Effect of Addition of Rice Husk Ash and Super Plasticizer on Pervious Concrete

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Abstract - *In this paper, we have carried out detailed experimental studies of the partial replacement of cement by rice husk ash (20% by the weight of cement), by adding super plasticizers (0.15% & 0.25%) and varying size of aggregates. The tests performed on pervious concrete includes slump test for workability. In this test maximum size of aggregate used is 38mm, compressive test on cube for size (150 x 150 x 150 mm) at 7, 28 and 56 days of curing as per IS: 516 1959, Flexural strength on beam (150 x 150 x700 mm) at 28 days of curing as per IS:516 1959 and split tensile strength on cylinder (150 mm ø x 300mm) at 28 days of curing as per IS: 5816 1999. It has been observed from experimental results that the mechanical properties of pervious concrete increased by using small size aggregates (4.75 mm to 10 mm) in comparison to large size (10 mm to 20 mm) and all-in aggregates (4.75 mm to 10 mm & 10 mm to 20 mm). The pervious concrete has low strength as compared to conventional concrete.*

Key Words: Fly Ash, Rice husk Ash, Flexural Strength, Admixture, Compressive Strength, Split Tensile Strength

1.INTRODUCTION

Pervious concrete is a unique and effective solution to reduce the runoff from paved areas and recharging the ground water. Pervious concrete also naturally acts like a filter; it filters water from rainfall or storm and can reduce pollutant loads entering into streams, ponds and rivers. on the use and utilization of industrial, agricultural and thermoelectric plants residue in the production of concrete. Different materials with pozzolanic properties such as fly ash, condensed silica fume, blast-furnace slag and rice husk ash have played an important part in the production of high performance concrete.[1] In this pavement system, a 150–300 mm pervious concrete (PC) layer with a high air void content is placed on a highly voided stone bed as the base layer, to allow for a rapid infiltration of runoff through the pavement system. 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 materials to develop a pervious concrete mixture proportion and to check the workability, compressive strength and flexural strength and flexural tensile strength of pervious concrete.

2. EXPERIMENTAL MATERIALS

The work presented has carried out detailed experimental studies of the partial replacement of cement by rice husk ash (20% by the weight of cement), by adding super plasticizers (0.15% & 0.25%) and varying size of aggregate. The effects of RHA and FA on concrete properties were studied by means of the mechanical properties of concrete i.e. workability compressive strength, split tensile strength, and flexural strength.

2.1 CEMENT

The Ordinary Portland Cement of 43 grade Ultratech Cement conforming to IS: 12269 - 1987 is been used. Physical property and chemical composition of cement is as per Table 1.

S.NO	PROPERTIES	OBSERVED DATA	VALUES SPECIFIED BY IS:8112-1989
1	Specific Gravity	3.157	
2	Normal Consistency	30	
3	Initial Setting Time	80	More than 30 minutes
4	Final Setting Time	320	Less than 600minutes
5	Compressive strength (MPa) 7days 28days 56 days	24 35 44	More than 23 More than 33 More than 43

Table -1: Chemical Properties of cement

2.2 RICE HUSK ASH

The rice husk is an agricultural waste which is obtained from milling process of paddy and approximately 22% of the weight of paddy is rice husk. The process produces about 25% ash containing 85% to 90% amorphous silica plus about 5% alumina, which makes it highly pozzolanic. "Study conducted by Mehta [2] indicated that concrete with RHA required more water for a given consistency due to its absorptive character of the cellular RHA particles.

S.No.	Component	Quantity(%)
1	Silica Dioxide	84-95
2	Aluminum Oxide	0-2.6
3	Iron oxide	0-1.6
4	Calcium Oxide	0-1
5	Magnesium Oxide	0-.9
6	Sodium Oxide	0-.28
7	Potassium Oxide	0-1
8	Carbon	1-3

Table -2: Chemical Properties of Rice Husk Ash

2.3 SUPER PLASTICIZER

To maintain the high workability of concrete mix with ASTM C494 type A, high range water-reducing admixture R1000 super plasticizer was used, which is a dark brown, water-soluble, chloride free sulphonated naphthalene formaldehyde. According to the manufacturer, it has 40% solid content with specific gravity of 1.2. A number of aspects are usually the result of the addition of super plasticizers, taking into account the durability and the resistance for the long-term maintenance. Water-reducing additives restrain concrete to be permeated with fluids and solutions. It has been found that the provision of a high plasticity and initial and final strengths are advantages of plasticizers involved in prefabricated concretes.

2.4 COARSE AGGREGATES

The fine aggregate used was mining sand passing by 4.75 mm sieve. The coarse aggregate was crushed granite with size of 4.75 – 19 mm. The specific gravity and the standard of the tests for both the coarse and fine aggregate were conducted as specified in ASTM C 127-88 and ASTM C128-97, respectively.. The sieve analysis two different sizes are listed below:

a. Aggregate with 100% passing 20 mm sieve and 100% retained on 10 mm sieve.

b. Aggregate with 100% passing 10 mm sieve and 100% retained on 4.75 mm sieve.

2.5 WATER

Water is an essential component of concrete, as it actually participates in the chemical reaction with cement. Because it helps to increase the strength of the cement gel, the quantity and the quality of the water needs to be studied in depth.

3. EXPERIMENTAL PROGRAM

Specimens corresponding to various pervious concrete mix proportions were subjected to destructive testing to evaluate the influence of rice husk ash (10% by the weight of cement) and super plasticizers (0.15% & 0.25%) on the various mechanical properties of the concrete such as compressive strength, split tensile strength, flexural strength and bond strength. Results of each test have been mentioned in Tables 4.1 to 4.5. The variation of workability, compressive strength, split tensile strength and flexure strength of different concrete mix with age have been checked.

3.1 WORKABILITY

The workability of the concrete mix was measured by slump test. The slump of the concrete mix decreased with the addition of silica fume (6% of cement) and 0.13% of super plasticizers. The workability improved with the addition of 0.15% & 0.25% of super plasticizers.

Slump for Mix4, Mix5 and Mix6 has been decreased by 31%, 34% & 37% in comparison to Mix1, Mix2 and Mix3 respectively. The slump of pervious concrete mix Mix7, Mix8 and Mix9 decreased by 17%, 19% & 5% respectively w.r.t. Mix1, Mix2 and Mix3 and increased by 21%, 23% & 43% respectively w.r.t. Mix4, Mix5 and Mix6. The slump of concrete Mix10, Mix11 and Mix12 decreased by 29%, 22% and 14% respectively w.r.t. Mix1, Mix2 and Mix3 and increased by 6%, 17% and 37% respectively in comparison to Mix4, Mix5 and Mix6 respectively.

MIX. NO	SLUMP(mm)
MIX1	120
MIX2	135
MIX3	150
MIX4	83
MIX5	90
MIX5	95
MIX6	100
MIX8	110

MIX9	145
MIX10	85
MIX11	105
MIX12	130

Table-3: Workability of various pervious concrete mix proportions

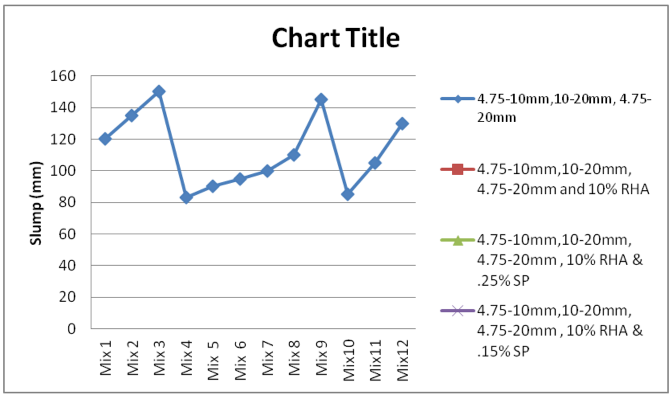

Chart-1 Variation of slump with different pervious concrete mix proportions.

3.2 Compressive strength

Compressive strength tests were performed on compression testing machine using cube samples. Three samples per batch were tested and the average strength of the values given in this paper. For this test concrete cube (150mmX150mmX150mm) or cylindrical specimen (150mm diameter, 300mm length)

Results of compressive strength of cubes of all mix proportions with water-cement ratio 0.34 have been shown in Table 4.2.and fig.4.

MIX. NO	7 DAYS	28 DAYS	56 DAYS
MIX1	17.11	22.65	24.15
MIX2	12.15	18.75	20.18
MIX3	14.10	19.27	21.42
MIX4	13.20	18.15	20.12
MIX5	9.16	15.25	18.75
MIX5	12.38	17.11	19.35
MIX6	16.45	21.14	23.95
MIX8	11.65	17.80	19.55
MIX9	13.90	18.32	20.59
MIX10	15.25	20.31	21.34
MIX11	10.27	16.18	18.25
MIX12	13	17.95	20.38

Table -4: Test results of compressive strength of different concrete mix proportions.

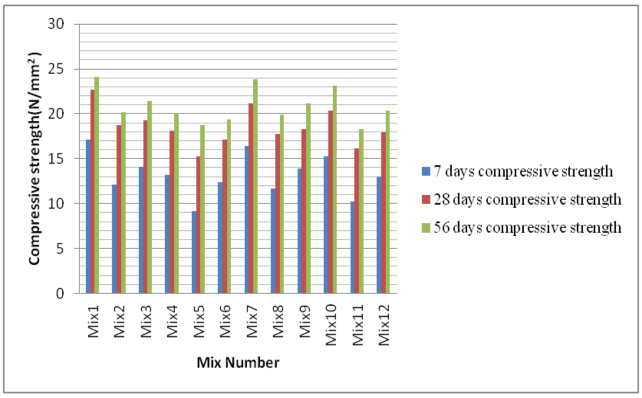

Chart-2 Variation of compressive strength of various pervious concrete mix proportions at different age.

The compressive strength of Mix1, Mix4, Mix7 and Mix10 was more than Mix3, Mix6, Mix9 and Mixl2 and Mix2, Mix5, Mix8 and Mix11 comparatively because pervious concrete made with small sizes aggregates has high strength in comparison to pervious concrete made with all-in-aggregates and with large size aggregates. The compressive strength of all the mix proportion with constant water cement ratio 0.34 at 7, 28 and 56 days has been shown in fig.4.5 to 4.8.The compressive strength of Mix1 is maximum and minimum at Mix5. The compressive strength of pervious concrete of Mix4 , Mix7 & Mix10 decreased by 20% ,7% & 11% respectively in comparison to Mix1 .The compressive strength of pervious concrete of Mix5, Mix8 & M11 decreased by 19%, 5% & 14% respectively w.r.t. Mix2. The compressive strength of pervious concrete of Mix6, Mix9 & Mix12 decreased by 12% , 5% & 8% respectively with respect to Mix3. Compressive strength was maximum at Mix1 and minimum at Mix5.

3.3 SPLIT TENSILE STRENGTH

This test also termed as Brazilian test. This test is more accurate than other tensile strength test to determine tensile strength of concrete. In this test cylindrical concrete specimen is used to find tensile strength. Results of split tensile strength of various pervious concrete mix proportions have been shown in Table 4.3. And Fig.4.9

MIX. NO	7 DAYS	28 DAYS	56 DAYS
MIX1	1.87	2.45	2.82
MIX2	1.54	1.83	2.28
MIX3	1.68	2.00	2.48
MIX4	1.52	1.82	2.19
MIX5	1.25	1.61	1.85
MIX6	1.45	1.75	1.98
MIX7	1.82	2.10	2.72
MIX8	1.50	1.78	2.15
MIX9	1.65	1.90	2.29
MIX10	1.62	1.97	2.35
MIX11	1.38	1.74	1.95
MIX12	1.56	1.87	2.10

Table -5: Test results for Split tensile strength of various pervious concrete mix proportions

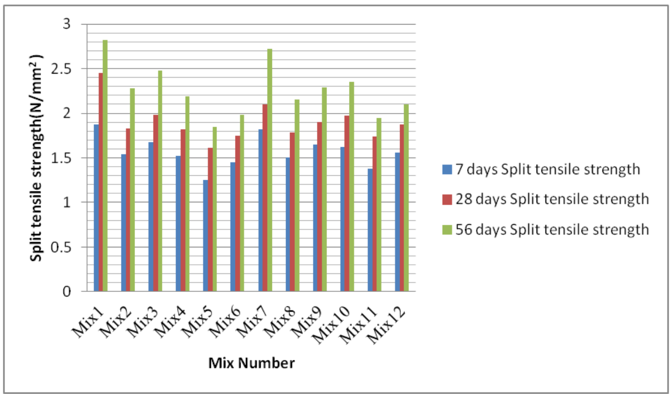

Chart-3 Variation of split tensile strength of various pervious concrete mix proportions at different age.

4. CONCLUSIONS

- Slump for Mix4, Mix5 and Mix6 has been decreased by 31%, 34% & 37% in comparison to Mix1, Mix2 and Mix3 respectively. The slump of pervious concrete mix Mix7, Mix8 and Mix9 decreased by 17%, 19% & 5% respectively w.r.t. Mix1, Mix2 and Mix3 and increased by 21%, 23% & 43% respectively w.r.t. Mix4, Mix5 and Mix6. The slump of concrete Mix10, Mix11 and Mix12 decreased by 29%, 22% and 14% respectively w.r.t. Mix1, Mix2 and Mix3 and increased by 6%, 17% and 37% respectively in comparison to Mix4, Mix5 and Mix6 respectively.

- The compressive strength of Mix1 is maximum and minimum at Mix5. The compressive strength of pervious concrete of Mix4 , Mix7 & Mix10 decreased by 20% ,7% & 11% respectively in comparison to Mix1 .The compressive strength of pervious concrete of Mix5, Mix8 & M11 decreased by 19%, 5% & 14% respectively w.r.t. Mix2. The compressive strength of pervious concrete of Mix6, Mix9 & Mix12 decreased by 12% , 5% & 8% respectively with respect to Mix3. Compressive strength was maximum at Mix1 and minimum at Mix5.

- The split tensile strength of Mix4, Mix7, Mix10 decreased by 26%, 14% and 20% respectively with respect to Mix1. The split tensile strength of Mix5, Mix8 & Mix11 decreased by 14%, 4% and 7% respectively w.r.t. Mix2.The split tensile strength of Mix6, Mix9 & Mixl2 decreased by 12%, 3% &5% respectively in comparison to Mix3. The split tensile strength was maximum at Mix1 and minimum at Mix5

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