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Plaster for Interior Walls Stabilized with Ixtle Fiber

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Abstract: There is a worldwide trend of using natural materials with a minimal carbon footprint and environmental impact; Thus, in 2009 it was declared the international year of natural fibers. This concern permeates the construction industry which is one of the most polluted, since the materials it uses emit large amounts of CO2 into the environment, such as steel and cement. It is said that for every ton produced, one ton of CO2 is emitted into the environment. In the present investigation, a coating stabilized with lime, natural saps and fiber of ixtle, extracted from the Agave lechuguilla Torrey, was developed. Both the plant and the fiber to which several physical and chemical tests were made were characterized; resulting in the size of 3 cm in the length of the fibers used in the mixtures which allowed greater adherence and less cracking.

Key words: ixtle, natural aloe vera, clay

1. INTRODUCTION

Of the 275 species, of the genus Agave from which different products are extracted, such as fibers, handicrafts, tequila, etc., the Agave lechuguilla Torrey plant that was selected, can be located basically in the northern area of Mexico, such as Nuevo León, Coahuila , Tamaulipas; it belongs to the family of the Agavaceae and from it, the fiber known as ixtle is obtained, generally used for the elaboration of handmade elements. The fibers have been classified by several authors. One approach is the one given by (Vissac 2014) where it classifies them as vegetable, artificial, animal and mineral and according to their function: Protect, isolate, carry, reinforce and filter.

In another approach, fibers can be classified as natural and man-made, including synthetic and recycled fibers; within the natural fibers. (Kadole; Hulle, 2014).

The fibers are used to increase the resistance to flexion in earthen architecture (Aymerich et al., 2016) and for its use either in construction or interior design it is necessary to understand the material (Gesimondo, Postel, 2011). So that they would not only be used for garden decoration, as (Starr, 2012) states.

Towards the decade of the 90s more than 10,000 tons of fiber were produced per year, and this employed more than 200,000 people in the harvest. The fiber was obtained by hand, carving it, drying in the sun and whitening. This fiber is known locally as ixtle, although abroad it is known as Tula fiber or Tampico fiber, due to the proximity of Tula, Tamaulipas and the port (Warnoc, 2013).

Several tests have to be carried out to determine how much fiber to add, which also depends on the type of element built, for example, in the case of adobe, it must be dosed in quantities of less than 40% (Calatan et al., 2016). In structures of conventional material such as concrete, fibers have also been used, not only in earthen architecture. The advantage of adding fibers is that they become eco-efficient (Lima, Faria,

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2016). (Afroughsabetl; Biolzi; Ozbakkaloglu, 2016).

Artificial fibers can be used to reinforce earth structures (Balkis, A.P. 2017). The sustainable effects of these must be considered with respect to those from plants (Kisku, N. 2017). Various natural fibers have demonstrated durability and resistance over time without modifying their mechanical characteristics (Bello, C. B. D. C. &Cecchi, A. 2017).

Natural fiber has been used in various types of mixtures to reinforce repairs in earth structures to increase their resistance to compression (Benyahia, A. et al., 2017) or to improve reinforcements for seismic conditions (Fagone, M., Loccarini, F. &Ranocchiai, G. 2017) as well as its thermal properties (Del Mar Barbero-Barrera, M. 2017).

2. GENERAL OBJECTIVE

Produce a coating using clay earth stabilized with lime, vegetable sap and using different proportions and fiber sizes of ixtle.

Particular Objectives

1.1.1 Perform physical-chemical tests, such as: compression tests, water jet, to the mixture, as well as characterization of the plant and fiber that include pH, microbiological, biodegradability, and density tests, among others.

3. METHODOLOGY

The fiber was tested in:

Microbiological tests

The post-exposure results showed no mycological development in the triplicate of the samples, this test was performed by staining.

pH

The results indicate that on average the pH is 7.8%. This was done by means of a potentiometer.

Fiber porosity

The percentage of porosity of the fiber is 3.6%.

Biodegradability test

Using the standard NMX-C-407-ONNCCE-2001 modified for the evaluation of the tensile strength and in an environment of 90% humidity, it was obtained that there is no modification in the fiber and there is no significant modification in the resistance to the applied tension.

Fiber density

The linear density (Densitex) showed an average result of 1258 kg / m3.

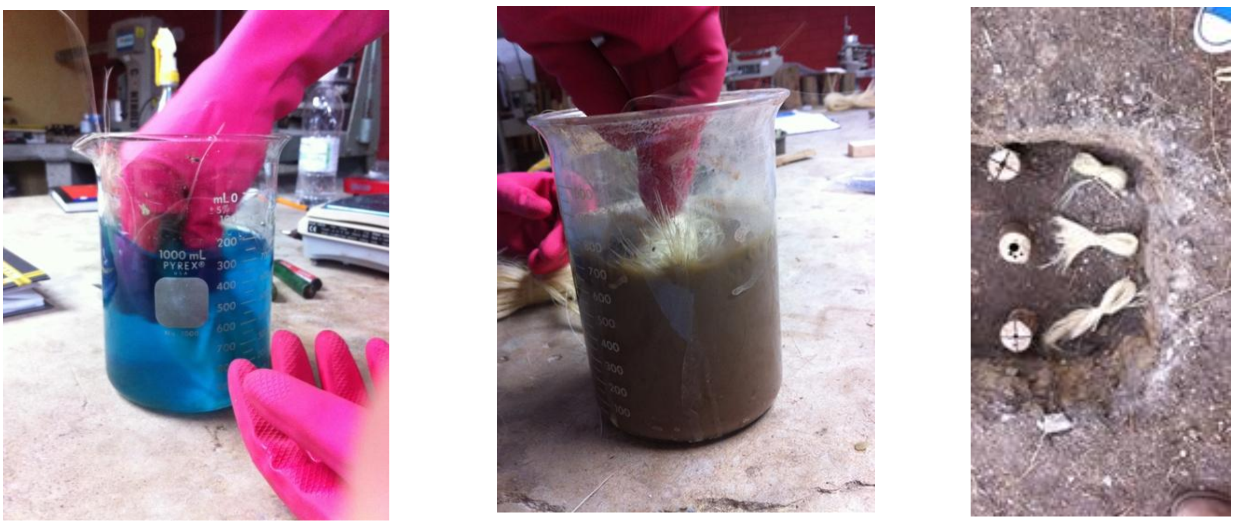

Photo 1.2 and 3: Microbiological tests, pH and biodegradability. Source: Dra. Yolanda Aranda

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The composition of the soil used is 31% of clay, 62% of fines that go through in its entirety by a # 4 mesh and correspond to sand, in addition to 7% of coarse aggregate. From this material: 93% goes through the mesh no. 4, 85% goes through the mesh no. 40, 62% goes through the mesh no. 200. The liquid limit is 27% to 34% while the plastic index is 14%; the linear contraction gave 5.8%.

On the other hand, the dry and loose volumetric weight was 1195 kg / m3 and the maximum dry volumetric weight obtained was 1744 kg / m3.

The preparation of the samples with lime consisted of:

1) Weighting the amount of soil and dosing the lime according to the weight.
2) Lime is added to the clay earth
3) The earth is homogenized manually with lime, and water is added, until obtaining a consistency for a slump of 10-12 cm.
4) The NMX-486-ONNCCE-2014 standard was the basis for the slump test used for mortar and compression tests. The earth used was composed of 40% plus 60% river sand, to which is added from 13% to 25% water and 1.2% fiber, then placed in a mold of dimensions: 0.15 m wide, 0.40 m long and 0.02 m thick.

Preparation of the samples:
Three groups of samples were made, always in triplicate: lime group, nopal mucilage group and aloe vera group according to how it is presented below.

Regarding the samples that correspond to the groups with lime, 3 groups of lime were made and each with 3 sizes of fiber. The lime was dosed in a proportion of 6%. The following proportions in each group were prepared for 3.5 kg of sample in each case. The three groups were elaborated with 1.4 kg of clayey soil, 2.1 kg of river sand which, once homogeneously mixed, adds 0.21 kg of lime. In this case, 700 ml of water and 0.50 kg of fiber were used.

Group 1: is added with 6% lime, the size of the fiber was 7 cm in length.
Group 2: is added with 6% lime, the size of the fiber was 3 cm in length.
Group 3: is added with 6% lime, the size of the fiber was 1 cm in length.

According to previous works (Aranda-Jiménez, 2010) vegetable saps are provided as follows:

Groups of acibar of aloe and cactus mucilage:
Two groups were made, each one was elaborated for 3.5 kg of sample in each case the following proportions in each group. The 2 groups were made with 1.4 kg of clay soil, 2.1 kg of river sand, and 0.21 g of lime.
Group 1: Mucilago:
For 3.5 kg of sample, 850 ml of cactus mucilage diluted to 25% w / w and 0.30 kg of fiber were used.

Group 2: Acibar of aloe:
For 3.5 kg of sample, 700 ml of acibar of aloe diluted to 20% and 0.80 kg of fiber were used.

4. RESULTS AND DISCUSSION

The results obtained in the first blends performed are shown in Figure 1, a and b, in which the morphologies used as part of the surface design are appreciated. In Figure 1 a) curves of approximately 6 cm diameter are visualized. On the right side in figure 1b we can see the design of diamonds with an angle of 90° and the center with textures based on diagonal lines.

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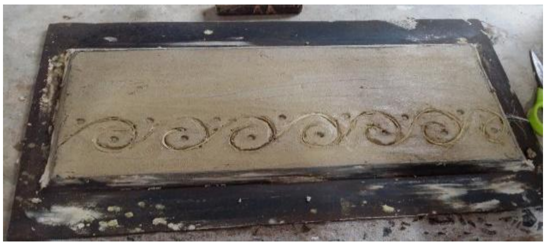
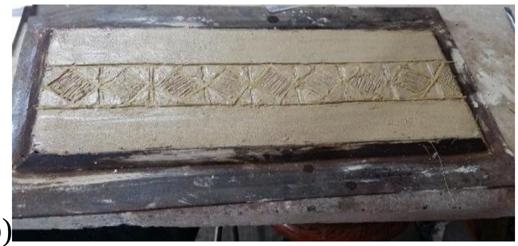
a)  b) 

Photo 4. a) Sample made with clay soil, sand, lime and water. b) has the same structure as in figure 1a, but fiber is added. Source: Monserrat Plaza

Photos 4 a) and b) show the photographs after 24 hours where the appearance of cracks or fissures of ± 0.1 mm thickness as a minimum and 0.4 mm as maximum.

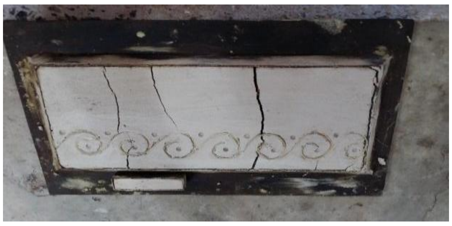
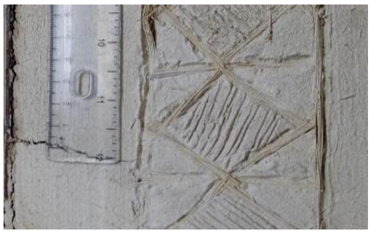
a)  b) 

Photo 5. a) Results obtained from the sample. b) Results obtained from sample 2. Source: Monserrat Plaza

Photos 5 a) and b) show the designs on the surface of the samples based on organic lines visualizing an aesthetic finish. Photo 5 a) also shows the use of green plastic rocks that formed the structure of a flower, whose stem was produced with interwoven ixtle from a set of 45 side fibers, a height of approximately 7 cm to 20 cm.

In this experiment developed in triplicate it was also noted that the adhesion of the interlacing of the ixtle was low because after 8 days it began to distinguish a separation of the same with the surface.

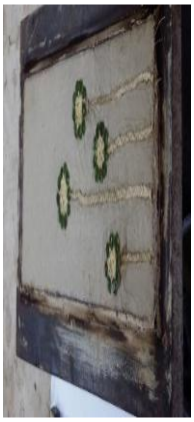
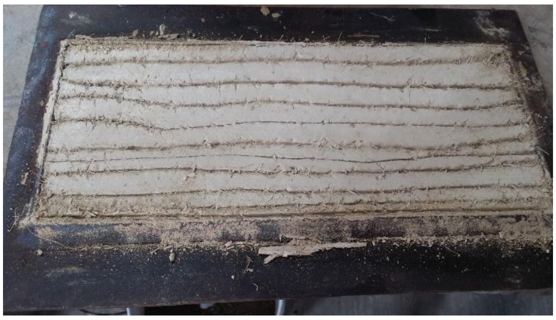
a)  b) 

Photo 6. a) Design based on tensioned fiber and stones b) Results based on organic lines. Source: Monserrat Plaza

After proceeding to make samples based on sand, lime and 25% cactus mucilage was added to the mixture, which was facilitated by the FADU materials laboratory.

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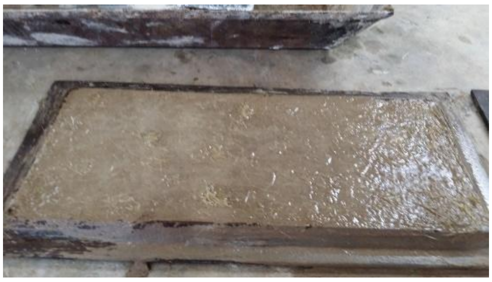
a)  b) 

Photo 7. a) Aggregate of cactus mucilage b) Once the mixture has been poured, it is allowed to dry in its mold. Source: Monserrat Plaza

In turn, samples were made with sand, lime and aloe vera was added, extracted from the leaves of aloe plants.

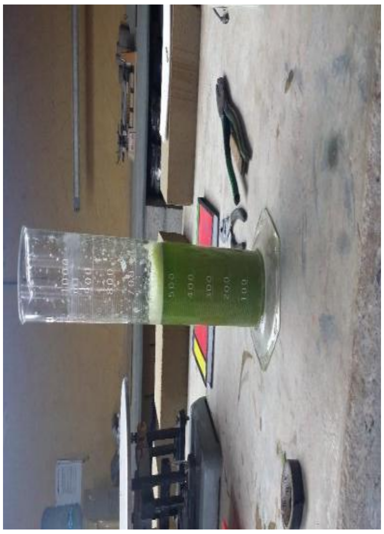
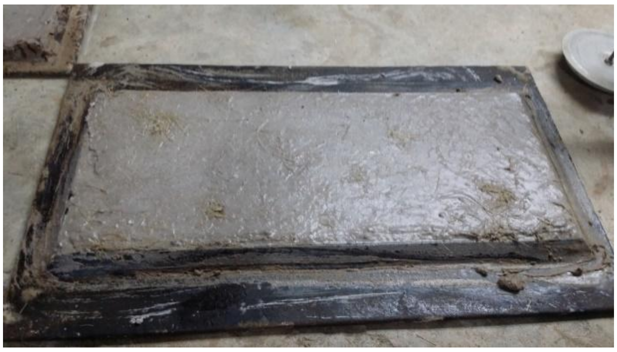
a)  b) 

Photo 8. a) Extraction of aloe vera b) Aggregate of aloe to the sample. Source: Monserrat Plaza

When tests of preparation of mixtures of soil with fibers of ixtle to diverse lengths were made, the effects of adding fibers after 14 days of preparation and drying at room temperature were visualized.

It was found that when fibers of more than 7 cm long are cut, they can not be adhered showing cracks, but if they are cut in a length of 3 cm or less this will achieve a better adherence of the fiber in addition to less cracking .

Table 3 shows the results of the compressive strength of the aloe vera mixtures. An average strength of 0.598206 MPa was found with a standard deviation of 0.23536 MPa. Table 4 shows the results for the mucilage mixture with an average of 0.647239 MPa with a deviation of 0.0686466 MPa. Although the results do not show a significant difference between them, a higher standard deviation is found in 3 with respect to 4.

Table 3: Results of the compressive strength of the acibar samples

Sample Number	Weight (g)	E- Max. MPa
1	1039,2	0,647239
3	1072,6	0,627626
3	1043,4	0,529559

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Table 4: Results of the compressive strength of mucilage samples

N° de Muestra	Peso (g)	E- Max, kgf/cm^2
1	1070,4	0,696272
2	1062,3	0,657046
3	1082,9	0,598206

It is important to point out that the white groups without dosage of any additive under the same conditions presented a resistance of 0.32543MPa with a deviation of 0.071, meaning that there is a significantly lower difference with respect to those that were dosed with acivum and cactus mucilage. separated.

Finally, an average value of 1.6 ± 0.2 g / cm3 for n1 and 1.5 ± 0.1 g / cm3 is found in the density results.

5. CONCLUSIONS AND FINAL COMMENTS

The addition of both cactus mucilage and aloe vera separately 25% (w / w) and 20% respectively improves the integration of the mixture, without finding significant difference with any, with this it is inferred that any can be used interchangeably; The decision will depend on the existence of the plants in the place. The mixture improves considerably in terms of cracks if the size of the fiber is less than or equal to 3 cm.

Regarding the resistance to understanding, values are reported up to 0.745305 MPa.

Although the coating was specified for interior walls it is recommended to perform abrasion and water resistance tests.

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