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Preliminary study on the use of corn cob as pore forming agent in lightweight clay bricks: Physical and mechanical features

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ABSTRACT

This study reports the effect of the incorporation of corn cob from Baleng (Cameroon) as pore forming agent in the production of porous ceramic brick. The bricks were prepared with addition of increasing amount of corn cob (0, 2, 5, 10, and 15 wt%) in the clay slurry. The samples were fired at different temperatures (900, 950, 1000, 1050, 1100 °C). Linear shrinkage, water absorption, porosity, apparent density and flexural strength of samples were measured and analyzed. It is observed that apparent density, flexural strength and linear shrinkage increase with temperature and decrease with increasing corn cob while the water absorption and the porosity decrease with higher temperature and increase with the amount of added corn cob. The obtained porous bricks could found uses as construction bricks or thermal/sound insulator parts.

1. Introduction

Ceramics are a huge class of materials largely consume nowadays. They are prepared at high temperatures from earthy materials (most often clays). To enhance the cohesion and/or the plasticity, additive materials are included to help retain shape during drying and firing [1]. As additives, many compounds such as sawdust [2], bauxite [3], starch [4], ashes [1, 5, 6], scrap glass powder [7], quartz [8], granodiorite [9], sub-micron alumina [10], boron nitride nanotubes [11], are used to reduce environmental problem associate to the pollution cause by certain wastes and/or to improve certain properties of ceramics products.

Corn cob is a traditional material with a low life-cycle [12]. It is an agricultural waste difficult to punch naturally. It is commonly used for stock farming, as fired wood in cooking, for the litter of hares, horses, oxen, sheep and cows [5]. It is used as substrate for the synthesis of Monascus pigment [13]. When corn cobs are burned, ashes are used as pouzzolan for blended cement [14,15]. Corn cobs have the potential to be used as a sustainable building material for thermal insulation or as filling material for external walls [16]. Corn cob particles also have a high thermal insulation performance [17].

Taking into account that corn cob, after extracting the corn, is generally considered as an agricultural waste, an interesting economic and sustainable benefit may result from its use in the building sector. For instance, it can be an alternative sustainable raw material for lightweight aggregate making. Pinto et al., [18,19] used corn cob for concrete making and show that the obtained products have the adequate properties required for lightweight concrete for non-structural application purposes. In Cameroon, the production of corn is one of the most important agricultural activities. Corn is used for beer manufacturing, breeding and for the human consumption. Large amount of corn cob derived from these activities is discarded as a waste. For instance, the institute of agricultural research for development of Cameroon (IRAD) was producing 817 million tons of corn in 2009. After Shinners and Binversie [20] and Pordessimo et al., [21], the mass of corn cob with respect to grain mass is average 10%. Hence, a production of 817 million tons of grain is associated to 81.7 million tons of corn cob waste for which usages are to be found instead of simple discarding. As reported by Palanivel [13], corn cob is made of 32.5%–45.6% cellulose; 39.8% of hemicelluloses and 6.7%–13.9% of lignin. The present work aim is to evaluate the effect of corn cob dosage as additive for porous clay bricks making. The obtained bricks are characterized by X-ray diffraction, physical properties (porosity, bulk density, water absorption, linear shrinkage) and mechanical (flexural strength) evaluation.

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Table 1
Chemical analysis of the clay (Elimbi et al., 2002) and that of the corn cob mineral ashes (CCMA).

Oxides	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	LOI[a]	Total
BO1 (%)	48,01	27,41	7,34	2,34	0,12	0,06	0,31	0,41	0,02	–	13,83	99,92
CCMA (%)	31,64	1,76	1,12	0,20	0,55	1,25	2,62	31,70	0,24	5,41	22,71	98,69

[a] LOI: Loss on Ignition.

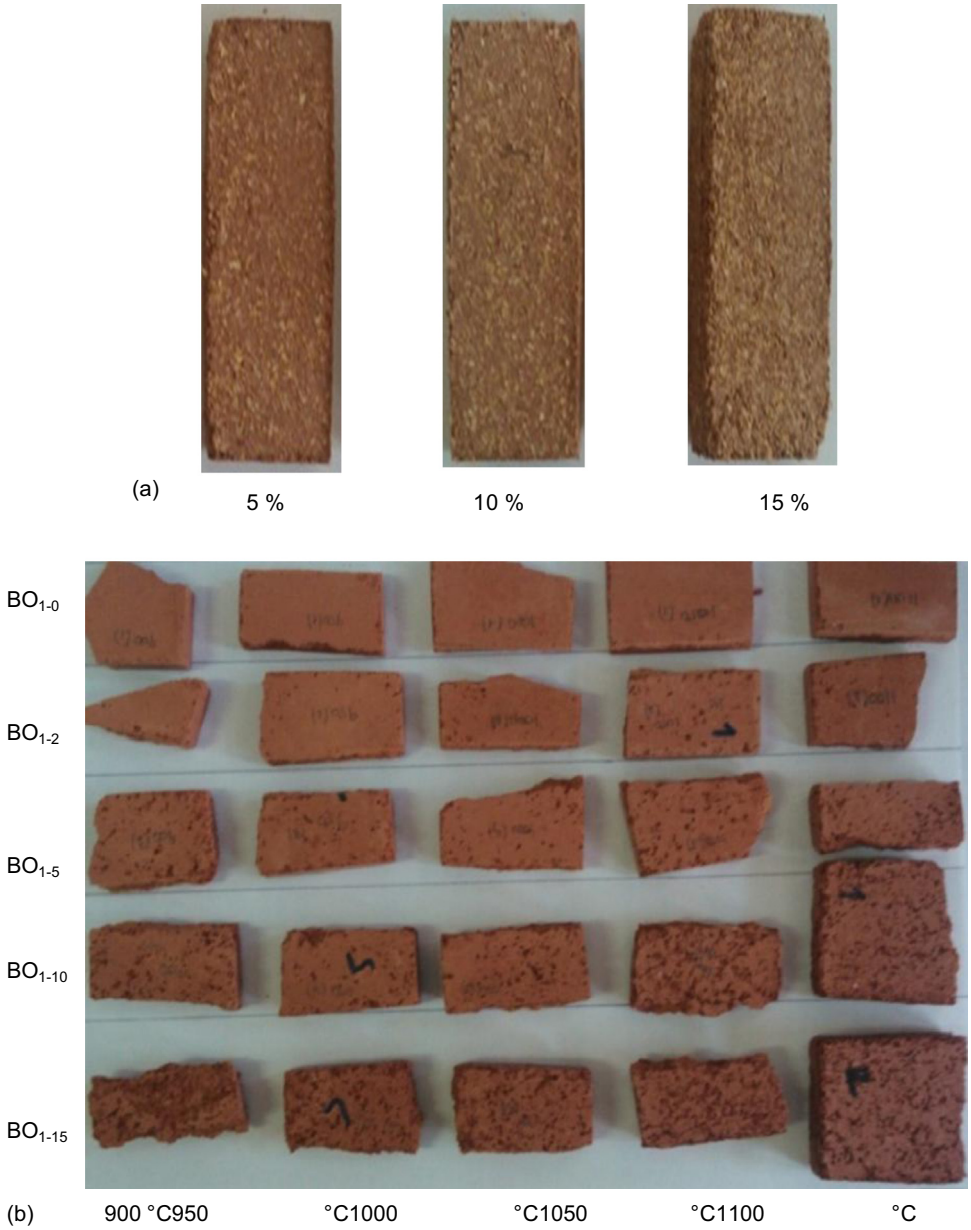

Fig. 1. Photographs of unfired corn cob–clay bricks (a) and fired corn cob–clay brick (b).

2. Materials and methods

2.1. Materials

Corn cob was taken in Baleng in the West region of Cameroon. It has a very heterogeneous macroscopic texture. The corn cob was punched and sieved using a 1.25 μm mesh. The loss on ignition at 550 °C of the corn cob was 92% and was indicative of the organics content. This organic content is in accordance with the average data reported by Palanivel [13]. The mineral ashes were 8% with average composition given in Table 1. It can be noticed that the main oxide in the corn cob mineral ashes are silica and potassium oxide.

The clay used is taken in the locality of Bomkoul (geographical coordinates 4°06′N and 9°48′E), in the Littoral region of Cameroon. Prior to their used, both corn cob and clay are crushed, ground and sieved using 1.25 mm sieve and kept in polyethylene bags. The clay sample is red and was subject to mineralogical and physico-chemical analyses in a previous study [22]. Table 1 shows the chemical composition and loss on ignition of the raw clay. The