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Influence of Water Dosage on the Compressive Strength of Earth Concrete Containing Corn Stalks Fibres

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ABSTRACT

The influence of the water content on the compressive strength of the soil – corn stalk fibres – water mixture is analysed in this study. The clay soil is mixed with corn stalk fibres with a water volume variation of 16 to 20% in increments of 1% to produce concrete samples stored in an enclosure at room temperature. On these samples, the density is determined every day to monitor the evolution of water loss as well as compressive strength. It appears that the loss of density decreases with the day and stabilizes from the 26th day and that the best compressive resistance is obtained for a water content of 18%.

Keywords: clay soil; corn stalks fibres; compressive strength; water rate.

INTRODUCTION

The use of earth material in construction has been done for centuries and has enabled the construction of several towns and countryside [1].

Under the name of construction material, raw earth has been used in different forms. The range of materials taken from the earth is almost infinite, from "banco", a kind of paste composed solely of clayey soil and water, to terracotta, including cob which include, in addition to earth and water, a filling of cow hair, blades of grass or straw. However, it offers limits because of its great shrinkage (appearance of cracks limiting its tensile strength) and its aptitude for excessive creep [2 – 9].

In order to improve its characteristics (resistance, durability, etc.), it can be mixed with other local materials such as: straw, wood shavings, horsehair, beef dung, rice husks, cement or lime….

In the south of Togo, corn cultivation is a very important activity generating plant debris such as corn stalks. These stalks are either burned, or left in the fields when there is a possibility that the stalks will rot in the fields.

One possibility to remedy this, is to transform these stalks into fibres to incorporate them into the soil-water mixture.

In this study the influence of the water dosage on the compressive strength of the soil-corn stalk fibres-water mixture is analysed.

MATERIALS & METHODS

The soil used during this study is clayey soil from a construction site in the city of Lomé, the capital of Togo. It is a slightly plastic silt with 31% clay whose characteristics are in table 1. Chemically, it is a hydrated aluminium silicate with a high iron content

(iron clay) with a negligible content of Titanium and Barium oxide and which can be used as a refractory in the ceramic (earth construction) or cement industry. The fibres (figure 1) are obtained by grinding corn stalks free of leaves and roots. These fibres are light and very hygroscopic from the first minute (Table 1). It is reported that the water absorption capacity of corn stalks fibres is very high. This intrinsic characteristic of the stalks must be strongly considered in the formulations to be proposed. There are therefore two possibilities: either suggest pre-wetting of the stalks before incorporating them into the earth concrete matrix or incorporate it directly by adjusting the water dosage. Since water absorption is almost immediate, it was opted to incorporate corn stalks fibres without pre-wetting.

Table 1: Clay soil and corn stalks fibres characteristics

Characteristics		Clay soil	Corn stalks fibres
Apparent density		1.24	0.087
Clay content (%)		31%	-
Sand content (%)		69%	-
Atterberg limits	Liquidity limit	25	-
	Plasticity limit	12.53	-
	Plasticity index	12.47	-
Absorption rate (%)		-	193,60% in one minute

Figure 1: Corn stalks fibres

To study the effect of the water dosage, the volume composition of the soil – fibre mixture is set at 80% soil and 20% fibres. Then a volume variation of the water is carried out by the volume of the soil mixture – corn stalk fibres in an interval of 16 to 20% in steps of 1%. 16/32 test specimens are made and stored in an enclosure at room temperature. From the fifth day and at 24 hours intervals, the mass of the test pieces is measured. When the mass stabilizes, the test is carried out to measure the compressive strength on the specimens.

RESULT AND DISCUSSION

Figure 2 shows the variation of specimens' densities as a function of age for each water content.

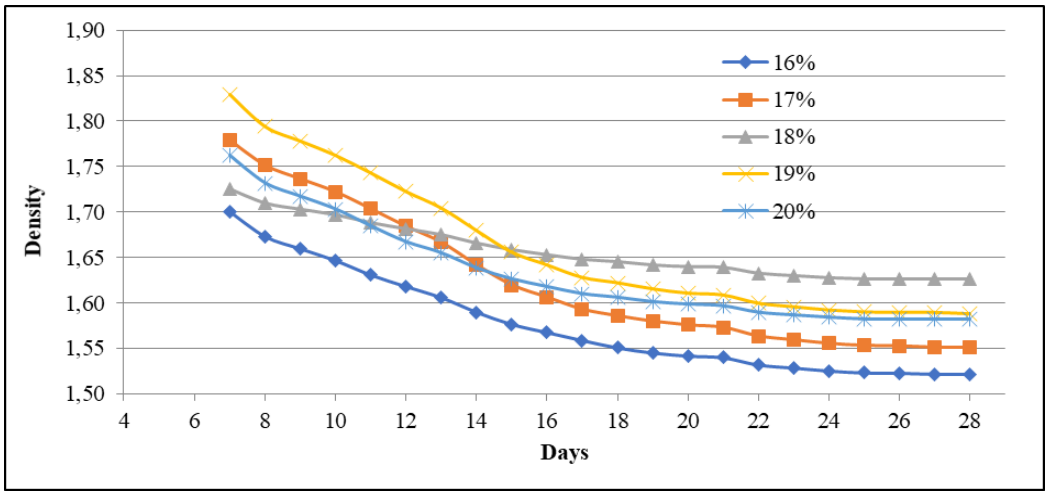

Figure 2: Density evolution according to age

We notice a decreasing evolution of the density of the samples as a function of time, reflecting a loss of water. This loss is very significant during the first fifteen (15) days and begins to stabilize from the 20th day to be zero on the 28th day. The water loss is lower for the test pieces containing 18% water which gives the highest density after the losses (table 2).

Indeed, we notice that the density increases with the water content up to 18% then decreases. This reflects the effect of water dosage on density: an excess or insufficient water is therefore detrimental to density.

Table 2: Compressive strength and densities of samples

Water rate (%)	16	17	18	19	20
Initial density	1.700	1.779	1.725	1.830	1.762
Density at 28 days	1.522	1.551	1.626	1.588	1.582
Water loss rate at 28 days (%)	10.47	12.81	5.71	13.23	11.71
Compressive strength (MPa)	0.393	0.512	1.144	0.732	0.989

Table 2 also presents the results of compressive strength measured at 28 days of age where water loss has stabilized. From this table we deduce Figure 3 showing the evolution of the compressive resistance as a function of the water content and Figure 4 showing the evolution of the resistance as a function of density.

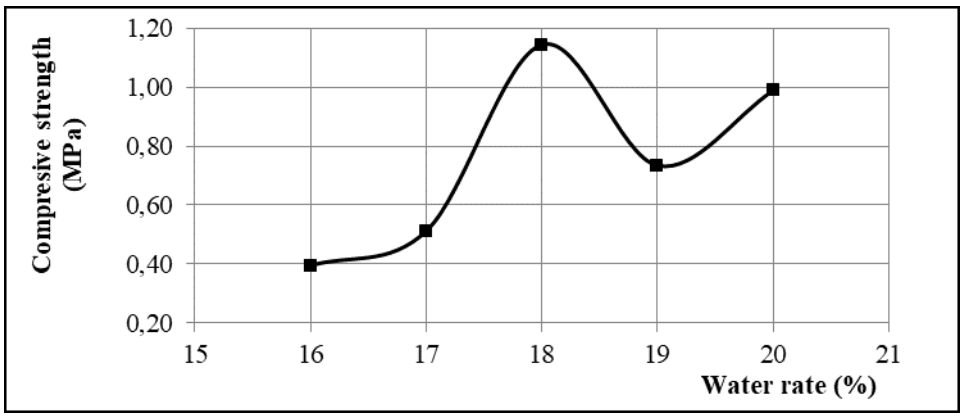

Figure 3: Compressive strength evolution according to water rate

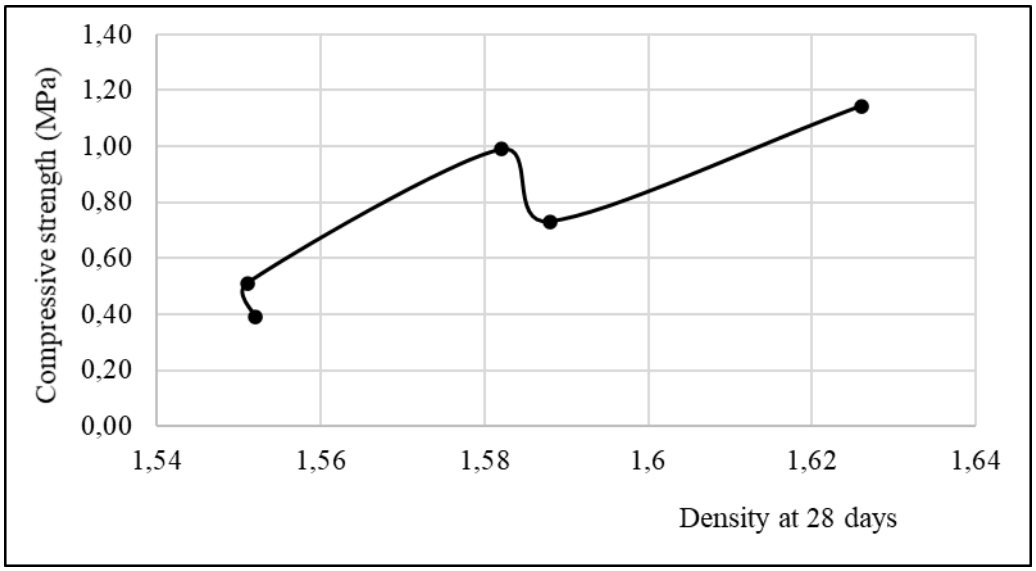

Figure 4: Compressive strength evolution according to density

It appears from Figure 4 that the compressive strength increases with the water content up to a rate of 18% then decreases like the density: a lack or excess

of water therefore has a detrimental effect on the compressive strength as in the case of density.

From Figure 5, we notice that the compressive strength increases with density, reflecting the influence of the latter on the compressive strength.

CONCLUSION

This work aims to show the influence of water dosage on the characteristics of the soil-corn stalks fibres mixture. It appears that considering the mixture studied, 80% soil and 20% corn stalks fibres, a water rate of 18% is sufficient to have the best compressive strength.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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