Experimental study on ecofriendly bricks with cost effectiveness ensuring sustainability

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***Abstract*— Brick is the most widely used building material in the field of construction. Brick is manufactured locally and has been emphasized all over the world because of their easy availability and low cost. Brick is one of the important materials in the construction of which is widely used and highly demand in the construction of a structure in the civil engineering sector. Brick is one of the most demanding masonry units. It has the widest range of products. However, the consumption of natural resources such as sand in brick production resulted in resource depletion, environmental degradation, and energy consumption. The present use of cement is evaluated to be around 12 million tons per year and is yet expanding day by day.The production of cement is very hazardous to the environment as itproduces heat and an excessive amount of CO2.Carbon dioxide emissions are a serious environmental problem in cement production. It is a well-known fact that the production of one-ton cement exhaust around one ton of carbon dioxide directly into the atmosphere.In this project, we will see the solution for this problem. In this study, brick clay has been replaced with Groundnut shell powder and Tapioca cassava powder. These groundnut shell powder and Tapioca cassava powder will reduce carbon footprint, reduce resource depletion, reduce environmental degradation and energy consumption is increased.So the bricks with groundnut shell powder and Tapioca cassava powder has been analyzed for various parameters.**

***Index Terms*— Bricks, Compressive strength, Groundnut shell powder, Tapioca cassava powder, Alternatives, Replacement, density, soundness, ecofriendly, environmentally friendly**

I. INTRODUCTION

Brick has been regarded as one of the longest lasting and strongest building material, made from locally available sources, used throughout history. The main disadvantage is the environmental impact involved in the manufacturing process of clay brick. To overcome this drawback, a challenge has been made to raise the overall efficiency of clay brick by adding other suitable materials along with clay in the manufacturing process. Considering environmental impact and the efficiency, there is a need to find some alternative so as to reduce the impact of the clay brick manufacturing process on the environment and at the same time increase the overall performance of the brick.

Clay bricks are very durable, fire resistant, and require very little maintenance. Clays as raw material for clay bricks is most valued due to their ceramic characteristics. Clays are derived from the decomposition of rocks such as granite and pegmatite, and those used in the manufacture of brick are usually from alluvial or waterborne deposits. The presence of rock particles causes the clays to burn into bricks of varying colours and appearance. The important properties of clays that make them highly desirable as brick materials are the development of plasticity when mixed with water, and the hardening under the influence of fire, which drives off the water content. Normally, the physical nature of the raw materials controls the manufacturing methods. The overall process fundamentally consists of screening, grinding, washing and working the clay to the proper consistency for moulding into bricks, regardless of whether the process is done by hand or machine.

However, the consumption of natural resources such as sand in brick production resulted in resource depletion, environmental degradation, and energy consumption.So in order to reduce these effects replacement or alternatives are made in bricks. The

reuse of groundnut shell waste and tapioca cassava waste would reduce energy consumption and environmental pollution in the building sector, particularly in the manufacturing of masonry blocks. The recycling of trash into raw materials for masonry block production aids in fostering sustainable growth and environmental preservation.

II. MATERIALS USED

A. Clay

Clay is a finely- grained natural rock or soil material that combines one or more clay minerals with possible traces of quartz (SiO4), metal oxides (Al2O3, Mg O etc.) and organic matter.

B. Groundnut Shell powder

Groundnut shell powder reduces agricultural waste and lowers the environmental impact of brick production by decreasing reliance on cement. Groundnut shell powder can be used to create a sustainable and potentially stronger building material.

C. Tapioca Cassava powder

Tapioca Cassava have capability to interact with calcium hydroxide in cement resulting in formation of supplementary cementitious compunds. It reacts with calcium hydroxide in presence of moisture results in extra cementitious compounds.

III. METHODOLOGY

Traditional brick manufacturing method was employed to mix the raw materials. In this study, materials were measured using weighing balance. Then the clay was mixed well with water form a suitable correct plasticity and the workability. After that the GSP and TSP was mixed manually with the glue clay while adding water until reach the proper mixing. The GSP and TSP mixed clay material was filled in a rectangular wooden mould to get green bricks. The green bricks were protected by sawdust to avoid engaging with other newly prepared clay bricks. These green clay bricks were subjected to direct air dry under sunlight of temperature around 35 °C for a week. The sundried clay bricks were burned in a brick kiln of temperature range 600 °C to 850°C.

IV. RESULTS

A. Results

The mechanical and physical properties of the produced brick were analyzed which were namely; density, compressive strength, flexural strength and water absorption.

Particle size analysis: Particle analysis can be done by different size of sieves, but here this test was not done, because the aim of the research was to disseminate the knowledge to the local markets and improve the self-employment of the local community.

Density (ρ) analysis: Density is defined as the ratio between the dry mass and the volume of the clay brick, quantifying the quantity of clay found in the volume. It is evident from the definition; higher value is the denser brick and evidently enhanced its mechanical and durability properties.Literature shows that the typical value of the apparent density of the normal fired clay brick range from 1200 to 2200 kg. m−3 . To determine the average densities, mass, length, width and the height of the brick was measured using mechanical balance and Vernier calliper of sensitivity 0.1 g and 0.01 mm respectively. In each series, three bricks were recorded and average densities were calculated using equation.

Density = Mass / Volume

Water absorption analysis: Water absorption analysis was done to determine the water absorption property of the fired clay bricks. Three bricks from each percentage of GSA addition were analyzed. Initially, the bricks were kept under the sunlight of temperature of 35 °C to 40 oC for one day and the dry weight of the bricks were measured. Then the bricks were immersed into water of temperature of 20 °C to 23 o C for one day. Wet bricks were allowed to settle down for few Waters absorption analysis was done to determine the water absorption property of the fired clay bricks.Three bricks from each percentage of GSA addition were analyzed. Initially, the bricks were kept under the sunlight of temperature of 35 °C to 40 ºC for one day and the dry weight of the bricks were measured.Then the bricks were immersed into water of temperature of 20 °C to 23 oC for one day. Wet bricks were allowed to settle down for few minutes after taken out form the tank and the wet weight of

each brick was measured. Water absorption percentage was calculated using equation
Wet weight of the brick -Dry weight of the Brick Water absorption = Wet weight of the brick -Dry weight of the Brick/Dry weight of the Brick X 100%

Compressive Strength (CS) analysis: Compressive strength analyses were done using Universal Testing Machine.The testing procedure was performed. Initially, the brick surfaces were smoothened to get smooth parallel surfaces to form a good surface contact between the brick and the two pressing discs fitted in the machine. The compressive strength of bricks was measured with the help of a pressure gauge of sensitivity 2 kg.cm-2 attached to the Universal Testing Machine. The maximum force applied to just break the brick (or force at failure), width, and length of the block were recorded. Three bricks from each set were measured and the average compressive strength was determined using equation. Compresive Strength = Force at failure/ Width of the brick *length of the brick

Efflorescence test: The soluble salts if present in bricks will cause efflorescence on the surface of the bricks. To find out the presence of soluble salts in brick, it is immersed in water for 24 hours. It is then taken out and allowed to dry sunshade. The absence of grey or white deposits on its surface indicates the absence of soluble salts. If the white deposit covers about 10% surface, the efflorescence is said to be slight and considered moderate, while the white deposit covers about 50% surface. If grey or white deposits are found on more than 50% of the surface, the efflorescence becomes heavy and it is treated as serious, when such deposits are converted to powdery mass.

Shape and size: The bricks were closely examined to ensure they adhered to standard size and shape. Ten bricks were selected at random and stacked to measure the uniformity of length, width, and height. The bricks were required to be rectangular with sharp edges to meet the required quality standards.

Soundness test: The soundness of the brick was tested by striking two bricks against each other. The brick should not break, and a clear ringing sound should be produced if the brick is of good quality.

V. CONCLUSION

From the results achieved gotten from this study on the mechanical properties of straw reinforced unfired and fired clay bricks for sustainable building construction, the following conclusions were obtained:

The compressive and flexural strength resistances of the fired bricks reduced as the Groundnut shell powder and Tapioca cassava powder addition level increased, but their porosity increased with this addition.

The sample with Groundnut shell powder addition and Tapioca cassava powder addition showed good potential as ceramic bricks due to the optimize differences in linear shrinkage, water absorption and bulk density.

The development of Groundnut shell powder and Tapoica cassava powder fired bricks is a promising recycling method for low-cost and light-weight bricks production. Due to the results on the results obtained for the addition of Groundnut shell powder and Tapioca cassava powder used in this study, I recommend the addition of Groundnut shell powder and Tapioca cassava powder.

This new clay bricks can be manufactured on site itself, low cost, semi labour skills and local economy will flourish. Not only has that by introducing the use of locally available natural agro waste materials directed to ecological structure.

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