An Experimental Study on use of Rice Husk Ash in Stabilized Mud Blocks

Harsha H N[1] Radhakrishna[2] Amar R[3] Priyanka C K[4]
[1,3]Assistant Professor [2]Associate Professor [4]Student
[1,2,3,4]Department of Civil Engineering
[1,3,4]GEC, Hassan, Karnataka [2]RVCE, Bangalore, Karnataka

Abstract— In developing countries like India there is acute shortage of housing units, more than 60% of its population is living in sub standard houses, and there are huge demands for low cost building units. Generation of huge quantity of ash causes air pollution and other environmental impacts to nature when disposed off or unscientifically dumped into landfills. Hence there is a strong need to utilize ash in construction applications, effect of Rice husk ash (RHA) in Stabilized mud blocks (SMB) are investigated in this present study. In this experimental investigation, all the ingredient materials such as soil, Granite cutting dust (GCD), cement and RHA are basically tested. The mud blocks are casted by altering the percentage of water content and GCD and then the optimum values are selected. Ordinary Portland cement is replaced by RHA in varying percentage of 10%, 20%, 30% upto 100%. SMB's are casted by MARDINI block pressing machine. These are selected as optimum combinations. Then these blocks are tested for all engineering properties such as compressive strength, water absorption, and block density. By obtaining these values, results are tabulated, respective graphs are plotted and analyzed. Target wet compressive strength for grade 30 class SMB as per IS 1725-1985 is achieved by stabilizer proportion of 70% cement and 30% RHA.

Key words: Rice husk ash, Stabilized mud blocks, Granite cutting dust, Compressive strength, Block density, Water absorption

I. INTRODUCTION

The allocation of best quality housing is granted as a foremost responsibility for prosperity of people in all the countries. For this purpose, building materials depend on natural deposit are often used. The commercialized performance of these deposits frequently leads to abundant environmental issues. To lessen the effect on environment, earth can be used in numerous ways. But some undesirable properties of earth such as losing strength when immense with water, defective dimensional stability, erosion due to rain, these deficiencies can be discarded significantly by stabilizing the earth with cement or lime.

For every 1ton manufacturing of cement, closely 1ton carbon dioxide emission was established. This adverse response on environment can be reduced by the effective utilization of resources. Hence, the new technology target on stabilized mud blocks (SMB) advancement. Cement stabilized compressed earth blocks are energy effectual, cost minimization and habitat favorable (Environmental friendly) building materials.

India is a main rice yielding country. Rice mill originates a byproduct called as husk. Husk encloses the paddy grain. During milling about 78 % is collected as rice, bran and broken rice and remaining 22 % is collected as husk. In rice mills husk is utilized as fuel to produce stream for boiling process. During firing process, husk includes about 75 % of biological volatile substance and rest 25 % husk is converted into ash, the formed ash is known as Rice husk ash (RHA). 85% - 90% of amorphous silica is present in this RHA. Rice husk was used as a fuel in rice mill for boiler and for brick burning which produces pollution that can hazardous to the health of citizens around the site. This analysis tries to make use of RHA with partial and full replacement of cement.

II. MATERIALS

A. Soil

Soil is end product after successive weathering action of rocks. Soil characteristics vary depending on nature of the parent rock and different types of climatic influences at a particular site. Soil used in present study is obtained from the campus of government engineering college, Hassan. The soil is collected below 2 feet and passed on with 4.75mm IS sieve.

B. Granite Cutting Dust (GCD)

In the present research work, granite cutting dust is used, which is collected from lakshmi granite industries, located at industrial area in Hassan. This has particles sizes varying from 600µ-300µ.

Fig. 1: Granite Cutting Dust (GCD)

Sl. No.	Characteristics	Value	Unit
1	Specific Gravity	2.52	-
2	Bulk Density Loose density Compacted density	1.90 2.10	g/cc g/cc
3	Fineness Modulus	2.26	-
4	Bulking of GCD	33.60	%

Table 1: Physical properties of GCD

C. Cement

For the production of stabilized mud blocks, cement is used as a common stabilizer. For this experimental investigation 53 grade OPC conforming to IS: 4031(Part 4,5) -1988 has been used.

D. Rice Husk Ash (RHA)

Rice husk ash is obtained by burning rice husk. Rice Husk Ash (RHA) was supplied from a brick kiln The RHA collected from the kiln is free from debris and consists particles of different size.

As Rice husk ash obtained from brick kiln consists of several fractions and sieved through 90 micron IS sieve to match with the size of cement. Chemical and physical properties of ash are analyzed and represented in table 2 and 3 respectively.

Fig. 2: Rice Husk Ash (RHA)

Sl. No	Test conducted	% by mass, Cement	% by mass, RHA
1	Silicon dioxide (SiO2)	85.8	17-25
2	Calcium Oxide (CaO)	1.4	60-67
3	Magnesium Oxide (Mgo)	0.4	6(MAX)
4	Alumina (Al2O3)	0.25	8-Mar
5	Ferric Oxide (Fe2O3)	0.64	0.5-6
6	Sulphuric Anhydride(So3)	0.093	2.5(MAX)
7	Loss On Ignition	3.29	4(MAX)
8	Insoluble Residue	85.79	2
9	Sodium as (Na2O)	0.2	1(MAX)
10	Potassium as (K2O)	0.94	1(MAX)
11	Chloride (Cl)	0.028	0.10(MAX)

Table 2: Chemical composition of RHA

Sl. No.	Characteristics	UnitUnit	Value	Requirement as per
1	Setting time Initial setting time Final setting time	 Min Min	 150 215	IS:1727-1967
2	Standard consistency	%	34.00	
3	Specific gravity	-	2.15	

Table 3: Physical Properties of RHA

III. METHODOLOGY

In this experimental investigation, all the ingredient materials such as soil, GCD, cement and RHA are basically tested as per specified Indian Standard Codes. The mud blocks are casted by altering the percentage of water content and GCD with respect to soil. Based on maximum dry density (MDD) results, optimum ranges are selected as 10% (Water content) and 30% (GCD). SMB's are casted by MARDINI block pressing machine. Then the blocks are casted by 8% cement as main stabilizer for finding the MDD and optimum moisture content.

Based on the study results the combinations C2W5, C3W4 and C4W4 are selected. These selected combinations tested for both wet and dry compressive strength. As the study intends maximum utilization of industrial waste, so the combination C4W4 is selected for further experimental works. Ordinary Portland cement is replaced by RHA in varying percentage of 10%, 20%, 30% upto 100%.Target wet compressive strength for grade 30 class SMB as per IS 1725-1985 is achieved by stabilizer proportion of 70% cement and 30% RHA.

Abbreviated forms of combinations are:

C2W5 = 80% soil + 20%GCD + 8%cement + 12% water
C3W4 = 70% soil + 30%GCD + 8%cement + 11% water
C4W4 = 60% soil + 40%GCD + 8%cement + 11% water

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

A. Compressive Strength (Wet And Dry)

By studying physical and chemical composition of rice husk ash, stabilizer percentage is fixed as 8% and cement is replaced by RHA in various proportions. Compressed SMB's casted using selected combination of GCD and soil as C4W4. Cement has been replaced by RHA in the combinations of C4W4A1, C4W4A2, C4W4A3, C4W4A4, C4W4A5 and C4W4A6 are tested for wet and dry compressive strength and results are tabulated below.

In the above mentioned combinations A1,A2, A3, A4, A5 and A6 represents the RHA percentage of 10%, 20%, 30%, 40%, 50% and 60% respectively with respect to cement.

Composition	Wet Compressive Strength (N/mm^2)		
	3 days	7 days	28 days
C4W4	2.01	2.63	4.69
C4W4A1	1.74	2.80	4.38
C4W4A2	1.55	2.49	4.17
C4W4A3	1.23	2.21	3.97
C4W4A4	1.03	1.98	3.39
C4W4A5	0.83	1.49	2.61
C4W4A6	0.49	1.10	1.96

Table 4: Wet compressive strength of optimum combination (3, 7 and 28 days)

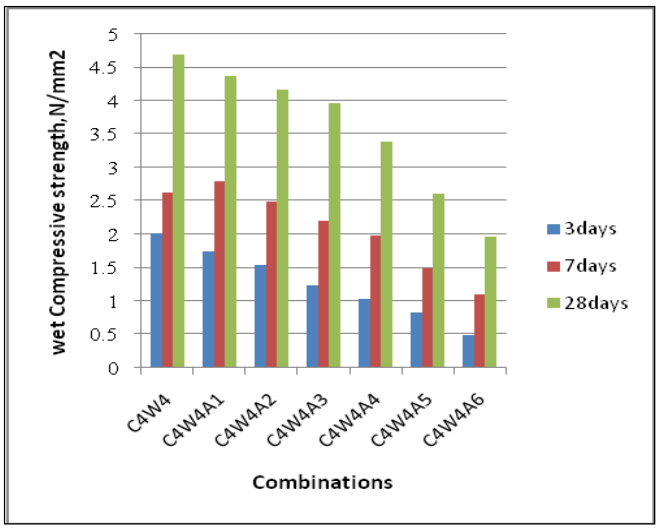

Fig. 3: Wet compressive strength results of RHA replaced combinations

Composition	Dry Compressive strength (N/mm^2)		
	3 days	7 days	28 days
C4W4	3.25	5.83	8.15
C4W4A1	3.14	5.60	8.04
C4W4A2	2.69	4.83	7.56
C4W4A3	2.41	4.73	7.28
C4W4A4	2.22	4.69	7.08
C4W4A5	1.76	4.34	6.67
C4W4A6	1.24	3.42	5.52

Table 5: Dry compressive strength of optimum combination (3, 7 and 28 days)

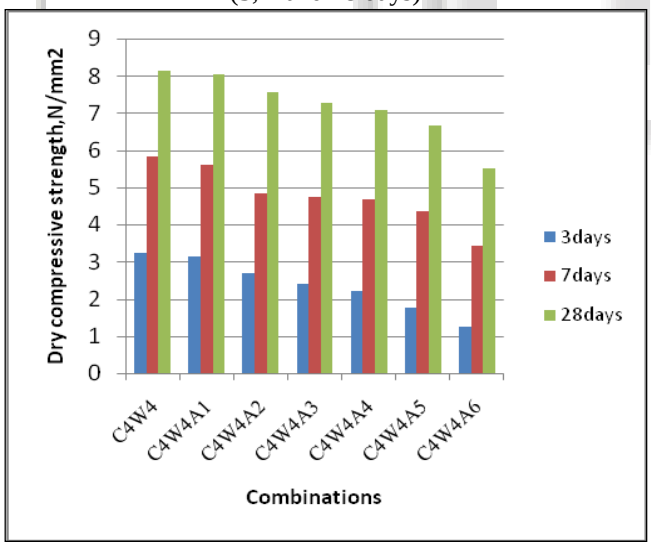

Fig. 4: Dry compressive strength results of RHA replaced combinations

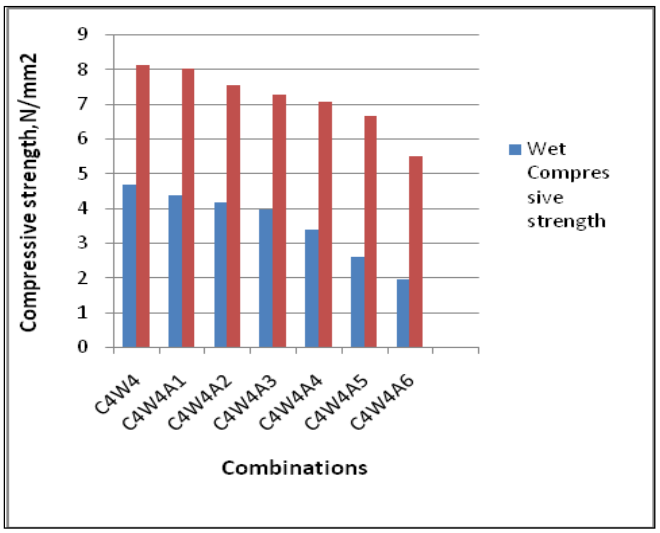

Fig. 5: Comparison of 28 days wet and dry compressive strength of different combinations

B. Block Density

Rice husk ash incorporated stabilized mud block are cured or 28 days and sun dried to determine the density of block. Three blocks are taken for calculating block density. Volume of each block is calculated by measuring length, width and height. Block density is the ratio of mass of block in grams to the volume of block in cubic centimeter.

Sl. No.	Block mass (gms)	Block volume (mm3)	Density (g/cc)	Average density (g/cc)
Block1	4990	232×108×98	2.03	2.02
Block2	5002	230×109×99	2.01	
Block3	5019	231×108×99	2.03	

Table 6: Test results for dry density of blocks

C. Water Absorption Test

Water absorption test is done for compressed stabilized mud blocks prepared using optimum combination of granite cutting dust and RHA. Test procedure followed is in accordance with IS 3495-1992 (Part 2) and results for three blocks tested are tabulated below. Water absorption is given in terms of percentage absorption of water gained after immersion in cold water for 24 hrs.

Fig. 6: Water absorption of blocks

SI. No.	Initial mass (gms)	Final mass (gms)	Water absorption in %	Average water absorption in %
Block1	4980	5390	8.23	8.56
Block2	4992	5414	8.45	
Block3	4989	5439	9.01	

Table 7: Test results of water absorption test

V. CONCLUSION

RHA from brick manufacturing industries can be satisfactorily used as supplementary stabilizing agent with cement as main stabilizer.

Blocks with GCD as replacement for soil and RHA as stabilizer were found to have good surface finish with straight edges and well defined corners.

Compressive strength values gradually decreases with every percentage replacement of cement by RHA due to reduction of cement content.

Selected combination C4W4A4 gives a wet compressive strength of 3.39 N/mm^2 and dry compressive strength of 7.08 N/mm^2. Blocks produced with this combination come under class 30 grade of soil based blocks as specified in IS: 1725-1982.

Block density of 2.02g/cc and Water absorption of 8.56% was observed in GCD and RHA incorporated compressed stabilized mud blocks.

RHA stabilized mud blocks can be acceptably used as low cost alternative to conventional building blocks.

Finally it is concluded that industrial wastes such as GCD and RHA can be effectively used in the production of SMB.

REFERENCES

[1] Baba Shehu Waziri, Zanna Alhaji Lawan, Mustapa, Ma'aji Mala-"Properties of compressed stabilized earth blocks (CSEB) for low cost housing construction: A preliminary investigation"- International Journal of Sustainable Construction Engineering and Technology (ISSN: 2180- 3242), vol.4, No. 2, 2014

[2] Dr.S.M.Ali Jawaid-"Rice husk ash-lime blended building bricks"- International Journal of Earth Sciences and Engineering ISSN: 0974-5904, vol.03, no.02, April 2010, pp.302-309

[3] Jayanti Rajput, R.K.Yadav, R.Chandak- "Effect of rice husk ash used as supplementary cementing material on strength of mortar"- International Journal of Engineering Research and application (IJERA) ISSN: 2248 9622,vol.3,Issue.3, May-June 2014, pp.133- 136

[4] N.Vamsi Mohan, Prof.P.V.V.Satyanarayana, Dr.K.Srinivasa Rao- "Performance of rice husk ash bricks"- International Journal of Engineering Research and applications (IJERA) ISSN: 2248-9622, vol.2, Issue 5, September-October 2012, pp.1906-1910

[5] Fetra Venny Riza-"Application of RHA's pozzolanic properties in the making ofs CEB" International Journal of Sustainable Construction Engineering and Technology (ISSN: 2180-3242), vol.2, Issue 2, December 2011

[6] IS 2720-4 (1985): Methods of test for soils, Part 4: Grain size analysis, Bureau of Indian Standards, New Delhi, India

[7] IS 2720-5 (1985): Methods of test for soils, Part 5: Determination of liquid and plasticlimit Bureau Of Indian Standards, New Delhi,India

[8] IS 2720-3 (1980): Methods of test for soils, Part 3: Determination of specific gravity, Bureau Of Indian Standards, New Delhi , India

[9] IS: 12269-1987 - Specifications For 53 Grade Ordinary Portland Cement, Bureau Of Indian Standards, New Delhi, India

[10] IS 1727 (1967): Methods of test for pozzolanic materials, Bureau Of Indian Standards, New Delhi , India

[11] IS:1725 – 1982 "Specification For Soil Based Blocks Used In General Building Construction" Bureau Of Indian Standards, New Delhi , India

[12] K.S Jagadish "Building with stabilized mud" I.K international.

