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Analysis of Strength of Pervious Concrete by Adding Rice Husk Ash and Glass Fibre

Ashish Shende[1], Puja Borkar[2], Rahul Borghare[3], Sanghamitra Manvar[4], Rameez Raza[5], Saurabh Bhaisare[6], Shubham Kamerkar[7], Shweta Bais[8], Trideb Nandi[9], Sumit Meshram[10]
[1,2,3,4,6,7,8,9]*Student, Dept. of Civil Engineering, Wainganga College of Engineering & Management, Nagpur, India*
[5,10]*Assistant Professor, Dept. of Civil Engineering, Wainganga College of Engg. & Management, Nagpur, India*

***Abstract*: Pervious Concrete is a special high porosity concrete consisting of cement, Coarse aggregate and water with no or little amount of fine aggregate. Pervious concrete has been found useful in various applications but the most important application is for pavement construction since it helps in reduction of waterlogging and for ground water recharge. But due to its poor strength it is not useful in the construction of pavement for heavy traffic. In this work, we will analyse the effect of addition of various proportions of Rice Husk Ash and Glass Fibre on the strength and permeability of pervious concrete.**

***Keywords*: Porosity, waterlogging, Rice Husk Ash, Glass Fibre, Permeability.**

1. Introduction

Pervious concrete consists of cement, Coarse aggregate and water in which little or no fine aggregate may be added (upto 10% by weight of total aggregate) and it has just enough cementitious paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids. Its void content ranges from 18% to 35% and strength from 2.8 to 28 N/mm2. The infiltration rate typically ranges from 80 to 720 litres per minutes per square metre.

Pervious concrete is a unique and effective solution to reduce the runoff from paved areas and recharging the ground water. Pervious concrete can uproot storm water more rapidly than conventional concrete. It is directly recharging the ground water so eliminates the need of retention pond, swales and storm water management devices. It is also eliminates costly storm water detention vaults and piping systems. Thus reduce construction expenses, safety issues and maintenance cost. The waste management problem has already become severe in the world. The problem is compounded by the rapidly increasing amounts of industrial wastes of a complex nature and composition.

Many research organizations are doing extensive work on waste materials concerning the viability and environmental suitability. Therefore, the main objective of this study is to use Rice Husk Ash and Glass Fibre materials to develop a pervious concrete mixture proportion and to improve the compressive strength and flexural strength of pervious concrete. In 2010 India alone produces around 120 million tons of rice paddy per year, giving around 24 million tons of rice husk per year and 6 million tons of rice husk ash per year.

Fig. 1. Pervious concrete

2. Literature review

Suryanti Rapang Tonapa, Desi Sandy, Lisa Febriani, 'Experimental study of pervious concrete with various addition of RHA'. In this research paper, an experiment was performed to improve the compressive strength of pervious concrete by adding Rice Hush Ash Fibre in various proportions. It is concluded that porous concrete with the addition of RHA Fibre, the pore volume value is reduced from normal porous concrete. The more grains of RHA the smaller the pore volume of porous concrete. Likewise, with volume weight of concrete the more addition of fibre is smaller volume weight of concrete. For the value of compressive strength, the more the addition of fibre the resulting compressive strength is smaller.

Rinki. K. Khot, R.S Deotale, Abhijeet R. Narde, 'To study the partial replacement of cement by flyash and RHA &natural sand by Quarry sand in concrete. By april.' The percentage of water cement ratio depends on quantity of RHA & QS used in concrete because RHA is highly porous material. The compressive strength increase by addition of quarry sand in addition to FA& RHA. Though the cost of RHA is zero thus we preferred cement RHA in concrete as compared to silica fumes & is also economical. due to high absorbing quality of the RHA the dosage of super plasticizer had to be increased along with RHA fineness to maintain the desired workability. Since RHA increase the strength but decreased the workability of material so to increase the workability FA is added with the combination of RHA. According to the mix the combine gradation 45 % QS replaced by NS meets the grading limit as per IS 383-

1970.according to the combined grading 45% QS gives good strength but it has also been resulted then on adding more percentage of QS i.e, 60% it also has given better results. Permeable voids are decreasing with age of curing.

Saeid Hesami, Saeed Ahmadi, Mahdi Nematzadeh, 'Effect of Rice Husk Ash & fibre on Mechanical Property of Pervious Concrete.' In this research paper, Rice Husk Ash is used for partial replacement of cement and a mixture of different fibre such as glass fibre, steel fibre and PPS fibre are used in different proportions to enhance the mechanical property of pervious concrete. The results obtained were as follows;

- The optimum percentage of RHA in the specimen without fibre is 8% while it is between 8& and 10% in the specimens with fibre series. This indicated that the addition of fibres to the concrete containing RHA does not considerably affect the optimal amount.
- The compressive, tensile and flexural strength in concrete with 12% of RHA were found to be slightly lower than those of 10% of RHA, as the optimum RHA amount, while its permeability is considerably high than that of 10% of RHA.
- The mechanical properties including the compressive, tensile and flexural strength were found to be the maximum for w/c ratio of 0.33.
- For 8% to 10% replacement of RHA and w/c ratio of 0.33, the compressive strength of pervious concrete containing fibre & RHA increases by 34%, 37%, and 36% for glass, steel and PPS fibre respectively.
- In three w/c ratio of 0.27, 0.33, 0.4, a similar trend was observed for the compressive, tensile and flexural strength of concrete containing both RHA and fibre but the range of optimum percentage of RHA was different. Moreover, for all cases, the compressive, tensile and flexural strength rises at a rapid slope before the optimum percentage and drops gradually afterwards.

Aishwarya Gopinath, Amala D, Anjitha G Nath, DrisyaVasudev A, Justin Thomas, 'Fibre Reinforced Pervious Concrete using Banana Fibre.'In this research paper, Banana fibres are used to reinforce pervious concrete in order to improve engineering properties of pervious concrete.The main objective of this study was to evaluate the strength ad permeability characteristics of pervious and to compare the behaviour of plain pervious concrete and banana fibre reinforced pervious concrete. The results obtained were as follows;

- When comparing the 10mm and 12m sized aggregate the maximum compressive strength will be at 10mm sized aggregate.
- When comparing the 10mm and 12m sized aggregate the maximum permeability will be at 12mm sized aggregate.
- Comparing between the two sized aggregate the 12mm aggregate will be more convenient for pervious concrete.
- For particular mixed examined for 28 days, the compressive strength values ranges from 7.58 to 10.77 N/mm2 for
- 0%, 0.1%,0.2%, 0.3% and 0.4% and maximum value for compressive strength is for 0.2% banana fibre reinforced pervious concrete.
- It is concluded that the amount of fibre used should be in range of 0.2% to obtain pervious concrete with good strength and permeability.

3. Experimental material

- *Cement:* (43 grade OPC) Cement is a binding Material. It is the substance which dioxide is used for construction that sets hardens and adheres to other materials like sand aggregate together.
- *Sand:* Sand is a granular material composed of finely divided rocks and material particles. It is defined by the size being finer than gravel and closer than silt. River sands are, mostly used for construction works.
- *Aggregate:* There is a broad category of coarse to medium grained particulate material used in construction. These are the most mined material in the world. It gives the strength to concrete. Due to the relatively high hydraulic conductivity values as compared to most soils, aggregate is widely used is drainage application. In our experiment, aggregate passing through 12.5mm IS Sieve and retaining on 10mm IS Sieve is used.
- *Water:* Water is the key ingredient, which when mixed with cement forms a paste that binds the aggregates together. For construction work drinkable water is preferred as it contains very little salts.

Rice husk ash is obtained by burning rise husk in a controlled manner without causing environmental pollution. When properly burnt it has high SiO_2 content and can be used as a concrete admixture. Rice husk ash improves workability and stability, reduces heat evolution, thermal cracking and plastics shrinkage. It also exhibits high pozzolonic characteristics and contributes the high strength. There are two methods of burning rice husk i.e. Open Air burning & Special Furnace Burning. Open Air burning is adopted in our case and the ash obtained is grounded finely and passed through 425µ IS Sieve. The RHA has following characteristics,

Table 1
Chemical properties of Rice Husk Ash

S. No.	Particulars	Proportion (%)
1.	Silicon dioxide (SiO_2)	85.5-95.5
2.	Aluminium oxide (Al_2O_2)	0.0-2.5
3.	Iron oxide (Fe_2O_3)	0.0-1.5
4.	Calcium oxide (CaO)	0.0-1.0
5.	Carbon (C)	2.0-4.0
6.	Sodium oxide (Na_2O)	0.0-1.0
7.	Potassium oxide (K_2O)	0.0-3.0

Fig. 2. Rice husk ash

Glass fiber is a material consisting of numerous extremely fine fibers of glass. Glass fibre has roughly comparable mechanical properties to other fibres such as polymers and carbon fibre. It is much cheaper and significantly less brittle. The diameter of glass fibre is 0.15mm and length of fibre is 40mm to 50mm. The type of fibre used is S-2 glass fibre. The Glass fibre used in this research has the following properties;

Table 2
Mechanical Properties of Glass Fibre

Fibre type	Tensile strength (MPa)	Compressive strength (MPa)	Density (g/cm^3)	Thermal expansion (µm/mc)	Softening TC
E-glass	3445	1080	2.58	5	846
S-2 glass	4890	1600	2.46	2.9	1056

Fig. 3. Glass fiber

4. Mix designs

A. *Ratio of material*

- Grade of porous concrete (1:4) cement aggregate), 43 grade OPC is used.
- Fine aggregate is used 5% by total weight of coarse aggregate.
- Coarse aggregate passing from 12.5mm is sieve and retained on 10 mm is sieve.
- RHA in different proportion by weight of cement i.e. 8% and 10%
- Glass fibre in different proportion by total weight concrete i.e.0%, 0.2%, 0.4% and 0.6%.

B. *Specimen*

For performing compressive strength test on different types of concrete cube the different specimen cubes are have to cast.

- For 8% replacement of RHA 3 cubes for each batch. (7, 14,28 days) no. of batches = 4 (fibre 0%, 0.2%, 0.4%, 0.6%).
- For 0% RHA and fibre 1 cube.
- Total no. of cubes required for testing 4 (7, 14, 28 days) – for RHA 8%, 4 (7, 14, 28 days) – for RHA 10%.

Mix design for concrete:

Table 3
Mix Design for single cube

	Mix	Cement (kg)	Aggregate (kg)	Sand (kg)	RHA (kg)	Fibre (kg)
RHA 8%	F – 0%	1.532	7.02	0.35	0.123	-
	F –0.2%	1.532	7.02	0.35	0.123	0.00554
	F –0.4%	1.532	7.02	0.35	0.123	0.011088
	F –0.6%	1.532	7.02	0.35	0.123	0.0166
RHA 10%	F –0%	1.494	7.02	0.35	0.166	-
	F –0.2%	1.494	7.02	0.35	0.166	0.00554
	F –0.4%	1.494	7.02	0.35	0.166	0.011088
	F –0.6%	1.494	7.02	0.35	0.166	0.0166
RHA 0%	F –0%	1.66	7.02	0.35	-	-

5. Tests and results

A. *Compression Test Results*

Table 4
Compressive strength for RHA 8%

Days	RHA	Fibre	Compressive Strength(N/mm^2)
7	8%	0%	8.4
		0.2%	8.23
		0.4%	7.8
		0.6%	7.3
14	8%	0%	11.34
		0.2%	11.01
		0.4%	11.56
		0.6%	10.1
28	8%	0%	12.56
		0.2%	11.36
		0.4%	10.82
		0.6%	10.3

Table 5
Compressive strength for RHA 10%

Days	RHA	Fibre	Compressive Strength(N/mm^2)
7	8%	0%	9.16
		0.2%	8.8
		0.4%	8.41
		0.6%	7.98
14	8%	0%	12.31
		0.2%	12.1
		0.4%	11.75
		0.6%	11.2
28	8%	0%	13.68
		0.2%	13.5
		0.4%	12.7
		0.6%	12.4

B. *Constant Head Permeability Test Result*

Table 6
Permeability of Pervious Concrete

S. No.	Percentage of Glass fibre	Permeability (litre/min)
1	0%	12.28
2	0.2%	12.11
3	0.4%	11.96
4	0.6%	11.72

6. Conclusion

From the results obtained from various experimental analysis following conclusion can be drawn;

- The compressive strength of pervious concrete for

RHA 10% is found to be greater than that of RHA 8%.

- The addition of fibre does not affect the compressive strength of pervious concrete.
- The permeability of pervious concrete decreases with the addition of glass fibre since the voids of the concrete gets filled with some percentage of glass fibre.
- The permeability of pervious concrete is not affected by the addition of RHA.
- As Rice Husk Ash is a waste material and easily available it can be used to increase the pervious concrete without affecting the permeability. Also it is a cheap by-product which can be effectively used as a partial replacement of cement there by reducing the overall cost of construction.

7. Future scope

The pervious concrete may be used in following applications;

- Due to the very high permeability the pervious concrete may be used as a replacement of sand bed in rain water harvesting system. Thus the removal of sand can be avoided by just backwashing of pervious concrete layer used which will reduce the cost.
- Already pervious concrete is being as used as pavement material for light traffic, for heavy traffic the concrete fails in meeting the strength demand, by using RHA the strength of pervious concrete may be increased and it may find application in pavement for heavy traffic.
- Pervious concrete being economical may be used for parking lots, sideways, walkways etc. which will drain all the excess water coming over it and thus extra drainage system won't be necessary.
- Paver blocks made by pervious concrete will not only be cheap but will allow easy flow of water through it and will recharge the ground water.

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