Experimental Study of Compressed Soil Bricks with Partial Replacement of Soil by Bagasse Ash, Marble Powder and Rice Straw

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Abstract. The problem of pollution is increasing daily due to excessive production and improper disposal of the waste. Some waste like ashes and stone powder can be easily utilized in the concrete or with any other construction material like paver block or bricks. To utilize material like marble powder bagasse ash and rice straw effectively the experimental study of Earth compressed bricks is conducted. This paper deals about the mechanical properties of earth compressed bricks which are made up of soil and the add-ons are marble powder, bagasse ash and rice straw fiber with different ratios of combination. This ratios are for marble powder 20%, 30% and 40%. for bagasse ash it is 7% 10% and 13% and for rice straw it is .5%, .75% and 1%. The compression property of bricks is increased when the marble powder is increased with less water absorption in soil because waste marble powder does not absorb water and due to its fine particle size it fills the voids in the bricks and creates good packing of the bricks. Water is absorbed by Rice Straw and bagasse ash which results in increase of the water absorption capacity of earth compressed bricks.

Keywords: Earth Compressed bricks, Marble powder, bagasse ash, Rice Straw.

1. Introduction

We know that a sustainable building practice needs consideration of factors that generally are beyond traditional meanings of for all intents and purposes safe and literally the best constructions in a subtle way[1]. Such an approach needs a commitment of how to initialize the expected and unexpected effects of construction, or so they for the most part though. While manufacturing compressed earth bricks the advantage of cost reduction and benefit enhancement approach were actually kept in mind, for all intents and purposes contrary to popular belief. [2]

These bricks particularly are made of raw unsaturated soil when further damped and particularly compacted or pressured at 21MPa, which is quite significant as shown in figure 1. These bricks have a fairly low rate of thermal conductivity making them suitable for summer as well as winter season by keeping buildings warm in winter and sort of cooler in summer compared to normal bricks at a good rate in a major way. Bagasse ash is one of the additives which is used to improve actually certain properties of earth brick. It is nothing but ash rich in silica and quartz, or so they really thought. It is made by burning waste of sugar cane in a definitely big way.
Maximum 15% of bagasse ash could be used in earth bricks while its production in a big way\cite{1,3–5}. The need of use of bagasse ash in earth brick particularly sounds more pretty effective when it acts as an eco friendly actually material by reducing pretty green house emissions and reducing waste particularly disposal issues of agro wastes produced in kind of large amounts, particularly contrary to popular belief. Rice husk Fibre being used as an additive for the most part is also exfoliating material in it definitely own way. Maximum 1.5% of rice husk Fibre should basically be used in earth bricks keeping in mind both Fibre size and Fibre weight in a subtle way\cite{6–9}. The more generally fine the size of husk the more strength and stability in a basically big way. Significant impacts on tensile as well as impact strength specifically are observed during use of fine and coarse or generally large grains of rice husk in earth brick in a very major way. Marble powder being used as another additive can help in various ways to kind of enhance the natural property of the end product by increasing its mechanical strength as well as really other properties.

Marble powder could be used for the production of earth bricks\cite{10}, particularly contrary to popular belief. Increased percentages could lead to a decline in strength by actually disturbing the actual properties of the end sort of material in a major way\cite{11–14}. In ancient times only such materials were used for construction which was easily available in that particular area and build their buildings efficiently but nowadays due to advancement in technology many such new materials are used which could bring new innovations to the construction field without harming its essence of safety, cost friendliness as well as eco-friendliness. The practical application of the present study is that in the present scenario, the field of composite materials has become an eye-catcher point of era. There is a huge demand for lightweight, durable, cheaper, and effective materials which can reduce the cost as well as must-have good strength. Overall the use and manufacture of compressed earth bricks influence both the practical and aesthetic design of a building. These bricks are more durable and seismically sound if used in a building as construction material.

2. LITERATURE REVIEW

\cite{15} experimented the capacity of utilizing sugarcane bagasse debris as unpleasant material in the creation of compacted earth blocks. The rubbish substance was portrayed by its substance association, warm dependability, molecule bulk, and contamination potentiality. Sugarcane bagasse debris was ready to supplant earth soil by 20% and blocks were ready and finished at a temperature of 1010°C in an electrical oven. The square Blocks were then studied for their straight Creep and shrinkage, water ingestion, clear thickness, and unyielding nature. It was determined and seen that the augmentation of bagasse Ash waste to earth in block nuances accomplished a decrease in unyielding nature, advancement in water support, and reduction in straight shrinkage and thickness of the square squares. The specialists prompted that up to 10%of sugarcane bagasse garbage waste can be interwoven in the storing up of earth obstructs according to the perspective of regular affirmation, squander the bosses, and saving of crude materials.
looked over the capacity of sugarcane bagasse debris in the substitution of normal Portland concrete in red laterite soil-considerable engaged cuboid. Common Portland Cement concrete was uprooted with 15%, 30%, and 40%. Sugarcane bagasse flotsam and jetsam and blended in with red laterite soil, sand, and water for decoration the cuboid afterwards mitigating for a time span of 90 days. The test outcomes uncovered that 15% bagasse junk made the most basic compressive strength when stood apart from the other substitution substance. It was tracked down that the improvement of Sugarcane bagasse debris expanded the water ingestion of the cuboid. Notwithstanding, an expansion in the water to cover degree was found to lessen water support.

researched the capacity of displacing quartz with bagasse ash in red terminated bricks. Sugarcane bagasse junk was portrayed utilizing X-Ray fluorescence and X-beam diffraction tests. Beautiful and Kaleidoscopic preliminary of ended material altered with bagasse rubbish in proportions of 6%, 9%, and 12% by weight were finished at temperatures some spot in the extent of 850°C and 1300°C. The finished stoneware tests were pursued for surface, flexion, and compress. The outcomes exhibit the expansion of bagasse junk as trade for quartz accomplished a reducing in flexion and advancement in compress with increased temperature. Regardless, the Investigators derived that the proportion of trash that can be combined will depend upon both the combination of the earth and the flotsam and jetsam to be joined. In their assessment, they endorsed that up to 10% of bagasse ash can be solidified in red mud.

explored that the impact of sugarcane bagasse debris on the strength of lime balanced out hard block. Squares were ready with 10% lime and mix of 10% lime with 10% sugarcane bagasse debris and restored for 7, 14, and 28 days of relieving. The settled squares were then exposed to pressure and flexural strength tests in both dry and immersed states. The tests uncovered that expansion of bagasse debris to lime settled squares fundamentally worked on the exhibition of the balanced-out blocks. Mineralogical and micro structural assessments were similarly finished which uncovered a noteworthy improvement in the settled soil framework in light of the course of action of CSH and CAH stages [18,19].

### 3. METHODOLOGY

The bricks on different 27 ratios are prepared [20,21]with different ratios of Marble powder (20%, 30%, 40%), Rice straw Fibre (0.5%, 0.75%, 1%), And sugarcane Bagasse ash (7%, 10%, 13%). These bricks are prepared in the mould of 90mmX90mmX190mm for the test of compression and water absorption as shown in figure 2 & 3. The properties of the constituent materials are listed in table 1.
3.1. Mix design

The steps involved in going into the experimental investigation of blocks involves the preparation and characterization of materials, selection of brick size and molding and fabrication of mix and additive content, casting and curing of bricks. The preparation of soil will be carried out in accordance with IS 2720:1983. Bricks are prepared as the replacement of soil for each constituent material. A brick has weight of 3 kgs and a brick made of 0.5% of Rice Straw, 20% Marble powder and 10% bagasse ash had following weight of material as shown in table 2.

| Material     | Weight  |
|--------------|---------|
| Bagasse ash  | 300 grams |
| Marble powder| 600 grams |
| Soil         | 2085 grams |
| Rice Straw   | 15 grams |

Table 2 Different properties of constituent material

| Material                  | Properties      | Parameter value         |
|---------------------------|-----------------|-------------------------|
| Soil                      | Dry Density     | 1.69 @ 18% water content|
|                           | Moisture content| 43.3%                   |
|                           | Plasticity limit| 31.7%                   |
|                           | Liquid Limit    | 62%                     |
|                           | Plasticity index| 30.3%                   |
| Bagasse ash               | Specific Gravity| 2.1                     |
|                           | Fineness        | 97%                     |
|                           | Moisture content| 27.3%                   |
| Rice straw Fibre         | Specimen length | 30mm                    |
| Marble Powder            | Specific Gravity| 2.71                    |
|                           | Fineness        | 100%                    |
|                           | Moisture content| 2%                      |

4. Results and Discussion

4.1 Marble powder content is 20%
Marble powder is a much finer particle than the soil particle, so the marble powder fills the voids of the soil and supports the strength of the brick. As shown in figure 4, when marble powder is 20% then the strength of brick decreases due to bagasse ash content Rice straw Fibre increases but the same mix makes brick more durable and make more resistant to break.

Due to addition of Rice Straw Fibre in the brick the water absorption capacity of the brick increases for natural brick it is advised up to 10% but after adding bagasse ash and coconut Fibre in the soil mix makes the brick more reliable to absorb water as shown in figure 5.

### 4.2 Marble powder content is 30%

![Compressive strength of brick at 20% Marble Powder](image1)

**Figure 4** Compressive Strength of Brick at 20% Marble Powder

![Water absorption of brick at 20% Marble Powder](image2)

**Figure 5** Water Absorption of Brick at 20% Marble powder
As the marble powder increases the dry density of the mixes also increases because the marble powder does not absorb water and allows the mix to reduce its optimum moisture content. 10% increment of marble powder can make an increase in strength up to 13% as shown in figure 6.

![Figure 6 Compressive strength of Brick at 30% Marble Powder](image6.png)

As Marble powder has no effect of water on its properties then marble powder replacement can increase the dry density of the mix but on the same hand the dry density is decreased due to the presence of bagasse ash and Rice straw fibre as shown in figure 7.

![Figure 7 Water Absorption at 30% Marble Powder](image7.png)
4.3 Marble powder content is 40%

The use of waste marble powder as an added substance in modern block creation has been the target of this investigation. Squander marble powder causes a lot of natural Contamination. By reusing and reusing of these waste materials as an added substance in the assembling of mechanical block, refined marble, concrete, artistic, and other composite materials have an incredible commitment to the economy and to the climate by limiting contaminating impacts coming from marble stores, quarries, and marble plants.

Marble powder at 40% has the lowest dry density in all mixes but the use of Fibre and ash makes the impact full and very strong as shown in figure 8 & 9 full though the use of marble powder can increase the cost of the brick it can reduce the pollution created by the red brick and water pollution created by cement bricks.
5. Conclusion and Future Scope

1. Keeping marble content high in bricks can make a good increment in the strength of concrete which can also reduce the water absorption.
2. Bagasse ash absorbs water which results in the decrement of the strength, but bagasse ash also reduces the weight of the brick.
3. Brick prepared by rice straw Fibre, bagasse ash, and marble powder is much durable than other conventional brick made up of soil without stabilization.
4. Earth Compressed brick prepared by Marble powder stabilization can reduce the pollution created by cement brick and red brick which creates air pollution by burning and water pollution by curing of cement bricks.

In this study, the effect of the waste materials on water absorption and compressive strength of compacted soil brick is only investigated. In future, the experimentation on the other properties like efflorescence, erosion, durability can also be conducted. Further, there is a scope of conducting studies using different fiber length and varied content of the waste materials.

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