International Seminar On Non-Conventional Energy Sources for Sustainable Development of Rural Areas,
IJAERD- International Journal of Advance Engineering & Research Development
e-ISSN: 2348-4470, p-ISSN:2348-6406
Impact Factor: 4.72, DOI:10.21090/ijaerd

Study on the Components of Ash Bricks

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Abstract---*Bricks are considered as the backbone of the construction industry. They are perhaps the most important building construction material. But the unlimited use of clay is harmful to society as all the bricks kilns in India depend on good quality clay available from agricultural fields and presuming a weight of 3 kg. Per brick.Thetotal clay taken out from the agricultural fields per day was over 300 million tonnes for 10,000 Crore bricks. Moreover, clay bricks available in certain regions are poor in quality and costly which have forced engineer's tolook for better material capable of reducing the cost of construction. So the use of industrial waste products such as fly ash, for making bricks is ecologically and economically advantageous since apart from saving precious top agricultural soil, it meets the social objective of disposing industrial waste i.e. fly ash which otherwise is a pollutant and a nuisance. The ever increasing volume of fly ash quantities in the world has not been remotely matched by its utilization. Environmental concerns have been raised in some parts of the world where coal is the main power generatingresource and where bricks are also the main building material. So far, few attempts at manufacturing bricks from more than 80% fly ash have been made. The author believes that fly ash on its own is an excellent raw material for brick manufacturing which can be extensively used in different construction materials. The objective of this paper is to study the components used in the manufacture of ash bricks along with their properties and regions where they found.*

Keywords: *Components of fly ash bricks*

I. INTRODUCTION

In India about 75% of the power generation plants are coal based, tonnes of coal is consumed every year due to which more than 110 million tons of ash is generated as a residue, from a survey it is found that about 170 million of ash is generated from the different industries since the year 2010, at present approx. 65000 acres of land is filled up by ash pond. As the requirement of energy for the developing countries in particular area is fulfilled from the combustion of coal. The disposal of the increasing amounts of thermal waste from coal-fired thermal power plants is increasing day by day, this disposal of the thermal waste is termed as fly ash, which is composed of the non-combustible mineral portion of coal consumed in a coal fuelled power plant and the powdery waste remained as residue from the various plants and factories. Fly ash is a powdery substance obtained from the dust collectors in the electrical power plants that use coal as fuel. There are two basic type of fly ash Class C and Class F [2]. Due to rise in demands and industries, fly ash is being accumulated as waste material in large quantities near thermal power plants. As the power requirements of the country goes up, the amount of waste produced will also increase enormously creating problems for its safe disposal due to lack of adequate disposal facilities. Its use in the construction industry i.e. (in manufacturing of bricks) will be helpful in its disposal and also help in controlling pollution. Fly ash bricks are made of fly ash, lime, gypsum and sand. These can be extensively used in all building constructional activities similar to that of common burnt clay bricks. The fly ash bricks are comparatively lighter in weight and stronger as compared to common clay bricks. As an industrial waste, fly ash presents some environmental and storage problems our country needs approximately 250 billion bricks per year for all kind of construction works, to make 60 billion bricks, 185 million tons of top soil is needed. Ultimately near about 7500 hectares of very fertile land is deliberately eroded to meet the demand of clay bricks for construction every year. This devasting act is slowly killing our environment and we will be left with no fertile land for agriculture in near future, deforestation also occurs in search of soil source for clay brick manufacturing [1]. However, it has been used widely as an excellent mineral additive in the construction industry [3, 4]. The use of fly ash prevents different environmental pollution, and it contributes in reducing need for natural resources. Fly ash is available in different types, such as C and F. The F type has a low Calcium content, and its content of SiO2 + Fe2O3 + Al2O3 is greater than 70 (ASTM C 618) [5]. It is a finely divided residue resulting from the combustion of powdered coal and collected by electronic precipitators in thermal power plants. Presently in India, approximately 160 million tons of fly ash is produced by thermal power plants every year. The estimation for generation of fly ash as a residue during the year 2031-32 would be expected to be around 900 million tons [6]. Since fly ash is being accumulated as waste material in large quantity near thermal power plants and creating different serious environmental pollution problems, its utilization as main raw material in the manufacture of bricks will not only create sample opportunities for its proper and useful disposal but also help in reduction of environmental pollution control to a greater extent in the surrounding areas of power plants. In view of superior quality and eco friendly nature and government support the fly ash bricks, as in 2014 according to order of 'The Supreme Court of India' it is illegal to use red burnt clay bricks in the construction activities. The central and state Governments are greatly concerned about top soil erosion towards production of massive quantities of bricks, in the background of enormous housing needs. The ministry of power, Government of India, issued circulars to all concerned department and

organizations to promote the use of fly-ash in the production of building materials by offering several incentives. However, on 22.05.1998, the Ministry of Environment and Forests mooted a proposal to ban the excavation of top soil within a radius of 50 km. About 150 million ash bricks have been manufactured and used in house consumption. All the fly ash bricks manufacturing plant use similar processes called FAL-G Technology by using fly ash, cement/lime and gypsum to manufacture bricks. These bricks are water cured, thus avoiding the need of firing or stream curing of the bricks [7]. The consumption of earth-based materials as clay, shale and sand in brick production resulted in resource depletion, environmental degradation, and energy consumption. Virgin resources are mined from riverbeds and hillsides to service brick industry leaving mines areas un-reclaimed. Environmental degradation accompanies such mining activities with air pollution and remains after the mines cease operations, leaves scars on the landscape [8]. The demand of fly ash Bricks is gradually increasing day by day not only in the metropolitan cities but also in urban & rural sector.

II. MATERIALS USED IN ASH BRICKS

2.1. Fly Ash

Fly ash is finely divided residue resulting from the combustion of powdered coal and transported by the flue gases and collected by electrostatic precipitator [11]. Pulverized fuel ash commonly known a2.1s fly ash shall conform to Grade 1 or Grade 2 of IS 3812. The proportion of the Fly ash is generally in the ratio 60-80%, depending upon the quality of raw materials as fly ash must be collected from the 1 and 2 field of E.S.P (electrostatic precipitator) which meet the required grade 2 of IS: 3812. Fly ashes vary in colors, perfect size, and mineralconstituents depending upon origin of coal burning. Indian fly ashes contain higher content of un-burnt carbon (10% to 16%) where as in American fly ashes it is less (around 5%) [10].The process of coal combustion results in coal ash, 80% of which is very fine in nature & is thus known as fly ash, which is very harmful for environment as well as for mankind as it leads several health impacts on human such as asthama and respiratory problems. So it is must that is utilised by the means of different purposes.It is studied that when it is exposed to open air, if intake by person will cause thesame effect as a single person smokes 1 lakh cigarette at a time, some of its properties are as follows:

Reduced Shrinkage It possesses lubricating properties and this action helps in reduction of dry Shrinkage.

Decreased Permeability It is long term pozzolanic action of fly ash, which ties upfree lime, results in fewer bleed channels and decreases permeability.

Spherical shape particles of fly ash are almost spherical in shape, allowing them to flowand blend freely in mixture.

Higher Strength With respect to time fly ash continuously combines with free lime which results inincreasing structural strength of mixer.

Improved Finishing Sharp, clear architectural definition is easier to achieve, with less worry about in-place integrity.

Ball bearing effect "ball-bearing" effect of fly ash particles creates a lubricating action when concrete is in its plastic state.

2.1.1. Uses of Fly Ash

These earth elements primarily consist of silica, alumina & iron etc. and its physicochemical parameters are closely resembles with volcanic ash, natural soil and Portland cement etc. These properties, therefore, makes it suitable for use in ceramic industries and helps in saving the environment and Natural resources.

Fly ash in bricks

Fly ash bricks have a number of advantages over the conventional burnt clay bricks. Unglazed tiles for use on footpaths can also be made from it. Awareness among the public is required and the Government has to provide special incentives for this purpose.

Fly ash in manufacture of cement

Fly ash when mixed with lime and water forms a cementious compound with properties very similar to that of Portland cement. Because of this similarity, fly ash can be used to replace a portion of cement in the concrete, providing some distinct quality advantages. The concrete is denser resulting in a tighter, smoother surface with less bleeding.

Fly ash in distemper

Distemper manufactured with fly ash has similar properties like white cement & has been used in several buildings in Neyveli, Tamil Nadu etc. in India. The cost of production will only be 50% that of commercial distemper.

Fly ash as fertilizer
Fly ash serves as a good fertilizer. It provides the uptake of vital nutrients/minerals (Ca, Mg, Fe, Zn, Mo, S and Se) to crops and vegetation, and can be considered as a potential growth improver [9].

2.1.2. Types of Fly ash bricks

C class fly ash
Fly ash normally produced by burning lignite or sub-bituminous coal. Some class C fly ash may have CaO content in excess of 10%. In addition to pozzolanic properties, class C fly ash also possesses cementious properties. Fly ash used is of type class C with a specific gravity of 2.19[11]. Ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash hardens and gets stronger over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulphate contents are generally higher in Class C fly ashes.

F class fly ash
Fly ash normally produced by burning anthracite or bituminous coal, usually has less than 5% CaO. Class F fly ash has pozzolanic properties only [11]. The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 20% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime mixed with water to react and produce cementitious compounds. Alternatively, adding a chemical activator such as sodium silicate (water glass) to a Class F ash can form a geo-polymer. The chemical properties of Fly ash are shown in Table 1.

Table 1: Chemical properties of fly ash **[12].**

Components	Percentage
Aluminium oxide	23.55
Silicon-di-oxide	45.98
Calcium oxide	18.67
Iron oxide	4.91
Sodium oxide	0.24
Magnesium oxide	1.5
Potassium oxide	1.80
Sulphur tri oxide	1.47
Loss of ignition	2.31
Chlorine	0.005

2.2. Stone dust
They are collected from the concreting plants. It must be strictly aware that the dust selected should not contain more than 5% of deleterious materials such as slit and field test by the use of measuring cylinder be done before per truck load to determine the percentage of slit and clay particles available in dust.

2.3. Lime
Lime is an important binding material in building construction. It is basically Calcium oxide (CaO) in natural association with magnesium oxide (MgO).Lime reacts with fly ash at ordinary temperature and forms a compound possessing cementitious properties. After reactions between lime and fly ash, calcium silicate hydrates are produced which are responsible for the high strength of the compound [11].Hydrated lime is used for Fly-Ash Brick making shouldconform to class C grade as specified in IS: 712:1984. The CaO purity in the lime should not be less than 85% which can be ascertained by testing and as well as taking test certificate from the lime suppliers. It has tendency to react with CO_2 present in the air in presence of moisture and produces $CaCO_3$ which does not have binding properties and spoils the quality of lime to be used for Fly Ash Bricks[10]. Quick Lime or hydrated lime or both can be mixed in the composition. Lime should have minimum 40% CaO content. Commercially available slaked lime is sieved and used [12]. It can be easily available from the different acctelyne industries as a waste.

2.4. Gypsum
Gypsum is a non- hydraulic binder occurring naturally as a soft crystalline rock or sand. Gypsum have a valuable properties like small bulk density, incombustibility, good sound absorbing capacity, good fire resistance, rapid drying and hardening with negligible shrinkage, superior surface finish, etc. In addition it can strengthen material or increase viscosity. It has a specific gravity of 2.31 grams per cubic centimetre. The density of gypsum powder is 2.8 to 3 grams per cubic centimetre [11]. Hydrated calcium sulphates are called gypsum. ($CaSO_4$+$2H_2O$). Gypsum should have minimum 35% purity and 5 to 15% may be used. It's procured from the industry[12].Gypsum selected for making fly ash bricks should be free of lumps, it should be tested as per IS 1288-1982.its should be concerned that its purity must be

more than 80%, if any variation in purity the percentage of gypsum should be adjusted in the mix to obtain good quality of bricks

2.5. Cement

Cement is binding material, a substance used in construction that sets and hardens and can bind other materials together. The most important types of cement are used as a component in the production of mortar in masonry, and of concrete, which is a combination of cement and an aggregate to form a strong building material.Physical analysis of 53 Grade Portland cement as per IS 12269-1987. The physical properties of cement which are used in fly ash bricks along with their testing are:-

Consistency tests
Testing should be done as per IS code 12269- 1987
The normal consistency should be 22% tested with the help of vicat's apparatus.(Testing should be done as per IS code 8112 - 1976).

Initial Setting Time
Testing should be done as per IS code 12269- 1987.
The normal Initial Setting Time must be 30 min.

Final setting time
Final setting time must be 600 min or 10 hours.

Specific gravity of cement
Specific gravity of cement must be 3.15.

Fineness of cement
Testing should be done as per IS code 4031 - 1996 {Part -I}.
Fineness of cement must be around 5.0%.

Soundness of cement
Testing is done by the help of Le-Chatelier Apparatus. (Testing Should be done as per IS code 4031 - 1996 {Part -III}, and IS5514-1996)
Soundness of cement must be around 2 mm.

Compressive strength of cement
Testing should be done as per IS code 12269- 1987
Compressive strength must be in 3 days = 27.52N/mm^2& 7 days = 36.28 N/mm^2 [10].

2.6. Quarry dust

It is residue taken from granite quarry. Due to excessive cost of transportation from natural sources locally available river sand is expensive. Also creates environmental problems of large-scale depletion of these sources. Use of river sand in construction becomes less attractive, a substitute or replacement product for concrete industry needs to be found. Whose continued use has started posing serious problems with respect to its availability, cost and environmental impact . In such a case the Quarry rock dust can be an economic alternative to the river sand. Usually, Quarry Rock Dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of hollow blocks and lightweight concrete prefabricated Elements. After processing fine particles of size less than 4.75 mm is used in this work [11].

III. MIX PROPORTION FOR MAKING FLY ASH BRICK

IV.

To make the fly ash brick following different materials mix proportions can be used. In Table 2 shows the various mix proportions [11].

Table 2: Mix proportion of material

Proportions	Fly ash (%)	Lime (%)	Gypsum (%)	Quarry dust (%)
A	15	30	02	53
B	20	25	02	53
C	20	30	02	48
D	25	20	02	53
E	30	15	02	53
F	35	10	02	53
G	40	05	02	53
H	40	10	02	48
I	50	25	02	23

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