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RECYCLING OF BAGASSE ASH AND RICE HUSK ASH IN THE PRODUCTION OF BRICKS

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ABSTRACT:
Today researches all over the world are focusing on ways of utilizing either industry or agricultural wastes as a source of raw materials for the construction industry. These wastes utilization would not only be economical, but may also help to create a sustainable and pollution free environment. The main objective of thesis is to develop environment friendly and energy saving bricks from Sugarcane bagasse ash (SCBA) and Rice husk ash (RHA). SCBA and RHA is a voluminous by-product from sugar refining industry and rice mills respectively. The sample of these waste materials was analysed with regarding to chemical composition and particle size distribution by scanning electron microscopy (SEM). In this study SCBA & RHA are mixed in particular proportion (2.5%,5%,10%,15%,20%) is provided as the replacement of clay in the production of bricks. The experimental results showed that the use of SCBA-RHA-CLAY combination bricks is lighter in weight, durable, non hazardous energy efficient, additional strength gains due to pozzolanic properties and reduction in permeability because of pore refinement.

KEYWORDS: Sugarcane bagasse ash (SCBA), Rice husk ash (RHA), scanning electron microscopy (SEM), pozzolanic property.

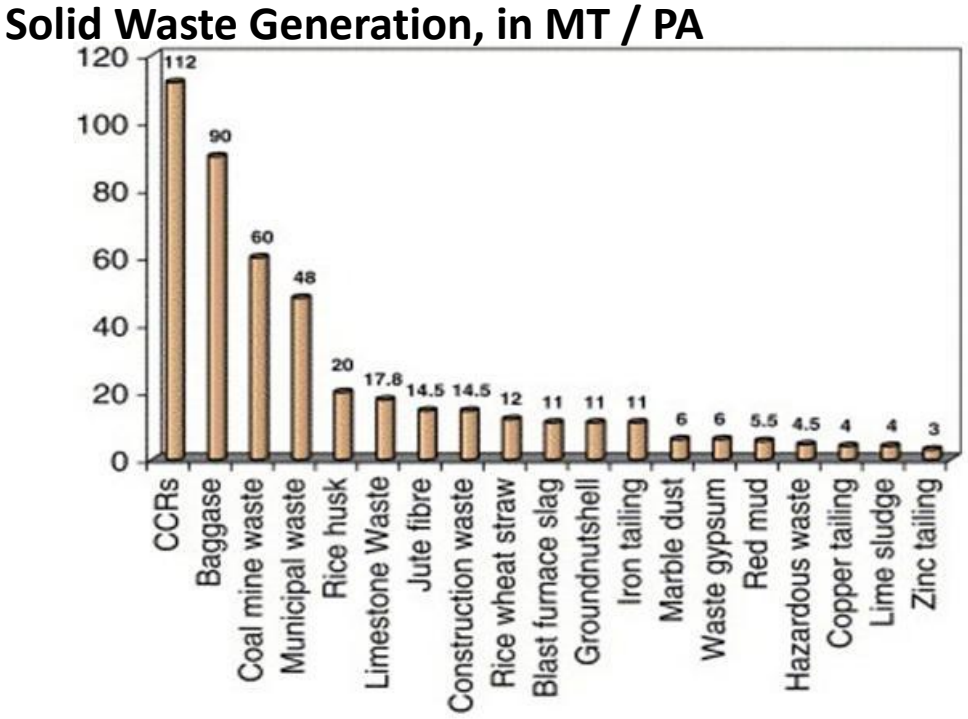
1.INTRODUCTION

1.1 GENERAL

Population scenario comes towards India by means of increasing industries. The fruitful efforts of industries lead to develop India. As the industries increases also the waste coming from them at the end of product increases. At the end of survey result coming that the amount of the approximately 250 to 300 million tons of industrial wastes are being produced every year by chemical and agricultural process in India. It is very essential to dispose these wastes safely without affecting health of human being, environment, fertile land, sources of water bodies; etc. Sugar cane bagasse, the fibrous residue after crushing and juice extraction of sugarcane, is a major industrial waste product from the sugar industry. Shelter is a basic human need and owning a house becomes a life long struggle as majority of Indians find housing costs prohibitively expensive. This problem becomes even more acute when considering the low income families who accounts for about 60-70% of Indian population. This brings out the need to reduce the cost of the housing and make it affordable for the booming population. Burnt clay bricks are being used extensively and the most important building material in construction industry. In India the building industry consumes about 20000 million bricks and 27% of the total natural energy consumption for their production. In addition to this, Clay bricks available in certain region are poor in quality and have lower compressive strength, higher water absorption, high efflorescence, higher wastage during transportation and handling, uneven surface etc., which have forced engineers to look for better .

1.2 GENERATION OF WASTE:

Growth of population, urbanization and rising standards of living have contributed to an increase in the quantity and variety of solid wastes generated by industrial, mining, domestic and agricultural activities. Globally the estimated quantity of waste generation was 12 billion tonnes in the year 2002, of which 11 billion tonnes were industrial wastes.**About 19 billion tonnes of solid wastes are expected to be generated annually by the year 2025**. Generation of all these inorganic industrial wastes is estimated to be 290 Million Tonnes per annum in India.



Solid Waste Generation from Different Sources in India

Fig 1.1

1.3BRICKS:

A brick is a block or a single unit of a kneaded clay-bearing soil, sand and lime, or concrete material, fire hardened or air dried, used in masonry construction. Lightweight bricks (also called lightweight blocks) are made from expanded clay aggregate. Fired bricks are the most numerous types and are laid in courses and numerous patterns known as bonds, collectively known as brickwork, and may be laid in various kinds of mortar to hold the bricks together to make a durable structure. Bricks are produced in numerous classes, types, materials and sizes which vary with region and time period, and are produced in bulk quantities. Two most basic categories of bricks are fired and non-fired brick. Fired bricks are one of the longest lasting and strongest building materials sometimes referred to as artificial stone and have been used since circa 5000 BC. Air dried bricks have a history older than fired bricks, are known by the synonyms mud brick and adobe, and have an additional ingredients of a mechanical binder such as straw.

In addition to the fired bricks, some chemically set bricks also existed that do not undergo the process of firing. Some of the chemically set bricks are calcium-silicate bricks and concrete bricks.

Calcium Silicate Bricks:

Calcium silicate bricks are also called sand lime or flint lime bricks depending on their ingredients. Rather than being made with clay they are made with lime binding the silicate material. The raw materials for calcium-silicate bricks include lime mixed in a proportion of about 1 to 10 with sand, quartz, crushed flint or crushed siliceous rock together with mineral colorants. The materials are mixed and left until the lime is completely hydrated; the mixture is then passed into moulds and cured in an autoclave for three to fourteen hours to speed the chemical hardening. The finished bricks are very accurate and uniform, although the sharp arises need careful handling to avoid damage to brick and bricklayer. The bricks can be made in a variety of colours; white, black, buff and grey-blues are common and pastel shades can be achieved. This type of brick is known as fly ash bricks, manufactured using the FaL-G (fly ash, lime and gypsum) process. Calcium-silicate bricks are also manufactured in Canada and The United States, and meet the criteria set forth in ASTM C73 – 10 Standard Specification for Calcium Silicate Brick (Sand-Lime Brick). It has lower embodied energy than cement based man-made stone and clay brick.

Concrete Bricks:

Bricks of concrete with sand aggregate can be made using a simple machine and a basic assembly line. A conveyor belt adds the mixture to a machine, which pours a measured amount of concrete into a form. The form is vibrated to remove bubbles, after which it is raised to reveal the wet bricks, spaced out on a plywood sheet. A small elevator then stacks these palettes, after which a forklift operator moves them to the brickyard for drying.

Concrete bricks are available in many colours and as an engineering brick made with sulphate-resisting Portland cement or equivalent. When made with adequate amount of cement they are suitable for harsh environments such as wet conditions and retaining walls. They are made to standard BS 6073, EN 771-3. Concrete bricks expand and contract more than clay or sand lime bricks so they need movement joints every 5 to 6 metres, but is similar to other bricks of similar density in thermal and sound resistance and fire resistance.

Clay bricks:

The majority of used are made from clay and shale; they are used preliminary in the construction of walls by bleeding and jointing of bricks into established bonding arrangement. Clay is an abundant raw material with a variety of uses and properties. It is a complex of group of material that consist of minerals commodities, each having somewhat different mineralogy, geological occurrence, technology and applications. They are natural earth fine grained minerals of secondary origin and composed of an aluminates silicate structure with an additional iron, alkalis and alkaline earth element. Common clays are sufficiently plastic to permit ready moulding and when firing, they make at 1000^{o}C. The clay bricks has been traditionally manufactured by mixing the ground clay with water forming into the desired shape, size, drying and firing.

1.4BAGASSE ASH:

Nowadays, it is commonplace to reutilize sugar cane bagasse as a biomass fuel in boilers for vapor and power generation in sugar factories. Depending on the incinerating conditions, the resulting sugarcane bagasse ash (SCBA) may contain high levels of SiO2 and Al2O3, enabling its use as a supplementary cementious material (SCM) in blended cement systems. Uses of Sugarcane bagasse ash waste in brick can save the sugarcane industry disposal costs and produce a ‘greener’ bricks for construction.

The burning of bagasse which a waste of sugarcane produces bagasse ash. Presently in sugar factories bagasse is burnt as a fuel so as to run their boilers. This bagasse ash is generally spread over farms and dump in ash pond which causesenvironmental problems also research states that Workplace exposure to dusts from the processing of bagasse can cause the chronic lung condition pulmonary fibrosis, more specifically referred to as bagassosis. So there is great need for its reuse, also it is found that bagasse ash is high in silica and is found to have pozzolanic property so it can be used as substitute to construction material.

Fig 1.2 Shows ash 0f SUGARCANE BAGASSE

TABLE1
CHEMICAL COMPOSITION OF SCBA

SI. No	Component	Mass %
1	Silica (SiO2)	66.89
2	Alumina (Al2O3)	29.18
	Ferric Oxide (Fe2 O3)	
3	Calcium Oxide (CaO)	1.92
4	Magnesium Oxide (MgO)	0.83
5	Sulphur Tri Oxide (SO3)	0.56
6	Loss of Ignition	0.72
7	Chloride	-

1.5RICE HUSK ASH:

Rice husk ash is obtained by burning rice husk. Physical properties of RHA are greatly affected by burning conditions. When the combustion is incomplete, large amount of unburnt carbon is found in the ash. When combustion is completed, grey to whitish ash is obtained. The amorphous content depends on burning temperature and holding time. Optimum properties can be obtained when rice husks are burnt at 500 - 700° C and held for short time, this temperature at which the husk is being burnt is less then that required for formation of clinkers in cement manufacturing process, the resulting ash can be used as a replacement of cement in concrete. The Rice Husk ash used in plain cement concrete often achieves economy and cost savings and imparts specific engineering properties to finished products. The chemical composition of RHA produced by utilizing the fluidized bed type furnace is reported to be SiO2 (80- 95%), K2O (1-2%) and un-burnt carbon (3-18%). The pozzolanic activity of rice husk ash is effective in improving the strength.

Fig 1.3 Shows ash 0f RICE HUSK ASH

TABLE2
Chemical and physical properties of RHA

Oxide composition (% by mass)	RHA
SiO_2	88.32
Al_2O_3	0.46
Fe_2O_3	0.67
Cao	0.67
MgO	0.44
Na_2O_3	0.12
K_{2O}	2.91
LOI	5.81
Specific gravity	2.11

2 .LITERATURE REVIEW

Rice husk ash, rice straw ash, peanut shell ash have been individually proved to be an effective partial replacement to cement. They all have different chemical compositions individually. Their combination with cement achieved higher compressive strength at early stages used individually.

Mangesh V Madurwar, Sachin A Mandavgane, Ph.D. et al (2014)
SBA-QD-L bricks are up to 40% lighter than the conventional locally available bricks and hence support in lightweight construction projects with larger design loads. Observations during the tests showed that SBA-QD-L brick composition with SBA (50% by weight), quarry dust (30% by weight), and lime (20% by weight) exhibits the water absorption of 19.70% (less than 20%) and the compressive strength of 6.59 MPa, which is almost double the conventional commercially available clay bricks (3.5 MPa) and satisfies the requirements in IS: 2185 (Part-I) (BIS 1979) and SP: 21 (BIS 1983) for a building material

Apurva Kulkarni, Samruddha Raje, Mamta Rajgor. et al (*Oct 2013)*
Bagasse ash bricks reduce the seismic weight of building. It reduces the density of bricks from 20 (clay bricks) to 11(bagasse ash bricks).

Cbatveera, P. NtmJtyonglkul. et al (1994)

This research is conducted to develop new kinds of pozzolana from other agricultural wastes apart from rice husk and rice straw. The study investigated the use of coconut husk, Corn cob and peanut shell ash as pozzolana. The properties of CHA, CCA and PSA namely specific gravity, fineness, chemical composition and the strength activity index with Portland cement were determined. For properties of paste, only ordinary Portland cement and 30% PSA were investigated for normal consistency and initial and final setting time. CCA mortars have lower compressive strength than the controlled mortar (0% CCA) while PSA mortars showed higher compressive strength than the controlled mortar (0% PSA).Among the four mortars tested for chemical attack, PSA mortars showed higher resistance against sulphate attach and RHA against acidic attack

AeslinaBinti Abdul kadir - He in his research investigated on bricks durability of cast brick with industrial sludge. The results show that the earth brick can be replaced with sludge up to 40% by weight with satisfactory value in strength. The compressive strength of brick without sludge and 5% of sludge were 11.7 MPa and 17.6 MPa respectively. The compressive strength was decreasing with addition of sludge beyond 5% from 17.6 MPa to 10.5 MPa. For water absorption result, when the sludge added more than 10% by weight, the water absorption was gradually increased. In the study, addition of sludge into brick gives dual benefits of safe disposal of sludge from industry and also conversation of brick making.

Hegazy et al - He discussed the incorporation of water treatment sludge and rice husk ash in clay bricks. In the study, 25%, 50% and 75% by weight of water treatment sludge was added to produce clay bricks. Each brick series was fired at 900^{o}C, 1000^{o}C, 1100^{o}C and 1200^{o}C. The compressive strength of brick value were 5.7 MPa to 6.8 MPa for the control brick and 2.82 MPa to 7.82 MPa for sludge-RHA brick. Meanwhile, for the water absorption test, the results were 9.94% to 11.18% of control brick and 17.41% to 73.33% for sludge-RHA brick respectively. From the obtained results, it was concluded that by common temperature, 75% addition was the optimum sludge to produce the bricks. On the other hand, Hegazy et al. [17] also discussed the corporation oof water sludge, silica fume (SF) and rice husk ash (RHA) in brick making. Three different series of sludge of SF and RHA proportion which were (25:50:25%), (50:25:25) and proportion which were (25:50:25%), (50:25:25) and (25:25:50%) were incorporated.

Each brick was fired at 900^{o}C, 1000^{o}C, 1100^{o}C and 1200^{o}C. For the compressive strength and water absorption the results obtained 5.03 MPa to 8.12 MPa and 16.24% to 52.11% respectively. The operating at the temperature commonly practiced in brick klin could be concluded that mixture consists of 50% of sludge, 25% of SF and 25% of RHA was the optimum materials proportions that demonstrated obvious superior properties to the 100% clay control-brick.

Ingunza, Liew - They used 5%, 10%, 15%, 20%, 25% and 30% of sewage sludge incorporated into soft-mud brick with 12 specimens for each sludge percentages. From the result obtained there is no sign of alteration in colour or odour. Brick with 35% sludge were very brittle and there are some of dimension reduction changes between 1mm to 7mm. Based on the result, the brick mass significantly loss according to the percentage of sludge. Wengalo reported the same conclusion. Ingunza also claim that bricks manufactured with 20%, 25% and 30% are above the limit proposed [23]. In terms of properties the water absorption result shows there were increment for each brick compared to control brick. With 25% of sludge used, the brick absorbing capability increased to an average of 160% more than control brick. The sludge brick with 25% and 30% inclusion do not meet minimum standard required but other percentages comply with the minimum standard strength.

3. SCOPE AND OBJECTIVE

3.1 SCOPE

A new kind of pozzolana from agricultural wastes as such Sugarcane Bagasse Ash and Rice Husk Ash is made.The production of bricks by using SCBA and RHA ash having some cement poperties is done. A number of 4 bricks are to be cast for each replacement levels (0%, 5%, 10%, 15%) with combination of SCBA and RHA ash is done . The beams are to be cured and crushed at 7, 28 days. The results are compared with the conventional bar chart and graphs.

3.2 OBJECTIVE

- To find the properties of clay including initial setting time, final setting time and normal consistency and specific gravity.
- To find the mechanical and physical properties of SCBA and RHA ash including sieve analysis, water absorption and specific gravity.
- To find the physical and mechanical properties of clay sample including sieve analysis, water absorption and specific gravity.
- To design a proper mix of ash materials and it should mixed efficiently with clay sample
- The material is placed in mould and compacted and allowed dry in direct sunlight for two days
- After hardened,they are placed in chambers for heating process,
- Bricks are tested for compression on 7th and 28th day.
- Comparison is made between conventional bricks and sugarcane bagasse and rice husk ash bricks are made and graphs are drawn.

4. EXPERIMENTAL METHODOLOGY

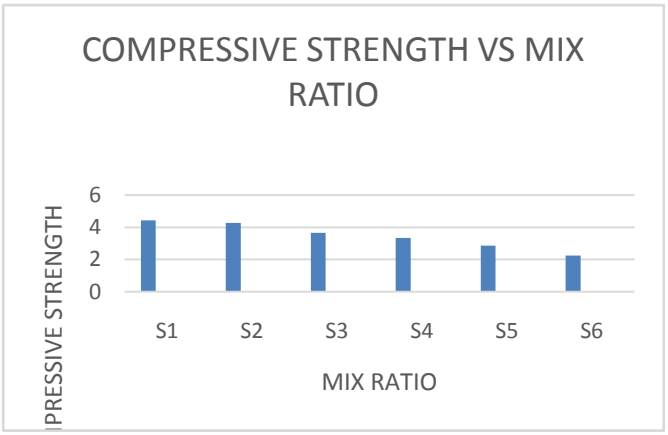
The selection of the materials used for the casting of the bricks have been done based on basic preliminary tests that are conducted and compared to the criteria as stated in their respective codes. The test that has been performed on the materials and their results are listed below under their respective material chapters.

The evaluation of Bagasse and ricehusk ash for use as a replacement of clay material begins with the brick testing. Brick contains Bagasse and ricehusk ash. With the control brick, i.e. 10%, 20%, 30%, 40%, 50% and 60% of the clay is replaced with Bagasse ash and ricehusk ash, the data from the Bagasse ash and ricehusk ash brick is compared with data from a brick without bagasse ash. Five bricks samples were cast having size of 190x90x90mm.The manufacturing process of bricks broadly consists of three operations viz. mixing the ingredients, pressing the mix in the machine and curing the bricks for a stipulated period. Selection of machinery depends on the bricks mix contents. For manufacturing bagasse ash and ricehusk ash bricks, the best suited machinery is a Vibro - press machine, which is an indigenous low cost machine and can be run by ordinary semiskilled worker. Its production capacity is 1000 bricks per shift and can be operated in two shifts without operation/maintenance load. The maintenance cost is so lo that it can be ignored. 15 lakh bricks can be produced for each machine in its life cycle.

5. RESULTS AND DISCUSSIONS

5.1 COMPRESSION TEST

The brick specimens are immersed in water for 24 hours. The brick is filled flush with 1:3 cement mortars and the specimen are stored in damp jute bag for 24 hours and then immersed in clean water for 24 hours. The specimen is placed in compression testing machine with 6 mm plywood on top and bottom of it to get uniform load on the specimen. Then load is applied axially at a uniform rate of 14 N/mm2. The crushing load is noted. Then the crushing strength is the ratio of crushing load to the area of brick loaded. Average of five specimens is taken as the crushing compressive strength of brick so formed increases with increase in ash content but decreases with the increase in combination of ash content beyond 15%



TRIAL NO.	COMPOSITION (%)			WEIGHT PER BRICK (Kg)	DENSITY (kg/m^3)	WATER ABSORPTION (%)
	SCBA	RHA	CLAY			
S1	5	5	90	3.440	22.35	15.94
S2	10	10	80	3.400	22.09	16.30
S3	15	15	70	3.340	21.70	18.48
S4	20	20	60	3.300	21.44	20.73
S5	25	25	50	3.216	20.89	21.87
S6	30	30	40	3.160	20.53	22.45

5.2 Density of Brick:

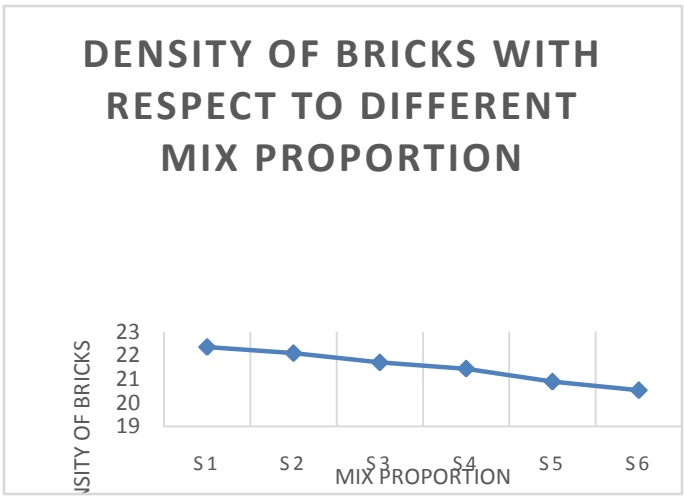
It is observed that the density of brick decreases as the percentage of additive (Rice husk and bagasse ash) increases . Since the density of the additive (ash) is equal to 0.53 t/m3, it will float in water. The mixing was done with soil by proportion of weight; a great volume of additive will replace the soil volume because of their lower density. This leads to reduction in the density of the brick.

5.3 Water Absorption of Brick:

The major factor affecting the durability of brick is water absorption. The less infiltration of water in the brick, the more durable is the brick. So, the internal structure of brick must be intensive enough to prevent the intrusion of water. The water absorption was determined by using the procedures described in ASTM C67-00 (2000). It is found that water adsorption property of prepared brick decreases initially with an increase in ash content (Fig 5) up to optimum ash content of 15%. However, it increases afterwards. This is due to fact that addition of additive (ash) to the soil generates the desired heat of hydration which starts the pozzolanic reaction resulting in gel formation. At an optimum ash percentage, a homogeneous gel formation takes place in which all the soil particles will be involve in pozzolanic reaction leading to formation of less porous hard cementitious product. Any further increase in ash proportion in soil will result in excess of ash which remains unused and prevents the soil particles from point to point contact leading to increase in porosity.

CONCLUSION:

The following conclusions can be drawn based on results obtained ; the substitution of SCBA and RHA can be used up to20 % for best results in producing bricks.there is abundance



of this materials in developing countries and it will helps in thousands of tonnes of waste from the environment annually.

It is observed that the compressive strength decrease with increase in percentage of ash content in bricks. The additiopn of some amount of ash content reduces the self weight of bricks.

- The compressive strength of brick so formed increases with increase in ash content but decreases with the increase in combination of ash content beyond 15%.

- Reduction in the disposal of ash and land degradation.
- The RHA and SCBA used in this study is efficient as a pozzolanic material; it is rich in amorphous silica (88.32%). The loss on ignition was relatively high (5.81%). Increasing RHA fineness increases its reactivity.
- Reduction in permeability because of pore refinement.
- Bricks are lighter in weight and economical.

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