USING SUGARCANE BAGASSE ASH AS A BUILDING MATERIAL

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Abstract— Abstract: **If industrial waste is not properly disposed of, it can be detrimental to the environment and human health. One of the largest agricultural waste products in the world is the fibrous byproduct known as "bagasse," which is created when sugarcane is crushed and the juice is extracted. Bagasse is still used as a biomass fuel for boilers, but after burning, the byproduct is unusable and is usually dumped into rivers, having detrimental impacts on human health, the environment, arable land, and water sources. etc. Sugarcane bagasse ash (SCBA), which is produced as a result of incinerating sugarcane bagasse, may have significant concentrations of Si02 and Al203. Bricks made from sugarcane bagasse ash waste can reduce disposal expenses for the sugarcane industry and result in "greener" construction materials. In this study, the cement in the cement bricks can be replaced by bagasse ash, lime, quarry dust, and waste. It is feasible to make bricks by mixing various ratios of bagasse ash, lime, quarry dust, and waste. The bricks must undergo laboratory testing following the completion of the production process, and the findings are analyzed in terms of water absorption and compressive strength. The purpose of this research was to create affordable, environmentally friendly bricks in order to preserve environmental harmony and prevent the ash disposal issue. Additionally, it was anticipated that bricks would need to be more energy-efficient, lighter in weight, and compliant with IS 1077:199 compressive strength standards.**

Keywords— ***sugarcane bagasse Ash (SCBA), lime (L), quarry dust (QD), etc.***

1. INTR0DUCTION

A brick is a sort of block used to construct masonry structures such as walls, pavements, and other features. The term "brick" technically refers to a block made of dried clay. Bricks can be attached to one another by mortar, adhesives, or by interlocking. Bricks are made in large quantities and come in a wide range of classes, types, materials, and sizes that change depending on the place and the time period.

There is a shortage of traditional building construction materials as a result of scarce natural resources and growing urbanization. On the other hand, the energy required to produce typical building materials1pollutes the air, water, and land. Uncontrolled agro-waste accumulation, particularly in emerging nations, is of growing environmental concern. Therefore, it is crucial to create innovative technologies that recycle garbage and turn it into useable materials in order to safeguard the environment and promote the sustainable growth of civilization. Due to the growing volume of sludge produced by various industries or plants in India, there is a significant demand for ecologically safe reuse and effective disposal methods for bagasse ash. Sludge is frequently disposed of in landfills in India, but the country's expanding urbanization has made it harder and harder to locate suitable landfill sites.

Waste products were used to make brick and other building materials, including sewage sludge, red mud, fly ash, granulated blast furnace slag, sugarcane bagasse ash (SBA), recovered paper mill waste and fly ash.. As a result, incineration has emerged as one of the few options for sludge disposal. Bagasse ash from combustion can be disposed of in the long run by utilizing it as a building material. Repurposing this sludge as a building material, namely incorporating this bagasse ash into bricks, is one option for managing this sludge. We all know that India is the world's second-largest producer of sugarcane, right after Brazil. 4 million hectares of sugarcane were planted each year. Each year, sugar plants can process 40 million tonnes of sugarcane. About 300 kilogrammes of bagasse are collected for every tonne of crushed sugar cane. Bagasse was previously used as the fuel for making sugar. However, only a third of the bagasse is burned; the rest is thrown away. That is to say, the potential for producing briquettes from bagasse is enormous. Bagasse often contains 40 to 50% moisture, which makes it difficult to utilise as fuel. Bagasse is often stored before being processed further. It is kept moist for storage in order to produce power, and the moderate exothermic reaction brought on by the breakdown of leftover sugars causes a small drying of the bagasse pile.

In building, cement is a binder—a chemical compound that sets and hardens materials to bond them together. It is uncommon to utilize cement by itself to bind aggregate and sand.

The waste product from the stone crushing industry is called quarry dust. It is a concentrated material in the form of dust, and it is widely accessible—200 million tonnes annually. It is discarded because it is useless and polluting the environment. Recycling these wastes by incorporating them into building materials is a feasible solution to the pollution problem and can become an alternative building material as a partial replacement for cement, making concrete more inexpensive and having higher workability in addition to long-term strength. Lime is a unique and adaptable substance. It has a long history of usage in water and waste treatment, agriculture, building, and other fields. The creation of paper, sugar, steel, and calcium silicate bricks are just a few of the more contemporary manufacturing and processing businesses that employ lime. Particular focus is placed on the use of lime in the construction sector and the contribution it can make to the development of affordable building materials.

In the production of building materials and components including bricks, hollow bricks and structural concrete, the fly ash-lime-gypsum cementation binder finds extensive use. The usage of straw, cotton waste, rice husk ash, limestone dust, wood sawdust, and processed waste tea are only a few examples of the agro-industrial waste that has been attempted to be included into the brick-making process. Pore-forming agents (waste material) were added to the bricks before fire to decrease thermal conductivity.

Engineers have been pushed to explore for substitute materials as a result of the necessity to conserve traditional building resources that are running out. A workable solution to the pollution issue is the recycling of such wastes by incorporating them into construction components.

A widespread and plentiful masonry building material that continues to be favoured for its many distinguishing qualities is the baked clay brick. As a result, throughout the past century, research on the recycling of waste materials by incorporating them into bricks has become increasingly popular, with variable degrees of success across a wide spectrum of waste materials. This popularity is probably due to the variety of wastes that can be mixed into the brick-making material, but more importantly, the high temperature used to fire the bricks allows for both the fixation of wastes into the vitreous phase of the brick as well as the volatilization of potentially dangerous components. In the present study, the possibility of employing bagasse ash or sugarcane sludge as a partial replacement for clay in bricks is examined. There is a shortage of traditional building construction materials as a result of scarce natural resources and growing urbanization. On the other side, the energy needed to produce traditional building materials contaminates the air, water, and land. Uncontrolled agro-waste accumulation, particularly in emerging nations, raises environmental concerns. Therefore, it is crucial to create innovative technologies that recycle garbage and turn it into useable materials in order to safeguard the environment and promote the sustainable growth of civilization.

2. OBJECTIVES

1. By varying the percentages of cement, lime, quarry dust, and sugarcane bagasse ash, the compressive strength of the brick can be achieved.
2. To make use of the waste produced by the sugarcane industries.
3. Protection of the environment for future generations.

3. MATERIALS AND METHODOLOGY

A) MATERIALS

A. Cement:

Ordinary portland cement will be the type of cement utilized. It is a fine powder made using extremely accurate manufacturing techniques. The fine components become a paste when combined with water, which bonds and hardens when placed in water. As a result of the powder's variable composition and fineness, cement can have various qualities. Concrete's primary ingredient is cement. It is a low-cost, high-quality building material that is employed in construction projects.

B. Sugarcane bagasse Ash:

Bagasse ash is produced by the burning of bagasse, a sugarcane waste product. Currently, bagasse is burned as fuel in sugar plants to power their boilers. Environmental issues result from this bagasse ash, which is typically scattered over farmland and dumped in ash ponds. Additionally, according to study, working around dusts from bagasse processing can lead to pulmonary fibrosis, a chronic lung disease that is more particularly known as bagasse. Therefore, there is a significant need for its reuse. Additionally, bagasse ash is discovered to be high in silica and to have pozzolanic properties, making it a suitable substitute for other building materials. The bagasse ash from sugarcane has an impact on cement quality. Its physical characteristics include fineness, expansion, setting time, and compressive strength. It has a good chemical composition that includes silica and aluminum.

C. Quarry dust:

Quarry dust, a byproduct of the crushing process, is a concentrated material that can be utilised as aggregates, particularly as fine aggregates, in concrete. The rock is crushed into various sizes during quarrying operations; the dust that results from this process is known as quarry dust and it is produced as trash. It becomes useless as a result and adds to air pollution. As a result, it is advised that quarry dust be used in building projects to reduce construction costs, preserve building materials, and guarantee the efficient use of natural resources. There is increasing pressure on the majority of developing countries to replace fine aggregate in concrete with an alternate material, either partially or entirely, without compromising the concrete's quality. Quarry dust has been used in the construction industry for a number of things, including bricks, tiles, aggregates, building materials and materials for building roads.

D. Lime:

To produce acetylene with the maximum yield possible, pure calcium oxide is fused with coke. The superior grade raw ingredients are directly responsible for the quality of the final carbide lime. Physically, having highly finely divided particles makes carbide lime better since it has smaller, finer particles. Greater speed and reactivity result from smaller particle sizes.

B) METHODOLOGY:

- When producing CEMENT-SBA-QD-L bricks, we took into consideration bricks with dimensions of 230x110x80 mm.
- Different combinations of cement, SBA, quarry dust, and lime will be made. The weight ratios of SBA and quarry dust in the composition mix will vary, although only slightly.
- Additionally, the components will be weighed before combining.
- Moulds will be pressed with the freshly created mixture. The bricks will be removed from the moulds after pressing, and all brick samples will also be cast. After the bricks are submerged in water for one day, all the samples will be maintained for drying until the day of the test.

4. COMPOSITION DETAILS:

The various brick compositions are also shown in table No. 1, and the chemical characteristics of cement, lime, sugar cane bagasse ash, and quarry dust have been listed below. Chemical testing of the materials is not done for this project.

Table I. Composition details of bricks

Trail no	SBA (%)	QD (%)	CEMENT (%)	LIME (%)	TOTAL (%)
1	60	10	10	20	100
2	55	15	10	20	100
3	50	20	10	20	100
4	45	25	10	20	100

Table II. Chemical composition details of quarry dust

Elements	$Si0_2$	Al_20_3	Fe_20_3	Ca0	Mg0	$S0_3$
Quarry dust	49.10	14.71	13.85	8.48	4.49	0.09

Table III. Chemical Composition Details Of Lime

Elements	Si02	Al203	Fe203	Ca0	Mg0	S03
Lime	5.80	1.83	0.62	67.54	13.93	-

Table IV. Chemical composition details of Cement

Elements	SiO2	Al2O3	Fe2O3	CaO	MgO	SO3
Cement	21.00	6.00	3.50	65.00	0.70	1.50

Table V. Chemical composition details of sugarcanebagasse ash

Elements	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3
Sugarcane Bagass eash	59.05	2.40	3.34	14.75	2.11	0.92

5. BASIC TESTS ON MATERIALS:

I. Tests on cement

A. Specific gravity of cement

Observations:

1. Weight empty specific gravity of bottle (W1) = 26.14gm
2. Weight specific gravity of bottle + Cement (W2) = 44.89gm
3. Weight specific gravity of bottle + Cement + Kerosene (W3) = 78.77gm
4. Weight specific gravity of bottle + Kerosene (W4) = 66.07gm
5. Weight specific gravity of bottle is filled only with water (W5) = 75.89gm

$$Gk = \frac{66.07-26{\cdot}14}{75{\cdot}89-26{\cdot}14} = 0.802$$

Specific gravity of kerosene, Gk = 0.802

$$\text{Specific gravity of cement} = \frac{(\omega_2-\omega_1)\times Gk}{(\omega_4-\omega_1)-(\omega_3-\omega_2)}$$

$$\frac{(44.89-26.14)\times 0.802}{(66.07-26.14)-(78.77-44.89)}$$

Result: Specific gravity of cement = 3.15

B. Normal consistency test:

The standard consistency or normal consistency of a cement is based on the depth to which the Vi-cat plunger must penetrate, which is typically 5-7 mm from the bottom of the Vi-cat mould, and how much water is required (measured as a percentage of the dry cement's weight) to create a uniformly consistent cement paste.

Fig. I Taking raw material

Table VI. Result of normal consistency test

Trial No	Weight of cement in gm	% of water by weight of cement	Volume of extra water in ml	Penetration (IR-FR) in mm
1	400	25	100	0
2	400	26	104	0
3	400	27	108	0
4	400	28	112	0
5	400	29	116	3
6	400	30	120	5

Result: Normal Consistency of Cement used for Study = 30%

C. FINENESS OF CEMENT:

Fineness of Cement is measured by sieving cement on standard sieve. The proportion of cement of which the cement particle sizes are greater than the 90micron is determined.

Table VII Result of fineness of cement

SL No.	Description	Trail 1	Trail 2
1	Weight of Cement (W1-gm)	100	100
2	Weight of Cement retained in 90Micron Sieve (W2-gm)	2	3
3	Finesse of Cement	98	97
4	Avg Fineness of cement	97.5	

Result: fineness of Cement used for Study:

Tests on quarry dust:

A. Specific gravity test on quarry dust

Table VII Result of specific gravity test on quarry dust

Sl. No.	Particulars	Trial 1	Trial 2
1	Empty wt of pycnometer W1 gm	605	605
2	Empty wt of pycnometer + (1/3) of quarry dust, W2 gm	960	950
3	Empty wt of pycnometer + (1/3) of quarry dust+water, W3 gm	1685	1685
4	Empty wt of pycnometer + full of water,w4 gm	1475	1475
5	Specific gravity of quarry dust	2.44	2.55
6	Avg Specific gravity of quarry dust	2.49	

6. MANUFACTURING PROCESS OF BRICKS:

- Firstly the basic tests are conducted on materials, and then the materials are taken according to the proportion by weighing.
- To remove lumps in the sugarcane bagasse ash, sieving is used.
- After that, the components are thoroughly blended to ensure even distribution.
- After that, water was added in accordance with the results of the basic cement test. We utilized 30% consistency cement for our experiment. For each composition, we prepared a batch of 20 kg.
- In addition, 30% of the water for overall weight was taken into account.

Fig. II Weighing of materials

Fig. III Mixing process

- The mixing is done thoroughly and the wet mix is placed inside the mould and compacted properly to get the good strength.

Fig. IV Placing the mix.

- After 10 minutes the bricks are taken out from the mould and the bricks are kept dry for 24 hours.
- Then the bricks immersed in the water until before the day test conducted on the bricks.

Fig. V Curing process

Fig. VI Compression test on bricks

Fig. VII After drying of bricks

7. RESULTS AND DISCUSSION:

Table VII. Test on 7 days bricks

Trail no	Dry wt (KG)	Wet wt (KG)	Compressive strength (N/mm2)	Water absorption(%)
T1	2.7	2.8	4.03	3.8
T2	2.5	2.6	3.58	4
T3	2.85	3	3.37	5.26
T4	2.75	2.95	4.00	7.27

Table VIII. Test on 14 days bricks

Trail no	Dry wt (KG)	Wet wt (KG)	Compressive strength (N/mm2)	Water absorption(%)
T1	2.75	2.9	4.18	5.45
T2	2.67	2.85	4.37	6.74
T3	2.88	3.1	4.57	7.76
T4	2.72	3	4.71	10.29

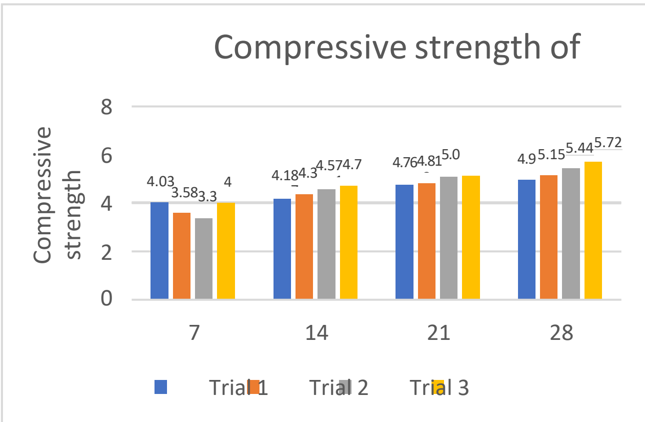
Table IX. Test on 21 days

Trail no	Dry wt (KG)	Wet wt (KG)	Compressive strength (N/mm2)	Water absorption (%)
T1	2.83	3.075	4.76	8.65
T2	2.69	2.97	4.81	10.4
T3	2.79	3.1	5.08	11.11
T4	2.87	3.2	5.13	11.49

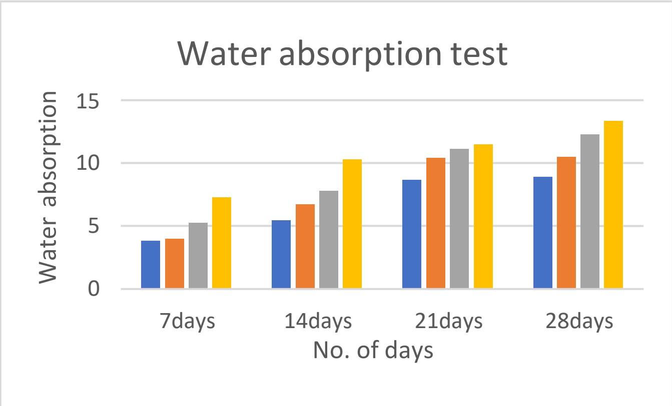
Table X. Test on 28 days bricks

Trail no	Dry wt (KG)	Wet wt (KG)	Compressive strength (N/mm2)	Water absorption (%)
T1	3.03	3.3	4.96	8.91
T2	2.76	3.05	5.15	10.5
T3	2.85	3.2	5.44	12.28
T4	2.74	3.1	5.72	13.13

I. Graph over compressive strength of bricks



II. Graph over water absorption of bricks



The manufacturing of cement has been investigated using sugarcane bagasse ash (SCBA), a byproduct of the sugarcane industry. SCBA can replace some of the cement used in building products like bricks since it contains high quantities of silica, a crucial component in cement. The affordability and accessibility of SCBA in cement bricks is one of its key benefits.

The ability to lessen the negative effects of building on the environment is another benefit of employing SCBA in cement bricks. Builders may lessen the amount of garbage transported to landfills and the carbon emissions linked to conventional cement manufacture by employing waste products like SCBA.

The use of SCBA in cement bricks is not without its difficulties. Making sure the bricks execute consistently high standards is one of the biggest challenges. Due to the fact that SCBA is a by-product, its makeup might change based on the kind of sugarcane utilized, the processing technique, and other elements. Due to this, ensuring that the bricks adhere to the necessary standards for strength and durability may be challenging.

Lime increases the workability and setting time of the mix when used as a brick material, making it possible to produce a larger batch of bricks at once. We utilized lime 20% at a constant rate for each composition to lengthen the time that cement mixtures took to set. More lime is used, which reduces compressive strength and also causes an increase in efflorescence.

The availability and inexpensive cost of quarry dust make it one of the key benefits of using it in cement bricks. Quarry dust can be purchased for less money than regular sand because it is a waste product. Additionally, places with stone quarries are home to abundant supplies of quarry dust.

Quarry dust might potentially increase the strength and longevity of cement bricks, which is another benefit. Quarry dust can replace some of the cement used in building materials like bricks since it includes a lot of silica, a crucial component in cement. The bricks may become stronger and more resilient as a result, resisting damage and deterioration overtime.

8. CONCLUSION

- Results for the bricks' various compositions were as anticipated.
- It has been demonstrated that employing SCBA in cement bricks has a favorable effect on the environment.
- The characteristics and environmental advantages of sugarcane bagasse ash bricks have showed promise as an alternative to conventional bricks.
- It has been discovered that bagasse ash, a byproduct of sugarcane processing, contains pozzolanic characteristics that make it a useful substitute for cement in the manufacture of bricks. This will lower the carbon emissions linked to the manufacture of cement.
- Bricks made from sugarcane bagasse ash have also shown to have strong mechanical qualities, including compressive strength and water absorption, making them appropriate for a variety of construction uses.
- They might lessen the trash produced during the sugarcane processing.
- Because of its characteristics, sugarcane bagasse ash bricks can be used for partitions, load-bearing walls, and non-load-bearing walls in a variety of construction projects.
- Quarry dust also has a high silica content, which improves bonding.
- Quarry dust usage reduces the amount of quarry dust in landfills.

REFERENCES

1. BangarSayali.S, Shubhangi, N. GawadeAnjali Y (2018): Review Paper on Replacement of Cement with Bagasse Ash Phakhe
2. M. Suresh Kumar Reddy, Shaik Bepari Fayaz Basha, S. Mahaboob Basha (2018): Bagasse Ash an Effective Replacement in Fly Ash Brick
3. Rohan Rajput, Mayank Gupta (2016): Utilization of bagasse ash as a brick material.
4. Kulkarni, S Raje, and M Rajgor, (2013): Bagasse ash as an effective replacement in fly ash bricks.
5. https://theconstructor.org/building/field-tests-on-building-lime/16049/