline is **13.45%.**
- In case of RCPT for Pervious Concrete due to High Porous Property, the Resultant is **Short Circuit.**

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