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Short Communication

Study of improvement of mud bricks stabilized with cement characteristics by addition of rice husks ashes

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Abstract

This paper aims at studying the possibility of reducing cement rate in mud bricks stabilized with cement without impairing their characteristics. For this purpose, it is envisaged to add rice husks ashes to cement-soil mixture in various proportions. The study has consisted of making brick specimens which were submitted to density and compressive strength tests. The study has revealed that the addition of rice husks ashes not only increase bricks compressive strength but also reduce cement rate in the mixture.

Keywords: Rice husk ash, Mud brick, Cement stabilized, Compressive strength, Soil.

Introduction

The soil has been used in construction since olden days and is still today one of the most widespread materials. At present days, about one-third of the world population lives in an earthen habitat. The success of this construction method is explained by the availability of raw material. Bio-source material, universal, abundant and easily accessible, it has undeniable ecological and economic advantages. It also has the advantage of being able to be used in an extremely diverse manner (bricks, daub applied to a wooden armature, mud, etc.), thus offering a wide range of possibilities as well architectural as esthetical. This versatility of building soil allows it to be used in various contexts (rural or urban) and for different purposes (houses, silos, prestige building, etc.). The "raw soil" building material is made of mainly of sands, clays and water and has strength flaws. One of the solutions to improve properties of the material consists in stabilizing it to give it irreversible properties in face of physical stresses.

The stabilized soil is a mixture of clay soil, water and of a quantity of stabilizing agents intended to increase the compressive and humidity resistance of the material. Stabilization therefore consists of consolidating the soil natural qualities to obtain a durable building material. The stabilizing agents commonly used for stabilization are lime, cement, emulsions of bitumen or resins and soaps. The stabilizer often used in Togo is cement, with a rate varying between 6 and 10%, depending on soil nature[1,2].

In Togo, the agricultural waste management is often difficult because there is no regulation regarding the management of this waste. Each farmer manages its waste the best he can: most of the time, wastes are thrown into nature or burnt without special precautions. To overcome this phenomenon, one of envisaged solutions is the use of this waste in construction. Indeed, studies conducted worldwide, including the characterization of concretes based on palm oil shell[3-6] and rice husks[7-11], have shown that it is possible to obtain lightweight concretes with agricultural waste. It has even been shown that these concretes can be used in manufacturing bricks and interjoists[11-12].

In this article, the use of rice husks ashes in cement stabilized soil is being considered in order to reduce the cement rate which is increasingly expensive in Togo.

Materials and methods

Rice husks, waste from paddy rice decortications, are a very light and hygroscopic material[10-12]. The rice husks used in this study come from Kovié, a village about 27 km north of Lomé, the capital of Togo. They are used in ashes form (Figure-1) obtained after incineration of rice husks. To obtain ashes, rice husks are first burned. After rice husks incineration, black ash is obtained and poured into a closed basin so as to allow a slight air inlet in order to initiate a slow combustion. About 24 hours after, as a result of slow combustion, the black ash stored in the basin becomes gray, ready to be used for making the mortar.

The soil used comes from Tové, a village located at 50 km north of Lomé. It is a predominantly clay soil free of humus.

The cement which has served as binder in this study is the CPJ 35 distributed by the company CIMTOGO, one of the cement plants in Togo. The water used is the drinking water supplied by the company ‘‘Togolaise des Eaux’’ (TdE).

Table-1 below summarizes rice husks ashes and the soil used characteristics.

Table-1: Rice husks ashes and soil characteristics.

Characteristics		Soil	Rice husks ashes
Sand and clay content	Sand rate (%)	44,4	-
	Clay rate (%)	55,6	-
Density	Absolute density	2,5	1,33
	Apparent density	1,51	0,34
Limits of Atterberg	Liquidity limit (%)	31,77	-
	Limit of plasticity (%)	15,95	-
	Plasticity index	15,82	-
Water content (%)		17,64 %	-

Figure-1: Rice husks ashes.

To determine rice husks ashes influence on mud bricks stabilized with cement characteristics, we have varied rice husks ashes mass rate relative to rice husks ashes and cement mass from 0 to 60% in 10% increments. The soil mass is kept constant. The cement rate for the mixture without rice husks ashes is set at 9% of soil mass[1,2]. So doing, the mass of rice husks ashes and cement mixture remained fixed at 9% of the soil mass. The water volume is adjusted during bricks manufacture and must allow a good mixture moistening.

Table-2 shows quantities of materials used for each variation. These quantities allow obtaining six (06) bricks of dimensions 29x14x10 cm^3. The manufactured bricks are kept in the shade, sheltered from the sun and rains to avoid the risks of cracking during the setting. These bricks after storage are subjected to density and compressive strength tests according to European norm EN 772[13] at 7^{th} and 14^{th} day of age. Each result is the average of six (06) samples.

Table-2: Quantities of materials used.

Rice husks ashes rate	Soil mass (kg)	Cement mass (kg)	Rice husks ashes mass (kg)	Water volume (liters)
0%	54	5,0	0,0	6,0
10%	54	4,5	0,5	6,0
20%	54	4,0	1,0	6,4
30%	54	3,5	1,5	6,7
40%	54	3,0	2,0	8,0
50%	54	2,5	2,5	8,0
60%	54	2,0	3,0	8,0

Results and discussion

The bricks densities determined at 7^{th} and 14^{th} day of age are shown in Table-3. Relative variations of rice husks ashes bricks densities with respect to density of bricks without rice husks ashes are also shown.

Table-3: Bricks densities.

Rice husks ashes rate (%)	Day 7		Day 14	
	Density	Relative variation (%)	Density	Relative variation (%)
0	1,90	0,00	1,91	0,00
10	1,86	-2,10	1,77	-6,84
20	1,84	-3,15	1,79	-6,28
30	1,84	-3,15	1,78	-6,28
40	1,79	-5,79	1,71	-10,47
50	1,68	-11,58	1,66	-13,09
60	1,64	-13,68	1,61	-15,71

From the above table, it appears that bricks density decreases with the increase in rice husks ashes rate. This is due to the fact that rice husks ashes are less dense than cement. From the 7^{th} to the 14^{th} day, bricks density decreases due to water departure in the bricks.

The compressive strengths of specimens crushed at 7^{th} day and 14^{th} day of age are shown in Table-4. In this Table, for each crushing day, we also present the relative variation of rice husks ashes bricks compressive strength compared to those of bricks without rice husks ashes.

Table-4: Bricks compressive strength.

Rice husks ashes rate (%)	7^{th} day		14^{th} day	
	Compressive strength (MPa)	Relative variation (%)	Compressive strength (MPa)	Relative variation (%)
0%	2,34	0,00	2,26	0,00
10%	2,34	0,00	2,43	7,52
20%	3,25	38,89	2,53	11,95
30%	3,43	46,58	3,24	43,36
40%	2,51	7,26	2,32	2,65
50%	1,98	-15,38	1,74	-23,01
60%	1,25	-46,58	1,26	-44,25

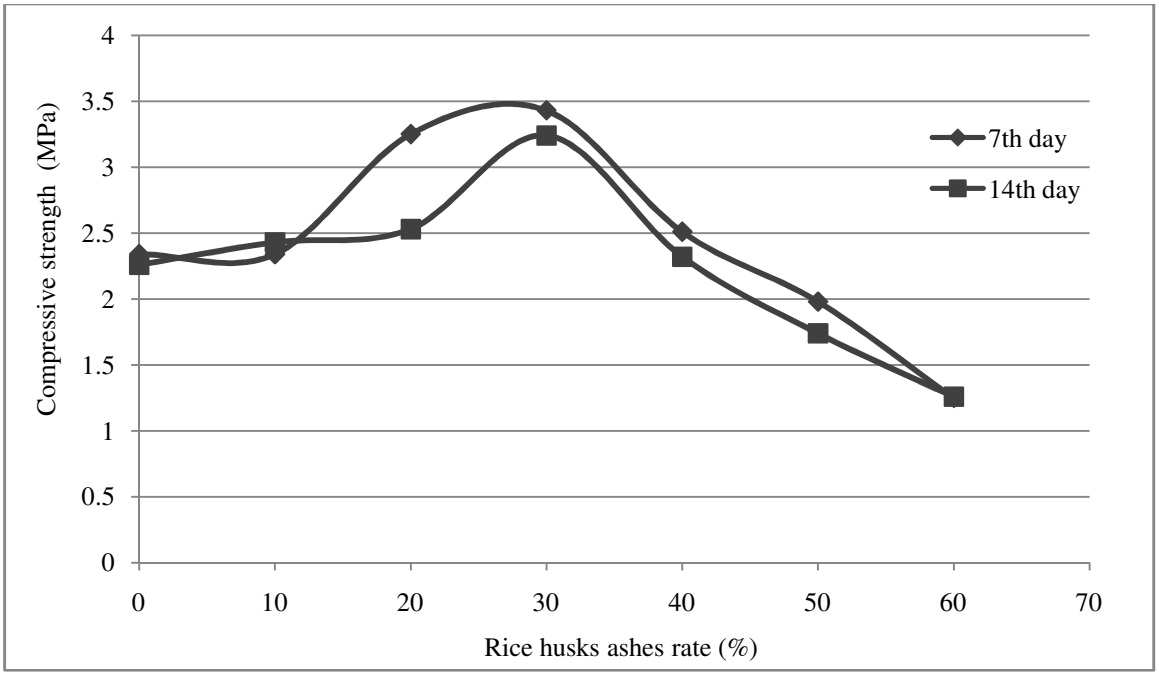

Figure-2: Variation of compressive strength as rice husks ashes rate function.

From Table-4, we obtain the curves of Figure-2 which illustrate the variation of bricks compressive strength as a function of rice husks ashes.

The bricks compressive strength variation curves as a function of rice husks ashes rate (Figure-2) present two phases of variation: i. an increasing phase that expresses a low rice husks ashes content resulting in a low hygroscopic power in bricks mass, a reduction in the shrinkage phenomenon and an increase in bricks compressive strength; this growth is observed for rice husks ashes rate less than or equal to 30% (Figure-2); ii. a decreasing phase which translates a rice husks ashes excess: indeed rice husks ashes become harmful in bricks since the cement becomes under dosed to act as a binder. Negative values of relative variation (Table-4) illustrate this decrease.

Rice husks ashes remarkably increase mud bricks stabilized with cement compressive strength (Figure-2). This increase is of 45% order. Beyond 50% of rice husks ashes, bricks containing rice husks ashes compressive strength is lower than those of bricks without rice husks ashes. Rice husks ashes dosage in soil may therefore be harmful to bricks compressive strength.

The optimum dosage for mud bricks stabilized with cement is 30% of rice husks ashes, approximately: 54kg of clay soil, 3.5kg of cement, 1.5kg of ashes of rice bales and 6.7 liters of water.

Conclusion

The effect of rice husks ashes rate on mud bricks stabilized with cement compressive strength has been this work purpose. The clay soil is mixed with rice husks ashes and cement in varying proportions. The density measurement showed that bricks density decreases with rice husks ashes content increase. The compressive strength determination results underscore that rice husks ashes improve by almost 45% bricks compressive strength and reduce the quantity of cement.

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