Experimental Study of Sugarcane Bagasse Ash and Quarry Dust in Partial Replacement of Brick Material

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Abstract

For Economic, Environmental, and technical reasons, the use of industrial and agricultural waste products in industry has been the subject of research. Sugarcane Bagasse, like Ethanol vapor, is a fibrous waste product of the sugar refining industry. This waste product is already polluting the environment, necessitating immediate waste management solutions. During the sawing and polishing operations, the quarry industry creates a considerable quantity of waste, mostly in the form of powder, which pollutes and harms the environment. As a result, the goal of this article is to describe and assess the potential for utilising Bagasse Ash and Quarry Dust created by brick-making enterprises. Bagasse Ash and Quarry Dust were used as partial replacements for brick material in the ratios of 0 percent, 5 percent, 10 percent, 15 percent, and 20 percent for bricks of size 22cm 10.5 cm7.5 cm. The bricks were fired at 900°C for 24 hours before being evaluated for water absorption and compressive strength.

Keywords- Bricks, Quarry Dust, Bagasse Ash, Waste Management.

I. INTRODUCTION

A large quantity of garbage is generated in India from industries, construction, agriculture, and other sectors. It is possible that these waste items are harmful since they have not been disposed of properly. When carefully researched, a considerable amount of waste material may be used in the building industry. Rural building in adjacent regions can benefit from the use of these waste materials because it is both cost-effective and environmentally benign. Researchers in India are examining the possibilities for using locally accessible trash in construction projects at the moment. The results to date show that such materials have a wide range of applications. But in India, just a handful materials have been tested. Some industrial waste products have been investigated in a similar manner. Rural building construction uses cement and lime kiln dusts, quarry waste, slag, fly ash, construction & demolition wastes, rice husk ash, bagasse ash, etc.

There are a number of wastes (such as cement and lime kiln dust) that are amassing throughout the world and posing financial and environmental challenges in disposing of them. Debris disposal is getting more expensive, and as sustainable resource management becomes more of a priority for many communities, landfilling and incineration are becoming less accepted.

Coordination and dedication are required from all stakeholders engaged in dealing with the rising disposal problem of these materials, including government agencies, corporations, the public, and specialists. Recycling and using these resources in the construction of buildings is one way to decrease the waste disposal problem.

A preliminary study was conducted in India to assess the availability of viable waste materials and their appropriateness for use in building construction in the country's capital city. In some circumstances, building construction businesses may be allowed to charge for the appropriate use of waste materials that would otherwise require costly treatment for disposal.

Quarry Dust

Various noise, dust and aesthetic control measures are required in a quarry. Quarries are formed when large rocks are broken down into smaller pieces. This substance is very similar to sand, however it is primarily grey in colour.

Fine particles from quarry washing, crushing, and screening, as well as wet silty clay from sand and gravel washing, make up quarry dust. Typically, these materials are put in ponds or stored in a wet condition. Dehydration and reclamation of these materials are required before usage. For parking lots or low-volume roadways, quarry dust fines can be used to create fill or borrow material, as a concrete and flowable fill filler, for base or subbase stabilisation or as a cement stabilised subbase material.

Bagasse Ash

Ash from bagasse production is used in agriculture. Bagasse is the solid waste material left behind after cane sugar juice has been extracted. Sugarcane bagasse is the fibrous residue left over after all the sugar has been extracted. It is utilised as fuel in boilers for heat generation in the same sector, leaving 8-10 percent of it as trash (SCBA). This ash is regarded to be a trash and is disposed of in an ecologically damaging way.

II. OBJECTIVE

- To use non-conventional materials in the manufacture of bricks.
- To test the quality of brick with bagasse ash and quarry sand.
- To protect the environment by using non-conventional materials like bagasse ash and quarry dust which result in substantial depletion of virgin resources.

III. LITERATURE REVIEW

Apurva Kulkarni, Samruddha Raje, Mamta Rajgor(2013), Bagasse Ash As An Effective Replacement In Fly Ash Bricks:

After sugar cane has been crushed and juice extracted, a fibrous residue called bagasse is left behind. Depending on the incinerating circumstances, sugarcane bagasse ash (SCBA) may have significant amounts of SiO₂ and Al₂O₃, making it suitable for use as supplemental cementitious material (SCM) in blended cement systems

Alaa A.Shakir, Sivakumar Naganathan, Kamal Nasharuddin Bin Mustapha(2013), Development of Bricks from Waste Material:

This study describes the results of a nonconventional brick-making experiment utilising fly ash (FA), quarry dust (QD), and slab scale (BS). Because the new process does not use clay or shale, nor does it require high pressure on the mould or high temperature kiln burning, it has significant environmental and ecological benefits. Billet scale and fly ash have an optimal ratio of 1:1, and billet scale and quarry dust are optimal at 1:1. The bricks created in this study can be utilised as an alternative to regular bricks, according to the results of this research.

Raut .S.P (2011) Development of Bricks from Various Industrial and Agricultural Waste Material:

An rise in environmental concerns has come from the accumulation of uncontrolled industrial or agricultural solid waste, particularly in developing nations. It indicates that recycling such wastes as a sustainable construction material is not only a realistic solution to the pollution problem, but also a cost-effective alternative for designing green structures. Waste-Create Bricks were developed by adding different waste materials to raw materials at varying degrees, with the goal of using industrial and agricultural waste products as construction materials (WCB). The evaluated strategy for the design and development of WCB utilising industria is shown in Figure 1..

Aigbodion. V. S, S.B Hassan, T.Ause and G.B. Nyior(2010), Potential Utilization of Solid Waste (Bagasse Ash):

This study describes the chemical and physical properties of bagasse ash in order to evaluate its potential for application in industry. For economic, environmental, and technological reasons, research has focused on the use of industrial and agricultural waste products in the industry. Sugar-cane bagasse, coupled with ethanol vapour, is a fibrous waste product of the sugar refinery industry.

Mangesh V. Madurwar, Sachin A. Mandavgane,Rahul V. Ralegaonkar(2014), Use of Sugarcane Bagasse Ash as Brick Material:

An use of sugarcane bagasse ash (SBA), a biofuel by-product, as a major raw material for brick manufacture was investigated in this article. Rather using natural river sand, quarry dust (QD) was used as a binder in the bricks. For new brick material, we used a mixture of SBA and QD-L. 20 percent lime added to SBA-QD bricks increased

compressive strength to 6.59 MPa. The results revealed that agricultural solid waste may be used to manufacture construction materials.

IV. MATERIAL AND METHODOLOGY

Red soil

Iron hydroxides are the cause of the red hue of red soil, commonly known as Terra Rosa. Heavy rainfall dissolves carbon from calcium carbonate parent rock and silicates are leached from the soil, resulting in iron hydroxide deposits. Usually, they are limestone depressions or locations where the flora has been relegated to the carport (low-lying scrub).

Fig.1. Red soil

Clay

Naturally occurring aluminium silicate comprised largely of fine-grained particles, clay is a natural product. When burned or dried, clay minerals harden and provide flexibility to clay deposits. They may also include a variable quantity of water that has been trapped by polar attraction inside the mineral structure.

Fig. 2. Clay soil

As well as organic elements that do not provide plasticity, clay deposits can contain inorganic minerals. In terms of size and mineral composition, Clay is distinguishable from other fine-grained soils by contrast. While silts, which are fine-grained soils that do not include clay, tend to have larger particle sizes than clay, there is some overlap in terms of particle size and other physical qualities, and there are numerous naturally occurring deposits that contain both silt and clay.

Bagasse ash

Ash from sugarcane bagasse is a by-product of sugar manufacturing. Once upon a time, this fibrous waste was simply removed from the mill and burned on the fields adjacent to it, causing environmental damage as well as financial burdens on the firm. Sugarcane bagasse is composed of roughly 50% cellulose, 25% hemicelluloses, and 25% lignin, according to the USDA. When sugarcane is processed into bagasse and residual ash, roughly 26 percent of each tonne of sugarcane is produced. Despite being a substance that is difficult to degrade and containing few nutrients, agricultural ash is utilised as a fertiliser.

Quarry dust

Building products such as aggregates, bricks, and tiles have been manufactured using quarry dust. Crushers generate crushed sand with a particle size of less than 4.75 mm from hard quarry rock. A quarry's extraction and processing produces quarry fines, which are gathered from a nearby quarry. Depending on the rock type, blasting and crushing methods employed, the amount of crushed rock generated will vary.

Methodology

Preparation of Bagasse Ash and Quarry Dust

In preparation of bagasse ash and quarry Dust the following process are involved

Drying

Drying is free from liquid or moisture, having or characterised by little or no rain and marked by the absence of natural or normal moisture. DRYING is a mass transfer process that involves the evaporation of a solid, semi-solid, or liquid to remove water or moisture. For this to happen, there must be a heat source and a sink for the vapour that is generated by this process. Water is usually always the solvent to be extracted from bio-products and medicines. The bagasse ash collected is kept under sunlight for 2 to 3 days. Quarry Dust is brought in wet condition so that they do not fly with air as they are too fine particles. They are dried at normal room temperature for 1-2 days.

Fig .3. Drying of Bagasse ash

Sieving

In separating desirable components from unwanted materials or characterising particles, sieves or sifters are used. The bagasse ash and quarry dust which is dried is of different sizes, so to maintain a uniform size the particle is sieved in IS 2.36mm sieve for bagasse ash and IS 1.00mm sieve for Quarry Dust. The particle passing through the sieve is used in manufacturing. Using sieving to separate particles of varying sizes is a simple and convenient approach.

In a tiny sieve for sifting flour, the pores are so small that only very fine flour particles may pass through. When the sieve is rubbed against the screen windows, the coarse particles that have been retained are broken up. Sieves with varying sorts of holes are employed depending on the types of particles to be sorted.

TESTING OF MATERIALS

Specific Gravity

When using a pycnometer, make sure that it is clean and dry. Cap it tightly and weigh it (W_1). pycnometer The cap is marked with a vertical line parallel to the pycnometer's axis to guarantee the cap is screwed to the same mark every time.

Pycnometer is opened by unscrewing cap and adding 200g of oven-dried soil. When the cap is tightened, the weight is calculated (W_2).

The pycnometer is entirely filled with water and dried from the outside. The weight is taken as a percentage of body weight (W_3). Clean and dry the empty pycnometer. Only water is used to fill the pycnometer's chamber. As soon as the cap has been screwed on, it is wiped dry. The weight is taken as a percentage of body weight (W_4).

TABLE 1. SPECIFIC GRAVITY OF RED SOIL

S.no	Weight of each item	Weight(kg)
1	Weight of pycnometer(W_1)	0.66
2	Weight of pycnometer + soil(W_2)	0.94
3	Weight of pycnometer + soil +water(W_3)	1.54
4	Weight of water + pycnometer(W_4)	1.37

$$\begin{aligned}
 \text{Specific Gravity} &= (w_2 - w_1) / [(w_2 - w_3) - (w_1 - w_4)] \\
 &= (0.94 - 0.66) / [(0.94 - 0.66) - (1.54 - 1.37)] \\
 &= 2.54
 \end{aligned}$$

The specific gravity of red soil is found to be 2.54

Fig. 4. Liquid Limit Graph

The Liquid limit of Red soil is 39%

The Plastic limit of red soil is 13.6% and Plasticity index of red soil is 25.4%

Clay

The specific gravity of red soil is found to be 2.72

Fig. 5. Liquid limit graph for clay soil

The Liquid limit of Clay soil is 40%

The Plastic limit of clay soil is 8.69% and Plasticity index of clay soil is 31.30%

Quarry Dust

The same specific gravity calculation has been carry out for bagasse ash. The specific gravity of quarry dust is found to be 2.09

Bagasse Ash

The same specific gravity calculation has been carry out for bagasse ash. The specific gravity of bagasse ash is found to be 2

Fig. 5 . Liquid limit graph for clay - Red soil

The Liquid limit of mixture of Clay and Red Soil is 37%

The Plastic limit of clay- Red soil is 11.11% & Plasticity index of clay & Red soil is 25.89%

Fig. 6. Liquid limit for Clay, Red soil and Bagasse ash

The Liquid limit of Clay, Red Soil & Bagasse Ash combination is 33%

The Plastic limit of clay- Red soil-Bagasse Ash is 11.11% & Plasticity index of clay-Red soil- Bagasse Ash is 21.89%

Fig. 7.s variations in Liquid Limit of various mixtures

Testing of Non-Conventional Bricks

After 24 hours of soaking in potable water, two bricks from each type are selected for compression strength testing and water absorption testing. For clay-bagasse and quarry bricks, the technique provided in IS 3495-part 1:197(9) for evaluating standard size clay bricks applies. With the use of a compression testing machine, the compressive strength is determined. As a rough approximation, two specimens are tested for each percentage, and the average of the two results is utilised. Water-immersed specimens having a significant amount of trash did not yield encouraging findings in terms of compressive stress and water absorption. Due to the fact that the test specimens did not meet the required dimensions stipulated in the IS code, we manufactured and examined samples of commercial bricks of similar size. In order to compare the strength of the lab-scale bricks to the strength of standard-size bricks, these data were used.

Reduction in weight of bricks

Bagasse ash and quarry dust are used to decrease the bricks' weight. The weight of the brick decreases as the percentage of trash added increases. In addition, the bagasse includes aluminium, a light weight material. As a result of the increased sintering temperature, weight loss did not rise much.

V. CONCLUSIONS

- Bagasse ash and quarry dust is available in large amount throughout the year. As the production of bagasse ash and quarry dust is in large quantity, it can be utilized for the manufacture of construction material like brick etc.
- It is known from the graph that the compressive strength of the brick which is partially replaced by bagasse ash and quarry dust obtain an optimum value at 20%, at a firing temperature of 9000C for manufacturing of clay-bagasse quarry brick.
- If the quarry dust and bagasse ash are directly disposed on land then the permeability of the soil reduces due to the blockage of pores in soil, which leads to stagnant of water and becomes the breeding place for the mosquitoes causing many diseases to living beings.
- Since the disposal of these wastes is costlier it can be partially replaced in a brick and also the usage of clay and red soil is considerably reduced.
- The reduction in the weight of bagasse quarry clay brick without compromising on strength could be advantageously used for multi-storey construction to reduce the dead weight of the structure. This brick can be used to build compound wall and for low cost construction buildings.
- Main conclusion is that the compressive strength of clay sludge brick is 20- 25% more when compared to conventional brick. This is achieved when clay and red soil are partially replaced by bagasse ash and quarry dust by 20% each respectively.

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