LAUTECH Journal of Engineering and Technology 5(1) 2009:58 - 63

EFFECT OF RICE HUSK ASH IN THE PRODUCTION OF HOLLOW SANDCRETE BLOCK

F.A. Olutoge

Department Of Civil Engineering,
University of Ibadan, Ibadan, Nigeria.

ABSTRACT

The effect of Rice Husk Ash as a component of hollow Sandcrete blocks was investigated. The objective was to reduce the present high cost of building construction.

The rice Husk Ash used was derived from rice husk which is a bye- product of milling of rice. Batching of the material was done by weight and a nominal mix proportion of 1:6 of cement and sand respectively was used. One hundred and twenty samples of hollow sandcrete blocks were produced in two different sizes 226 x225 x 450 (mm) and 150 x 225 x 450 (mm). Various proportions of rice husk ash i.e. 0%, 4%, 10% 20% and 30% were used as replacement of cement in the mix. The compressive strength of the samples were determined after 28days using the universal testing machine and the average values obtained were 2.8, 2.2, 2.5, 2.0, and 1.7(N/mm²) respectively. It was concluded that rice husk ash blocks have relatively lower strength compared to blocks without rice hush ash. At 10% ash replacement however, the hollow block developed compressive values of 2.5N/mm² which met the minimum standard required for building construction. Cost analysis showed that a saving of 5.3% per block can be achieved through use of rice husk ash blocks. It was therefore recommended that rice husk ash blocks with up to 10% replacement can be used in building construction for non-load bearing walls such as fence walls and partitions.

INTRODUCTION

The Portland cement hollow block has been a major construction material in the building industry and progress in block technology should necessarily consider the fact that, there is need for conserving resource and the environment with proper utilization of energy. The increase in the cost of the most important constituent material of blocks i.e cement has made its necessary to search for other alternatives.

A reduction in the cost of the constituent material of blocks such as cement will go a long way in reducing the cost building construction, as this material i.e blocks take about 65% of a complete building's component.

Industrial and agricultural bye-products that would otherwise litter the environment as waste product or at best be put into limited use could gainfully be employed as building materials. Wastes can be used as filler material in concrete, admixtures in cement, and raw material in cement clinker, or as aggregates in concrete. One of such materials is Rice Husk. Rice husk ash is the product of the combustible reduction of rice husk. Rice Husk is the dry outer covering of rice seed, produced form milling of rice as an agricultural waste product.

Beagle and Beagle (1971) listed over thirty proved or possible uses of rice husk ash ranging from soil stabilization to abrasive components of toothpaste as apparently used in Sri Lanka, dust bath for conditioning coats of fur bearing animals and as an abrasive in mechanics. Geronimo (2003) reported that rice husk with less carbon and more silica can be used to produce rice husk ash, which can significantly improve the durability of concrete used in building and substantially replace silica fumes as an additive. In In a recent research program, Danish (2003) reported that rice husk ash is amorphous silica not crystalline and thus has no quartz inversion and melts at a lower temperature and are nearly all silica (99%), which has the ability to improve resistance to concrete against chloride penetration. Korisa (1958) carried out two different chemical analysis and the results obtained for the chemical compositions of rice husk ash showed the presence of elements like silicon, calcium and manganese, which constitute the major trace element in plant growth.

Jackson and Dhir (1988) reported that cement is the chemically active agent in its products, while the aggregate plays no part in chemical reactions.
Its usefulness arises because it is an economical filler material with good resistance to volume changes, which take place after mixing and it improves the durability of the products.
The focus of this study is to determine the effect of incorporating various proportions of rice husk ash replacement (5%, 10%, 20% and 30%) by weight of cement on the physical and strength properties of hollows sandcrete blocks and its economic considerations.
There are there different sizes of blocks used in the construction industry depending on the purpose of use. These sizes are:

- 225mm x 255mm x 450mm blocks (9 inches block)
- 150mm x 255mm x 450mm blocks (6 inches blocks)
- 102mm x 255mm x 450mm blocks (4 inches blocks)

METHODOLOGY

This section describes the experimentation carried out on hollow block samples of sizes 225mm x 255mm x 450mm and 150mm150mm x 255mm x

450mm. The contents of a conventional block are cement and sand in the ratio 1:6. Part of the cement used will be replaced by 5%, 10%, 20% and 30% of rice husk ash.

Production of Rice Husk Ash

Rice husk ash was realized as a result of burning rice husks. A cylindrical container opened at one end, and of about 700mm in height and 360mm in diameter was used for this purpose. Small holes of about 10mm in diameter were made on the closed ends using 10mm diameter nails. These holes were to facilitate the circulation of air during the destructive crystallization of the rice husk. The rice husk was compacted in three layers using palms, each layer with a height of about 150mm. The cylindrical container with compacted husk was placed on fire produced from dry wood and allowed to burn in open air for 5 to 6 hours before the woods were removed. The container was left for about 18 hours while the destructive distillation of rice husk into rice husk ash took place. The resulting rice husk ash was sieved with 0.3μmm sieve to remove the unburned husk.

Production and Testing of Blocks

The batching of materials for this project was done by weight since this is capable of eliminating error due to variation in the proportion or voids contained in a specific volume. A nominal mix proportion of 1:6 of cement and sand was used respectively with a water-cement ratio of 0.6 (value obtained from trial mixes). A manual method of mixing was adopted using the shovel, hand trowel and head pan. There were five different mixes for each type of block, one as control with no rice husk ash replacement while the remaining four were produce with ordinary Portland cement partially replaced with rice husk ash in various proportions. The proportions used were 5%, 10%, 20%, and 30% by weight of cement. The hollow blocks with 0% rice husk ash replacement were used as control sample for the purpose of comparison. The cement and rice husk ash were mixed dry separately with the required percentage replacement, then sand was added and all the materials mixed properly until a uniform colour was obtained. The required water content was added gradually to the mixed dry components and thorough mixing done to ensure uniformity.

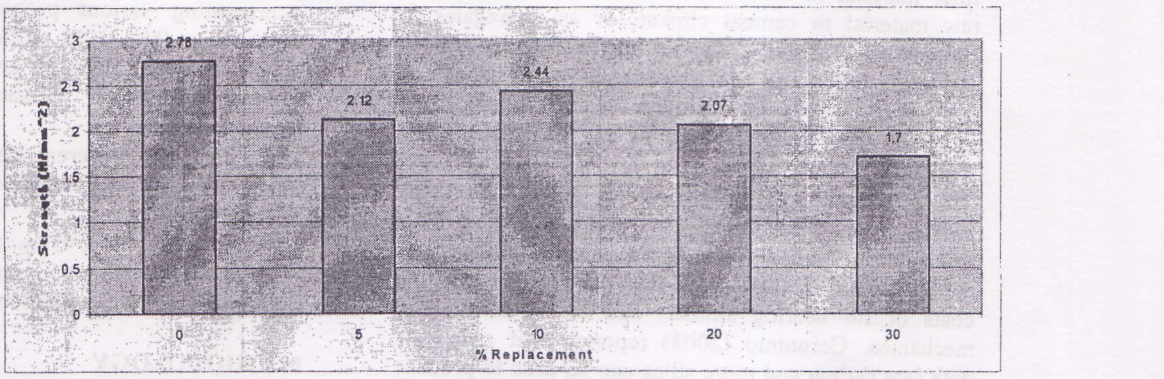
Two different sizes of mould were used for the two sizes of blocks (i.e 225mm x 225mm x 45mm and 150mm x 225mm x 450mm). The moulds were filled with the thoroughly mixed components and compacted with the thoroughly mixed components and compacted with not less than 15 strokes of stamping using an inch board (80mm x 300mm). The surface of the mould was then smoothened and excess material scraped off the surface mould using the inch board, the mould was then turned upside down on a flat smooth wooden surface of the blocks and the mould was removed immediately. Wetting of the blocks began twenty-four (24) hours after casting and this was done for the duration of twenty eight (28) days during which the blocks were left to dry under the effect of radiation from the sun. One hundred and fifty blocks were produced for testing. The blocks were subjected to compression test using the Avery Denison Universal Testing Machine. Steel weights placed on the bench of the machine were used to support the blocks after which the load cells were applied and necessary reading recorded.

RESULT AND DISCUSSIONS

The results obtained from the loading carried on the hollow Sandcrete blocks with different percentage replacement of cement by rice husk ask with their corresponding bar charts are shown in Table 1 to 6 and Figures 1to 6.

Table 1: Result of the first sample of 225 x 225 x 225 (mm) blocks, tested with the required percentage replacement of cement by rice husk ash.

Percentage Replacements	Dimension Ext. (mm)	Dimension Hole (mm)	Weight (kg)	Net surface area (mm^2)	Crushing load (kN)	Strength (N/mm^2)
0%	222x225x450	150x160	23.145	53250	148	2.78
5%	222x225x450	150x160	23.134	53250	113	2.12
10%	222x225x450	150x160	23.132	53250	130	2.44
20%	222x225x450	150x160	23.121	53250	110	2.07
30%	222x225x450	150x160	22.018	53250	90	1.70

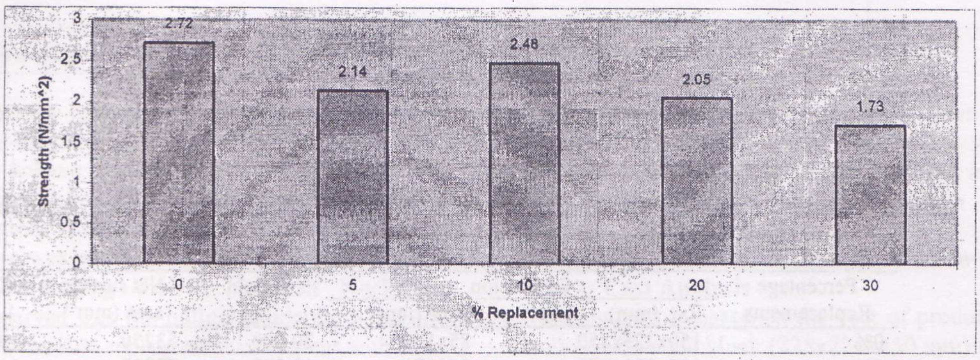


Percentage Replacement

Figure 1: First sample of 225x255x450 (mm) blocks (Compression Test)

Table 2: Result of the Second sample of 225 x 225 x 225(mm) blocks, tested with the required percentage replacement of cement by rice husk ash.

Percentage Replacements	Dimension		Weight (kg)	Net surface area (mm^2)	Crushing load (kN)	Strength (N/mm^2)
	Ext. (mm)	Hole (mm)				
0%	222x225x450	150x160	23.80	53250	145	2.72
5%	222x225x450	150x160	23.144	53250	114	2.14
10%	222x225x450	150x160	22.632	53250	132	2.48
20%	222x225x450	150x160	22.121	53250	109	2.05
30%	222x225x450	150x160	22.110	53250	92	1.73



Percentage Replacement

Figure 2: Second sample of 225x255x450 (mm) blocks (Compression Test)

Table 3: Result of the third sample of 225 x 225 x 225 (mm) blocks, tested with the required percentage replacement of cement by rice husk ash.

Percentage Replacements	Dimension		Weight (kg)	Net surface area (mm^2)	Crushing load (kN)	Strength (N/mm^2)
	Ext. (mm)	Hole (mm)				
0%	222x225x450	150x160	23.200	53250	145	2.70
5%	222x225x450	150x160	23.130	53250	114	2.12
10%	222x225x450	150x160	23.129	53250	132	2.44
20%	222x225x450	150x160	23.121	53250	109	2.10
30%	222x225x450	150x160	22.000	53250	92	1.765

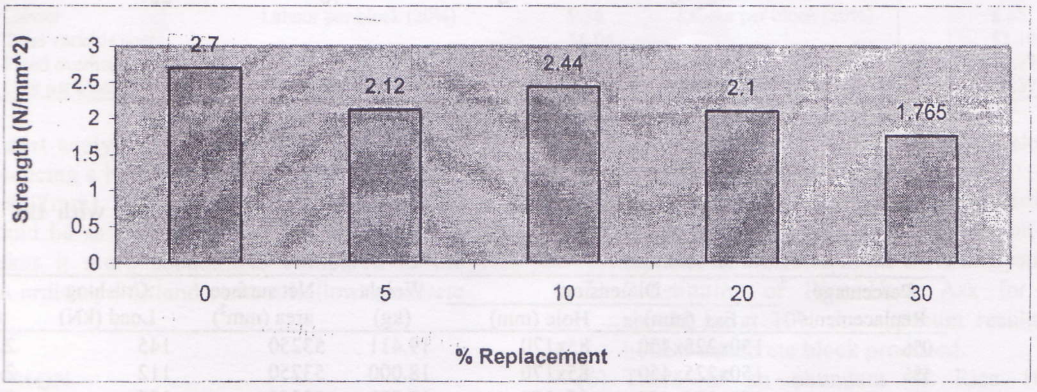


Figure3: Third sample of 225 x 225 x450 (mm) blocks (Compression Test)

Table 4: Result of the first sample of 150 x 225 x 450 (mm) blocks, tested with the required percentage replacement of cement by rice husk ash.

Percentage Replacements	Dimension		Weight (kg)	Net surface area (mm^2)	Crushing load (kN)	Strength (N/mm^2)
	Ext. (mm)	Hole (mm)				
0%	150x225x450	85x170	19.892	53250	147	2.77
5%	150x225x450	85x170	17.900	53250	114	2.12
10%	150x225x450	85x170	17.890	53250	134	2.52
20%	150x225x450	85x170	17.835	53250	111	2.09
30%	150x225x450	85x170	17.435	53250	95	1.79

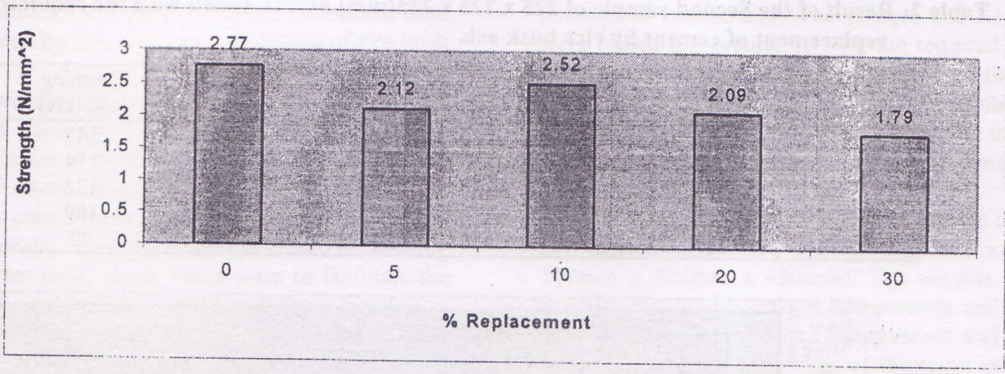


Figure 4: First sample of 150x225x450 (mm) blocks (compression Test)

Table 5: Result of the second sample of 150 x 225 x 450 (mm) blocks, tested with the required percentage replacement of cement by rice husk ash.

Percentage Replacements	Dimension Ext. (mm)	Hole (mm)	Weight (kg)	Net surface area (mm^2)	Crushing Load (kN)	Strength (N/mm^2)
0%	150x225x450	85x170	20.000	53250	147	2.77
5%	150x225x450	85x170	18.200	53250	115	2.17
10%	150x225x450	85x170	17.910	53250	136	2.56
20%	150x225x450	85x170	17.800	53250	110	2.07
30%	150x225x450	85x170	17.540	53250	97	1.83

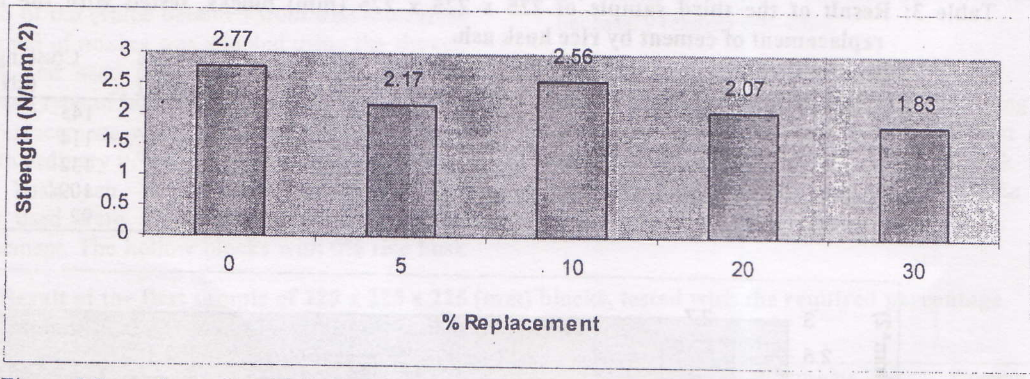


Figure 5:Second sample of 150x255x450 (mm) blocks (Compression Test)

Table 6: Result of the third sample of 150 x 225 x 450 (mm) blocks, tested with the required percentage replacement of cement by rice husk ash.

Percentage Replacements	Dimension Ext. (mm)	Hole (mm)	Weight (kg)	Net surface area (mm^2)	Crushing Load (kN)	Strength (N/mm^2)
0%	150x225x450	85x170	19.411	53250	145	2.73
5%	150x225x450	85x170	18.000	53250	112	2.11
10%	150x225x450	85x170	17.900	53250	134	2.52
20%	150x225x450	85x170	17.850	53250	109	2.05
30%	150x225x450	85x170	17.500	53250	93	1.75

The minimum strength required of the blocks is.80 N/mm^2

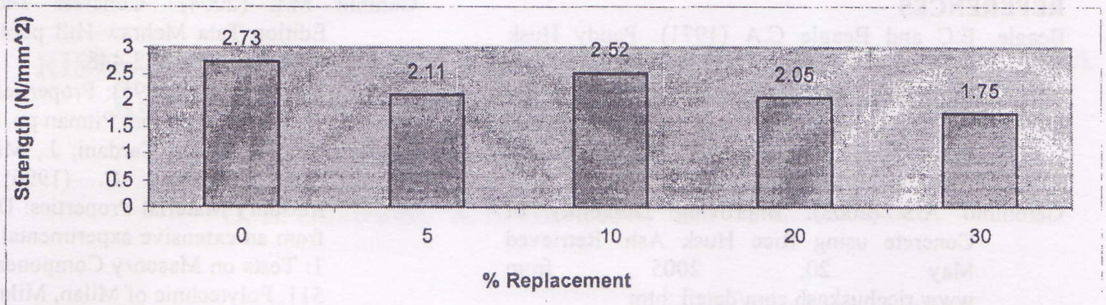


Figure 6: Third sample of 150x255x450 (mm) blocks (Compression Test)

From the results and graphs drawn, it could be observed that the 225 x 225 x 450(mm) and 150 x 225 x 450(mm) behave similarly under loading, In all cases, the unmodified block i.e the 0% replacement hollow sandcrete blocks was higher than other blocks in which there was partial replacement of cement with rice husk ash. Among the rice husk ash blocks, it would be observed that the hollow sandcrete block in which there were 10% replacement of cement with rice husk ash recorded the maximum strength. Further increase in the percentage replacement of cement with rice husk ash beyond 10% resulted in a decrease in the strength of the hollow sandcrete blocks.

The 10% replacement level which gave optimum strength values could be the point where the pozzolanic characteristics of rice husk ask and cement are at a maximum.

Economics Of Rice Husk Ash Hollow Sandcete Blocks Cost Analysis

This analysis is based on the cost of producing a unit hollow sandcrete block (225x225x450 mm) made from cement and sand, and a modified block made from cement, 10% replacement of cement using rice husk ash and sand.

Cost of Materials

Table 7: Direct Cost of Blocks

S/N	Description of Items	Ordinary Portland cement hollow sandcrete blocks	Cost	Cement/ RH.A Sandcrete block	Cost
1	Cement	1.66kg of cement= (1.66x870/50)	28.88	1.5kg of cement = (1.5x870/50)	26.10
2	Sand	(160/320) head pan of sand = (160/320x5600/160)	17.50	(160/320) head pan of sand	17.50
3	Water	1.5 liters	0.30	2 liters	0.40
4	Rice Husk Ash		-	0.166kg of R.H.A (0.166x150/100)	0.25
5	Labour	Labour per block (20%)	9.36	Labour per block (20%)	8.85
6	Total variable cost		56.04		53.10
7	Fixed overhead cost (25%)		14.03		13.27
8	Cost per block	O.P.C. Block	70.07	Cement/ R.H.A block	66.37

From the cost analysis, it can be inferred that a unit cost of producing a hollow sandcrete block of size 225 x 225 x 450(mm), made from Rice Husk ash and cement could be as low as N66.37 (5.3% reduction), which makes it more economical compared to the convention ordinary Portland cement hollow sandcrete blocks.

CONCLUSION

In this study, the results of incorporating various percentage of rice husk ash in the production of the hollow snadcrete blocks have been presented. From the results, the following conclusion can be drawn;

(1) Rice Husk Ask has the properties of a lightweight aggregate
(2) The water-cement radio needed by rice hush ash hollow sandcrete blocks is slightly higher than that of normal aggregates.
(3) It is possible to use rice Husk Ash as particle size substitute for cement to produce non-load bearing sandcrete blocks as it developed an average strength of $2.5N/mm^2$
(4) There is a slight resemblance in the particle size range of Rice Husk and the cement that it replaces as indicated in the sieve analysis.
(5) Substitution of Rice Husk Ask for cement should be at 10% for optimum results in the hollow sandcrete block produced.
(6) There is an abundant of Rice Husk in developing counties of the word and in this manner will help in removing millions of tonnes of waste from the environment yearly.
(7) There is a 5.3% reduction in cost per block if Rice Husk Ash hollow Sandcrete block is used instead of the conventional hollow Sandcrete block.

From the conclusion arrived at, it is recommended that Rice Husk Ash hollow Sandcrete block be used for fence walls, partitions and other non-load bearing walls.

REFERENCES

Beagle, E.C and Beagle C.A (1971): Paddy Husk utilization. Paper presented at UNIDO Conference on Rice Processing, Madras, India

Danish J. (2003): Use of Rice Husk in Concrete. Retrieved August 12 2003 from www.upe.br/hpc/paper.htm

Geronimo A.S (2003): Improving Durability of Concrete using Rice Husk Ash. Retrieved May 20, 2005 from www.ricehuskash.com/detail :htm

Jackson, N and Dhir, R.K (1988): Civil Engineering Materials, 4th Edition. The Northern Publishing co.Ltd, Liverpool, England pp 125-132

Korisa, J (1958): Rice and its Bye-Products, 2nd Edition, Arnold Edward Publishing co., London p. 442

Gamblir M.L (2004) : Concrete Technology 3rd Edition Tata Mchraw-Hill publishing Co.Ltd New Delhi. Pp 352-448.

Neville, A.M (1995): Properties of Concrete, 4th Edition, London, Pitman pp. 8 – 30.

Baronio, G., Binda, L., Cardani, J., Mirabella, R.G., and Tiraboschi, C. (1996) : Measuring Masonry Material Properties: Detailed results from an extensive experimental research. Part 1: Tests on Masonry Components. Report No 511, Polytechnic of Milan, Milan, Italy.

Beati, S. and Ranocchiai, G (1994): A critical review of experimental techniques for brick material. Proc., 10th Int.

Brick and Block Masonry Conference, Calgary, Canada pp. 1247 – 1255.

Mehta, P.K. (1994): Rice Husk Ash – A Unique Supplementary Cementing Material, In: Advances in Concrete technology, MSh Report 94 – 1 (R) CANMET. Pp. 419 – 444.