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Influence of Rice Husks Ashes on Air-Drie dearth Bricks Characteristics

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Abstract

The objective of this article is to study rice husk ash (RHA) adding effect on the compressive strength, density and shrinkage of air-dried earth bricks. Two clay soils with different clay rates (one containing 60.6% clay and the other 41%) are mixed with RHA at rates ranging from 0 to 14% to make bricks. These bricks are subjected to density, shrinkage and compressive strength tests at different ages. The obtained results show that RHA increases the compressive strength and reduces the shrinkage of the bricks. This effect is optimal for a dosage of 8% RHA for bricks made with very clay soil and 4% RHA for those obtained with less clay soil. The best resistances are those of the bricks of the most clayey earth which, on the other hand, present a significant shrinkage.

Keywords: Rice husk ash, shrinkage, compressive strength, clay bricks, clay soil.

Introduction

The soil, which until recently had many constraints preventing its use in a generalized manner because of the ignorance of its properties, today presents a different panorama. The soil, which can be used in several ways, offers a wide range of architectural possibilities. Even if it is not all soil that can be used for construction, there is still a multitude of soil adapted to a certain technology, sometimes requiring an amendment on site. Many constructions have been built either with rammed earth construction, mud or even adobe technique, all over the world and, after centuries and centuries, they sometimes still show a good state of use.

The application of raw earth technologies cannot systematically replace conventional materials, such as concrete, because the latter has properties that earth material, even highly compacted such as certain Compressed Earth Blocks will never have.

Rice husks are agricultural by-products from husking rice, having a chemical composition (80 to 90% silica), prompting its application in many fields, especially in construction field[1-3]. They can be used directly or in the form of ashes obtained after incinerating rice husks. In all cases, these additions have been proven to improve the properties of soils or bricks[4-14]. The bricks considered are often bricks obtained from clay soil. Indeed, the clay contained in the earth serves as a binder in the manufacture of these bricks.

In this article, the study of rice husk ash (RHA) effect on the characteristics of air-dried earth bricks is envisaged using two earths with different clay rates. The objective is also to appreciate the effect of the clay content on the improvement brought by the RHA.

Materials and methods

RHA is obtained after incinerating rice husks which are waste products from the husking of Paddy rice. RHA used in this study come from Kovié, a village about 27km north of Lomé, the capital of Togo. RHA are light (Table-1) with a granular class of 0.063/1.

Two types of soil are used for this study. These soils come from the northern suburbs of Lomé. Table-1 presents the characteristics of the soils used. These two soils are sandy clays that do not contain humus, but soil N°1 (S1) contains more clay than sand, which is the opposite for soil N°2 (S2). S1 is plastic (PI> 15) with a clay content of 60.6%. S2 is less plastic (PI<15) with a clay content of 41%.

Table-1: Characteristics of the materials used.

Characteristics		Soil N°1 (S1)	Soil N° 2 (S2)	RHA
Sand and clay content	Sand content	39,4	59	-
	Clay content	60,6	41	-
Density	Absolute density (g/cm^3)	2,5	2,67	1,8
	Apparent density (g/cm^3)	1,18	1,21	0,28
Atterberg limits	Liquidity limit	30	23	-
	Plasticity limit	14	11	-
	Plasticity index (PI)	16	12	-
Water content (%)		4%	4%	-

To determine the influence of RHA dosage on the mechanical and physical characteristics of air-dried earth bricks, the RHA/ earth-ash mixture weight ratio is varied in a range from 0 to 14% in steps of 2%. Table-2 gives the quantities of materials used for each assay.

Table-2: Quantity of materials used for the different dosages.

RHA rate (%)	Soil weight (kg)	RHA weight (kg)	Volume of water for mixing (liters)
0	1716	0	315
2	1702	34,72	323
4	1675	69,79	336
6	1656	105,67	353
8	1594	138,60	375
10	1495	166,11	381
12	1455	198,38	383
14	1430	232,84	390

The bricks produced are kept in shade, protected from sun and bad weather to best avoid the risk of cracking during setting (Figure-1). These bricks after conservation are subjected to density, shrinkage and compression strength measurements (Figure-2) according to standard EN 772[15] at age of 7, 14 and 28 days. Each result is the average of six (06) values.

Figure-1: Bricks kept in shade.

Figure-2: Compressive strength measurement.

The compressive strength (σ in MPa) is given by:

$$\sigma = \frac{F}{S} \tag{1}$$

where: F is the load at sample break, S is the sample area.

The shrinkage is measured on each side of the bricks and an average is calculated. The shrinkage is given by:

$$r = \frac{L_0 - L}{L_0} \tag{2}$$

Where: L_0 is the initial dimension of bricks, L: is the final dimension of bricks.

Results and discussion

Table-3 gives the densities of the samples of the various mixtures at seven (07), fourteen (14) and twenty-eight (28) days of age. The densities variation as a function of RHA rate according to the type of soil and the age is shown in Figure-3.

From 0 to 2% of RHA, the density of S1 bricks increases by 1.1% and decreases beyond 2% of RHA with a reduction rate of between 0.5% and 9%. The density of S2 bricks increases between 0 and 4% of RHA and decreases beyond 4% of RHA: the rate of decrease varies between 2% and 4.5% while the rate of increase varies between 1.5% and 9.5%. Indeed, due to lack of compression, there is a void volume inside the bricks dosed at 0%. The increase in the densities of the bricks dosed at 2% and 4% would be due to the decrease in the volume of void filled by the fine elements brought by RHA. The decrease in density is due to a greater substitution of the earth material by the ash material which has a low density compared to that of the earth.

The variation of the densities of S2 bricks are slightly higher than that of S1 bricks. The bricks made with soil S2 have the highest densities. This is explained by the high sand content (59%) that S2 contains compared to that of S1 (39.40%).

Table-4 presents the results of the shrinkage measurement carried out on the bricks on the 7th and 14th day of age. Figure-4 illustrates the brick shrinkage variation as a RHA rate function according to age and type of soil.

Table-3: Bricks densities.

RHA rate (%)	Soil S1			Soil S2		
	7 days	14 days	28 days	7 days	14 days	28 days
0	1,89	1,82	1,74	1,99	1,89	1,85
2	1,89	1,84	1,76	2,06	1,95	1,89
4	1,88	1,82	1,74	2,08	1,97	1,90
6	1,84	1,79	1,73	1,96	1,84	1,80
8	1,82	1,77	1,70	1,93	1,82	1,78
10	1,78	1,75	1,68	1,93	1,80	1,74
12	1,74	1,72	1,67	1,91	1,79	1,74
14	1,72	1,69	1,67	1,81	1,71	1,69

Table-4: Bricks shrinkage.

RHA rate (%)	Soil S1		Soil S2	
	7 days	14 days	7 days	14 days
0	4,00	4,11	3,46	3,50
2	3,72	3,75	2,18	2,20
4	3,14	3,37	2,12	2,18
6	3,66	3,69	2,11	2,14
8	2,25	2,31	2,35	2,37
10	2,47	2,49	2,30	2,33
12	2,67	2,73	1,62	1,68
14	2,82	2,82	1,48	1,51

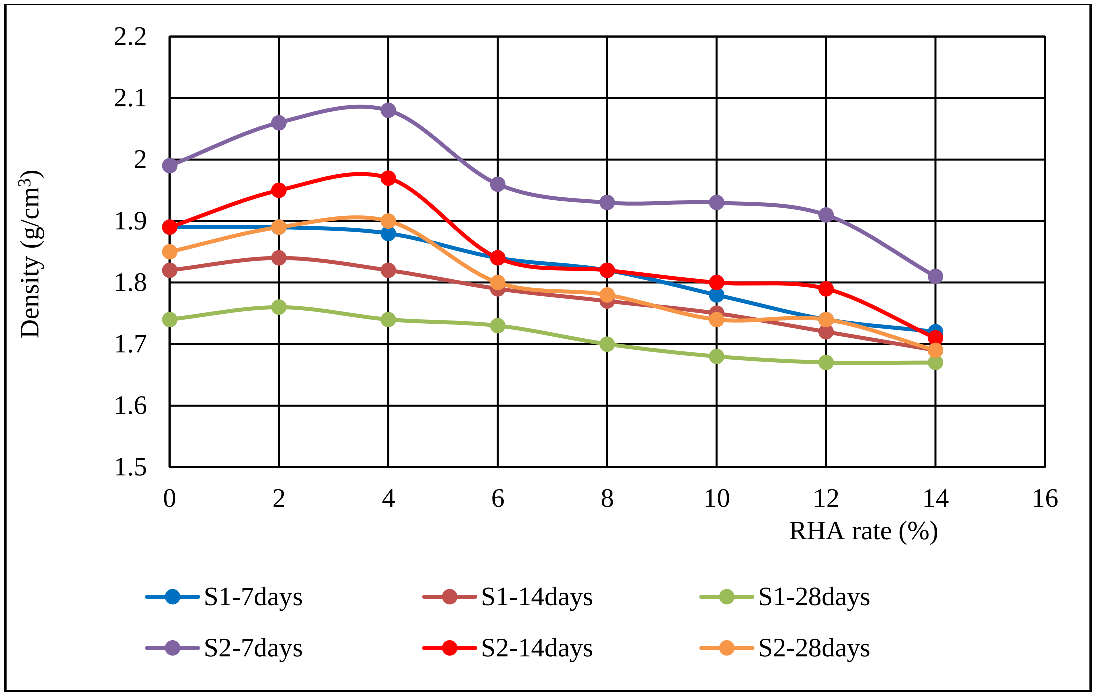

Figure-3: Density variation curve as a function of RHA rate.

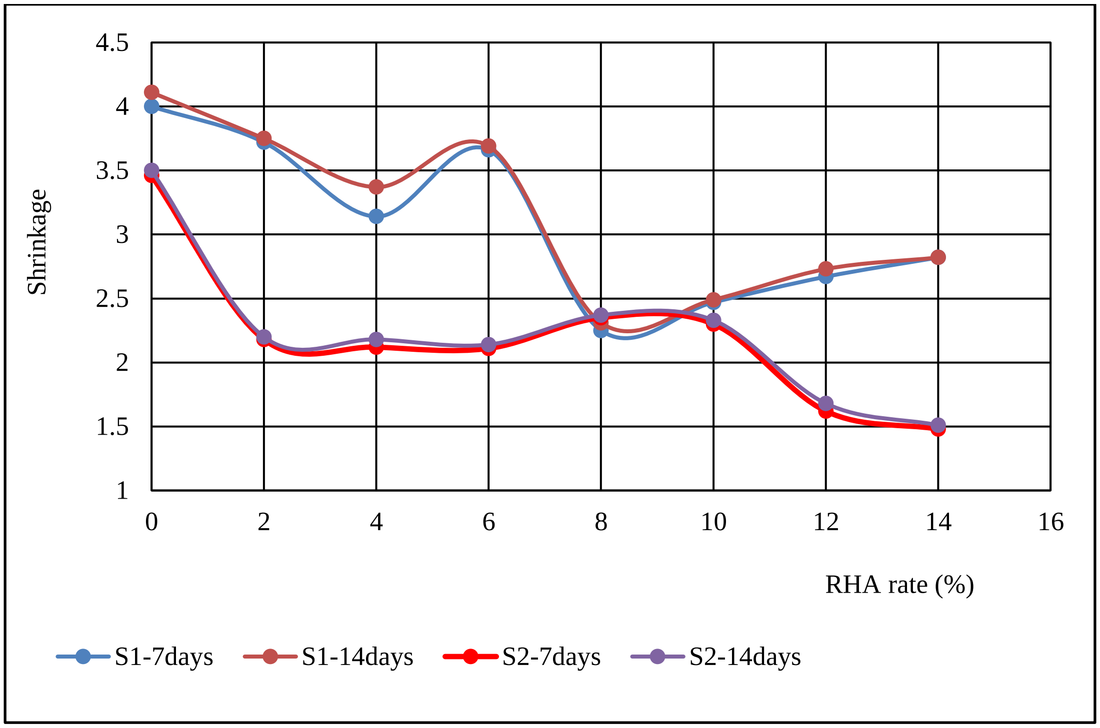

Figure-4: Variation of bricks shrinkage as RHA rate function.

There is a decrease in shrinkage at each age when RHA rate increases. This reduction varies from 7% to 44% for S1 bricks and is maximum at 8% of RHA. For S2 bricks, the decrease varies from 37% to 57% and is maximum at 14% of RHA. The shrinkage is more important for S1 bricks than S2 bricks: in fact, S1 contains more clay than S2 and the clay is at the origin of the more or less significant shrinkage of the earth bricks. The shrinkage decreases faster for S2 bricks than for S1 bricks: the effect of RHA is not the same for the two types of earth. One could say that a soil containing more than 50% of clay is less sensitive to the addition of RHA than a soil containing less than 50%.

The results of the compressive strength measurement tests are shown in Table-5.

Table-5: Bricks compressive strength.

RHA rate (%)	Compressive strength (MPa)			
	Soil S1		Soil S2	
	14days	28 days	14days	28 days
0	1,19	0,40	0,82	0,42
2	1,86	0,74	1,01	0,89
4	1,87	0,72	1,12	0,99
6	1,92	0,72	0,91	0,82
8	2,42	1,02	0,89	0,67
10	2,21	0,82	0,99	0,69
12	1,89	0,62	0,99	0,82
14	0,97	0,80	1,00	0,70

Bricks compressive strength variation according to the earth used, the age and the RHA rate is illustrated in Figure-5

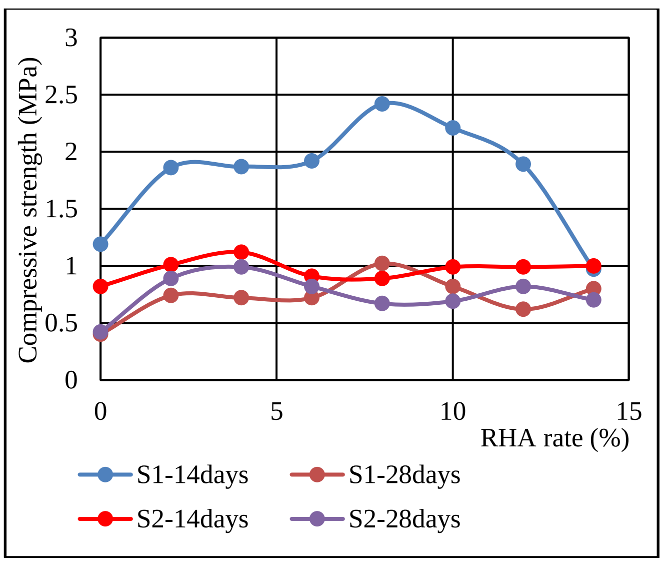

Figure-5: Variation of bricks compressive strength as RHA rate function

Compressive strength for bricks dosed with RHA are higher that of bricks without RHA: RHA has therefore significantly improved the compressive strength of bricks. The S1 bricks have better resistance than S2 bricks. Clay being the binder in clay bricks, its presence at a more or less important rate influences the resistance of bricks.

On a given day, the compressive strengths of the bricks increase with the dosage of RHA to reach a maximum at an RHA rate then decreases: i. the increase rate varies from 56% to 155% for S1 bricks and is maximum at 8% of RHA. Beyond 8% of RHA, this resistance decreases but remains greater than the compressive strength of bricks without RHA; ii. for S2 bricks, the increase rate varies from 64% to 155% with a maximum at 4% of RHA. iii. The compressive strength is therefore optimal at 8% RHA for S1 bricks and 4% RHA for S2 bricks. This difference in optimal RHA rate for bricks is linked to the clay rate of the two earths: in fact, S1 containing more clay needs more RHA than S2 to reduce clay effect.

The bricks compressive strength increase would be due to a strengthening of the bonds thanks to the silica of the RHAs and a reduction in the phenomenon of shrinkage resulting from a reduction in the clay content. The decrease in compressive strength would be due to a significant decrease in clay in the soil, no longer allowing it to play its role of binder and thus making the bricks less resistant.

From the 14^{th} to the 28^{th} day of age, we notice that the compressive strengths decrease with a rate varying between 17% and 66% for S1 bricks and between 11% to 48% for S2 bricks. This decrease would be due to a fairly large evaporation of water and shrinkage causing cracks in the bricks causing their embrittlement.

Conclusion

This work consisted in investigating the rice husk ash (RHA) rate influence on the mechanical and physical characteristics of air-dried earth bricks. It also aims to assess the clay content effect on the improvement brought by the RHA to the clay bricks. To do this, RHA is mixed with two types of clay soil to make bricks, one soil being less clayey than the other.

It appears from the results obtained that the addition of RHA to the two earths improves the compressive strength and the shrinkage of the bricks produced. This improvement is optimal for a dosage of 8% for the most clayey soil and 4% for that which is less clayey. Bricks made with the most clayey soil have better resistance than bricks made with less clayey soil: a large presence of clay is therefore beneficial for resistance but harmful for shrinkage. Adding RHA helps to remedy this by increasing resistance and decreasing shrinkage. It would be important to know the limit values of clay rates to have in a soil for its use in the making of bricks.

References

1. Ghassan Abood Habeeb and Hilmi Bin Mahmud (2010). Study on Properties of Rice Husk Ash and Its Use as Cement Replacement Material. *Materials Research*, 13(2), 185-190.

2. Houston D.F. (1972). Rice Hulls. In: Rice: Chemistry and Technology. American Association of Cereal Chemists; St. Paul, MN, 301–340.
3. SK S. Hossain, Lakshya Mathur & P.K. Roy (2018). Rice husk/rice husk ash as an alternative source of silica in ceramics: A review. *Journal of Asian Ceramic Societies*, 6(4), 299-313, DOI: 10.1080/21870764.2018.1539210
4. Ramaji, A. E. (2012). A Review on the Soil Stabilization Using Low-Cost Methods. *Journal of Applied Sciences Research*, 8(4), 2193-2196
5. H. Chao-Lung, Bui LeAnh-Tuan & Chen Chun-Tsun (2011). Effect of rice husk ash on the strength and durability characteristics of concrete. *Construction and Building Materials*, 25(9), 3768-3772, https://doi.org/ 10.1016/j.conbuildmat.2011.04.009
6. M. S. Sultana, M. I. Hossain, M, A. Rahman, & M. H. Khan (2014). Influence of Rice Husk Ash and Fly Ash on Properties of Red Clay. *Journal of scientific research*, 6(3), 421-430. doi: http://dx.doi.org/10.3329/jsr.v6i3.15343
7. Ayite Y. M. X. D., Pachoukova I., Agbo K.E. and Bedja K. (2017). Study of improvement of mud bricks stabilized with cement characteristics by addition of rice husks ashes. *Research Journal of Material Sciences*, 5(7), 1-4
8. Leonardo Behak (2017). Soil Stabilization with Rice Husk Ash. Rice - Technology and Production, Amanullah and Shah Fahad, Intech Open. pp 1-238. ISBN: 978-953-51-3029-1, 978-953-51-3030-7,
9. Sasui, Watcharin Jinwuth and Sirimas Hengrasmee (2018). The Effects of Raw Rice Husk and Rice Husk Ash on the Strength and Durability of Adobe Bricks. *Civil Engineering Journal*, 4(4), 732-742. http://dx.doi.org/ 10.28991/cej-0309128
10. D. Eliche-Quesada, M.A. Felipe-Sese, J.A. López-Pérez, A. Infantes-Molina (2017). Characterization and evaluation of rice husk ash and wood ash in sustainable clay matrix bricks. *Ceramics International*, 43(1), Part A, 463-475.
11. A. M. Portillo-Rodríguez. (2013). Characterization of materials formed by rice husk for construction. 2nd International Meeting for Researchers in Materials and Plasma Technology, *Journal of Physics: Conference Series*, 466. 012038 doi:10.1088/1742-6596/466/1/012038
12. Yawovi Mawuénya Xolali Dany Ayité, Irina Pachoukova and Koffi-Sa Bédja. (2017). Effect of Rice Husks Concrete Preformed Coffers and Bricks Use on Building Structural Elements. *Advances in Materials*, 6(6), 159-164. doi: 10.11648/j.am.20170606.17
13. Ayite Y.M.X.D., Kodjo K.M. and Bedja K. (2011). Détermination d’une application des bétons de balles de riz dans le bâtiment au Togo. *Journal de la Recherche Scientifique de l'Université de Lomé*, 13(2), 1-8.
14. Patil Nita Babaso and Sharanagouda, H. (2017). Rice Husk and Its Applications: Review. *International Journal of Current Microbiology and Applied Sciences*, 6(10), 1144-1156. doi: https://doi.org/10.20546/ijcmas.2017.610. 138
15. European Standards CSN EN 772 (2015). Methods of test for masonry units.