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Fissure Analysis in Sustainable Earth Plaster Added with Fiber of Ixtle

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Abstract - **The plasters of earth is the skin that protects the vernacular patrimonial architecture of this material and have been studied extensively, however, and given its importance, modern techniques have been used to monitor the cracking and microcracking of them. One of these techniques is the fractal dimension, which is a tool of dynamic systems that provides information according to the approach in which it is used. Some properties of the elements, such as roughness, can be determined from this tool, as well as the determination of the cracking and its behavior. The objective of this work is to analyze the stabilized earth covering with vegetable wise by means of the fractal dimension; a prototype was created for this purpose where the samples were placed and the results obtained were that is found a relationship between fissures and the stabilizing dosed. It was found that when ixtle fibber is used with an organic compound reduces fissure formation showing a better stabilization..**

Keywords - Fissures, Revoke, Fiber of ixtle.

I. Introduction

The subject of plasters with earth has been widely studied, however, the way to stabilize them and control fissures or cracking offers a variety of possibilities where the researcher can work creatively. There are several types of stabilizers according to their classification: Natural and mineral, within the natural ones, plant saps like mucilages or acibares have basically been used; of minerals, lime, cement and bitumen are commonly used. With respect to fibers: there are animal, vegetable and artificial hair, for this research the natural fiber of ixtle was used, which was subjected to various tests such as: biodegradability, microbiological, water absorption, alkalinity, pH, density, Porosity, etc.

Ground mortars have two advantages: They are permeable to water vapor and their mechanical behavior is similar to that of ground walls. (Hamard, E, Morel, J et al., 2013) In addition there are comparative environmental impact studies of these mortars of earth with lime and cement mortars, where the results show that, these mortars require little energy and the greatest impact is in the mortars produced with fossil energy (Melià, P., Ruggieri, G., et.al.2014). On the other hand there are studies of thermal conductivity of these earth mortars, stabilized with straw and used to cover straw walls, where the results indicate that, the thermal conductivity decreased at the time of increasing the amount of fiber, straw has the great effect of changing the thermal conductivity, more than the effect of the sand. (Ashour, T., Wieland, H., 2010). Other studies indicate that the fibers improve the behavior of mortars more than of masonry, (Qamar, F., Thomas, T., & Ali, M. 2018) and for sustainability, materials from the region must be used, in this case the extracted and processed ixtle fiber from the Agave lechuguilla Torrey, an endemic plant from the states of Coahuila, Nuevo León and Tamaulipas, was used. (Miranda F, Hernández-X 2013).

The main objective of this work is to analyze the microcracking of the stabilized coating with vegetable saps and ixtle fiber to determine the best behavior of the stabilizer, using the fractal dimension as a tool.

II. Development

A. Natural stabilizers

The materials to be used as binders of natural origin were selected, the materials that worked with this property, of sustainability, are listed below: Mucilage of nopal, corn starch, aloe vera and xanthan gum. Here are some of the most important properties:

The mucilage is a viscous liquid that is extracted from cactus (Opuntia rastrera spp) that has been used vernacularly in construction. It is mainly composed of polysaccharides highly soluble in water and can function as a cementing agent (Ladd et al., 1996). On the other hand the ixtle is the fiber extracted from the agave torrey lechuguilla, from the family of the agavaceas, which are used to elaborate an infinity of products from crafts such as belts, bags, fabrics, even brushes, fibers for carving, ropes, where some of them have some resistance to stress (Ortega-Lerma, M. et al., 2016).

Xanthan gum is a polysaccharide, the most economical with respect to the other 3 and relatively easy to get. It is produced by the bacterium Xanthomonas campestris found in vegetables. Negative charges on the carboxyl groups of the side chains cause the molecules to form very thick fluids when mixed with water. It is used as a suspension agent, stabilizer, and thickener in various industrial applications. It has a high molecular weight that is obtained by the fermentation of carbohydrates. It is soluble in both hot and cold water, hydrates quickly once dispersed and facilitates water retention producing highly viscous solutions at low concentration. Their solutions have uniform viscosities in temperature ranges from freezing to near the boiling point, with excellent thermal stability.

The species of the genus Aloe contains a mixture of glycosides called Aloin collectively, which is the active principle of the plant. The proportion of compounds is as follows:

- Two yellow-bright resins, very active, possibly identical, soluble in sodium bicarbonate, 30%.
- A very active resin soluble in sodium bicarbonate 6.8%
- Aloin, slightly active, 15.0%
- Emodin, slightly active 1.5 to 1.8%
- Water-soluble inactive substances, 15.2%
- Amorphous substances that produce stomach alterations but that do not reach the purgative effect, 5.1%

The aloe vera contains 12 enzymes. These enzymes consist of a protein fraction or apoenzyme and a prosthetic group or coenzyme.

III. Methodology and Experimental Part

In the prototype created expressly in the Faculty of Architecture Design and Urbanism of the Autonomous University of Tamaulipas, Mexico (UAT) Samples were placed.

The walls are of land poured and previously tests of adherence were made in it, creating a rough surface by means of a scratched, placing the wall a slurry of earth and finally by means of a polymer, the last two to create a phase intermediate between the wall and the flattened earth. The dimensions of each sample are: 1.20x0.75m

A. Test description

The analysis of the samples of the coating was performed, with these samples were prepared by mixing sand, clay, lechuguilla, and the raw materials used as binders, nopal Mucilage, aloe vera, corn starch and Goma Xantana, its application was evaluated in test blocks and applied in the flattening test area of the University.

With respect to the 12 samples analyzed, they were placed on the south wall of dimensions 5m x 2.40 m, with variable lengths of fiber, it was done in triplicate

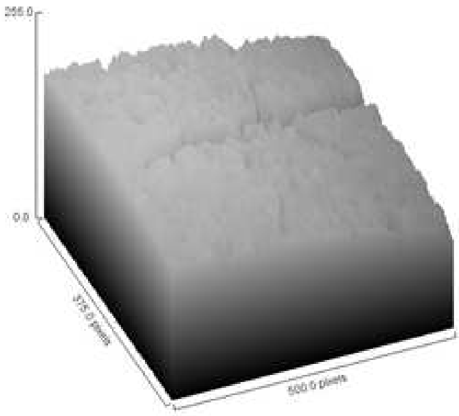
L1, L2 and L3 without fiber; L4, L5 and L6 with fiber of 0.005 m; L7, L8 and L9 with 0.01 m fiber; L10, L11 and L12 with 0.03 m fiber

We proceeded to identify and photograph the samples, treatment was performed in Image J software, to pass the images to binary and then image of contours was made. The fractal boux counting dimension analysis of each of the samples was performed.

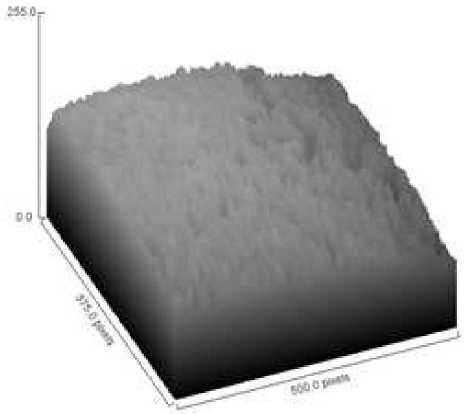
IV. Results

Results were obtained plotting the surface of the sample. As it can be seen, it is possible to stabilize an earth mixing to produce material for construction use. Fiber sizing play an important role in earth stabilization.

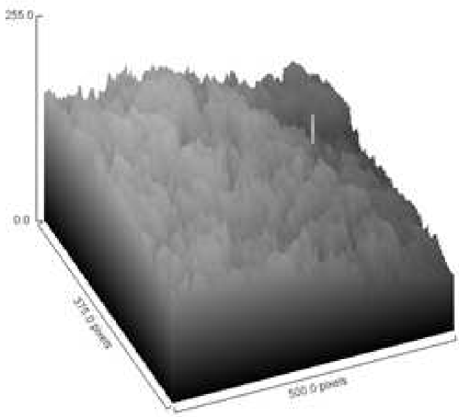
Organic products use in this work, came from vegetables and have the characteristic of high viscous fluid that changes rheology of the mixing. Although this property is not determinated in this work it would be useful to make an interaction effect analysis among compounds.



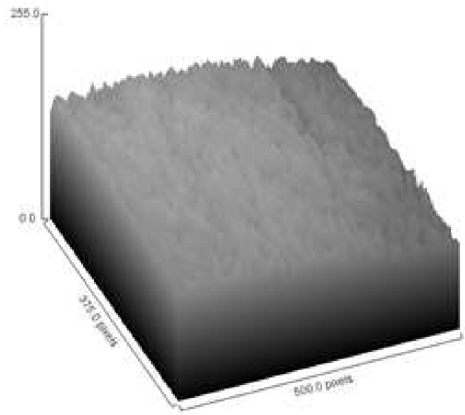
Fécula de Maíz



Goma Xantana



Mucilago de nopal



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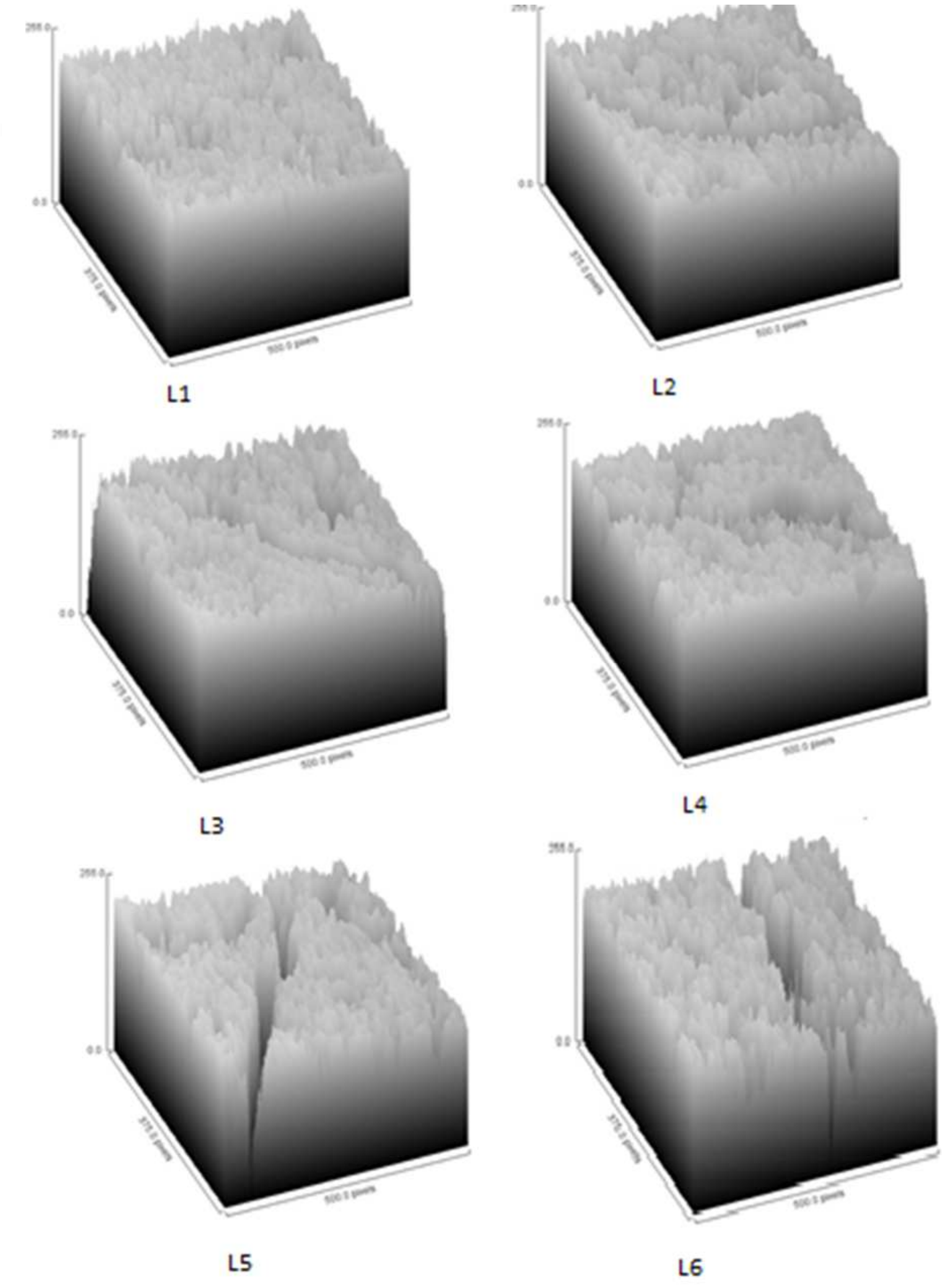

Figure 1.- Different surface images from earth plasters.

Table 1 shows the results for the fractal dimension of the plant wise samples, Xantana gum and cornstarch, as well as the samples elaborated with different percentages of fiber applied in the prototype.

A correlation is observed between the amount of fiber added, the length and the percentage of cracking, with samples 1, 2 and 3 without fiber, samples 4, 5 and 6 fiber of 0.005m; samples 7,8,9 Fiber of 0.01 m and 10,11 and 12 with fiber of 0.003m, samples with fiber less than 1 cm had better behavior.

Table 1.- Fractal dimension and surface profile

Sample	Fractal Dimension	Surface area of the cracks (%)
Corn starch	1.10	2.41
Xantana Gum	1.26	2.45
Nopal Mucilage	1.16	3.88
Aloe Vera	1.41	1.63
L1	1.17	0.99
L2	1.20	4.93
L3	1.25	6.22
L4	1.23	6.46
L5	1.18	7.14
L6	1.66	7.83
L7	1.20	9.00
L8	1.32	4.68
L9	1.22	8.75
L10	1.24	6.02
L11	1.23	4.19
L12	1.24	4.66

Table 1: Samples with different sustainable binders and different fiber proportions
Source: self made.

V. Conclusion

As for the mixtures with mucilage, aloe and starch:

- The fractal dimension of the analyzed samples is in the range of 1.10 to 1.66, the values close to 1.0 indicate that the analyzed areas present irregularities in their form very low, that is to say, the contours are more regular. The sample that presented less irregularities in its form was the mixtures that contained corn starch.

With respect to the samples placed in the prototype and added with aloe and different sizes of fiber:

- The sample that showed the most irregularities in its form was the L6 mixture that was in the test area for flattening.

Regarding the surface profile, the range of the analyzed samples is from 0.99% to 9.00%. A correlation is observed between the amount of fiber added, the length and the percentage of cracking, with samples 1, 2 and 3 without fiber, samples 4, 5 and 6 fiber of 0.005m; samples 7,8,9 Fiber of 0.01 m and 10,11 and 12 with fiber of 0.003m

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