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Impact of the wood chips content on the mechanical properties and relation between the young modulus and the compressive strength of clay bricks stabilized

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Abstract

Wood is an abundant resource of the forest, output and transformed by the wood industry, and joinery. This transformation generates a great quantity of waste which poses a problem of pollution of the environment. In order to take into account the management of the wood chips for the environmental protection and to reduce the cost of housing, clay bricks stabilized at 4% of cement blended with wood chips were manufactured. In order to evaluate the impact of chips and sawdust on the mechanical properties of bricks, an experimental study, was made on these bricks according to the various wood contents of various species [mahogany (or khaya ivorensis), kambala (or excelsa will chlorophora) and limba (or terminalia superba)]. A universal press and a centrifugal machine enabled us to make a correlation between the Young modulus and the compressive strength. We evaluated the effect of wood chips on the one hand, and the nature of wood on the other hand on the compressive strength and the Young modulus of bricks. The results obtained show that the incorporation of the shavings decreases the rigidity of bricks; and that the bricks stabilized with cement and blended with the kambala waste are more rigid than those with mahogany and limba waste. We established the relation between the Young modulus and the compressive strength. The results show that the Young modulus decrease with the compressive strength some is the nature of wood.

Keywords: Stabilized ground bricks, Cement, Chips of mahogany, Kambala and limba, Young modulus, Resistance in compression.

Introduction

The valorization of local materials in buildings construction, became currently one necessary solution to economic problems of countries, in particular, countries in development process. The re-use of different wood chips, which constitute one of environmental pollution sources, was the subject of several work[1-3] of which, several related to the effect of incorporation of wood chips in a cementing matrix, or in a cement and clay matrix, on the mechanical, thermal and acoustic properties[4-8].

We were interested in this work to make a comparative experimental study of the mechanical properties of composite bricks with the scrap different wood on the one hand, and the influence of the content of these wood scrap on the relation between the Young modulus and the compressive strength of bricks on the other hand.

Materials and methods

The propagation velocity of sound in bricks is given by the quotient of test-tube length (L) over time of traverses (t) of sound wave in brick. Time t was in experiments given using an apparatus with ultrasound called PUNDIT7 at 28 days.

We determined the compressive strength of bricks using a universal press of mark IGM (General Engineering of Measurement) whose compressive force is 250KN; and provided with a memory on a numerical device.

The granulometric distribution of wood chips which is spread out between 0,5 and 20 mm for the chips; and lower than 0,8mm for the sawdust[4,7], was made using a series of standardized sieves in accordance with the standards NF IN 933-1[9] and NF IN 933-2[10].

Results and discussion

Influence of wood chips content on the Young modulus of clay bricks stabilized with cement: The Young modulus is the property usually used to characterize rigidity; it is also a technological property of first need for employment of structures. The elasticity modulus was given in this study according to the propagation velocity of sound, the Poisson's ratio and the bricks density.

$$E = \rho v^2 \frac{(1-\nu)(1-2\nu)}{(1-\nu)} \quad (1)$$

With: ρ: density in (kg/m3); V: speed of sound in (m/s); ν: Poisson's ratio; E: elasticity modulus in (MPa).

Influence scrap different wood in Clay Bricks Stabilized with cement on the Young modulus: Figures-1 and 2 show variation of elasticity modulus (Young modulus) of Stabilized Clay Bricks (S.C.B.) to equal percentage of sawdust or chips of different wood studied.

With the various wood sawdust: In Figure-1, the results of measurement of elasticity modulus of Clay Bricks Stabilized with cement, with incorporation of sawdust of various wood species are given. We notice after analysis that: i. The elasticity modulus of Clay Bricks Stabilized decreases with the increase of sawdust content, some is the nature of wood used (Figure-1). That is explained by the fact that the increase of sawdust content involves a growth of the pores in clay-cement matrix, growth which has for consequence, reduction of bricks rigidity. ii. At equal percentage (2%; 4%; 6% and 8% of sawdust), the elasticity modulus of clay bricks stabilized with cement (4%), with sawdust of «kambala tree» is higher than that of bricks with sawdust of mahogany tree and «limba tree» (Figure-1). That means that the bricks with sawdust of «kambala tree» are more rigid than those with sawdust of mahogany tree and «limba tree». This confirms our results on compressive strength of clay bricks stabilized with 4% of cement and with sawdust of «kambala tree».

With the different wood chips: Figure-2 has the results of measurement of the Young modulus of clay bricks stabilized with cement, with chips of different wood. We also notice that after analysis of the figures that: i. At 4% of cement and at equal percentage of chips (Figure-2), the Young modulus of bricks clay stabilized and with chips of kambala, is much higher than that of bricks with chips of limba and mahogany tree. Thus, bricks clay stabilized and with built-in chips of kambala, would be more rigid than those with chips of limba and mahogany tree.

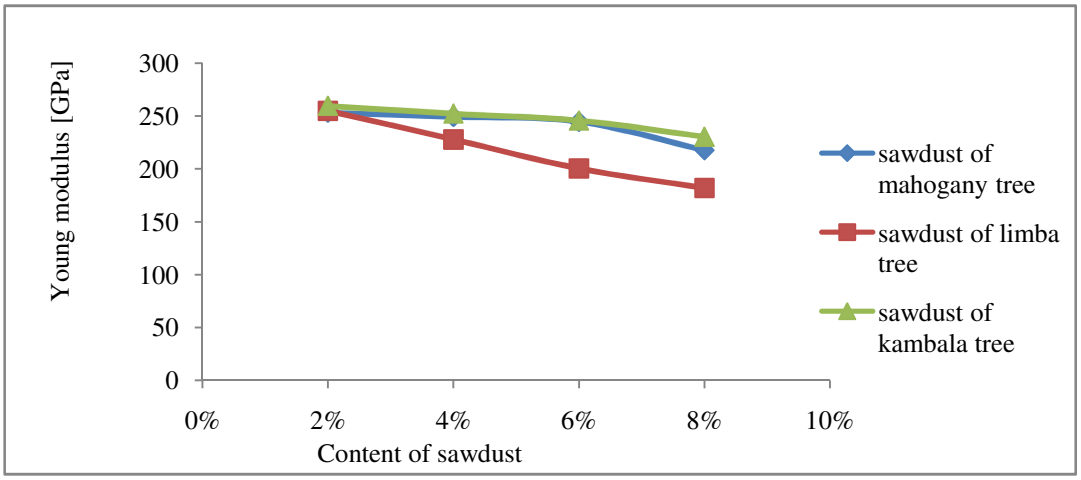

Figure-1: Variation of the Young modulus in clay bricks stabilized with cement (4%) in function of content of wood sawdust.

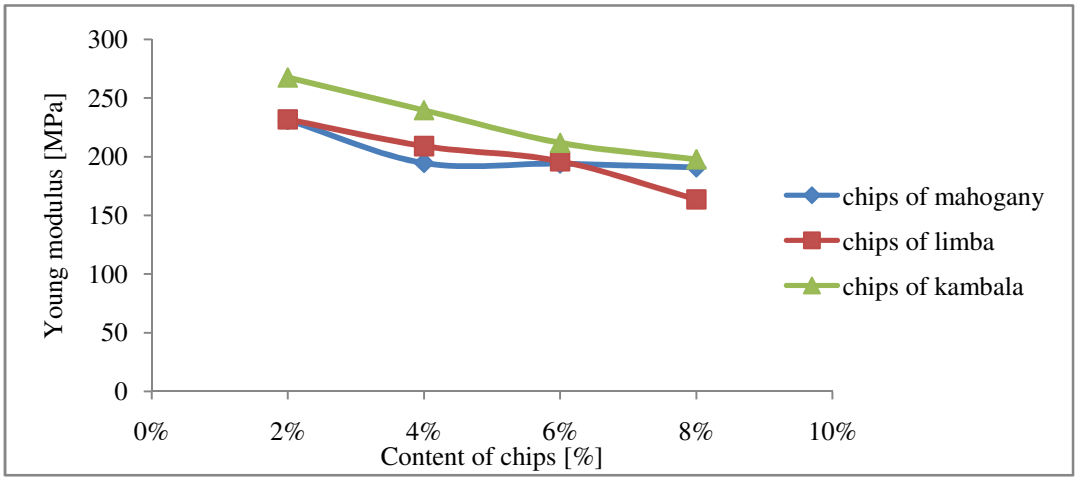

Figure-2: Variation of the Young modulus in clay bricks stabilized with cement (4%) according to the content of wood chips.

Influence scrap different wood on the compressive strength of clay bricks stabilized with cement: We note after analysis of Figures-3 and 4 that: i. The compressive strength of clay bricks stabilized with cement (4%), with sawdust of kambala (Figure-3), is higher than that with sawdust of mahogany and limba tree. ii. At 4% of cement (Figure-4), the compressive strength of clay bricks, with the built-in chips of kambala, is higher than that with chips of limba and mahogany tree. iii. The compressive strength of bricks decreases with the increase of waste wood content (sawdust or chips) some is the wood species (Figure-3 and 4).

Relation between the Young modulus and the compressive strength of bricks: Figures 5 and 6 present the relation between the Young modulus and compressive strength of clay bricks stabilized to 4% and 6% cement, with incorporation with various contents of different wood waste (chips and sawdust) at 28 days.

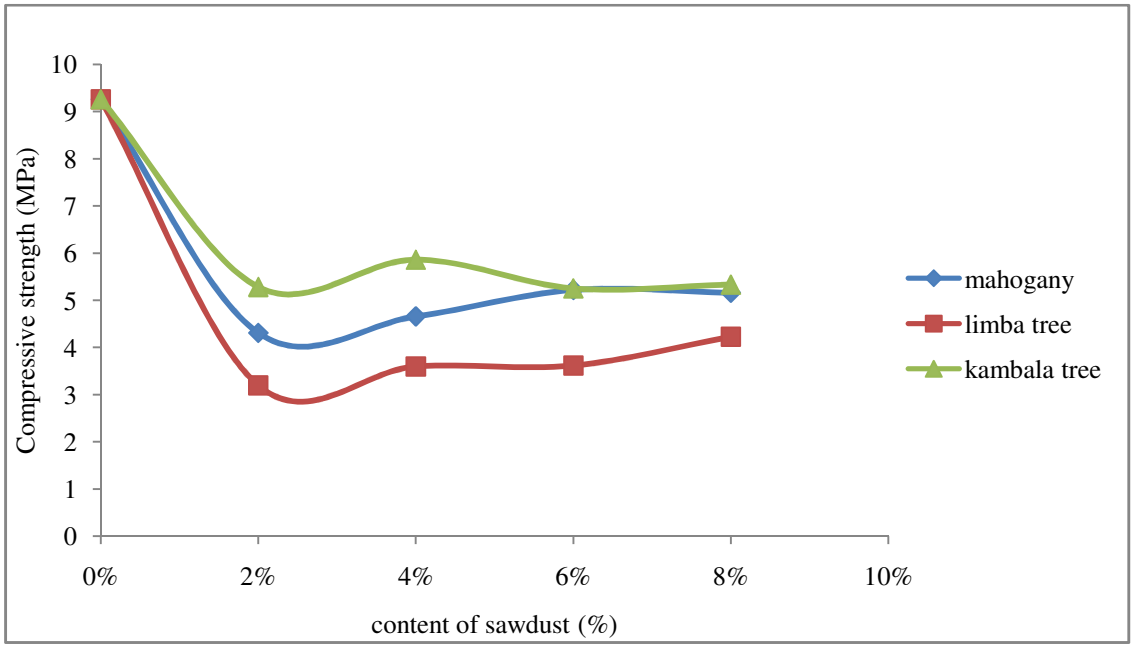

Figure-3: Compressive strength of clay bricks stabilized with cement (4%), according to the content of sawdust of different species from wood at 28 days.

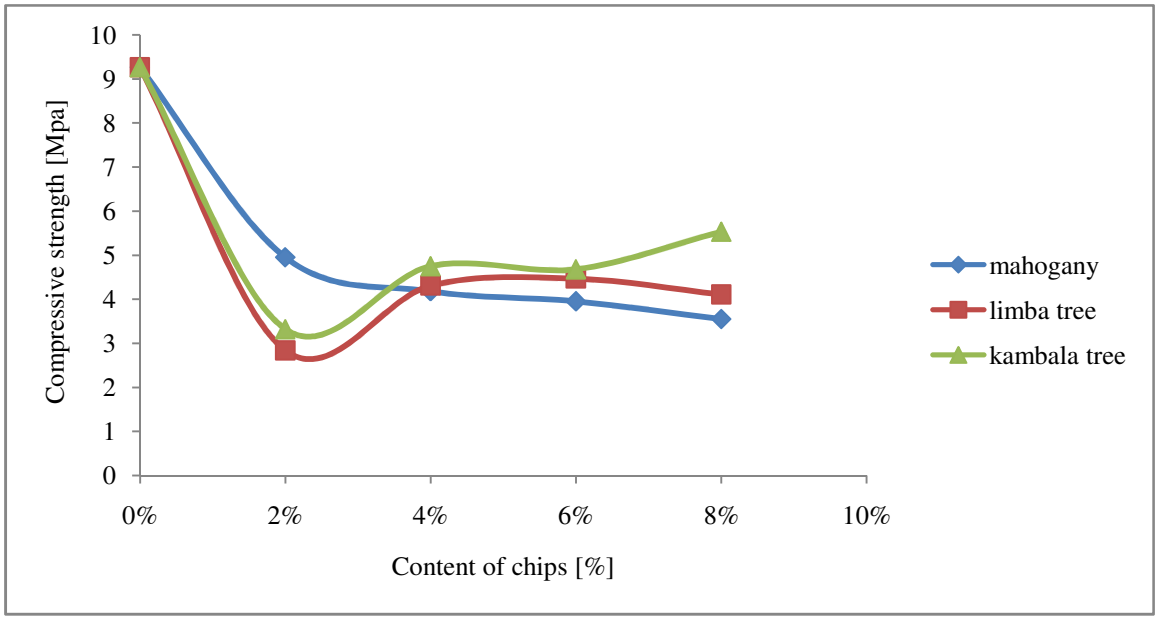

Figure-4: Compressive strength of clay bricks stabilized with cement (4%), according to the content of chips of different species from wood at 28 days.

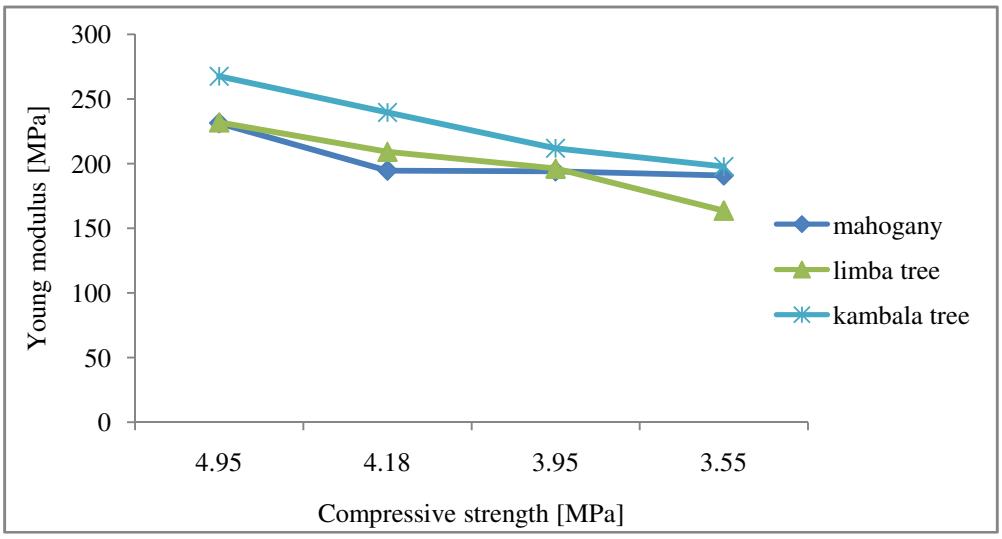

Figure-5: Relation between the Young modulus and the compressive strength of clay bricks stabilized with cement (4%), with incorporation of the chips of different wood.

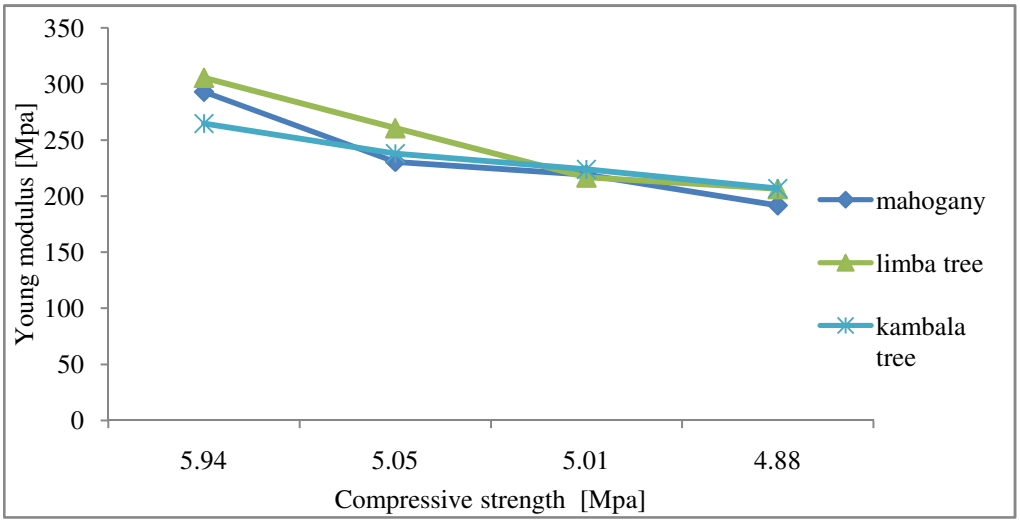

Figure-6: Relation between the Young modulus and the compressive strength of clay bricks stabilized with cement (6%), with incorporation of the sawdust of different wood.

We note that the Young modulus decrease with the compressive strength some is the nature of wood waste (chips or sawdust). We also note that the Young modulus increases with the content of cement. These last results are in agreement with those found by Kim J.K and alt.[11] on bricks out of cement mortar.

The greatest value of the Young modulus (305.7 Mpa) was found in clay bricks mixed with waste of limba (sawdust) for a resistance of 5.94 Mpa to the content of 6% of cement.

Conclusion

In this work, we studied the impact of the content of the scrap different wood on the mechanical properties from clay bricks stabilized and their relation; and the study revealed the following conclusions: i. The Young's modulus of clay bricks stabilized decreases with the increase of the content of wood chips some is the nature of wood and waste used. ii. The clay bricks stabilized in which waste of kambala is built-in, are more rigid and more resistant than those with waste of mahogany tree and limba some is the content of cement. iii. kambala would be to it the wood species whose waste would offer the best mechanical properties. iv. The Young's modulus decrease with the compressive strength some is the nature of wood waste (chips or sawdust).

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