FEASIBILITY STUDY ON BAGASSE ASH STABILIZED MUD BLOCKS WITH CEMENT AS PRIMARY STABILIZER

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Abstract

Due to quick urbanization, there is an immense interest for good quality building units. There is a degradation of environment due to generation of large amount of waste from different industries. Using this waste in constructive applications is a suitable alternative. Stabilized Mud Block (SMB) is an economical, energy efficient and eco friendly option for ordinary building block like Concrete block and burnt clay brick. Bagasse ash from Sugar factory, quarry dust and regionally available soil are used in the production of SMB.

Sand content of the soil is increased by using quarry dust which alters the soil to make it suitable for block production.8% of cement by weight of soil is fixed as stabilizer by studying the literatures. Diverse mixes of stabilizers are used by substituting every percentage of cement by bagasse ash and replacing soil with ash. Tests on blocks such as density, compressive strength, water absorption, efflorescence, dimensionality, durability test and prism tests are conducted to access their fundamental properties and performance. The outcomes demonstrated that compressive strength and block density is diminished with each percentage substitution of cement by bagasse ash. Water absorption values are well within permissible limits. A stabilizer mix 4% cement+ 4%Baggase ash has fulfilled the necessities of Class 30 evaluation of SMB as given in IS: 1725-1982. Bagasse ash can be utilized as a supplementary stabilizer with cement in the production of SMB. Use of industrial waste and bagasse ash in SMB have numerous advantages like cost reduction and viable management of waste by reducing environmental impacts.

Keywords: *Bagasse ash, stabilizer, mechanical and durability tests, economical and ecofriendly*

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1. INTRODUCTION

Infrastructural development of a country mainly depends upon growth of construction industry. From last few decades construction industry is growing rapidly. Hence there is a need to focus on the production of low cost building units. Now a days, variety of building blocks such as concrete blocks, burnt clay bricks, aerated blocks, size stone etc and building techniques such as brick masonry construction, RCC framed construction etc are present in construction industry. But some of these are not cost effective and are responsible for high carbon emission. Hence it is need to give importance to the production of cost effective and environmental friendly alternative building blocks. FAL-G bricks stabilized mud blocks and fly ash bricks are some of the alternative building blocks which results in low carbon emission.

In most areas of the world, soil is used as valuable material for mud construction. Mud construction is the oldest form of construction. In developing countries, the most energy efficient and economical form of construction is mud construction. But this form of construction is subjected to various environmental conditions. So there is essential to boost mechanical and durability properties of the soil. Such properties can be improved by adding certain percentage of stabilizing agent such as cement, lime, natural and industrial byproducts .The main objective of soil stabilization is to alter the soil properties so that it will give the desired stability. Compaction reduces permeability and increases strength and density of the block.

For masonry wall construction, stabilized mud block is emerged as cost effective, ecofriendly, energy efficient and low emboided energy building block.

1.1 Significance

There is a necessity to conduct experimental study to improve the bearing capacity of the soil and to improve the mechanical and durability properties of the blocks .By doing so, it is possible to ensure low cost alternative for construction, thereby reducing the environmental impacts and reducing the exploitation of non renewable resources and dependence on scarcely available materials.

1.2 Objective

- To identify the regionally accessible soil and to find its properties for the suitability in production of SMB.
- Production of SMB with Soil (77%) + Cement (0-8%) + Quarry Dust(15%) + BA(0-8%), for cement replaced with BA.
- To conduct various mechanical and durability tests on blocks made with above mentioned combinations.

1.3 Quarry Industry Waste

Crushing process done to obtain aggregates from stone will generate a waste called quarry dust. Quarry Rock Dust Crushed sand under 4.75 mm is delivered from hard stone rock utilizing condition of crushing plants. Generation of quarry fines is an outcome of extraction and handling in a quarry .The quantity generated relies upon the stone sort, measure of separation by impacting and kind of smashing utilized.

It has properties and chemical composition similar to that of sand. It is grey in colour. The positive point of utilizing quarry dust are financially viable, effortlessly accessible and the utilization diminishes the contamination in environment.

1.4 Sugar Cane Bagasse Ash

India is the second largest sugar producing country in the world. It contributes about 15% of the global production. After extracting the juice from sugarcane, a residue is left which is bagasse. This bagasse is used as fuel to run boilers in factory. Burning of bagasse at 700^0 C will result in the generation of solid waste known as Bagasse Ash. Because of its non biodegradable nature, it is considered as waste. It causes contamination of air, water, land and also threat to human health causing lung diseases. So scientific method of disposal of this waste is necessary.

In construction industry, it is used for various purposes such as stabilization of soil for construction of roads and embankments, stabilized mud blocks etc. It possesses pozzolonic property because of presence of high silica content. It is used as supplementary material in concrete and also used in manufacture of biocement and has yielded positive result. Hence there is need to carry out research on the properties of baggase fiery debris stabilized mud blocks, to produce environmental friendly, economical and easily available blocks.

Table 1: Chemical composition of bagasse ash

Constituents	% by mass
SiO_2	68.12
Al_2O_3	1.834
CaO	5.993
Fe_2O_3	2.10
K_2O	8.645
MgO	2.995
SO_3	2.450

1.5 Literature Review

Ajay Gupta et al [1] have conveyed a test examination on describing the properties of balanced out mud squares masonry utilizing cement soil mortars and exhibited the results. Results are: 1) Block quality influences the masonry strength, increase in masonry strength is directly proportional to increase in block strength 2)Cement soil mortars impacts the quality of SMB masonry and the quality is touchy to cement proportion of the mortar and is less delicate to earth substance of the mortar blend. Masonry utilizing cement mortar and cement lime mortar shows lower modulus than the SMB masonry utilizing cement soil mortar

Apurva Kulkarni et al [2] have attempted to replace bagasse ash in flyash bricks. They have focused on utilization of industrial waste bagasse ash for economical, environmental and technical reasons.0%-60% of flyash is replaced with bagasse ash and 0%, 5%, 10% 15% and 20% of lime is replaced with bagasse ash. For 10% replacement of flyash and lime with baggase ash ,maximum compressive strength is obtained at this replacement. The study reveals the fact that the seismic weight of building is reduced by use of baggase ash bricks

Ram W. Salim [9] he carried out the experimental investigation on stabilized mud blocks manufactured by supplementing 3% to 10% of bagasse ash in the interval of 3%.Unstabilized blocks did not satisfy the requirements of code for 28days test results. But the stabilized compressed earth blocks satisfy the requirement of code for minimum compressive strength. Compressive quality development rate between 14-21 day is higher for addition of 10% ash, where as 21-28 day compressive higher for 3%, 5% and 8% of ash. The results shows that there is disintergration of unstabilized mud blocks into smaller fragments ,where as concrete mode of failure pattern is observed in stabilized mud blocks.

2. MATERIALS AND MIX PROPORTION

Materials used are Soil, quarry dust,cement, bagasse ash, water

2.1 Soil

Generally accessible soil in the premises of campus is utilized to carry out present work.

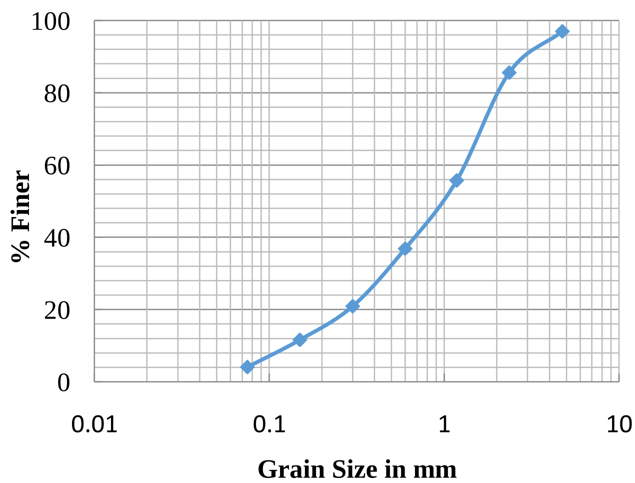

Fig 1: Soil Particle Size Distribution Curve

Soil is having a good representation of all sizes of particles, therefore it can be classified as **well graded sandy soil.**

2.2 Quarry Dust

Quarry dust available from near by industry is used to increase the sand content of the soil because it contains sand less than 60%.

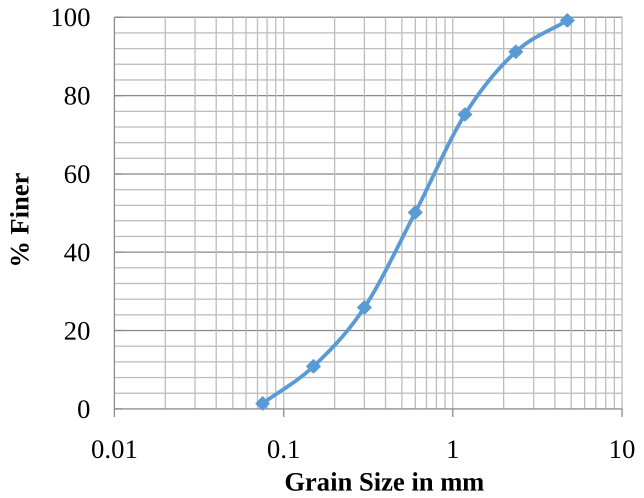

Fig 2: Particle Size Distribution Curve

It belongs to **Zone -2** ,according to **IS:383-1970**

2.3 Cement

Ordinary Portland cement of 53 grade is used

2.4 Baggasse Ash

Baggasse ash is obtained from sugar factory located in Srinivaspura village, 6km away from Channarayapatna taluk of Hassan district.

Fig 3: Bagasse Ash

Table 2: Physical Properties

Sl.No.	Physical Properties	
1	Colour	Light Blackish
2	Particle size	Less than 90µ
3	Specific gravity	1.97
4	Consistency	38 %
5	Initial Setting Time	210 minute
6	Final Setting Time	320 minute

The tests are carried out as per the procedure mentioned in **IS: 1727 -1967 for Pozzolanic Materials.**

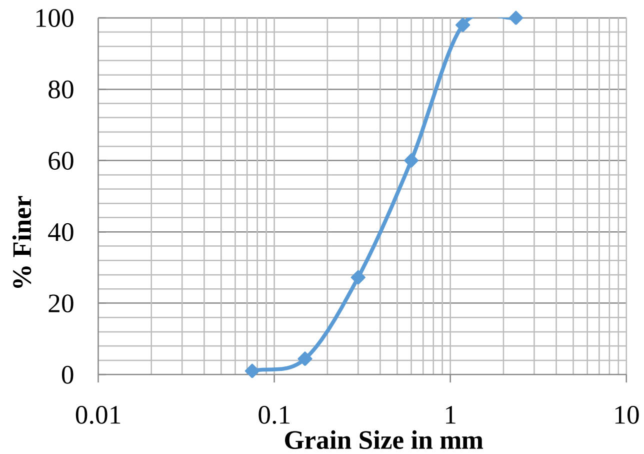

Fig 4: Bagasse Ash Particle Size Distribution Curve

It belongs to **Zone -3** , according to **IS:383-1970**

Since particles of sizes greater than 1.18mm are missing (from graph), the bagasse ash can be classified as material of **uniformly graded fine particles**.

2.5 Mix Proportion

For the production of SMB from the soil which is non expansive, the amount of stabilizer required is about 7% to 10%. 8% cement is used to block stabilization in the present work and every percentage of cement is substituted by bagasse ash. Soil and quarry dust quantity is kept constant. Production of blocks relies on impressive degree of its thickness, for this compaction of earth is done with optimum water percentage. When all said is done 10-12% of water by weight of dry materials is generally added. By experimentation strategy 10% water content was discovered to be agreeable.

For SMB production, a basic dry density of 1.85g/cm^3 is essential. A mould of 230*108*100 needs 4964 grams of dry materials in the wake of wastage of materials of about 8%.

Table 3: Mix Proportion for block

Combination of stabilizer
C8B0
C7B1
C6B2
C5B3
C4B4
C3B5
C2B6
C1B7
C0B8
SMB(ref)C4

C8B0- Cement 8%+0% Bagasse ash
SMB(ref) C4 - made with only 4% of cement

3. EXPERIMENTAL METHODOLOGY AND RESULTS

3.1 Block Density Test

From the samples random selection of blocks is done .Weight of blocks and dimensions are noted.

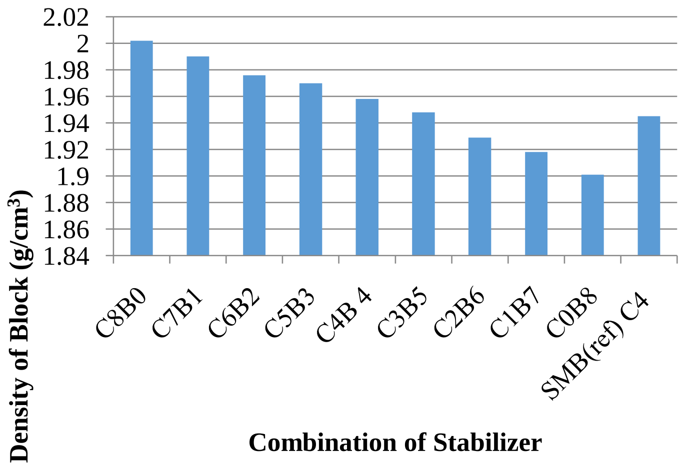

Fig 5: Block density for varying % of cement and baggase ash

Because of declination in the content of cement, declination is noticed in density. A distinction of 5.31% is seen in density of blocks with C8B0 and C0B8 combination. All density values are well over the base allowable estimation value. Little increment of 1% in density is noticed for C4 B4 block when contrasted with C4 block.

3.2 Compressive Strength

The load that causes failure is noted down and is the maximum load. For saturated test , the process is similar but the blocks are submerged in water for 24 hours

Table 4: Compressive strength for 28 days

Combination of stabilizer	DCS	WCS
C8B0	8.822	5.323
C7B1	8.442	5.052
C6B2	7.980	4.702
C5B3	6.305	4.00
C4B4	6.152	3.703
C3B5	4.230	2.632
C2B6	3.323	2.029
C1B7	2.650	-
C0B8	2.353	-
SMB(ref)C4	5.348	3.183

DCS - Dry compressive strength
WCS - Wet compressive strength

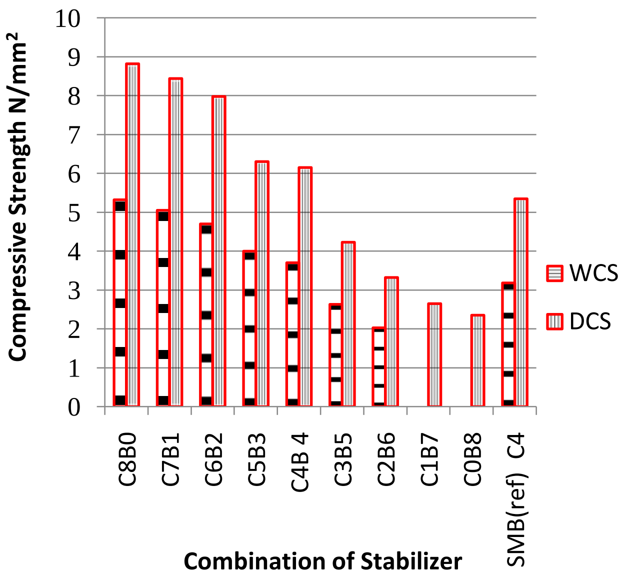

Fig 6: WCS and DCS for 28 Days

28 days WCS is around 60% of DCS . Increment of 16% and 14.8% is seen in WCS and DCS separately for 28 days curing, for block C4B4 in contrast with SMB(ref)C4. There is no wet compressive strength for the blocks C1B7 and C0B8. Blocks with below 2% cement substance deteriorated after submersion.

Fig 7: Failure Pattern of Blocks

Brick work fails by pounding, breaking into segments or by creating vertical splits. The bagasse ash blocks have failed by creating vertical breaks. After breakage also the blocks held their shape.

3.3 Water Absorption of Blocks

The blocks are dried in an oven till it achieves constant mass. Immersion of dried blocks completely in a clean water for 24 hours is done. After this immersion period, the blocks surface is dried and weight is noted down.

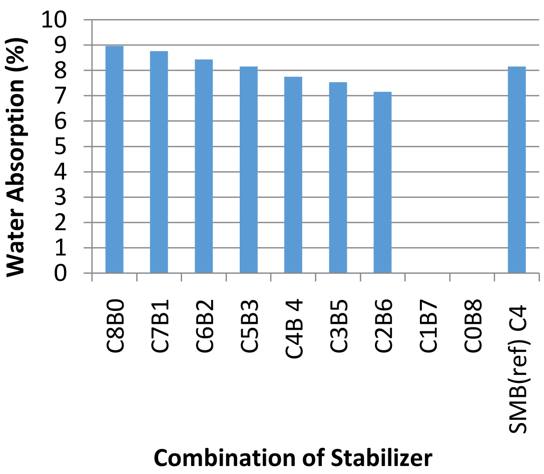

Fig 8: Water Absorption of Blocks

Water absorption values ranges from 7.156% to 8.96% and the qualities were discovered to be progressively diminishing with inclination in bagasse ash content. According to IS 1725-1982 SMB having a place with Clause 30 evaluation should have water assimilation values under 15%. Water engrossing property of blocks will satisfy the requirements of codal procurements.C1B7 and C0B8 blend mix blocks get deteriorated after drowning in water. The deterioration of blocks may be because of deficient binding substance.

3.4 Efflorescence on Blocks

A shallow level base dish containing adequate refined water to totally immerse the sample is utilized for the test. Place the end of the blocks in the dish, the depth of water in dish being 25 mm. Allow the blocks for complete ingestion of water. The point when the water has been retained and block gives off an impression of being dry, put a comparative amount of water in the dish for second time and permit it to dissipate as some time recently. Inspect the blocks for efflorescence after the second dissipation and report the outcomes

Fig 9: Efflorescence on Blocks

As the area secured by blooming on the square ranges from 10% to 30% of aggregate region, the degree of blossoming is accounted for as moderate.

3.5 Alternative Wetting and Drying Test Results

The test carried is as per the following, arbitrarily chosen blocks are six and they are dried.12 cycles of substitute moistening and evaporating is done. Declination in quality is noticed after this process.

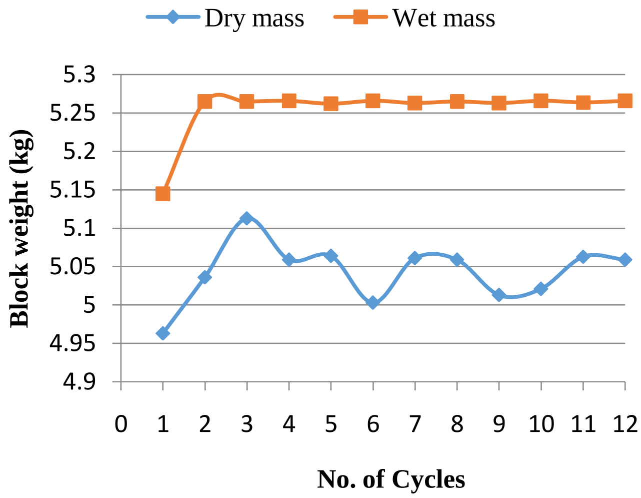

Fig 10: Average Mass of Blocks

C4B4 blocks are used. The normal mass of dry blocks shifts for every cycle because of the fluctuations in drying because of changing climate conditions. Extremly minor changes is seen as the blocks can't ingest water beyond immersion point.

WCS and DCS marginally declined after 12 cycles of substitute wetting and drying. 12.79 % and 4.85 % loss in WCS and DCS is watched separately. No visual harm is noticed.

Table 4: % Loss in Strength

Parameters	**Actual Compressive Strength(N/mm^2)**	**Compressive Strength after 12 cycles(N/mm^2)**	**% Loss in Strength**
WCS	3.703	3.283	12.79
DCS	6.152	5.867	4.85

WCS and DCS marginally declined after 12 cycles of substitute moistening and evaporation. 12.79 % and 4.85 % loss in WCS and DCS is watched separately. No visual harm is noticed.

3.6 Expansion on Saturation Test Results

Clay content in the block will responsible for contraction on drying and expansion on wetting of blocks. Saturated blocks are dried to constant mass.

The dimensions of dry and saturated blocks (48 hours immersed in water) are measured using vernier scale

Table 5: Expansion on Saturation Results

Sl. No (B)	**Parameters**	**IM* (mm)**	**FM (mm)**	**Expansion in (%)**
B1	**L**	229.515	229.589	0.032
	W	108.036	108.079	0.039
	H	99.005	99.041	0.036
B2	**L**	230.003	230.065	0.033
	W	108.502	108.549	0.043
	H	98.504	98.535	0.031
B3	**L**	230.009	230.082	0.031
	W	108.015	108.053	0.035
	H	99.531	99.570	0.039

IM Initial Measurement
FM Final Measurement

Expansion on immersion qualities ranges from 0.03% to 0.04%. Most extreme admissible extension quality is 0.15%. As the rate of extension is inside of the reasonable farthest point, the clay content in stabilized soil is admirable and the stabilization of bagasse ash blocks is found to be palatable.

3.7 Masonry Prism Test

Compression Test

The UTM is used for Compression test of balanced out mud square masonary. The uniaxial compression load is acting on the center of the prism. At last demec gage is unfixed well before the failure of the prism. Loading of prisms is carried out until the failure of prisms occurs.

Flexural Strength

The bond in the middle of block and mortar is vital in a wall for a few reasons. At the point when the two are all around fortified the wall shows great auxiliary uprightness and carries on like one unit. Once more, bond gets to be critical when a wall is exposed to parallel loads because of wind or seismic tremors.

Table 6: Test results of prism for C4B4 block

Parameters	**Obtained values**
Height to Thickness ratio (h/t)	4
Correction Factor	1.3
Corrected Prism Strength	1.85 N/mm^2
Masonary Efficiency	49.95 %
Basic Compressive Strength	0.46 N/mm^2
Flexural strength	0.26 N/mm^2

Correction factor is found out for the height to thickness ratio using Table 12 of IS 1905 – 1987. In compression prisms failed by developing vertical split cracks and in flexure the prism failed by failure of bond or brick. All values obtained are satisfactory.

Fig 11: Failure Pattern of Masonry Prism in Compression

Fig 12: Failure Pattern of Masonry Prism in Flexure

4. CONCLUSION

1) Bagasse ash can be utilized as a additional stabilizing agent with cement as primary stabilizer.
2) For every rate substitution of cement by ash there is diminishing of block thickness and compressive quality, however the blocks will have a smoother finishing and well characterized corners.
3) Stabilized blocks with stabilizer mix C4B4 have a wet compressive quality and dry compressive quality of 3.703N/mm^2 and 6.152N/mm^2 .The blocks of this stabilizer blend fulfills every one of the particulars of Class 30 evaluation of SMB as given in IS 1725-1982.In this type of blocks cement quantity reduces because half of the cement is replaced with baggase ash.
4) The water ingestion estimations of blocks are inside of the cut off values and diminish with increment in ash percentage. Bagasse ash goes about a filler material topping of pores.
5) This type of blocks results in cost reduction and are ecofriendly.

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