Thermal study in a coating added with *Havardia albicans* and *Guazuma ulmifolia lam*.

Rocio R. Gallegos-Villela, Yolanda G. Aranda-Jimenez, Eder Gomez-Espinoza, Edgardo J. Suarez–Dominguez

Abstract— **Nowadays, we should take advantage of the resources that the ecosystem itself brings and channeling the application of the materials sold within its scope or even to implement new natural products, without leaving out aesthetic trends and the user's comfort. There are areas in the country, like the south for instance, distinguished for their high temperatures along the year. Vernacularly, plants have been used to develop certain characteristics in the products used in construction; an example of this is the Chucum (Havardia albicans) and the Pixoy (Guazuma ulmifolia Lam.). In this research and extraction of the plants was made separately and the solution that was obtained was added to a mixture of white adhesive with which tests were made to analyze aesthetic finishes, permeability and thermal conductivity. With this mixture coating was made with several pieces of bricks, as well as the making of cast cylinders in molds. It was found that the pixy coating reduces water absorption was reduced up to 3.87% regarding the white one. As to thermal conductivity, important differences were observed, up to 72.7% for the coating made of a mixture of solution of Chucum extract and Pixoy for the tested proportion.**

Index Terms— **Sustainable, Retaken resources, Product application**

I. INTRODUCTION

The chucum or chukum, in mayan, (Tax: Havardia albicans (Kunth), other names related: *Acacia albicans Kunth*, *Pithecellobium albicans*, or *Feuilleea albicans* is a resin extracted from the tree of the same name (*Havardia albicans*), found distributed mainly in Central America (Belize and Guatemala); in Mexico in the states of Chiapas, Tabasco and the Yucatan peninsula. It's dark red, same tone as color wine [1]. It's mostly used for its wood, as tanner, as honey, in houses like live fencing and in medicine its dry bark powder can be used to treat wounds and the bark infusion con be used against diarrhea and as antiseptic [1] .

The last works have taken the job to improve the agricultural system of slash and burn corn, so that the experiments were developed during the past years to evaluate the establishment and growth of 18 shrubby legumes such as improve fallows in four years and its capacity to improve the productivity of temporal corn in two and a half subsequent years. Considering its fast and constant growth, greater survival capacity in the plants, wide and persistent coverage, greater capacity to reduce weeds, high wood production, high survival after pruned and favoring the growth and production of corn the specie *Pithecellobium albicans*, it presents itself a promising leguminous shrub to use in improve fallows south Yucatan [2].

The stucco, transformed today in vestiges, are vital testimonial to the prehispanic way of life due to numerous color and graphite traces that are preserved. Its spoilage, caused by elevated temperature and humidity conditions makes necessary its intervention through related and respectful materials. There have been various traditional Mayan mortar specimens, susceptible to been used in its restoration, to evaluate its differences and check its behavior in the face of specific physical testing, to select those more suitable to such end [2,3].

In general, even though it's been reported that chucum was used as a part of the constituents of the Mesoamerican architecture from a few decades ago [4], and that extracts of chucum were used in Mayan paintings [5,6] or as part of the materials used by humans [7]. Few of the studies that can be founded regarding the usage of this material, focusing mainly on its traditionally use [8] without making clear its structural usage [9]; issue that corresponds to the case of pixoy [10]. That it's until 2015 that it can be found in literature a document of a possible use as stabilizer [11] without the deepening in all its properties [2,3].

In the present work an analysis with the coating obtained using chucum and pixoy extracts is exposed as a part of the solution used to form a covering with the commercial adhesive with the purpose to determine the heating transferring capacity and its humidity absorption, as a qualitative analysis of the properties of the obtained material.

II. PROCEDURE FOR PAPER SUBMISSION

A. Experimental Part

For the experiments an aqueous solution was used, which was prepared with chucum and pixoy extracts, prepared from a separation of the tree's bark cutting it in pieces of approximately 2x4cm, placing a 20% of the solid weight in water and heating it to 90°C during 48 hours. Once the process is finished, its guarded in a polyethylene container well closed.

Different mixtures were made from a concentrate cold "C" Chucum, "P" Pixoy and "M" Chucum + Pixoy in 50-50%; to the concentrate 110g of white adhesive was added separately meaning 110g of white adhesive (Bexel) with 50ml of "C", 110g of white adhesive with 50ml of "P", 110g of white

Rocio R. Gallegos–Villela, Centro de Investigación Aplicada y Tecnológica. Circuito Golfo de México 200, Pórticos de Miramar, CP 89506 Cd. Madero, Tamaulipas. México

Yolanda G. Aranda-Jimenez, FADU. Universidad Autónoma de Tamaulipas. Circuito interior S/N Campus Tampico-Madero. Tampico, Tamaulipas. México

Eder Gomez-Espinoza, Centro de Investigación Aplicada y Tecnológica. Circuito Golfo de México 200, Pórticos de Miramar, CP 89506 Cd. Madero

Edgardo J. Suarez-Dominguez. Instituto de Ingeniería. Universidad Nacional Autónoma de México (UNAM). Circuito Interior S/N, Ciudad Universitaria, México

adhesive with 50ml of “M” and in the same way 110g of white adhesive with 50ml of purified water (in a traditional way).

Such ingredients were mixed obtaining a paste. Also casted cylinders were made with the same paste to measure the thermal conductivity, with the proportion of 800g of Bexel and 250mm of the “C”, “P”, “M” concentrates and purified water (traditional method).

Separately tests covering a solid were made. For that standard-sized cooked red brick was used, to which cuts of 4.7 x 4.7 x 11.30cms were made approximately. The different blocks were weighted, previously and individually identified, leaving to soak the 15h pieces and draining for a 75 min and registering in the same way its weight. For the casted cylinders molds with dimensions of 6.5 cm of diameter and 10 cm of height were made, identifying them individually. For the first permeability and thermal conductivity tests the bricks were identified in the following way:

A – B – C “M” mixture and white adhesive
D – E – F “P” mixture and white adhesive
G –H – I “C” mixture and white adhesive
J – K – L mixture of Purified water and white adhesive
M – N – O Natural state of the brick.

This blocks were submerged in potable water for a 24h period, waited before and after, posterior to the drying of the pieces the mixture was applied in an even way with a 2mm thickness approximately in all spaces, leaving to dry the mixture applied they were left submerged in potable water for another 75min laps for its final weight as well as the thermal measurement of each of the blocks: Table 1.

In an independent way thermal conductivity tests were made, for it cylinders samples were identified in the following way:

P – Q “C” mixture and white adhesive
R – S “P” mixture and white adhesive
T – U “M” mixture and white adhesive
V – W mixture of Purified water and white adhesive

The molds were filled with the mixture made of in each of the proportions, waiting for the dry to remove the molds and perform the thermal conductivity measurements (Table 2).

However, during the waiting several of the cylinders took longer time to set, even without its optimal consistence: Table 4.

III. Results and Discussion

In Table 1, the result for the thermal conductivity in brick blocks covered with mixture is shown, such test was realized in a 10min lapse. In this table is shown the measurement in one of the blocks of each group depending on the mixture, the lowest value found in the test was in the brick block with mixture “M” and white adhesive (A), having a value of 0.278 W/(m·K), the highest value found was in the brick with purified water and white adhesive (J) mixture, with a value of 0.48 W/(m·K), equivalent to a difference of 72.7%, namely the mixture used in block “A” registers a lower temperature in the interior of that block, which entails to a possible improvement of thermal comfort when used in dwelling buildings. In this table we can also observe that the variation between “M” mixture block with white adhesive (A) and the natural state of block (M) only presents a favorable difference of 6.5%, however the coating of the blocks is of vital importance to conserve its properties in the future, avoid humidity and fungus, and the better structural performance of the edification as a whole, without leaving aside the aesthetic enrichment that this contributes. Said tests were made triplicate.

Sample ID	K	Rho (average)	Err	Temp(0)
	W/(m·K)	°C·cm/W		°C
A	0.278	359.5	0.0121	28.39
D	0.361	276.8	0.0121	28.5
J	0.48	208.5	0.0084	28.63
G	0.394	253.6	0.0119	28.49
M	0.296	337.3	0.0085	28.73

Table 1.- the result of the thermal conductivity in brick blocks cover with mixture is shown; this test was made during a 10min lapse.

On table 2 is the result of thermal conductivity in cast cylinders and the qualitative characteristics of the samples is shown, this test was made during a 10min lapse. This table observes the measurement in one of the cylinders of each group according to the mixtures, the lowest value found in the test was the cylinder with the “C” mixture and white adhesive (p), having a value of 0.0548K, the highest value found was in the mixture “P” and white adhesive (R), with a value of 0.967K, which is equivalent to a difference of 77.4%, namely the mixture used in the cylinder “P” registers a lower temperature in the interior of that cylinder, which then implies a possible improvement of thermal comfort when used in dwelling buildings. However, it’s important to remark that the setting or drying time between a mixture and the other has a difference that goes from 50-75% in temperature or natural conditions (Table 4). Such tests were made twice.

Sample ID	K	rho	Err	Temp
	W/(m·K)	°C·cm/W		°C
P	0,548	182,4	0,0372	29,46
R	0,967	103,4	0,0092	28,43
T	0,795	125,7	0,0188	28,75
V	0,922	108,4	0,0077	28,02

Table 2.- Result of thermal conductivity in cast cylinders and the qualitative characteristics of the samples is shown, this test was made during a 10min lapse. The analysis temperature was of 28.5°C.

Table 3 shows the analysis of the qualitative characteristics of the samples taken from the cylinders. In doing the mixtures and having as a base the neutral color of the white adhesive each extract presented a characteristic of different color, obtaining in a natural way that may as well transferred as finishes in the construction sector giving favorable aesthetic results. Such tests were made twice.

Table 4 shows the dimensions and humidity result for the blocks of brick. In this table is observed the dimension of the blocks of bricks analyzed for each group, as well as the percentage measurement in each one according to the mixtures realized. The lowest value found was of the testing with the block of bricks with the "P" mixture and white adhesive (D), reaching a value of 3.61% of absorbed water, the highest value found was on the block of bricks in natural state (M), with a value of 5.13% of absorbed water, which is equivalent to a difference of 42.10%, meaning the mixture used in the "D" block registers a lower humidity content in the interior of the block, which then brings a possible improvement in the comfort by using it in dwelling buildings. In this table it can also be observed that the variation between the "P" mixture block with white adhesive (D) and the purified water with white adhesive from block (J) only presents a favorable difference of 3.87%, however there are zones in which humidity is relatively high that are of great help in the improvement and preservation of the interiors, as part of the ideal conservation for the structural system of the edifications.

Sample Id	Qualitative characteristics of cylinders
P	Brown colored. Not well compacted, dry, easy to break in hands, uneven surface
R	Clear orange colored. Compacted, dry. Apparently porous
T	Brown colored. Not well compacted, dry, easy to break in hands, uneven surface
V	Clear orange colored. Compacted, dry. Apparently porous

Table 3.- Analysis of the qualitative characteristics of the samples taken in the cylinders.

Id Block	Average dimensions (Brick section)	% of absorbed water (w/w)	Standard deviation
A	a= 4.7cm b= 4.7cm c= 11.6cm	4.82	1.18
D	a= 4.6cm b= 4.8cm c= 11.10 cm	3.61	1.20
G	a= 4.9cm b= 4.8cm c= 10.90 cm	4.88	0.07
J	a= 4.4cm b= 4.7cm c= 11.30 cm	3.75	0.81
M	a= 4.8cm b= 5.1cm c= 11.50 cm	5.13	0.75

Table 4.-Dimensions and the humidity result for the blocks of bricks

Table 5 shows the dimensions, weights and drying time and characteristics of every process realized to the cast cylinders in mold. This table observes the dimension of the analyzed cylinder per group, the exact ingredients used for the obtaining of each one. The time of setting, where it can be observed that there's a late difference in the time total drying time of over 50%, as well as the weight that such cylinder reached at the end of the testing.

Id Block	Compunds	Setting Time (h)	Cylinder weight
P	800 g adhesive + 250 ml de Chucum	96 h dry in 80%	425 g *
R	800 g adhesive + 250 ml de PIXAY	48 h dry in 100%	415 g
T	800 g bexel + 250 ml of M (50% pixay + 50% chucum)	96 h dry in 80%	380 g *
V	800 g adhesive + 250 ml of water	48 h dry in 100%	350 g

Table 5.- Weights and drying time and characteristics of every process realized to the cast cylinders in mold. Dimensions in all cases were: 6.5cm of diameter and 7.5cm of height. * denotes cylinder weight with mold.

IV. Conclusion

During the work of this research, several factors were taken into account, such as thermal conductivity, permeability and the possible usage as an architectural covering (aesthetic finish).

Based on the results obtained from the brick blocks, it is concluded that the mixture Pixoy plus adhesive, has an average of 42.10% less water absorption, regarding the same block without the appliance of the covering. In reference to the block with a coating of purified water and white adhesive, it presents a difference of 3.87%. Nevertheless, it's important to remark that such percentage could of great importance for the humidity that presents itself on the metropolitan area of Tampico, Madero and Altamira, Tamaulipas, for the improvement of interior comfort and the correct handling of structural frames.

Regarding the thermal conductivity, it is observed that the coating of the "M" mixture (50% pixoy + 50% chucum) and white adhesive is equivalent to a difference less than 6.5% regarding the natural, however the covering of the blocks is of high importance to preserve its properties in the future, avoid humidity and fungus in them, and the better structural operation of the edification as a whole, without leaving aside the aesthetic enrichment that this brings. Bringing as a result a difference, between this mixture and the commonly used potable water and white adhesive, of a 72.7%.

In the same way, in the cylinders made in a mold was observed a thermal conductivity of 77.4% regarding the commonly used mixture of white adhesive with potable water, as the natural pigmentation in such mixtures that may as well be a relevant factor for the interior finishing within the construction.

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ANNEX: PICTURES

FIG 01, shows the proportions used for the mixtures accordingly

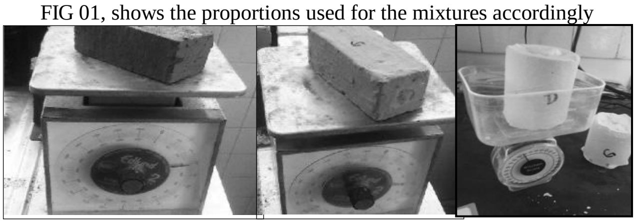

FIG 02, shows the weighting that was made to the blocks along the different stages described

FIG 03, the image shows the submerged blocks in potable water as part of the research

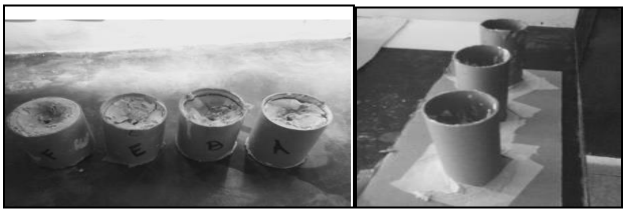

FIG 04, Pourage of the mixture into the molds and its labeling

FIG. 05, application of the mixture of the brick blocks as coating

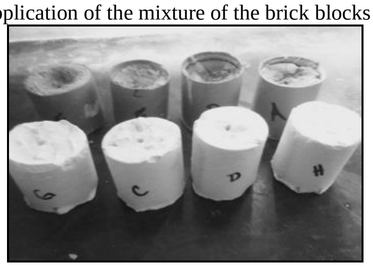

FIG. 05, Preparation of the cylinders for the thermal conductivity analysis

Rocio R. Gallegos–Villela, Centro de Investigación Aplicada y Tecnológica. Architect, M.Sc. student. Industrial design coordinator. Specialist in new construction techniques using biological materials from the environment

Yolanda G. Aranda-Jimenez, She holds a PhD studies in Architecture with emphasis on housing at FADU. Universidad Autónoma de Tamaulipas, Mexico Her research interests include earth construction and properties of sustainable materials. Member of: Sistema Nacional de Investigadores N1, Red PROTERRA, Representative of the UNESCO Chair for Earth Architecture at the University of Tamaulipas

Eder Gomez-Espinoza, Centro de Investigación Aplicada y Tecnológica. Graphic designer, specialist in studies of color combination and psychological effect of color in design of graphic messages.

Edgardo J. Suarez-Dominguez, . Instituto de Ingeniería. Universidad Nacional Autónoma de México (UNAM). Chemical and M.Sc.. Ph.D. student. His main work is found in new techniques of mechanical analysis in fluids and solids. SPE, SQM and SMF member