International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 12 Dec 2021, pp: 1189-1198 www.ijaem.net ISSN: 2395-5252

# A Study on Production of Eco Bricks Using Industrial Waste

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Submitted: 10-12-2021 Revised: 20-12-2021 Accepted: 24-12-2021

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**ABSTRACT** :-Many industrial wastes like blast furnace slag, fly ash and silica fume are used as a substituent cement material. But nowadays agriculture waste is also a very big issue in our country so researcher looks into this matter and utilizing the sugar cane baggage ash as a cement material to reduce the load on cement and also minimize the pollution.The partial replacement of ordinary Portland cement however by agricultural waste or agro-waste has been seen as an alternative solution for decreasing CO2 emission due to less cement consumption for construction industry.The traditional building materials, such as concrete type bricks, hollow type blocks, solid blocks, pavement type blocks, and floor tiles, are made from naturally available resources. This leads to environmental fragmentation as a result of extensive investigation, as well as the depletion of naturally occurring resources. Furthermore, during the operation phase and material processing,various noxious substances such as high levels of carbon monoxide, sulphur and nitrogen oxides, and suspended particles are released excess into the open atmosphere. These emissions have a detrimental impact on the environment, disrupting the functioning of environmental air, natural water resources, extensive soil, large flora and fauna species, and aquatic life, as well as affecting human health and living standards. As a result, various quantities in the environment may cause the current atmosphere to deteriorate. In recent years, it has become more importantin our society to improve sustainability and environmental conservation. It has been highlighted to investigate as the use of sustainable, low-cost,eco-friendly, lightweight, and compact construction materials in civil works has improved. expanding needs, improving environmental quality, and adhering to industry standards in terms of material requirements Our world is in the midst of a catastrophic overpopulation issue. Different types of by-products, generated from numerous sources such as commercial, domestic, industry, hospitals, public spaces, and so on, have collected in significant amounts in recent years. As a result, there is a pollution explosion. To address the issue of environmental degradation and the regular dumping of significant amounts of solid waste. The current study discusses a novel idea for making solid trash bricks that have been evaluated for fire and other strength features. Thisstudy paper is based on the concept of "waste to worth" in the building area, with the goal of casting bricks out of diverse waste materials.

**Key words**:- Building, brick, Fly Ash, silica fume

## I. INTRODUCTION

In a modern world every country deserves to have development and infrastructure that play vital role in the enhancement. The major used material in the infrastructure development is concrete. It is basically amalgam of aggregate, fine aggregate and ordinary Portland cement as the conventional binding material. As we know that in the production of cement affect environment very badly. The production of Ordinary Portland cement has been found to be responsible for about 6%–9% of global carbon (IV) oxide (CO2) emissions and cement industry has also been found to be the second largest CO2 emitting industry after the power generation.It was further found that each tone of cement production produces approximately one tone of CO2 emission. So researchers think about alternatives of cement and used industrial waste as the replacement of cement which waste has adhesive property like cement predicted to produce around 66 million tonnes of carbon dioxide (CO2) into the environment (Komyotra). 2005). On the one hand, the traditional brick-making industry

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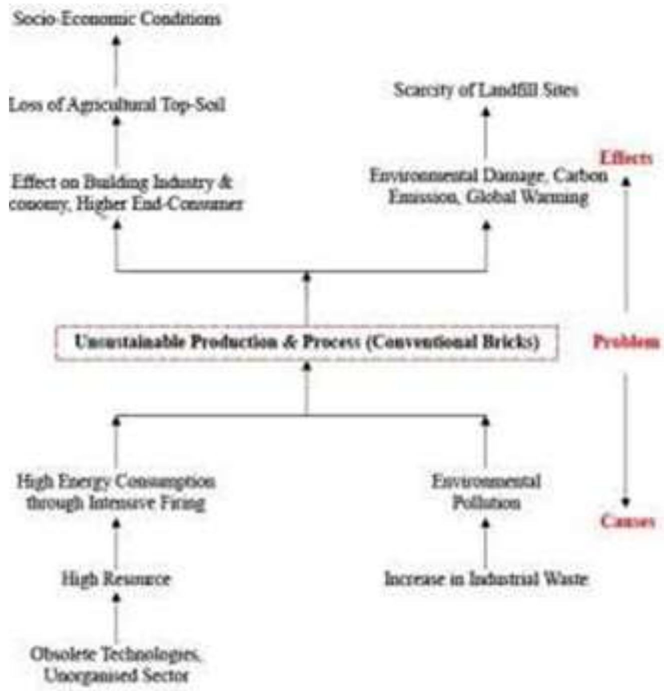
is suffering resource depletion in terms of coal and top soil erosion, as well as other harmful pollutants and particulate matter, rendering the brick-making process unsustainable (Figure 1.2 shows problems caused by conventional brick production and their effects). On the other hand, a large quantity of industrial waste, such as fly ash, pond ash, coal cinder, paper sludge, rice husk ash, blast furnace slag, marble dust, and so on, is ready to beused as a resource. A lot of study is being done to see whether there is away to use waste that would otherwise go unmanaged or end up in landfills.




## II. OBJECTIVE OF THE STUDY

Region classified under Indian Standard Criteria for Earthquake Resistant Design of Structures IS: 1893 (2002),placed under very severe seismic intensity zone V with zone factor 0.36. The buildings constructed on hilly slopein this zone are highly torsionally coupled and is most vulnerable to severe earthquakedamages. Proper assessments of the effect of earth quake shaking on the buildings structures constructed under hilly slope in seismic zone V and to suggest design model tolimitseverity of damages to property leading to minimum loss of economyand safety of lifeby “Earthquake analysis of buildings resting on sloping ground in seismic zone-V by static and dynamic method of analysis” is the objective of this synopsis for furtherance of thesis work.

### 2.1 LITERATURE REVIEW

**Diop et al. [3]** investigated the performance of bricks constructed from two distinct types of clay, each of which was treated at a different temperature. To make a thick paste, two separate clay samples with varied alkali concentrations (4, 8, and 12 M NaOH) were employed (alkali activation). The modified clays were statically compacted in a 2.5 cm diameter cylinder after vigorous hand mixing. A hand-operated hydraulic press was used to compact the soil. The clay's reaction with 8 M or 12 M NaOH went on for a long period. It was discovered that alkali activation improved the soils' overall stability.

**Cheah et al. [6]** investigated the mechanism of strength growth in pulverised fuel ash and high calcium wood ash bricks. The study's main goal was to report on the mechanical strength of a block made from pulverised fly ash (PFA) and high calcium content wood ash (HCWA) with low geopolymer content. Due to the angular particle form and porous nature of HCWA in comparison to PFA, the amount of mixing water required to attain standard consistency rose proportionally as the HCWA concentration increased in the HCWA-PFA hybrid geopolymerpaste system.

Fly Ash (FA) and Rice Husk Ash (RHA) were studied in alkali- activated bricks **by Hwang and Huynh [8]**. FA and RHA had mean particle

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sizes (D50) of 21.5 and 15.3 m, respectively. However, the FA was found to be more suited for alkali activation than RHA in the investigation. FA particles were also found to be rounder and smoother, whilst RHA particles were porous and angular in shape, making the combination of these waste materials appropriate.

**[9] IJESC, August 2019 23513 http://ijesc.org/ Khater et al.** Slag and metakaolin were alkali-activated at room temperature, resulting in the creation of calcium and sodium aluminosilicate gel. The activators employed were a 10% NaOH solution and a 5% liquid sodium silicate solution. The produced bricks were strong enough to withstand huge loads.

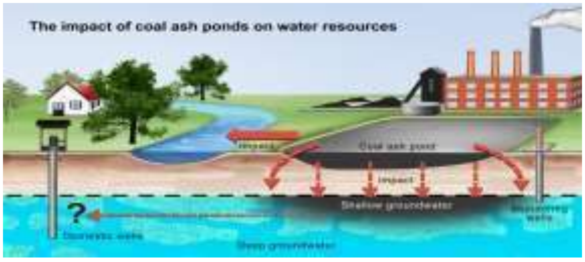
## III. MATERIALS AND METHODOLGY

**Fly Ash**

India now produces a tremendous amount of fly ash, estimated to be around 112 MT (Pappu et al. 2007). According to a recent study by the Centre for Science and Environment (CSE), fly ash disposal continues to be a serious issue, with only around 50 to 60% of total fly ash generated by the power sector being used in cement, concrete, bricks, backfill or road embankments, adhesives, and wall bollards. The rest is thrown into ash ponds that are inadequately built and managed

**Pond ash**

Pond ash is another significant byproduct of coal combustion in thermal power plants. One of the most serious warnings from the World Bank to India is that coal ash removal will necessitate one metre square of land per person. The majority of thermal power facilities in India use a wet ash disposal technique.




**Stone dust**

Stone dust, a by-product of the stone (granite) crushing process generated during quarrying activities, is one of the materials that has recently gained attention for use as concreting aggregates in a variety of applications such as cement mortar, building blocks, concrete, and controlled low strength material (Shakir et al. 2013). River sand prices have risen sharply due to scarcity. Crushed sand, commonly known as M-sand, stone dust, quarry dust, and other names, is a stone quarry byproduct. Stone dust can be a cost-effective substitute for river sand.


**Coal cinder**

Coal is used as a fuel in many sectors, including paper mills, to fire boilers and generate steam. When coal is burned in boilers, it creates a residue known as "coal ash, or coal cinder," also known locally as Bhuki or Rakhad. It's basically the powder or chunks of burned or unburned coal that haven't been reduced to ashes but can't be reduced any more. Coal cinder is a non-organic waste product. This by-product has the potential to be a useful resource, serving as a substitute for natural fines in bricks and concrete

**Paper sludge**

The process of making recycled paper includes a number of filtration procedures in order

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to preserve as much cellulose fibre as feasible. However, because the cellulose fibres are broken, recycling for the purpose of making new paper is only practicable for 3 to 8 cycles until sludge is produced. The proportion that passes the final filter is referred to as waste paper sludge or ETP sludge by the paper industry. On average, 35% of the material entering pulp and paper mills ends up as waste in the form of rejections

**Marble dust**

The marble business produces 6.5 million tonnes of garbage out of the total waste created. When marble is processed, two sorts of by-products are produced. The scrap contains marble slurry, which is water containing marble powder, as well as stones of irregular shape or smaller size. When one tonne of marble stone is processed, one tonne of marble slurry is said to be created. This dust is usually dumped along the riverbed or a nearby abandoned pit, contaminating the land, groundwater, and surface water.


bottom. For a long time, humans have been aware of the methods required to make quicklime, and chemists believe it is one of the earliest mical reactions known to man. For thousands of years, people have been using the material all around the world. Quicklime must be handled with caution. It can absorb carbon dioxide from the air as it rests, reverting to its original state. It has a high degree of binding ability. It has long been used as a binding material in the construction sector. This material has a wide range of applications, from mortar to flux. Lime is used in mortar and plaster, as well as in the production of soap, rubber, varnish, refractories, and lime bricks.

**Quicklime**

Both calcium oxide (quicklime) and calcium hydroxide are referred to as lime (slacked lime). Thermal breakdown occurs when limestone (calcium carbonate) is heated to roughly 1000°C. It loses carbon dioxide and becomes quicklime as a result. The reaction takes place in specifically designed kilns. In a continuous operation, limestone is added at the top and quicklime is removed at the


**Gypsum**

Gypsum is a soft sulphate mineral made up of calcium sulphate dehydrate (CaSO42H2O) that forms in sediment. It's a non-hydraulic binder that can be found in soft crystalline rock or sand in nature. Gypsum has a number of desirable characteristics, including rapid hardening and drying with minimal shrinkage, low bulk density, strong fire resistance, good sound absorption capabilities, and a superior surface quality. It has the ability to strengthen or raise the viscosity of a substance. Gypsum is used in the production of wallboard, cement, plaster of Paris, soil conditioning, and as a hardening retarder in Portland cement. It is also utilised in the production of bricks.


**Robo sand**

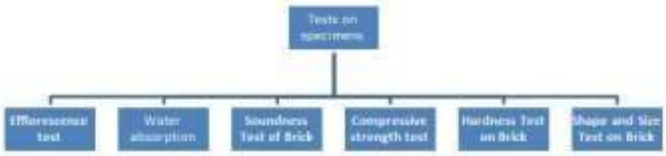
It is sand produce in the stone Quarry it is perfect replacement of the river sand utilisation in the construction robots and is prepared by grinded or crushed granite collected from good queries using higher technology three-stage vertical shaft impact machinery it is producing the largest form of concrete in PCC and RCC grades The main advantage of robots and our cubicle dimensions proper graduation and lack of impurities advantage of robo and are cheaper no improvement is sophisticated building strengt a physics properties of GreenSand

**Cement**

Cement is a globally employed binding material, a matter utilized for construction which helps in setting, hardens and interacts with other supplementary components, binding them together powerfully. Sand and gravel (aggregate) are typically bound together with cement. Cement is mixed with fine aggregate particles to make classic civil construction mortar. To produce concrete mix, use sea or river sand particles and gravel aggregates. Cement grades used in building projects are typically non-organic in origin, consisting of a lime or calcium silicate-based compound that can be classed as hydraulic or non- hydraulic depending on how well the cement adheres to the surface in the presence of water.

## IV. EXPERIMENTS

The specimens were tested for compressive strength, ultrasonic pulse velocity, and water absorption to investigate the effects of various waste replacements and additions, with the goal of identifying the process variables affecting the various engineering properties of unfired bricks made from industrial waste. The size of test specimens was 5×5×5 cm with a fixed percentage of lime, gypsum and mixing water to 9%, 3%, and 14% respectively. All the specimens were tested for curing age of 3, 7, 14, 28 and 54 days. After mixing the materials will be e breast into the mould and then bricks are placed on wooden plates and will be kept as it is for 2 days thereafter they are transported to open area where they are cured for 10 to 14 days also the bricks with same proportion are oven dried and different lab test are carried out to compare the strength parameters and quality with the conventional bricks



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This test was carried out according to the IS 1727-1967 requirements. The known-weight samples were placed in ceramic crucibles and held in the muffle furnace (Figure 4.4) for 2 hours, first at 100°C to remove moisture, then at 500°C and 1000°C for 2 hours, and the weight change was measured for each temperature. The difference between the starting weight of the sample stored in the muffle furnace and the final weight ofthe sample after each step to the original weight of the sample, expressed as a percentage of the beginning weight, was used to computethe LOI. The LOI values for the raw materials used are shown in Table4.2

**Water absorption test**

It is necessary to evaluate the amount of water absorption for novel materials such as coal cinder and paper sludge, as it is a critical factor in other testing and brick manufacture. It is a simple but significant test to measure the raw material's water absorption up to saturation.

**Calculation of Water Absorption of Bricks**

Water absorption by the brick specimen is given by the formula,

$$W = \frac{M_2 - M_1}{M_1} X\ 100$$

The average result shall be reported.where,

M2 = Wet Weight of brick after immersion of brick in water for 24hours

M1 = Dry Weight after oven drying of brick at 105-110 deg. C

**Compressive strength test**

The most significant test for determining the engineering quality of bricks is their compressive strength. The test was carried out according to IS 3495(Part 1)-1992. At 3, 7, 14, 28, and 54 days after curing, all prepared brick specimens for series A, B, C, and D blends were tested for compressive strength. Due to a lack of time, the 54-day compressivestrength test for series E blends was not conducted. At each test age, a minimum of three samples were tested. This test was carried out utilising an automatic Compression Testing Machine (CTM) with a capacity of 5000kN, and a constant progressive load of 0.6 kN/sec was applied (Figure 5.1). The ratio of ultimate failure load to the area of sample perpendicular to the direction of load application was used to compute compressive strength (MPa).

**Soundness Test of Brick**

Soundness test on bricks is carried out to determine the nature of bricks when subjected to sudden impact. It is a simple test in which two bricks are taken randomly from the stack of bricks. The bricks are then struck against each other. If it emits clear metallic ringing sound; the brick is of good quality.

**Shape and Size Test on Brick**

To maintain the uniformity in the construction, the bricks must be of proper shape and uniform size. A good brick must have a proper rectangular shape with sharp edges. For this test, about 20 bricks from the stacked bricks are taken. The samples taken are then stacked alongthe length, breadth and height and duly compared. If all the bricks are of similar size, then they can be used in construction works.

**Efflorescence test**

As water evaporates, efflorescence forms a fine, white, powdery layer of water-soluble salts on the surface of bricks. This test was carried out according to the IS 3495 (Part 3):1992 requirements. One end of the specimen was immersed in water for this test. 2.5 cm is the depth of immersion in water. The specimen was then placed in a warm (20- 30°C) and well-ventilated room until it absorbed all of the water and the excess water evaporated. The arrangement was covered with glassto prevent excessive evaporation

## V. RESULTS AND CONCLUSION

This chapter deals with the presentation of results obtained from various tests conducted on concrete specimens cast with and without silica fume is shown here. The main objective of the research program was to understand the strength and durability aspects of concrete obtained using silica fume as partial replacement for cement. In order to achieve

| Raw materials | Specific gravity |
|---|---|
| Fly ash | 2.18 |
| Pond ash | 2.03 |
| Coal cinder | 1.53 |
| Paper sludge | 1.23 |
| Stone dust | 2.85 |
| Marble dust | 2.88 |
| Quicklime | 2.29 |
| Gypsum | 2.46 |

the objectives of present study, an experimental program was planned to investigate the effect of silica fume on compressive strength and split tensile strength concrete. The experimental program consists of casting, curing and testing of controlled and silica fume concrete specimen at different ages.

**Water absorption test**

The fundamental aspect impacting the durability of bricks is water absorption. The less water that gets into the brick, the more durable it is, and the more natural environment resistance it will have. As a result, the internal structure of brick should be solid enough to prevent water entry. The bulk density of brick is defined as the weight of the brick divided by its volume. IS 3495 (Part 2):1992, often known as the 24-hour immersion cold water test, was used to conduct the water absorption test. This test was carried out by placing the specimen in a laboratory oven for 24 hours at a temperature of 100 5°C until it reached a basically constant mass. At a temperature of 27 2°C, the specimen from the oven was immersed in water for 24 hours.

| Series | Mix ID | Water absorption (%) |
|---|---|---|
| A | PA-0% (BM) | 15.4% |
| | PA-12.5% | 16.1% |
| | PA-25% | 18.2% |
| | PA-37.5% | 19.1% |
| | PA-50% (RM) | 19.8% |

**Compressive strength test**

For all ages, compressive strength falls as the fraction of stone dust replaced with pond ash increases. The total replacement of stone dust from the foundation mix (fly ash-stone dust-lime-gypsum) leads in a 50% drop in compressive strength at the age of 56 days, as illustrated inFigure 5.3, with the goal of using pond ash instead of stone dust. It's similar to pond ash in that it's permeable and finer than stone dust. Furthermore, stone dust is a powerful material that serves as aggregates in the brick system and might cause voids if replaced alone. It could also be explained by the fact that the system's initial porosity grew from
3.29 percent to 14.26 percent. It's worth noting that the compressive strength has increased significantly from 28 to 56 days.

**Efflorescence test**

The efflorescence results were really satisfying and encouraging. For series A, B, C, and E, the bricks created in this investigation showed no efflorescence. Because the white or grey deposits were less than 10%, slight efflorescence was noticed in series D brick specimens.
pond ash. As pond ash and coal cinder are used instead of fly ash, water absorption increases by 36 percent and 20 percent, respectively, when compared to the reference mix. Although coal cinder has a larger waterabsorption capacity, its finer particle size diminishes the matrix's overall water absorption capacity. As a result, when it comes to water absorption, coal cinder outperforms fly ash.

| Bricks | Compressive strength |
|---|---|
| Base mix ('Fly ash-stone dust-lime-gypsum' system) | Good |
| Replacement of stone dust with pond ash ('Fly ash-pond ash-lime-gypsum' system) Reference mix | Reduced, Good |
| Replacement of fly ash with pond ash ('Fly ash-pond ash-lime-gypsum' system) | Reduced, Poor |
| Replacement of fly ash with coal cinder ('Coal cinder-pond ash-lime-gypsum' system) | Better |
| Addition of paper sludge ('Fly ash-pond ash-paper sludge-lime-gypsum' system) | Highly reduced (Poor) |
| Addition of marble dust ('Fly ash-pond ash-marble dust-lime-gypsum' system) | Best |

When fly ash is replaced by pond ash and coal cinder, bricks become 16 percent and 18 percent lighter, respectively, when compared to a reference mix of "fly ash-pond ash-lime-gypsum."

Compressive strength, UPV, and water absorption are all reduced when paper sludge is added. When compared to the reference mix, it reduces compressive strength and UPV by 13 percent and 59 percent, respectively, while increasing water absorption by 29 percent. The density of the bricks is drastically reduced when paper sludge is added. This is due to the flaky and porous nature of the paperThe inclusion of marble dust boosts compressive strength and UV protection. At the age of 28 days, marble dust blends with 10% addition have the greatest compressive strength of 13.014 MPa and UPV of 2.75 km/s. It also hasa 22 percent increase in water absorption. The finer particle can be blamed for the significant increase in compressive strength. by increasing the packing of constituent materials, which reduces the initial porosity of the mix from 14.26 percent to 5.91 percent.

## SUMMARY

The study looked into ways to use various hazardous and non-hazardous industrial wastes in the production of non-structural, unfired bricks in asafe and profitable way. Paper sludge, pond ash, and other novel raw materials were offered to the brick business. a method for examining/selecting or formulating an effective feed mixture incorporating a new solid-waste material for making unfired bricks using coal cinder and marble dust for brick manufacturingInitially, physical and chemical parameters such as specific gravity, loss on ignition, and water absorption were used to classify all of the collected industrial waste. Blaine's air permeability equipment was used to determine the specific surface area. Following successful characterisation, the proportions of several mixes for casting specimenswere determined.

## CONCLUSIONS

The specific findings in this study with regard to various unfired bricks production systems led to the following conclusions:

With increasing percentage substitution of stone dust with pond ash, compressive strength and UPV decline. When stone dust is completely replaced with pond ash from the base mix, the compressive strength of the ‘fly ash-pond ash-lime-gypsum' system is reduced by 50%. In comparison to the base mix, the reference mix has a 28.5 percent increase in water absorption. In comparison to the base mix, the bricks made with pond ash instead of stone dust are 21% lighter. These results can be explained by the fact that pond ash is light weight and increases the system's initial porosity from 3.29 percent to 14.26 percent, as well as having a porous structure and finer particle size than stone dust, which is a heavy coarser material that improves matrix packing through interlocking.

With increasing percentage substitution of fly ash from the reference mix with pond ash and coal cinder, compressive strength and UPV

The density of the bricks is increased by adding marble dust. The density of the reference mix increased by 14 percent after a 10% addition. This can be due to the marble dust's dense bulk. The density gain is not significant with the additional addition because marble dust has been observed to increase matrix packing and fill voids generated by pond ash and fly ash.

From 28 to 56 days of curing age, there is a significant rise in compressive strength.

For all blends, UPV increases as the curing age of the brick specimen increases.

The ultrasonic pulse velocity is linearly proportional to the compressive strength of bricks. It is also true that the greater the compressive strength, the greater the UPV.

The water absorption of bricks is inversely related to their compressive strength. The percentage water absorption increases as the matrix's compressive strength falls. It is due to the fact that when the compressive strength of the matrix increases, the porosity of the matrix decreases.

The specific gravity of the basic raw materials and their packing in the matrix are directly related to the bulk density of brick specimens. The initial porosity of the matrix can also influence bulk density. The compressive strength of the bricks is directly proportional to its bulk density. It has been discovered that the higher the brick density, the better.

One of the controlling factors that governs the compressive strength, UPV, and water absorption of the bricks is the initial porosity of the blend. Compressive strength and UPV decrease when initial porosity rises, but water absorption rises.

Decline. When compared to pond ash-lime-gypsum, the ‘coal cinder- It is possible to pond ash-lime-gypsum' system had a smaller compressive strength reduction. This could be because coal cinder has a higher reactivity than correlate and forecast the approximate compressive strength of bricks depending on the initial porosity of the matrix using the results and analysis of this study. compares the compressive strength of several design mix blends employed in this investigation.

The findings of this study show that bricks containing industrial waste such as pond ash, coal cinder, and marble dust had marketable features as non-structural, controlled low strength bricks. This study's findings also give the brick industry with readily available new raw materials for brick making, as well as the waste-generating business with the potential to save money by lowering or eliminating trash disposal.

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