Bagasse Ash an Effective Replacement in Fly Ash Brick

M.Suresh Kumar Reddy[1], Shaik Bepari Fayaz Basha[2], S.Mahaboob Basha[3]
[1,2,3] (Assistant Professor, Depatrment of civil Engineering, Chaitanya Bharathi Institute of Technology, Proddatur, Andhra Pradesh, India)

Abstract:

There is a strong demand for environmentally safe reuse and effective disposal method for bagasse ash due to the increasing amount of sludge generated by the various industries or plant in India. Landfills are commonly used for disposal of sludge in India; rapid urbanization has made it increasingly difficult to find suitable landfill sites. Therefore, incineration has become one of the few alternatives available for disposal of sludge. The ultimate disposal of incinerated bagasse ash can is accomplished by using it engineering construction materials. One possible solution for the management of this sludge is to re-use it as a building material, namely, to incorporate this bagasse ash into bricks. The fired clay brick is one of the most common and abundant masonry building materials and remain popular for its many characteristic properties. As such, the recycling of waste materials by incorporating them into bricks has been a popular topic of investigation over the last century, with varying degrees of success across a wide range of waste material. This popularity is likely due to flexibility on the type of wastes which can be mixed into the brick making material, but more importantly, the high temperature involved in firing the bricks allows for the volatilization of dangerous component, as well as the fixation of wastes into the vitreous phase of the brick. The current study investigates the potential for reusing sugarcane sludge or bagasse ash by using it as a partial replacement material in fly ash bricks. Due to limited availability of natural resources and rapid urbanization, there is a shortfall of conventional building construction materials. Therefore, development of new technologies to recycle and convert waste materials into reusable materials is important for the protection of the environment and sustainable development of the society.

Keywords : Bagasse ash, Fly ash bricks, Waste materials.

INTRODUCTION:

BRICK:

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units lay in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials. Bricks are produced in numerous classes, types, materials, and sizes which vary with region and time period, and are produced in bulk quantities. Two basic categories of bricks are fired and non-fired bricks.

WASTE UTILIZATION IN CONSTRUCTION INDUSTRY:

Human and his activities produce a lot of wastes. At the same time, man consumes many things. Amongst the various things man consumes, building materials happen to be the largest in terms of weight being about 5 tons per capita per year, next only perhaps to water. Out of the total cost of house construction, building materials contribute 70% cost in developing14countries like India. One of the construction sector's major contributions to the preservation of the environment and sustainable development is the reuse and recycling of the waste materials it generates, i.e. reducing, reusing, recycling and regenerating the residues that originate the constructive activity. This has increased the life cycle of these materials, thereby reducing the amount of waste dumping and natural resource extraction.

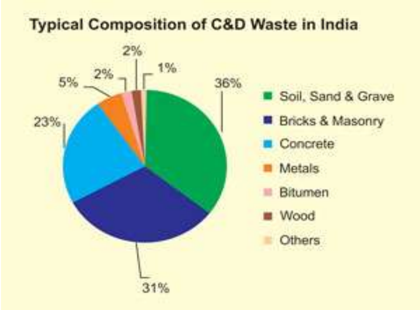

Fig. 1 WASTE UTILIZATION IN CONSTRUCTION INDUSTRY

LITERATURE REVIEW

Kulkarni Apurva , Raje Samruddha , Rajgor Mamta studied that Utilization of industrial and agricultural waste products in the industry has been the focus of research for economic, environmental, and technical reasons. Bagasse ash can be utilized by replacing it with fly ash and lime in fly ash bricks. Trial bricks of size (230x100x75) mm were tested with different proportions of 0%, 10%, 20%, 30%, 40%, 50% and 60% with replacement of fly ash and 0%,5%, 10%, 15% and 20% with replacement of lime.

Teixeira et allooked into the potential of replacing quartz with bagasse ash in red ceramic. Bagasse ash was characterized using X-ray fluorescence and X-ray diffraction tests. Prismatic probes of ceramic material amended with bagasse ash in quantities of 5%, 8%, and 10% by weight were fired at temperatures between 800°C and 1200°C. The fired ceramic probes were tested for texture, flexural strength, and shrinkage.. However, the authors concluded that the amount of ash that can be incorporated will depend on both the composition of the clay and the ash to be incorporated. In their study, they recommended that up to 10% of bagasse ash can be incorporated in red ceramic.

Madurwar V. Mangesh, Mandavgane A. Sachin and Ralegaonkar V Rahul have studied that Application of bio fuel by-product sugarcane bagasse ash (SBA) as a principal raw material for the manufacturing of bricks was studied. The optimum composition of SBA–QD–L brick is 15% and 25% lighter than the commercially available burnt clay and fly ash– cement bricks respectively. It was also observed that masonry bonding of SBA–QD–L bricks is stronger compared to commercially available fly ash and burnt clay bricks. Manufacturing process of SBA–QD–L bricks results in 50% and 6% reduction in energy consumption over the commercially available burnt clay and fly ash– cement building bricks.

METHODLOGY

MATERIALS

The materials used for bagasse ash as effective replacement in fly ash bricks are:-

- Cement, Fly ash, Lime, Sugar cane bagasse ash, Water

CEMENT:

The cement used was Ordinary Portland Cement. It was sourced from Ire, Osun State, Nigeria and it conformed to the requirements of BS EN 197-1: 2000.It is a fine mineral powder manufactured with very precise processes. Mixed with water, this powder transforms into paste that binds and hardens when submerged in water. Because the composition and fineness of the powder may vary, cement has different properties depending upon its makeup. Cement is the main component of concrete. It is economical, high quality construction material used in construction projects. Cement is made by grinding together a mixture of lime stone and clay which is then heated at a temperature of 1450C. The granular substance called "CLINKER", a combination of calcium, silicate, alumina and iron oxide.

BASICALLY, CEMENT IS PRODUCED IN TWO STEPS:

- First clinker is produced from raw materials.
- In the second step the cement is produced from cement clinker.

The first step can be a dry, wet, semi dry or semi wet process according to the state of the raw material.

TABLE 1:-Physical properties of cement

S.NO.	Particulars	Properties
1	Colour	Grey
2	Shape texture	Irregular
3	Mineralogy	Non Crystalline
4	Particle size	<150 microns
5	Odour	Odorless
6	Specific gravity	3.15
7	Appearance	Very fine

TABLE 2: Chemical properties of cement

S.NO	COMPOSITION	CEMENT
1	Cao	**50.7%**
2	SiO2	0.09%
3	Al2O3	0.03%
4	Fe2O3	0.02%
5	MgO	0.01%
6	K2O,Na2O3	0.19%
7	SO3	0.57%

TESTS PERFORMED ON CEMENT:

1. Fineness of cement
2. Consistency of cement
3. Initial and final setting time

FINENESS OF CEMENT:-

To determine the fineness of cement by dry sieving. Fineness Test on Cement is carried out to check proper grinding of cement. Fineness of cement particles may be determined either by sieve test or by permeability apparatus test. In sieve test, the cement weighing 100 gm is taken and it is continuously passed for 15 minutes through standard BIS sieve no. 9. The residue is then weighed and this weight should not be more than 10 per cent of original weight. In permeability apparatus test, specific surface area of cement particles is calculated. This test is better than sieve test and it gives an idea of uniformity of fineness. The specific surface acts as a measure of the frequency of particles of age size. The specific surface of cement should not be less than 2250 cm2/gm.

CONSISTENCY OF CEMENT:-

This test helps to determine water content for other tests like initial and final setting time, soundness & compressive strength. The basic aim is to fine out the water content required to produce a cement paste of standard consistency as specified by the IS :4031. The principle is that standard consistency of cement is that consistency at which the vicat plunger penetrates to a point 5-7mm from the bottom of vicat mould. Consistency refers to the relative mobility of a freshly mixed cement paste or mortar or its ability to flow. For a mortar the standard consistency is measured by flow table test. Generally the normal consistency for OPC ranges from 26 to 33%.

TABLE 3:-OBSERVATION FOR CONSISTENCY RESULTS

S.NO	Quantity of cement(gms)	Quantity of water(ml)	Percentage of water	Penetration in mm (from top)
1.	400	96	24%	17
2.	400	104	26%	14
3.	400	112	28%	10

4.	400	120	30%	12
5.	400	128	32%	7

INITIAL AND FINAL SETTING TIME OF CEMENT:-

When cement is mixed with water, it hydrates and makes cement paste. This paste can be moulded into any desired shape due to its plasticity. Within this time cement continues with reacting water and slowly cement starts losing its plasticity and set harden. This complete cycle is called Setting time of cement. The time to which cement can be moulded in any desired shape without losing it strength is called Initial setting time of cement. The time at which cement completely loses its plasticity and became hard is a final setting time of cement. The fineness of cement, the presence of salts in sand, atmospheric conditions. For example, cement requires a temperature of 27°c to complete Hydration, during winters the climate is low which stops the hydration and takes a longer time to set harden. As Per **IS: 4031 (Part 5) – 1988.** Initial and final setting time of cement is calculated using VICAT apparatus conforming to IS: 5513 – 1976.

FLYASH:

Fly ash is a fine powder produced as a product from industrial plants using pulverized coal or lignite as fuel. It is the most widely used pozzolanic siliceous or aluminosilicious in nature in a finely divided form. Fly ash concrete is an eco-friendly construction material. In the view of global warming effects reduce the emission of co2 released by the cement industry in the environment. For every 1 ton of cement emits 0.87 tons of carbon dioxide. By using fly ash we can meet growing demand in the construction industry as well as help in reduction of environmental pollution.

TABLE 4 :-Chemical composition of fly ash:

S.No	Oxide composition	Fly ash
1	Sio_2	54.90
2	Al_2o_3	25.80
3	Fe_2o_3	6.90
4	Cao	8.70
5	Mgo	1.80
6	Na_2o_3	0.63
7	K_2o	2.19

LIME:

Lime is calcium – containing inorganic mineral in which carbonates, oxides and hydroxides predominate. In the strict sense of the term, lime is calcium oxide or calcium hydroxide. It is also the name of the natural mineral (native lime) CaO which occurs as a product of coal seam fires and in altered limestone xenoliths in volcanic eject. The word lime originates with its earliest use as building mortar and has the sense of sticking or adhering.

TABLE 5:-Chemical composition of lime

S.No	Oxide composition	Lime
1	Sio_2	5.39
2	Al_2o_3	1.06
3	Fe_2o_3	0.39
4	Cao	28.60
5	Mgo	2.42
6	So_3	0.93

QUARRY DUST:

Quarry dust is a by-product of the crushing process which contains particle size from 0.75 to 5 mm. These stone dusts are not usable and dumped for land filling. But for few past years it has been utilized more than dumping to the other works like making concrete blocks and landscaping. Quarry dust is a great alternative product for Natural river sand also cost efficient at the same time. Since it's a waste product also provides availability. If quarry dust will be used for some construction purpose, the dust release from it will not affect the environment. Therefore, quarry dust should be used in construction works, which will reduce the cost of construction and the mining of river bed will be reduced and hence will not affect aquatic system.

Specific gravity: 2.57

Fineness modulus: 2.41

Density: 1.85gm/cc

Void ratio: 0.42 F

TABLE 6 :-Chemical composition of Quarry dust:

S.No	Oxide composition	Quarry dust
1	Sio_2	62.48
2	Al_2o_3	18.72
3	Fe_2o_3	6.54
4	Cao	4.83
5	Mgo	2.56
6	K_2o	3.18

SUGAR CANE BAGASSE ASH (SCBA):

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 causes environmental 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. 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%) and0.62% of residual ash. The residue after 2222combustion 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.

TABLE 7 :-Chemical composition of SUGAR CANE BAGASSE ASH (SCBA) :

S.No	Oxide composition	SCBA
1	Sio_2	73
2	Al_2o_3	6.7
3	Fe_2o_3	6.30
4	Cao	2.8
5	Mgo	3.2
6	Na_2o_3	1.1
7	K_2o	2.4

Estimation procedure for fly ash bricks with replacement of bagasse ash: (specify the quantities below)

- size of brick=(22.5*10*6.5) cm
- for 3bricks=3*(22.5*10*6.5)

volume of cube = 0.103*0.232*0.072 = 0.0017 m^3

Additional 50% is taken due to shrinkage of the material sum of mix proportions 1:1:2 = 1+1+2 = 4

Volume of cube = 0.0017*1.5= 0.0025 m^3

Volume of lime = (1*0.0025)/4 = 0.000625 m^3

Volume of stone dust and fly ash = (1*0.0025)/4 = 0.000625 m^3

Volume of bagasse ash = (2*0.0025)/4 = 0.00125 m^3

Weight of lime = 1200* 0.000625 = 0.7 kg

Weight of fly ash = 1340*0.00125 = 1.6 kg

Weight of stone dust = 1400*0.000625 = 0.81 kg

Weight of bagasse ash = 1110*0.00125 = 1.38 kg

TABLE 8:-EFFECTIVE REPLACEMENT OF FLYASH BY BAGASSE ASH

According to Proportion	Cement (kgs)	Fly ash (kgs)	SCBA (kgs)	Lime (kgs)	Quarry dust (kgs)
1:1:2	0.7	1.6	1.38	0.7	0.8
	1.2	1.6	1.8	1	0.8
	1.4	1.6	2.2	1.3	0.8

TABLE 9: QUANTITY OF FLY ASH BRICK

According to Proportion	Cement (kgs)	Fly ash (kgs)	Quarry dust (kgs)
1:1:2	0.9	1.67	0.875

WORK PROCEDURE

The evaluation of Bagasse ash for use as a replacement of fly ash material begins with the brick testing. Brick contains fly ash, Lime, water, and Quarry dust. With the control brick, i.e.5%, 10% and 15%of the fly ash is replaced with Bagasse ash, the data from the Bagasse ash fly ash brick is compared with data from a standard fly ash brick without bagasse ash.

The following are the steps involved for the preparation of bricks are as follows:-

1. Mixing
2. Moulding
3. Curing

Fig. 2 CURING

TESTS CONDUCTED ON BRICKS:

1. Water absorption
2. Compressive strength

WATER ABSORPTION:

Absorption test is conducted on brick to find out the amount of moisture content absorbed by brick under extreme conditions. In this test, sample dry bricks are taken and weighed. After weighing these bricks are placed in water with full immersing for a period of 24 hours. Then weigh the wet brick and note down its value. The difference between dry and wet brick weights will give the amount of w0061ter absorption. For a good quality brick the amount of water absorption should not exceed 20% of weight of dry brick.

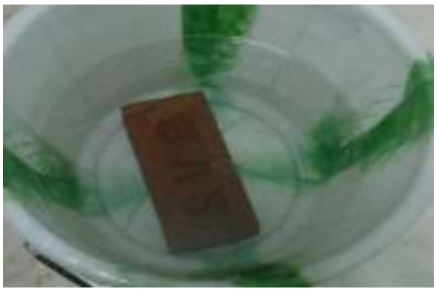

Fig.3 WATER ABSORPTION

COMPRESSIVE STRENGTH:

Crushing strength of bricks is determined by placing brick in compression testing machine. After placing the brick in compression testing machine, apply load on it until brick breaks. Note down the value of failure load and find out the crushing strength value of brick. Minimum crushing strength of brick is 3.50N/mm^2.if it is less than 3.50 N/mm^2, then it is not useful for construction purpose.

Compressive strength test on bricks are carried out to determine the load carrying capacity of bricks under compression. This test is carried out with the help of compression testing machine.

Bricks are generally used for construction of load bearing masonry walls, columns and footings. These load bearing masonry structures experiences mostly the compressive loads. Thus, it is important to know the compressive strength of bricks to check for its suitability for construction. Compression testing machine, the compression plate of which shall have ball seating in the form of portion of a sphere center of which coincides with the center of the plate.

compressive strength = load/area

Fig. 4 COMPRESSIVE TESTING MACHINE

RESULTS

The results are shown for brick. After testing brick the compressive strength testing is conducted for different replacement percentage of bagasse ash.

Compressive strength is calculated by using, fc = load/area

Brick:

The load applied is = 140 KN

Area of specimen = 6500 mm^2

The compressive strength = 21.5 N/mm^2

TABLE 10:-Compressive strength characteristics

PROPERTY	BAGASSE ASH BRICK	FLY ASH BRICK
Compression test	21.5 N/mm^2	14 N/mm^2

Water absorption	14.6%	12%

CONCLUSION

The use of bagasse ash in brick can solve the disposal problem; reduce cost and produce a 'greener' Eco-friendly bricks for construction. The Environmental effects of waste bagasse ash problem can be reduced by using it as a partial replacement in flyash brick. This helps in converting the non-valuable bagasse ash into bricks and makes it valuable. Bagasse ash bricks can reduce the seismic weight of building. By using the bagasse ash in brick manufacturing process the cost of brick can be reduced.

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