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Title: Ecological Waterproof Adobe Brick based on Straw and Manure

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PRESENTATION CONTENT

Introduction

Methodology

Results

Annexes

Conclusions

References

Introduction

Adobe, one of the world's oldest and most sustainable building materials, has been used for millennia due to its accessibility, low cost, and thermal properties. Despite its ability to keep interiors cool in various climates, its main limitation is its susceptibility to water damage. To improve water resistance, natural additives like straw and manure have been explored. These additives enhance the cohesion and durability of adobe. This project focuses on producing eco-friendly adobe blocks that incorporate these additives, creating a water-resistant construction material.

By addressing the weaknesses of traditional adobe through environmentally-friendly techniques, this initiative contributes to the preservation and advancement of age-old construction methods. Rigorous testing and a structured methodology aim to prove that enhanced ecological adobe can withstand various environmental challenges, ensuring its continued relevance and utility in the 21st century. This water-resistant ecological adobe, with its unique characteristics like varying sizes, the use of nopal as a natural binder, and smooth block surfaces, represents a blend of tradition, sustainability, and modern efficiency, making it an attractive option for sustainable construction projects today.

Methodology

1.- Selection and Preparation of Materials.

1.1 Clay soil

Clay, also known as mud, is a natural material composed of fine mineral particles mixed with water to form a malleable mass.

Characteristics of Clay Particles:

1. Particle Size: Less than 0.002 mm, giving it plastic and cohesive properties.
2. Constituent Minerals: Mainly phyllosilicates such as kaolinite, illite, and montmorillonite.
3. Electrical Charge: Negatively charged surface, influencing water retention.
4. Water Retention Capacity: Porous structure allowing water retention.
5. Interactions between particles: Cohesion and adhesion, determining plasticity and strength.
6. Crystalline and Amorphous Structure: Influences mechanical resistance and thermal stability.

Box

Figure 1

Title [red earth]

Reference [image own authorship_red earth]

1.2 Straw Preparation:
Straw is an excellent thermal and acoustic insulator, moisture regulator, easy to work with, and binds well with clay and lime.

Characteristics:

- Combustibility: Compacted straw bales have minimal combustibility.
- Water: Important to waterproof properly to prevent the straw from getting wet.
- Repairs: Easy to repair straw walls.
- Construction systems – walls: Load-bearing walls and independent structure construction.
- It is recommended to cut the straw into pieces of 2-5 cm before adding it to the soil mixture (Minke, 2000).

1.3 Horse and Cow Manure:
Contains low nutrients, improves soil structure, provides quality organic matter, and favors the presence of microorganisms. Improves mixture permeability.

Nopal
Used as a binder due to its high mucilage content, improving the cohesion and resistance of the mixture.

Box

Figure 2
Title [Straw]
Reference [image own authorship_straw]

Box

Figure 3
Title [horse Manure]
Reference [image own authorship_ horse Manure_itsh]

2. Preparation of the Mixture
2.1 Base Mix.

The selected soil must be free from stones and foreign elements and fully moistened, then allowed to rest for two days before molding.
An ideal place should be found for adobe production, with sand spread over the entire floor to prevent adobe from sticking.
Usually, two people can produce a considerable amount of adobe in a day using wooden molds called "adoberas."
Straw is added during the trampling process, and water should be added in small quantities to avoid excessive wetness.
The mixture should maintain its shape when placed in and removed from the mold.

Summary of the preparation of mud for adobe

- Prepare the mud and let it rest for 1 to 2 days.
- Mix straw with mud, with a recommended dosage of 1 shovel of straw for every 5 shovels of mud, using a shovel to mix.

Recommendations:
Soil Sifting: Remove stones and debris from the soil.
Initial Mixture: Mix the soil with water until a plastic, homogeneous consistency is achieved.
Incorporation of Straw: Add straw in a proportion of 5-10% of the total mixture volume, ensuring even distribution.
Manure Incorporation: Add manure in a proportion of 3-5% of the total volume, mixing well for uniform distribution (Catalán, P., & Moreno, J. Y 2019) (Minke, 2000) (Hussain & Ishida, 2013).

3. Block Molding

- Sprinkle sand in the mold to prevent sticking.
- Add an insulating layer of sand on the floor to avoid moisture.
- Turn them on their edge in an average of 4 days for optimal drying.
- A week later, stack them in a warehouse.

Appropriate percentages for the production of abobes.

• Sand: 55% to 75%
• Limos: 10% to 28%
• Straw: 15% to 18%
• Organic matter content: < 3%

Box

Figure 4
Title [wooden Mold]

Reference [image own authorship_ wooden Mold_itsh]

Procedure:
Use standard size wooden molds (14 cm wide x 20 cm long x 10 cm high) to form the adobe blocks.
Compact the mixture inside the molds to eliminate air pockets and ensure uniform density.
Remove the blocks from the molds and place them on a flat, well-ventilated surface for initial drying.
Compaction: Compact the mixture inside the molds to eliminate possible air pockets and ensure uniform density.
Extraction and Initial Drying: Remove the blocks from the molds and place them on a flat, well-ventilated surface for initial drying (Catalán, P., & Moreno, J. Y 2019).

4. Drying and Curing

- Adobe blocks must dry for 3 weeks.
- After 10 days, place blocks on their sides for uniform drying and high resistance.

¿How to make adobe more resistant?

- Mix ingredients wet, then add water. Best resistance achieved when mud doesn't stick to feet.
- Add straw and coarse sand to control micro-cracking.
- Ideal adobe composition: 15%-18% clay, rest sand or coarser aggregates.
- Excess clay causes long-term cracks; shortage leads to fragmentation.
- Compact mixture in mold, remove, and dry (curing) for about 21 days.

Procedure:

Sun Drying: Dry blocks in sun for at least 2 weeks, turning regularly.

Final Curing: Continue drying in covered area for another 2 weeks for complete curing and minimal cracking (Minke, 2000).

5. Tests and Evaluation.

5.1 Compression Strength

- Conduct random compressive strength tests on dry adobe blocks using a hydraulic press with values between 1.2 and 2.5 Mpa (Houben & Guillaud, 1994).
- Record the maximum strength before material failure.

5.2 Waterproofing:

- Water Absorption Test: Immerse the blocks in water for a period of 24 hours and measure the weight gain to determine water absorption. Simulated Rain Test: Expose the blocks to a continuous stream of water for a period of time and observe the resistance to surface erosion (Minke, 2000).

5.3 Durability:

- Wetting and Drying Cycles: Subject blocks to multiple wetting and drying cycles (21 repetitions) to assess durability under humidity fluctuations.
- Crack Observation: Inspect blocks visually after each cycle for cracks or structural damage (Hussain & Ishida, 2013).

Results

Section.1 Field Investigation: The research involved studying the local soil composition and availability of materials like clay and straw. Red earth from a nearby area was found to be easily accessible.

Section.2 Material Selection: Sustainable materials selected included clay, manure, sand, straw, water, and cactus as a natural binder. The materials were distributed, and each person contributed what was available locally.

Section.3 Change of Shape to Reach Final Product: Ecological adobe can be mixed by machining or traditional methods. The materials were compacted in molds after mixing. Improved adobe blocks with straw, manure, and cactus showed a 30% increase in compressive strength compared to traditional blocks. Blocks with 10% straw and 10% manure by weight were the strongest, achieving an average strength of 3.5 MPa (megapascals).

Box

Table 1

Title [Resistance in MPa of different mixtures]

Percentages of mixed materials for adobe tests, made with 5 blocks of each type of mixture					Resistance in Mpa.
Clay	Straw	Manure	Nopal	Lime	
60	20	10	5	5	2.90MPa
70	10	10	5	5	3.2MPA
75	10	10	5	0	3.5MPa
70	20	10	0	0	2.45MPa
65	15	10	0	10	2.84MPa
70	10	15	5	0	3.3MPa

Section.4 Production.

In this stage, the continuous manufacturing of the adobe is carried out, which will depend on the amount of resources that are at hand, such as the amount of raw materials, molds, labor, space for the adobes to rest. , product demand, among others.

Box

Table 2

Title [average production Time]

Mix Quantity	Number of adobes Brick 30*20*10	Mixing Time in minutes	Molding Time in minutes	Average Production Time in Minutes
1m3	156	20	2	2.12820513

Section. 5 Drying and Curing

Adobe blocks must dry for 20 days.

After 10 days, place the blocks on their sides or edges for uniform drying and high resistance.

The longest waiting time is the drying time, meaning each batch of 156 adobes takes 20 days to be ready for delivery.

Box

Figure 5

Title [Adobe brick]

Reference [image own authorship_ Adobe brick_itsh]

Section. 6 Inspections

The drying process was monitored to avoid cracks; if too dry, a little water was added.

Blocks underwent water absorption tests, soaking for 24 hours, and simulated rain exposure for 48 hours.

Improved blocks absorbed 40% less water than traditional ones and maintained structural integrity, while traditional blocks showed surface erosion.

The improved adobe, averaging 6.5 kg, absorbed only 1.08 liters of water (18% absorption).

Box

Table 3

Title [water Absorption]

Mix	Resistance in Mpa.	Absorption of liters of water
1	2.90MPa	1
2	3.2MPA	1.17
3	3.5MPa	1.17
4	2.45MPa	1.8
5	2.84MPa	0.97
6	3.3MPa	1.24

Section.7 Finished Product

The adobe was completed on time and met the necessary quality standards for manufacturing and sale.

A life cycle analysis was conducted to evaluate the environmental impact from material extraction to wall construction.

Tests on 156 adobes showed an average resistance of 3.2 KPa.

Box

Table 4

Title [average Resistance of the Different Mixtures]

Variable	N	Average	Standard Error of the Average	Standard Deviation	Minimum	Median	Maximum
Resistance in MPa	156	3.0644	0.0260	0.3241	2.4500	3.2000	3.50000

Conclusions

The production of improved adobe led to 20% less CO_2 emissions compared to concrete blocks. Utilizing manure and straw reduces resource needs and agricultural waste. Creating waterproof adobe requires a careful selection of materials and a precise combination to achieve a durable product. Team collaboration and coordination are essential for success.

Key materials include sand, red dirt, earth, straw, and water. Sand and red soil provide structural strength, while earth and straw improve plasticity and adhesion. Water is crucial for consistency. A detailed work plan, accurate measurement, and thorough mixing and molding are vital. Effective communication and mutual support within the team are critical.

The team's effort results in a quality product suitable for various construction applications. The shared experience strengthens bonds and builds trust. In summary, producing waterproof adobe as a team reflects the effort and dedication required for a durable and resilient outcome.

Annexes

Advantages And Disadvantages Of Adobe Brick

Table 1

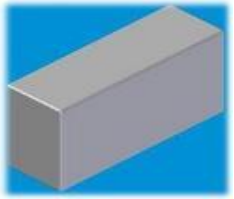
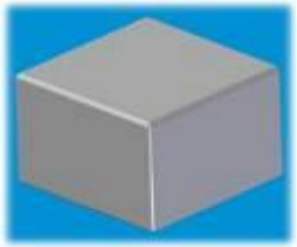
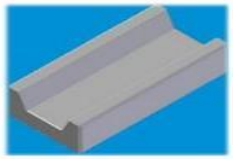
Advantages	*Disadvantages*
Good Thermal and Acoustic Insulation.	*Tends to Be Fragile.*
Easy Manufacturing and Dries simply in the sun.	*When it is Used for construction it is not possible to add more Weight to this.*
Its price is Affordable.	*Does not Resist Torsion.*
It is Ecological.	*It is not shock Resistant.*
Absorbs Heat and Keeps Cool.	*It can Be Destroyed in very drastic weather such as Storms.*

Types Of Adobes

Table 2

Types Of Adobes		
SIMPLE ADOBE ***(Not standardized)***	*Solid block of unsewn earth may have straw and/or small stones in engraving mode*	
ADOBE ***SEMI STABILIZED***	*Brick resistant to moisture due to its usual composition of 3% to 5% stabilizing agent or waterproofing agent.*	
STABILIZED ADOBE	*Solid block of unsewn earth that also contains more elements such as: asphalt, lime, cement.*	

Adobe Shape Table
Table 4

FORMS AND USES OF ADOBE BRICK		
	*ADOBE CLASSIC*	*Approximate weight: 6kg* *Construction: traditional on first floors, mortar of the same composition is glued to the pavement.*
	*HALF ADOBE CLASSIC*	*Approximate weight: 3kg* *Construction: traditional on first floors.* *Used for the edges on the walls where doors and windows go, avoiding cutting adobe by hand.*
	*SOLID GUTTER*	*Approximate weight: 3.5kg* *Construction: traditional.* *It is used to internally reinforce walls with iron and concrete making walls, beams, doors, windows.*

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