STUDY ON THE EFFECT OF SUGARCANE BAGASSE ASH AND BANANA FIBRE ON PRESSED LATERITE SOIL BRICK

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Abstract - *Bricks are one of the major construction materials as they are mainly used for the construction of walls in buildings. Laterite blocks or bricks are used to construct building in many parts of India where lateritic bed rocks are found abundantly. The pressed bricks become more popular than burnt clay bricks due to its economy in manufacturing and the strength. In this project, an attempt was made to study the behaviour of pressed lateritic bricks with sugarcane bagasse ash and naturally available banana fibre. The geotechnical properties of the soil with and without sugarcane bagasse ash and banana fibre were investigated. The bagasse ash content was limited to 0 to 15% at an increment of 3% and banana fibres 0.5, 1.0, 1.5 and 2%. Bricks of size 200x100x100mm were also cast and investigated for their strength properties.*

Key Words: **Laterite soil, Sugarcane Bagasse Ash(SCBA),Banana Fibre(BF), Compressive Strength, Water Absorption, Shape and Brick Pillar test .**

1. INTRODUCTION

In India, the building industry consumes about 20000 million bricks and which in turn consumes approximately 27% of total natural energy for their production (Saranya et al.,2016).On the other hand, pressed earth blocks or Pressed earth/ mud bricks becoming more popular construction material because of its cost effectiveness and sustainable energy requirement. Bricks are one of the most useful building materials used in construction works. Laterite blocks or bricks are used to construct building in many parts of India where lateritic bed rocks are found abundantly. Laterite rocks formed due to metamorphism. Lateritic soil formed in wet and hot tropical areas and is rich in silica, aluminium and iron. It is in premature state of laterite rock formation.

1.1 OBJECTIVES OF THE STUDY

The main scope of this present work is to study the effect of replacement of sugarcane bagasse ash and addition of banana fibre on properties of laterite soil bricks. Hence the following objectives were framed:

1. To study the geotechnical properties of lateritic soil (LS), Sugarcane Bagasse ash(SCBA) and Banana fibres (BF)
2. To determine the optimum moisture content (OMC) and maximum dry density(MDD) and UCC for the various mix proportions.
3. To study the mechanical properties of the brick contains sugarcane Bagasse ash and Banana fibres.

2.MATERIALS AND METHODOLOGY

2.1 MATERIALS USED:

All the materials used in the experimental investigation were locally available at lower costs. The materials in this present experimental research include Laterite soil, Sugarcane bagasse ash, banana fibres, and water.

2.1.1 Laterite Soil

Lateritic soil used in this study was collected from 1m below the ground level from D.K. the geotechnical properties of laterite soil are given in Table I.

TABLE I : PROPERTIES OF LATERITE SOIL

Specific Gravity	2.65
Liquid limit (%)	34.45
Plastic limit (%)	23.52
Plasticity index (%)	10.93
Gravel (%)	36.78
Sand (%)	34.47
Silt And Clay (%)	28.75
Maximum dry density (g/cc)	1.76
Optimum moisture content (%)	19.92
Unconfined compression strength (kN/mm^2)	112.90

2.1.2 Bagasse ash

Bagasse is a fibrous residue obtained from sugar cane during extraction of sugar juice at sugarcane mills. The average length of bagasse fibers is 80 mm and their average thickness is 0.2 mm. The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicellulose and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide (SiO2). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the sugarcane harvests. This ash is mixed with pressed earth brick to study its behavior of compressive strength. Sample used in this study was collected from Bannur near to Mandya. Properties of Sugarcane bagasse ash are given in Table 3.

TABLE 2: Chemical composition of Bagasse Ash

	SiO_2	Al_2O	Fe_2O	CaO	MgO	SO_3	K_2O	LOI
SBCA	62.43	4.38	6.98	11.8	2.51	1.48	3.53	4.73

TABLE 3: Properties of Bagasse Ash

Properties	Results
Specific gravity	2.27

2.1.3 Banana fibre

It is a natural fibre obtained from banana plant. This fibre is obtained mainly from pseudo stem and peduncle which acts as a strong fibre after dried properly. It is a bast fibre with appropriate stiffness and good mechanical properties. Fibre was obtained from Davanagere Dist. Karnataka. The availabilities of this fibre from banana stem are 5 to 10%. One centimeter length of fibre was used in this study.

FIG 1: Banana fibre

2.1.4 Water

Water is one of the most important ingredients used in the manufacture of the bricks. The water which is used for the mixing process should be free from impurities and deleterious content. The clean potable water which was available in the lab was used for the mixing process. As per the obtained results from the standard proctor test from the obtained OMC & MDD the water content used for the mix is calculated and is been used for the mixing process for the making of the bricks.

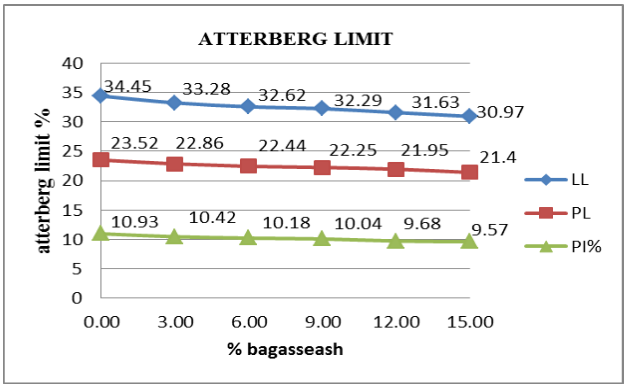
2.2 METHODOLOGY

The main objective of the experimental study was to study the behaviour of sugarcane bagasse ash and banana fibre on the pressed laterite soil bricks under compression, shape and brick pillar strength. The experimental investigation carried out in two stages. First, OMC and MDD was determined using standard proctor test for the soil with and without bagasse ash and banana fibres, followed by UCC test. Secondly, bricks of size 200x100x100mm were cast and dried for 7 days before testing. The bricks were tested for compressive strength test, water absorption test, shape test, and brick pillar test. With the constant 12% sugarcane bagasse ash and with the addition of various percentages of 0.5, 1, 1.5 & 2% of banana fibre a total 48 numbers of bricks were cast. These bricks were further compared with bagasse ash soil bricks.

3. RESULTS AND DISCUSSIONS

3.1 Atterberg Limits

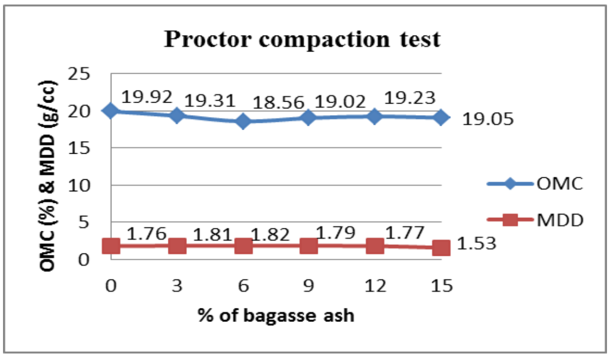
The Graph1 shows result of Atterberg limits (LL, PL, and PI) of soil containing various percentages of Bagasse ash. It was observed that, as the percentage of ash content increases there will be decrease in an atterberg limits. This change is due to reduction of plastic clay particles in the sample as bagasse ash particles are non-plastic.



Graph 1: Atterberg limits of soil containing various percentages of Bagasse ash

3.2 Compaction proctor test

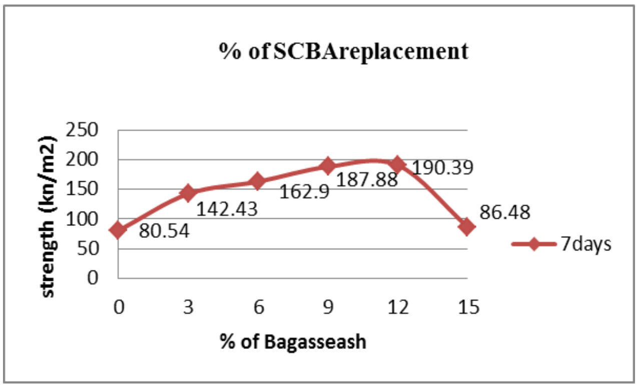
The graph 2 shows the variation in OMC and MDD of soil with varied percentage of Bagasse ash. It can be observed that there will be little increase in MDD up to 6% Bagasse ash. Beyond 6% reduction in MDD was observed. OMC is found almost unchanged. It is because the replacement of soil with bagasse ash which has relatively lower specific gravity (2.27) when compared to that of the laterite soil (2.65).



Graph 2 : Variation of OMC and MDD with bagasse ash.

3.3 Unconfined Compression Test

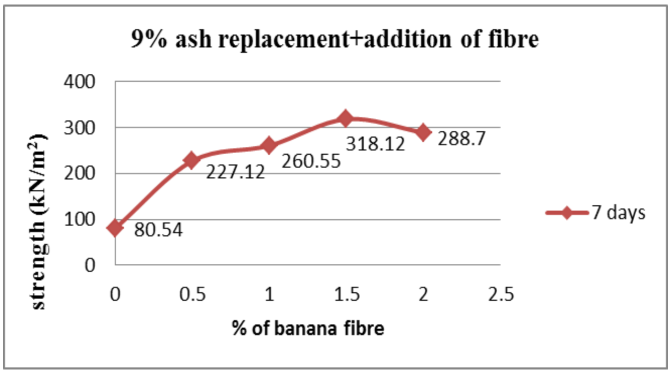
The Graph 3 shows UCC test results of soil containing various percentages of Bagasse ash. It can be seen from the figure that as the percentage of bagasse ash increases from 0 to 12% there is an increase in the UCC strength from 80.54N/mm^2 to 190.39N/mm^2. Then after, it drops to 86.48N/mm^2 for 15% replacement.



Graph 3: UCC test results of soil containing various percentages of Bagasse ash

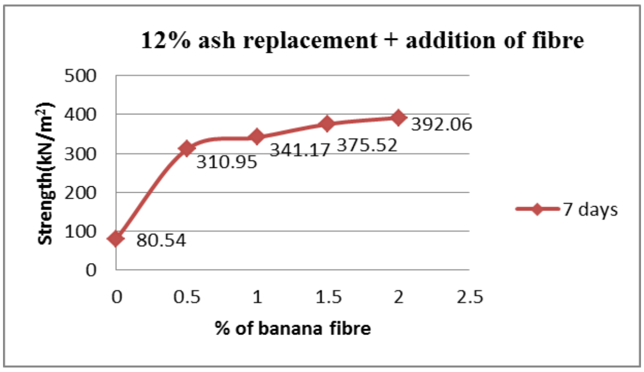
The maximum strength achieved when 12 % Bagasse ash was used. However, with 9% replacement also produced the same result. Hence, these percentage replacement were considered for further study with banana fibres.

The Graph 4 shows UCC test results for 9% SCBA with various percentages of banana fibre respectively. It can be seen from the figure that as the percentage of banana fibre increases from 0 to 2% there is an increase in the UCC strength from 80.54N/mm^2 to 318.12N/mm^2. Then after, it drops to 288.70 N/mm^2 for 2% addition in fibre. The maximum strength achieved seen in 1.5% banana fibre when used with 9% replacement.



Graph 4: UCC test results for 9% SCBA with various percentages of banana fibre.

Graph 5 shows UCC test results for 12% SCBA with various percentages of banana fibre respectively. It can be seen from the figure that as the percentage of banana fibre increases from 0 to 2% there is an increase in the UCC strength from 80.54N/mm^2 to 392.06N/mm^2.The maximum strength achieved seen is in 2% banana fibre when used with 12% replacement when compare to 9% ash replacement with various percentages of fibre. So for the production of bricks the maximum utilization of 12% of SCBA is used with various percentages of addition of banana fibre.

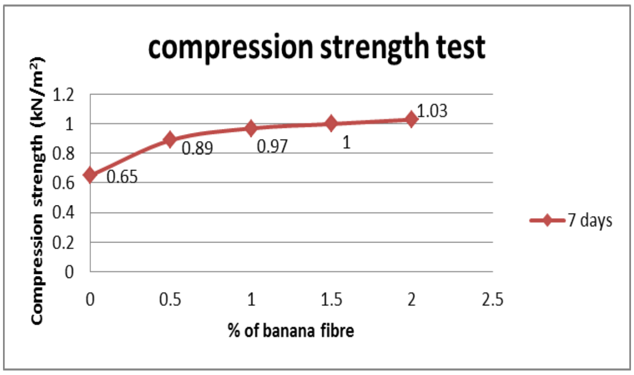


Graph 5 : UCC test results for 12% SCBA with various percentages of banana fibre.

3.4 Compression test

The size of the brick tested for compression is 200mmx100mmx100mm. Total three numbers of bricks were tested after 7 days which are kept under shade with constant 12% sugarcane bagasse ash by weight of soil with the addition of banana fibre as 0.5, 1, 1.5 & 2%.

The Graph 6 shows the compression test results for 12% SCBA with various percentages of banana fibre respectively. It can be seen from the figure that as the percentage of banana fibre increases there will be increase in the compressive strength from 0.65Nmm^2 to 1.03N/mm^2 when fibres were added to the mix 0 to 2% .



Graph 6: Compressive test results for the 12% SCBA with various percentages of fibre.

3.5 Shape test

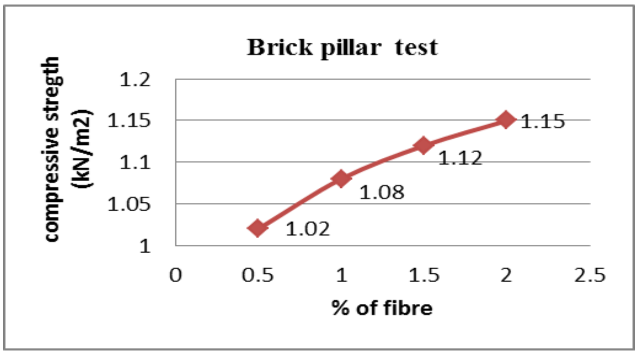
Here, change in dimensions of brick has been measured after kept in oven at 200°C for 24 hours. The brick which was originally 200x100x100mm was reduced to 198x98x98mm.

This indicates that shrinkage of material took place under temperature. Further noticed that the compressive strength increased 4N/mm²

3.6 Brick pillar test

This test is carried out in order to find the compression strength of the bricks when they use as building units, i.e brick pillar. In this test, three brick samples were laid with the cement mortar of 1:3 and is loaded under CTM after 7 days of curing to cement mortar. Curing is done using wet gunny bag.

Graph 7 shows the brick pillar test results for 12% SCBA with various percentages of banana fibres. It can be seen from the figure that as the percentage of banana fibre increases there will be increase in the compressive strength from 1.02N/mm² to 1.15N/mm² for 12% SCBA replacement. The strength obtained is quite lower when compared to the normal bricks which are burnt to get sufficient strength.



Graph 8 : Brick pillar test result for 12% SCBA with various percentages banana fibre.

4. CONCLUSIONS

[1]. The Atterberg limits (liquid limit, plastic limit and plasticity index) reduce when sugar cane bagasse ash was used for stabilization.

[2]. The UCC strength gets increased when sugar cane bagasse ash was used. 12% bagasse ash is found to be the optimum.

[3]. When banana fibers were used with 12% bagasse ash the unconfined compressive strength increased by about 26.4% with the addition of 2% of banana fibre.

[4]. Use of banana fibres increases the shear strength of the soil.

[5]. The compressive strength of bricks increase with addition of 12% SCBA and banana fibres.

[6]. The shrinkage of the brick material was observed in the shape test when it was kept in oven at 200°C for 24 hours.

[7]. The obtained results are not encouraging as it requires further stabilizing with stabilizers.

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