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STRENGTH AND DURABILITY STUDY ON AGRO WASTE BASED ON MUD BLOCK

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Abstract – *The study was conducted to investigate the potential of different ashes for the production of soil blocks for low cost housing. The stabilization properties of soil has been improved by some ashes such as bagasse ash (BA), rice husk ash (RHA), groundnut ash (GA) and combination of lime and ashes. Physical and mechanical properties of soil as well as ashes were determined as per guidelines of IS 2720 (Part 10). Each individual ashes were replaced by the soil in weight percentage @ 0%, 5%, 10%, 15%, 20%, 25% and 30% and as well as same process for the combination of ashes. Blocks were molded for each stabilization level. The solid blocks of 240x240x100mmin size were prepared by mixing soil, BA, RHA, GA and cement formed by compressing the mixture in Auram Press Machine. Blocks were molded and subjected to the compressive strength, water absorption by capillarity tests after curing 21 days and compared with relevant standards of compressive earth blocks. From the compressive strength test results, compressive strength were obtained for blocks admixed with 0%, 5%, 10%, 15%, 20%, 25% and 30% different ashes and as well as combination of ashes respectively. Finally soil blocks mixed with different percentage of ash had the highest compressive strength followed by blocks. The water exclusion also showed Significant improvement as the quantity of different ashes increases. Stabilizing of soil with different ashes can improve the properties of soil and soil blocks making the suitable for use as a building material for the construction of load bearing walls or sub grade layer of road construction.*

Key Words: **Alluvial soil, Bagasse, Groundnut Shell Ash, Rice husk ash, Mud block, *stabilized soil***

1. INTRODUCTION

Soil and earth are synonymous when utilized in reference to building construction. It refers to subsoil and will not be confused with the geological or agricultural definition of soil, which incorporates the weathered organic material in topsoil. Topsoil is usually removed before any engineering works are administered, or before soil is excavated to be used as artifact. Mud is that the mixture of 1 or several sorts of soil with water. Earth is one among the oldest materials used for building construction in rural areas. Soil stabilization may be a technique during which existing properties if the soils are improved by means of cementing materials or chemicals. Stabilization of soil can be carried out by using mechanical Stabilization, cementing stabilization and chemical stabilization. Bagasse is defined as fibrous residue of sugar cane stalks that remains after extraction of sugar. It is normally deposited as waste and it litters the environment. Sugar production is estimated to be around 26 million tons per year. With a production of 1,333 Lakh Tons, Uttar Pradesh accounts for 39% of total sugarcane production in the country. Bagasse ash may be a pozzolanic material which is extremely rich within the oxides of silica and aluminum. Pozzolans usually require e the presence of water in order for silica to combine with calcium hydroxide to form stable calcium silicate, which has cementitious properties. Sugar Company indicated that the annual production of bagasse was 234,046 tons from the crushed cane of about 568,098 tons which is 40% of the sugar cane processed. About 85% of this bagasse is burned on site at the factories to generate steam for the evaporative extraction of sugar. Alluvial soil is about 43% which covers an area of 143 km2, whereas in Bihar the most common soil is Gangetic alluvium of Indo-Gangetic plain region. India is an agricultural prime country so various crops are cultivated. India alone produces around 120 million tons of rice paddy per year, giving around 24 million tons of rice husk per year, for every 1000 kg of paddy milled, about 220 kg (22%) of husk is produced and when this husk is burnt within the boilers, about 55 kg (25%) of RHA is generated. Since lime is typically the most expensive constituent of mud block, the replacement of proportion of it with Groundnut Shell Ash (GSA) will improve Mud block affordability particularly for low-cost housing in Nigeria. The use of GSA will also contribute to the production of block of a higher quality at lower cost and reduces the environmental problem resulting from the accumulation of the shells in a large quantity in a particular area in Nigeria. Lime is calcium oxide (CaO) or hydroxides of calcium and magnesium and is made by limestone into either calcitic lime (high in calcium) or dolomitic lime (high in magnesium). Lime stabilization is the most widely used means of chemically for stabilizing unstable soils into structurally sound construction foundations. The use of lime in stabilization creates variety of important engineering properties in soils, including improved strength, improved resistance to fracture, fatigue, and permanent deformation, improved resilient properties, reduced swelling, and resistance to the damaging effects of moisture.

2. Objective

- To determine the chemical composition of agro waste such as sugarcane bagasse ash, coconut fiber, rice husk ash, groundnut ash and as well as expensive soil samples.
- To collect the soil samples and test the various parameters such as Maximum dry density, optimum moisture content, plastic limit, liquid limit, plasticity index, shrinkage limit.
- To determine physical and mechanical properties of expansive soils stabilized with lime and agro waste.
- To determine the amount of agro waste required for partial Scope replacement of lime for optimum expansive soil stabilization maintained at constant compaction force by using of hydraulic jack and Digital loading cell. Finally, to determine the compressive strength obtained at the age of 28 days for soil stabilization.

3. MATERIALS AND METHODS

In this particular project, materials used are as outlined.

- Bagasse ash: The fibrous residue used for this purpose leaves behind about 8-10% of bagasse ash, Vellore, Nammakal district (2017).
- Rice husk ash: Rice paddy used for this purpose leaves behind about 25% of ashes from Palani highway, dindugul (2017).
- Ground nut ash: The shells used for this purpose leaves behind about 4-5% of groundnut ash, settiyapatti, dindugul district (2017).
- Lime: The lime used in this study was purchased from hardware in chinnalapatti town.
- Red soil: The soil was collected from gandhigram at 112 SE in several trial pits.
- Water: water conforming to the requirements of water for mud block and curing as per Indian Standards.

Fig no 3.1 Bagasse ash

Table no 3.1 chemical composition of agro waste, lime and red soil

Description	Abbrevation	BA (%)	RHA (%)	GA (%)	Lime (%)	Red Soil (%)
Silica	SiO_2	66.23	93.8	16.21	0	8-10
Iron	Fe_2O_3	3.09	0.3	1.8	0.08	40-45
Calcium	CaO	2.81	0.89	8.69	95.03	3
Magnesium	MgO	1.54	0.32	6.74	0.04	-
Sodium	Na_2O	0.26	0.28	9.02	0.05	3-5
Potassium	K_2O	6.44	0.12	15.73	0.03	-
Alumina	Al_2O_3	1.90	0.74	5.93	-	18-22
Titanium	TiO_2	0.07	0.1	-	-	12-20
Manganese	MnO	0.60	-	-	0.6	-

3.1 Methods used are outlined below;

1) Grading test - Determination of the particle size distribution for the natural soil was conducted accordance to BS 1377 testing procedures.

Weight of soil sample taken for analysis (Ws) = 500g

Percentage of gravel = 0 %

Percentage of coarse sand = 12.6 %

Percentage of fine sand = 79.2 %

Percentage of silt and clay = 8.2 %

2) Moisture content - specimen are obtained and oven-dried at 105 ± 5℃for at least 12 hours. The samples were then reweighed, and the difference in weight was assumed to be the weight of the water driven off during drying. The difference in weight was divided by the weight of the dry soil, giving the water content of the soil a dry weight basis.

Moisture content of sample is 20.89%

3) Specific gravity - Specific gravity which is the measure of heaviness of the soil particles is determined by using the density bottle method and it was noted from the results that

Specific gravity of soil was 2.52

Specific gravity of BA was 1.95

Specific gravity of RHA was 1.91

Specific gravity of GA was 1.56

4) Atterberg limits - The test included the determination of the liquid limits, plastic limits and the plasticity index for the natural soil. The test are conducted for uncured samples in accordance if Indian standards testing procedures.

Liquid limit (wl) = 23.71 % plastic limit (Wp) = 20.89 %

Plasticity index (Ip) = wl - Wp = 23.71 – 20.89 = 2.81%

5) Maximum dry density and Optimum moisture content - The values of the dry densities are plotted against their respective moisture contents and MDD is deduced as the maximum point on the resulting curves. The corresponding value of moisture contents at maximum dry densities, which is deduced from the graph of dry density against moisture content, gives the optimum moisture content of red Soil. OMC – 12%; MDD – 1.934 g/cm^3

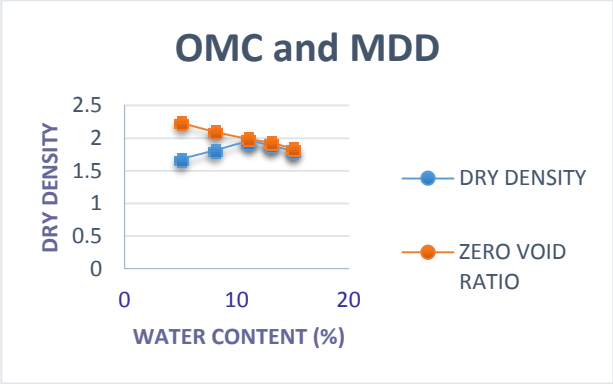

Chart -3.1: Maximum dry density and Optimum moisture content

3.2 Mix proportion

The mud block made for red soil, cement and agro waste ash was proportioned with the following mixes as follows

Table no 3.2.1 Mix proportion of stabilized soil

Mix ratio	Red soil	cement	Different ash	Total
M1	85	10	5	100
M2	80	10	10	100
M3	75	10	15	100
M4	70	10	20	100
M5	65	10	25	100

3.3 AURAM PRESS 3000

The solid blocks of 240x240x100mmin size were prepared by mixing soil, BA, RHA, GA and cement formed by compressing the mixture in Auram Press Machine.

Available force – 150 KN, Compression ratio – 1.6 or 1.83

Fig no 3.3.1 Auram Press 3000

3.4 Casting of blocks

The stabilized mud block was made by using AURAM press 3000 which was machine devised by the auroville earth institute. The blocks were made with bagasse ash and cement as the stabilizer with various proportions as given above. The size of the block is 240 x 240 x 100 mm. Total quantity of mix for one block is approximately 10.25 kg. Initially dry mix was done by adding soil, cement and bagasse ash allowed to mix. The AURAM machine works on the principle of single lever. The lever was pulled until the lock released. As the lock released the block was collected from the machine.

3.5 Curing of blocks

To achieve maximum strength, compressed stabilized earth blocks need a period of damp curing, where they are kept moist. This a common requirement for all cementitious materials. If the block is left exposed to hot dry weather conditions, the surface material will lose its moisture and the clay particles tends to shrink. This will cause surface crack on the block faces. Various methods are used to ensure proper curing. Such methods include the utilization of plastic bags, grass, and leaves etc. to prevent moisture from escaping. After two or three days, depending on the local temperature, cement stabilized blocks complete their primary cure. They can then be far away from their protective covering. As the stack of blocks is made up, the highest layer should be wetted and covered, and therefore the lower layer should be allowed to air dry to realize maximum strength. The curing period for lime stabilization should be at least four weeks. Compressed stabilized earth blocks should be fully cured and dry before used for construction.

Fig no 3.5.1 Curing of blocks

4. RESULTS AND DISCUSSION

The blocks are to be tested and find whether it is suitable for the construction work or not. Hence the following requirements carried out as per IS codal provisions.

4.1 COMPRESSIVE STRENGTH TEST - Compressive strength is the capacity of material or structure to withstand loads tending reduce size. It can be measured by plotting applied force against deformation at testing machine. From the 7 –day and 28- day.

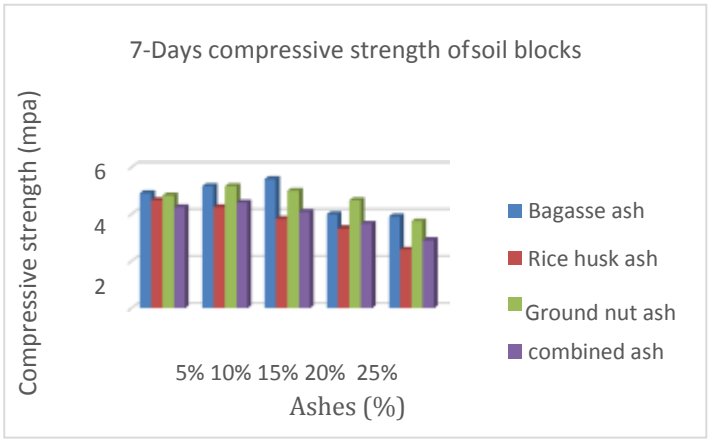

Chart 4.1 7-Days compressive strength of soil blocks

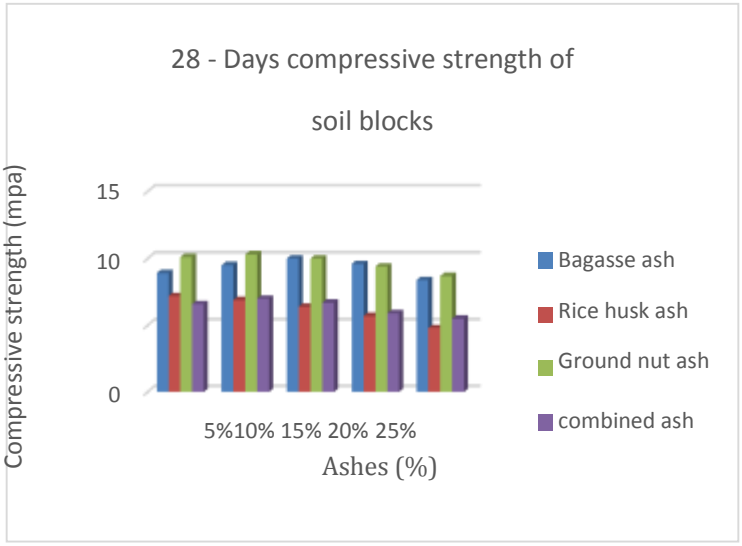

Chart o 4.2 28-Days compressive strength of soil blocks

Fig no 4.1 compressive testing machine

4.2 WATER ABSORPTION TEST

This test was conducted by partially immersing the soil blocks in water for 10 minutes. The absorption coefficient as indicated by Adam and Agip (2001) depends on the speed of absorption and deduced from the Equation.

W in $\frac{g}{cm^2\,min} = \frac{M_1 - M_2}{S\sqrt{t}}$

Where;

M_1-M_2= Mass of water, in grams, absorbed by the block during the test (g),

S = Surface area of the submerged face, in square centimeters (cm2), and

t = Duration of time of the immersion of the block, in minutes (min)

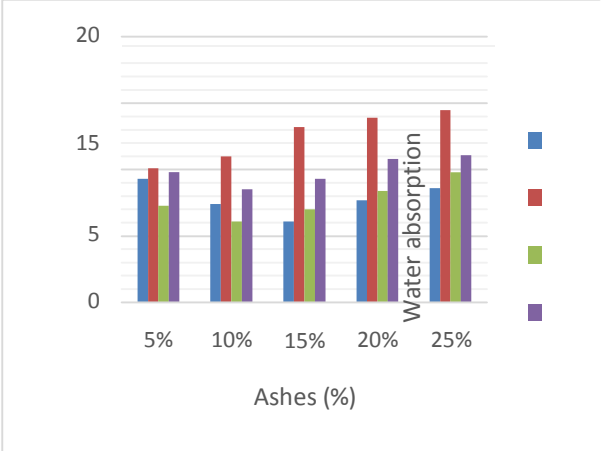

Chart o 4.2.1 water absorption test

5. CONCLUSION AND RECOMMENDATIONS

The following conclusions can be drawn from the results of the investigation carried out within the scope of the study.

- The soil used was silty sandy soil as indicated in the particle distribution curve and suitable for the production of soil blocks. The most Pozzolana compounds (Si$O2$,$Al2O3$ and $Fe2O3$) were available in small quantities, it was able to improve the engineering properties of the natural soil and the soil blocks. Stabilization of soil with ash significantly improved the compressive strength of soil blocks although blocks produced were suitable as masonry wall units.

- The soil blocks generally showed a remarkable improvement in their durability properties (water absorption by capillarity). Soil blocks also tend to have high water exclusion property as the quantity of different ash increases making it suitable as a masonry wall unit.

- Stabilization with ashes can improve the properties of soil blocks that can effectively replace the conventional masonry units which are noted for their negative environmental impacts.

- Further research to be carried out to investigate the abrasion behaviour of the stabilized mud blocks.

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