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EFFICIENT USE OF NATURAL ADDITIVES WITH UNFIRED CLAY BRICKS

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ABSTRACT

To meet the growing global demand for construction materials, more than 9 billion conventional bricks are produced each year. They are a substantial source of greenhouse gas pollution since they are frequently heated to increase their strength, which uses a lot of wood, coal, and natural gas. The toxic fumes emitted by brick kilns include a high concentration of carbon monoxide and sulphur oxides, which can be harmful to both human health and the environment. As stated by this assertion. The goal of this project was to create unfired clay bricks—also referred to as bricks—by incorporating fillers including alginate, and seaweed. These bricks are made by combining with the common brick-making clay, which are then combined with nothing but alginate powder, a natural polymer made from the cell walls of seaweed. This brick sample measures 19 cm by 9 cm x 9 cm, and different laboratory Clay (80%, 78%), and alginate (20%, 22%) are the mixed proportions used in tests such as compressive and flexural strength testing. For greater compressive strength, lessen the occurrence of cracks and deformation caused by contraction. Reduce the drying time and increase the bricks' resistance to bending.

Keywords: Compressive Strength, Flexural Strength, Alginate, Clay.

I. INTRODUCTION

The choice of materials is crucial in determining how environmentally friendly a structure will be. To do this, it is necessary to take into account the materials and energy used during production as well as their impact on operational elements like the quality of indoor air as well as the entire energy performance of the fabric of the building. Transport, upkeep requirements, and the potential for recycling or reuse after the building's useful life are all life-cycle factors that are significant. It has also been stated that the impact on the environment of construction materials will become increasingly significant as attempts to promote energy consumption and sustainable buildings in line with legal standards expand. This increased environmental consciousness has prompted research into alternate building materials that contain natural, biological ingredients. Is also rising, as compared to fossil fuels and petroleum-based products being explored for application in the building sector is the creation of unique bio-composite products that integrate bio-based resources in the form of natural materials or binders. A recent assessment by Coulson and Fuller demonstrated that biological products, such as cellulose and carbohydrates, as well as other oils and proteins, may be used in a range of building applications, including adhesive, masonry units, and panel goods. Agro-industrial waste and non-food crops have also been acknowledged as particularly excellent sources of useful organic resources.

Incorporating a biopolymer derived from seaweed into a composite building material is the aim of this study. Gala'n-Mar'n et alearlier.'s investigation, which utilized alginate as a binder inside an unfired clay brick, is strengthened by the present study. The position of the alginate element in the finished product, the significance of the chemical composition of the seaweed sources, and the influence of the alginate on characteristics other than mechanical strength were all clearly noted by the authors even though they noted that strength increased after the biopolymer was added. It was also clear that more research was required to fully understand the role of the alginate element in the final product. This research study examined a broad variety of alginate variations with three soil types and conducted additional characterization studies to more fully assess the practicality of using this abundant material in construction applications.

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1.1. Materials

1.1.1 Clay

Black clay, which is used to make bricks, may be found on agricultural land close to the village of Sitharamapuram in the Huzurnagar Telangana district.

Chemical composition of clay sample

Chemical element	Mass composition (%)
SiO2	59.6
Al2O3	22.4
Fe2O3	6.69
K2O	2.53
MgO	0.97
Cao	0.0777
Loss on ignition	5.34

Figure 1: Clay Sample

1.2 Additives

Alginate

Between 20–60% of the dry material in the cellular membrane of brown seaweeds is made up of an artificial polymer called alginate. In terms of its chemical composition, alginate is a wall co-polymer made up of (1-4)-linked D-mannuronic acid and M o acid residues, also referred to as M and G blocks. These components are arranged within the polymer chain in different ratios based on the origin of the seaweed.

Figure 2: Alginate Sample

II. LITERATURE REVIEW

- **Dove, Cassandra A. F. Fiona Bradley Seaweed biopolymers as additions for unfired clay bricks: Widely et al., 2016.**

In this study, natural additives (such as alginates) were employed to increase the bricks' fire resistance and durability. Alginate may be used as an additive to a production like unfired clay bricks when stronger particle

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bonding is desired. This study has improved our understanding of the role of the alginate component in such materials by highlighting the potential for increases in compressive and, in some cases, elastic modulus resilience. However, the volume of these rises varies depending on the type of alginate and soil type used. The largest strength modification was observed while using dirt.

- **C. Dove (2014) creation of unfired earth bricks utilizing bio polymers derived from seaweed.**

In this study, four distinct alginate compounds made from Scottish seaweeds were used to make small-scale unfired bricks and a lot of the findings demonstrated that both alginate products Boosted the flexural and compressive strengths of the bricks, however, the amount of strength improvement differed according to the kind of alginate used.

- **C. Rivera-Gomez, C. Galan-Marin (2020) Seaweed polymers and animal fibers to enhance unfired clay blocks characteristics**

In this study, researchers look at the impact of adding woolen, a natural animal fiber, to strengthen the ground and the alginate matrix. This study looked into the potential use of natural fiber as soil reinforcement. The surface fiber content polymer composites they produced for testing have properties that make them suitable for general use in the construction industry. Lastly, increased compressive strength was achieved by mixing animal fiber with soils that had previously been treated with alginate. The mechanical behavior of soil-only mixtures is considerably boosted by the addition of woolen to soil + alginate combinations.

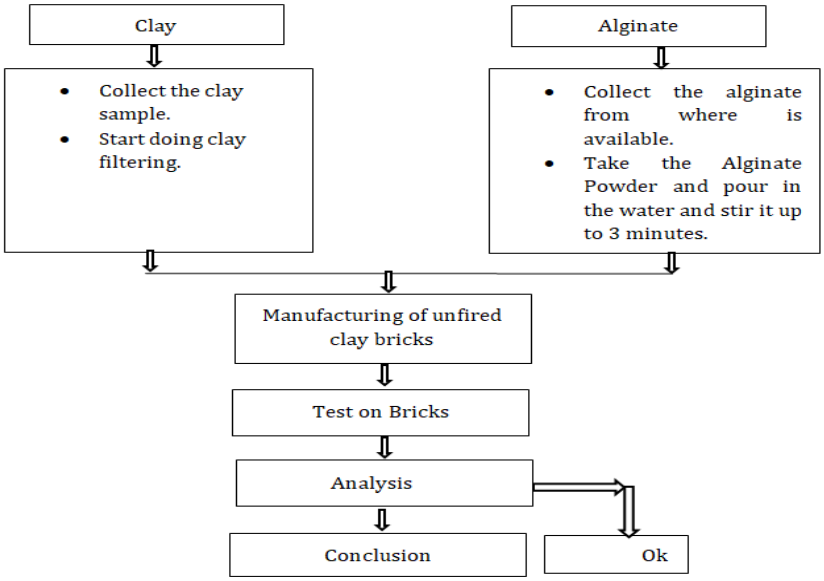
- **Straw reinforced unfired and fired clay brick for sustainable building construction, Soureiyatou Fadil-Djenabou, Published: 19 May 2022.**

Based on the findings of this investigation into the mechanical characteristics of fibre unfired as well as burnt clay bricks for the construction of sustainable buildings, When the level of straw addition grew, the burnt bricks' flexural and compressive strength resistances decreased, but their porosity increased. The authors suggest adding up to 10% of straws to unfired bricks for the best-quality bricks based on the findings of the study's addition of straw.

- **Enhancing properties of unfired clay bricks using palm fronds and palm seeds, John Bosco Niyomukiza, Joseph Akampulira, Published: 07 September 2022**

The findings of 114 unfired masonry samples' static, as well as dynamic hygric testing, are provided in this research. Unfired Earth Bricks (CEB) or plasters were used to prepare the samples. To ascertain their impact on moisture buffering capability, water vapor permeability, and sorption isotherms, the variety of soils, soil density, and preparation techniques were examined. By the Nordtest procedure, the Moist Acid neutralizing Value (MBV) was measured, allowing the results to be contrasted with those of more traditional materials.

III. METHODOLOGY



Flow Chart

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The methodology describes the above given flow chart.

3.1 Preparing the raw materials

The initial stage in creating the sample was to prepare and filter the raw components that will be used. The two essential components, clay were shipped from the nearby village of Sitharamapuram. On property held by the community, clay was removed from 20 cm of earth to obtain the finest grain possible. The clay was screened and sifted numerous times using various measurement sifters in order to achieve the smallest clay particles and exclude any unwanted particles that may jeopardise the homogeneity of samples.

Figure: 3 Clay Filtering

After that, was further processed by physically spinning it at various times to remove any impurities that would have a negative effect on the experiment. Three to five millimetres was the length of the wool pieces that were employed.

As for the stabilizer; the Alginate was purchased from Amazon and was prepared directly before the making of each sample when needed.

Figure 4: Alginate Powder

3.2 Preparation of Unfired Clay Brick

At the village of Sitharamapuram, adjacent to Huzurnagar, the sample was created. We create samples for three possible combinations, creating 12 samples overall.

The clay, wool fibre, and alginate mixtures are weighed and homogenised in a mould.

Table 1: Weight of raw materials

Clay (%)	Clay (g)	Alginate (%)	Alginate (g)	Total (g)
100	3000	-	-	3000
80	2400	20	600	3000
78	2340	22	660	3000

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Fig 5: Weighing Clay Sample

Fig 6: Weighing Alginate

IV. RESULTS AND DISCUSSION

4.1 Testing on Bricks

I'd like to do the following experiments, in this case, to find out more about the properties of unfired bricks. I compare the outcomes to those of conventional clay bricks after receiving the results.

Laboratory Test on brick

- Compression Test on brick
- Water Absorption test on brick
- Efflorescence Test on brick
- Dimensional stability test on brick
- Density Test on brick

Field Test on brick

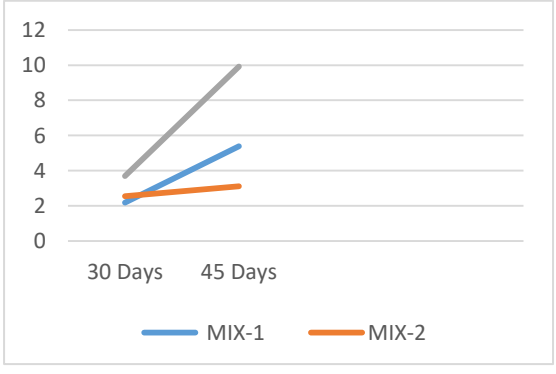
- Hardness Test on brick
- Soundness Test on brick
- Impact Test on brick
- Shape and Size Test on brick
- Structure Test on brick

4.1.1 Compression Test on brick

Table 2: Result of Compression Test in 30 and 45 Days

Duration	Mix-1	Mix-2	Mix-3
30 Days	2.18MPA	2.55MPA	3.7MPA
45 Days	5.39MPA	3.12MPA	9.92MPA

Figure 7: Testing Unfired Clay Brick



Graph 1: Compression test on Bricks

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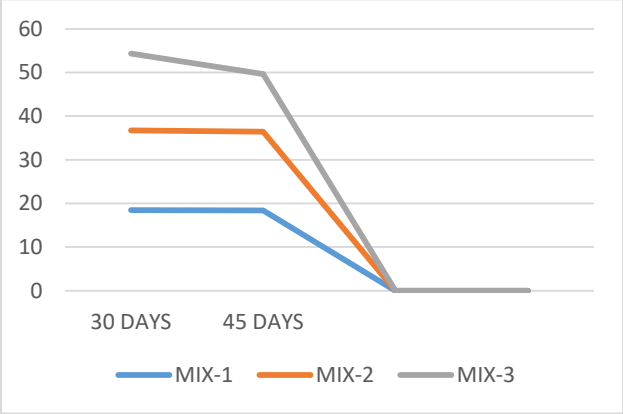
4.1.2 Water Absorption Test on Bricks

Figure 8: Testing on Water Absorption

Table: 3 Result of Water Absorption test in 30 and 45 Days

DURATION	MIX-4	MIX-5
30 DAYS	13.44%	15.11%
45 DAYS	16.10%	13.52%



Graph 2: Water Absorption test

4.1.3 Efflorescence Test on Brick

Figure 9: Water Absorption Test

Nil: When there is no perceptible deposit of efflorescence.

Slight: When not more than 10 percent of the exposed area of brick is covered with a thin deposit of salts.

Moderate: When there is a heavier deposit than under 'Slight' and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

Heavy: When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

Serious: When there is a heavy deposit of salts accompanied by powdering and/or flaking of the exposed surfaces.

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Table 4: Result of Efflorescence test

Types of Brick Sample	Efflorescence Test on Bricks
Conventional Brick	Nil
Unfired Clay Brick	Nil

4.1.4 Dimensional stability test on brick

We randomly select twenty bricks and measure their dimensions, width, and height. Finally, the brick size is given as 19×9×9 Cubic Centimetres, with variations of around 1–10 mm to be disregarded as shown in below figure 13 [a,b,c].

Figure 10: (a) Dimensional Test

Figure 10: (b) Dimensional Test

Figure 10: (c) Dimensional Test

4.1.5 .Density Test on brick

DENSITY = MASS/VOLUME

Figure 11: Bulk Density Test on Brick

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Table: 5 Result of Bulk Density Test

DURATION	MIX-1	MIX-2	MIX-3
30 DAYS	1.30 g/cm3	1.54 g/cm3	1.55 g/cm3
45 DAYS	1.26 g/cm3	1.48 g/cm3	1.49 g/cm3

Field Test on Bricks

4.1.6 Hardness Test on Brick

A scratch is made on a brick surface with the help of a fingernail. No impression has been left on the exterior; hence masonry is regarded as to be working diligently and used for building construction and as shown in figure-12.

Figure 12:- Hardness of the Brick

4.1.7 Soundness of a Brick

One brick is taken in each side, and the two are lightly struck against one another. A clear ringing occurs and the brick must not break, Hence concrete block is of excellent quality. Tasting requirements as shown in figure-13

Figure 13: Soundness of the Brick

4.1.8 Impact Test on Brick

In the brick impact test, a brick can fall from a height of 1 meter to the ground. If a brick is dropped on the ground, don't let it break your grace. If the brick does not crack or break into pieces, it indicates the best quality of the brick as shown in figure 14

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Figure 14: Impact Test on Brick

4.1.9 Shape and Size Test on brick

The bricks must be uniform, of the usual size and shape. Typical bricks should be rectangular. Brick edges and colour must be straight and uniform. The brick must not have sharp edges or cracks as shown in Figure 15.

Figure 15: Shape and Size Test on Brick

4.1.10 Structure Test on Brick

Choose one brick at random and break it to reveal the structure of the brick. Trace the inside of the brick. It should be homogeneous and free of lumps, as shown in Figure 16.

Figure 16:- Structure Test on Brick

V. CONCLUSION

The objective of this study was to determine if the addition of wool fibers to unfired clay brick enhances the mechanical properties of the material. As already mentioned before, it was proved that the thermal characteristics are improved in the clay bricks by adding Sheep wool to the mixture. More specifically, the

thermal conductivity showed that success of wool fibers to make the unfired clay bricks a good material for insolation and housing envelopment for thermal efficiency. Based on the literature review I have done, I have preferred to work on unfired clay bricks with sheep wool and Sodium alginate as a stabilizer. And the experimental part was conducted on different mix proportions in terms of compositions, dimensions, and drying time. As an answer to my problematic, the wool fibers does increase the mechanical properties of the unfired clay bricks. And the alginate stabilizer reinforced the bricks in term of resistance to compression more than wool alone by. Besides, the drying time and dimensions have also a major role in the bricks performance. The bricks with higher density and surface area showed less strength in comparison to the bricks with lower density and higher surface area.

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