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DEVELOPMENT OF PAVER BLOCK BY USING RICE HUSK ASH WITH THE PARTIAL REPLACEMENT OF CEMENT

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ABSTRACT

Rice husk ash is pozzolanic material with high silica content. It is a byproduct of boilers industries, where rice husk has been used as a fuel for burning and maintaining high temperature. Applications of rice husk ash in Paver block, which is technically sound and environmentally safe for sustainable development. In this study, partial replacement (by weight) of cement with RHA in paver blocks for determining the change in the compressive strength, water absorption and abrasive resistance of paver blocks. Partial replacement of cement in different percentage as like 0%, 15%, 20%, 25%, 30%, 35% and 45% has been done. The compressive strength has been determined at the end of 7, 28 and 56 days, water absorption test and abrasion resistance has been determined at 28 days.

Keywords : Abrasion resistance, compressive strength, paver block, rice husk ash (RHA), water absorption.

I. INTRODUCTION

According to the IS 15658:2006 Paver Block is a solid, un-reinforced pre-cast cement concrete paving units used in the surface course of pavements, with minimum horizontal cross-section of 50mm from any edge in any direction, having aspect ratio not more than four, except for complementary products. Paver Block is a commonly used decorative method of creating a pavement or hard standing. The main benefit of using paver blocks over other materials is that individual block can later be lifted up and replaced. Today precast concrete paver blocks are the most preferred choice for paving of footpaths, parking lots, bus stops, industries, for making roads in villages etc.

RHA Paver Blocks is an eco-friendly concrete paver block using RHA with the partial replacement of cement. Rapid growing of infrastructure development has made Portland cement concrete is the second most consumed commodity on earth. Due to manufacture of ordinary Portland cement, large amounts of carbon dioxide (CO2) is generated and released into the atmosphere. These reasons have initiated research in sustainability and eco-

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friendly methods for infrastructure development. Disposal of waste is another huge problem. This research has combined sustainability with waste management leading to a wonderful product called RHA paver blocks.

The mechanical properties in terms of flexural and tensile strength have been significantly improved with the addition of RHA and the fine RHA exhibited the highest shrinkage value due to the effect of micro fine particles which increases its shrinkage values considerably. (Habeeb and Fayyadh, 2010)

The use of rice husk ash leads to enhanced resistance to segregation of fresh concrete compared to a control mixture with Portland cement alone. Also RHA can significantly reduce the mortar-bar expansion. The mechanical properties of concrete are enhanced when the substitution of Portland cement was done by RHA. **(**Alireza Naji Givi, et al 2010).

II. OBJECTIVE AND SCOPE

The objective of this dissertation is given below-

[1] To utilize the waste material such as rice husk ash in paver blocks.

[2] To study properties of RHA used in paver blocks in lieu of cement.

[3] To study the effect of the partial replacement of cement with different replacement ratio i.e. 0%, 15%, 30%, 45% of RHA in the paver blocks used under light traffic conditions.

[4] To analyse/compare the properties like compressive strength, abrasive strength, water absorption and shape & size of RHA paver blocks with the conventional paver blocks.

[5] To develop RHA paver blocks using standard code of reference.

III. EXPERIMENTAL WORK

The Paver blocks were tested in terms of compressive strength, abrasion resistance and water absorption. In this study, normal cement concrete mix design for M 35 grade is used for the construction of Paver Block. IS 10262:2009 (Concrete Mix Proportioning Guideline) and IS 15658:2006 (Precast Concrete Block Paving - Specification) was used for design mix and different trials has been performed. In this concrete, cement, high water reducing & hardening admixture, coarse & fine aggregate and water is used. After the mix design is prepared, the replacement (by weight) of cement with RHA will be done with different ratios. The casting of paver blocks were done in a factory at Barwala with hydraulic press machine. The testing was conducted at NITTTR, Chandigarh.

The replacement was done in six different percentages. The engineering properties of paver block were tested according to the Indian Standards. For testing the compressive strength of paver block of I-shape of size 218 × 173 × 60 mm were casted and tested. The compressive strength of paver block was measured at 7, 28 and 56 days. Water absorption and Abrasion test was carried on 28 days. IS: 15658-2006 specifications were followed for testing of the paver blocks. This study aims at determining the suitability of using the RHA with partial replacement of cement in concrete paver blocks and helps us to make eco friendly paver block.

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IV. MATERIAL USED

4.1 Cement

Ordinary Portland cement of 43 grade was used throughout the investigation. The cement was available in the local market Chandigarh and kept in dry location. Table 1 shows the physical properties of OPC which were evaluated from the experimental work.

Table No. 1: Physical Properties Of Odinary Portland Cement

Sr. No.	Property	Results
1.	Fineness	3%
2.	Soundness	1 mm
3.	Setting time	Initial = 85 min Final = 165 min
4.	Specific gravity	3.15
5.	Compressive strength	After 3 days = 27.00 MPa
		After 7 days = 34.20 MPa
		After 28 days = 44.22 MPa

4.2 Rice Husk Ash

In this experimental work, rice husk ash is collected from Guru Metachem Pvt. Ltd. has been utilized. The chemical composition of the rice husk ash determined by X-Ray Fluorescence (XRF) analysis is shown in Table No.2 below.

Table No. 2: Composition Of Rice Husk Ash

Sr. No.	Constituents	Percentage Weight
1.	SiliconDioxide (SiO_2)	95.12
2.	Aluminium Oxide (AI_2O_3)	0.51
3.	Ferric Oxide (Fe_2O_3)	0.38
4.	Calcium Oxide (CaO)	0.61
5.	Magnesium Oxide (MgO)	0.39
6.	Sodium Oxide (Na_2O)	0.42
7.	Postassium Oxide (K_2O)	0.98
8.	Phosphorous Oxide (P_2O_5)	0.55
9.	Titanium Oxide (TiO_2)	0.05
10.	Sulphur Trioxide (SO_3)	0.10
11.	Chloride (Cl)	0.09
12.	Mangenese Oxide (MnO)	0.05
13.	Rhenium (Re)	0.02
14.	Others	0.73

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It can be seen from the above table that the rice husk ash contained a very high percentage of silicon dioxide as indicated by the values above. The specific gravity of rice husk ash using the density bottle test was found to be the 2.38.

4.3 Water

Prescribed in IS 456 : 2000, the potable water free from injurious amounts of deleterious materials and fit for drinking purposes was used for mixing as well as curing of concrete.

4.4 Aggregates

Aggregate plays an important role in concrete and its functioning. It account for 75-80% by mass in concrete. Aggregate is the granular material, such as gravel, crushed stone, sand, blast-furnace slag, or construction and demolition waste etc. that is used with a cementing medium to produce concrete.

4.4.1 Fine Aggregates

Fine aggregate (sand) are those that pass through No.4 (4.75 mm) sieve and are retained on the No. 200 (75 µm) sieve. The fine aggregates were tested as per IS: 383-1970. Washed sand from local crusher was used. The SSD (saturated surface dry) coarse and fine aggregates were used. The properties of F.A. used were as under:

Table No. 3: Properties of Washed Sand

Characteristics	**Value**
Grading zone of fine aggregates	Zone III
Specific Gravity	2.70
Silt Content	2.79%

4.4.2 Coarse Aggregate

Coarse aggregate are those, retained on the No. 4 (4.75 mm) sieve. Sieve analysis helps to find out size of aggregate and to determine the particle size distribution of coarse aggregates. The aggregates were tested as per IS: 383-1970. Crushed stone aggregate angular in nature is obtained from local crusher was used. The SSD (saturated surface dry) coarse and fine aggregates were used. The 10mm coarse aggregate is used in the study.

Table No. 4: Properties Of Coarse Aggregates

Characteristics	**Value**
Shape	Angular
Maximum Size	10 mm
Specific Gravity	2.76
Impact Value	5.9 %
Crushing Value	19.43

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4.5 Admixture

High range water reducing agent/super plasticizer and high early strength is used in the mix to reduce the water content in the mix and to obtain the initial hardening of the paver blocks so that the paver blocks should be stacked as early as possible.

V. MIX PROPORTIONS

The mix proportion shown below was used in the study for the making or conventional paver blocks.

Table No. 5: Mix Proportation

Material	Material source / Type	Weight Kg/m^3
Cement	Chandigarh City / OPC - 43 Grade	420
Sand	Local Crushers / Washed Sand (Zone III)	980.64
Coarse Aggregate	Local Crushers / Crushed Aggregates	1100.98
Rice Husk Ash	Guru Metachem Pvt. Ltd., Ahemdabad	Nil
Admixture	High Early Strength and High Range Water Reducing Agent.	2.1
Water	Clean and Portable Water	109.2

Further the cement is partially replaced (by weight) with RHA in the ratios of 0%, 15%, 20%, 25%, 30% 35% and 45%.

VI. RESULTS AND DISCUSSION

The Paver Block is designed on the basis of IS: 15658–2006 as per M-35 Grade Designation of-Paver Blocks. The results which are comes out from testing is given below:

6.1. Compressive Strength

After casting, the specimens (paver blocks) were tested by compression testing machine at 7 day, 28 days and 56 days for compressive strength shown in table and graph below.

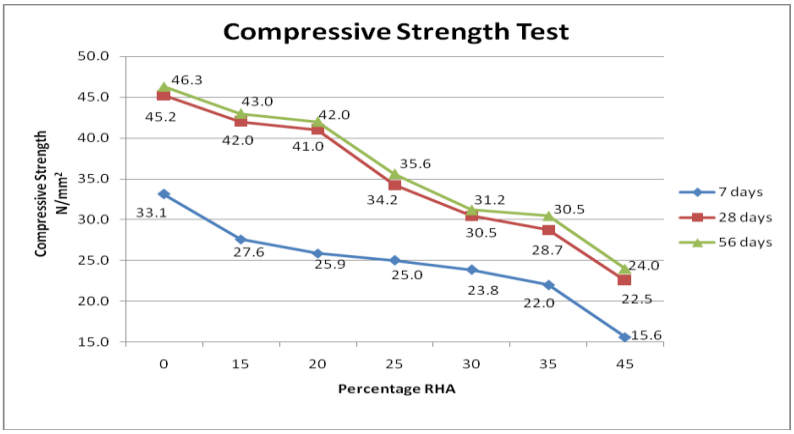

Figure 1- Compressive Strength Test Results

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6.2. Water Absorption Test

After casting the specimens (3 for each replacement ratio) were tested for water absorption at 28 days. The table & graph for the water absorption has been shown below.

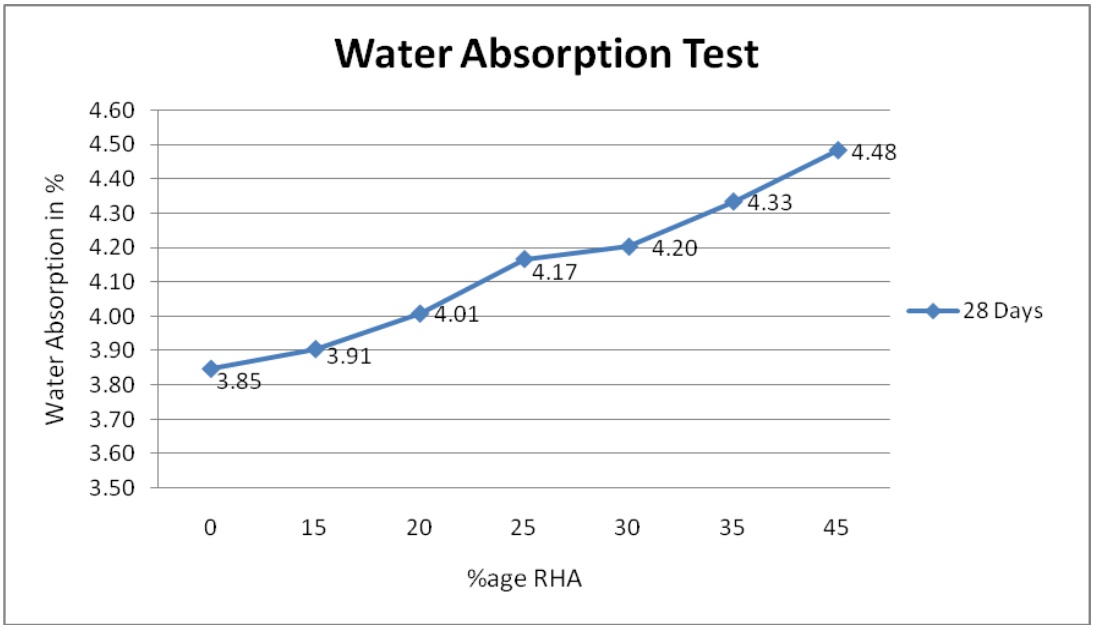

Figure 2- Water Absorption Test Results

6.3. Abrasion Resistance Test

After casting, the specimens were tested by abrasion testing machine at 28 days for abrasion resistance shown in table and graph below.

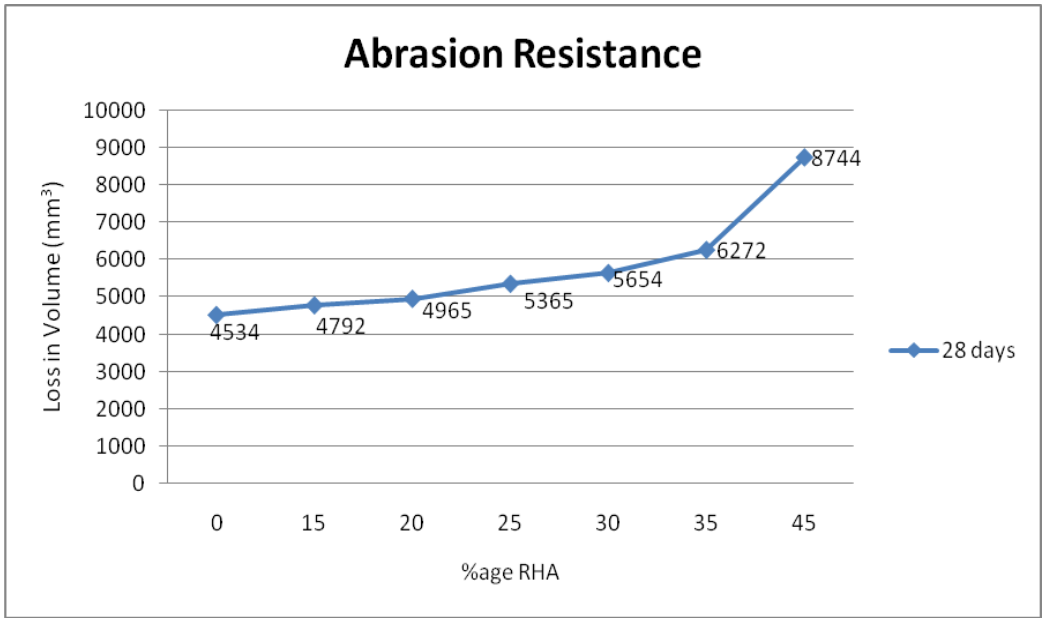

Figure 3- Abrasion Resistance Test Results

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VII. CONCLUSIONS

This work can be suitable for light traffic conditions as per IS 15658:2006. It has been seen from the above results that:

1. As the percentage of RHA increases the compressive strength of specimen decreases.
2. The abrasive resistance of the specimen decreases with increase in percentage of RHA.
3. The optimum level for the replacement (by weight) of RHA for light traffic condition i.e. M35 grade, I - shaped paver blocks made with hydraulic press/mechanical hydraulic machine is found to be 20%.
4. RHA based paver blocks are an economic environmental friendly solution to rice producing nations like India. The price of 1 ton of RHA is only a small fraction of one ton production of Portland cement.

VIII. FUTURE SCOPE

1. Proper design mixes with varying percentages of RHA with cement should be prepared.
2. The behaviour of RHA paver bocks should be seen for longer duration of time with different parameters.
3. Behaviour of RHA paver blocks can be compared with paver blocks with other materials like fly ash.
4. A suitable code for practice for supplementary cementitious materials should be prepared in which suitable properties of RHA should be given in detail.
5. Incorporating Rice Husk Ash in concrete should be explored for the technical and economic advantages for the rice growing nations.

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http://www.scielo.br

List Of Codes:

Code for aggregate testing - IS: 383-1970

Code for Precast Concrete Blocks for Paving - IS 15658:2006

Concrete Mix Proportioning - Guidelines - IS 10262:2009