Comparative Study on Fly Ash Bricks and Normal Clay Bricks

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Abstract— This paper presents Fly Ash brick properties, manufacturing process material required for preparing the clay bricks and fly ash bricks as per Indian standard code provisions, inspection and quality control. The textures of the bricks with Fly Ash were very similar to that of clay bricks; the sample with the additive contains spherical Fly Ash particles. These particles of Fly Ash led to a reduction in the density of the bricks and a substantial improvement in their durability. Use of this additive could have practical implications as a means of recycling and for achieving cost savings in brick production. The absorption coefficient, shape and size, density, weight, porosity, thermal conductivity and compressive strength of Fly Ash bricks compare with normal clay bricks that delivered good results. From the present study, it can be concluded that Fly Ash bricks used as an alternative to clay bricks.

Keywords: Fly Ash Brick, Compressive Strength, Absorption Coefficient, Clay Bricks

I. INTRODUCTION

During the India day by days the growth of development is increased that requires of electricity generated from the thermal power plant and this plant gives residue in the form of Fly Ash in major quantity. The rate of generation of Fly Ash far exceeds the increasing growth rate of its user. In the next ten years, the target of 95 % use of Fly Ash likely bring into existence [1]. If one considers the expected generation of Fly Ash over the next two decades, the volume projected is gigantic and its use program will have to be far more challenging than what is perceived today. In construction industries clay bricks were used in 180 billion tons of common burnt clay bricks are consumed annually approximately 340 billion tons of clay about 5000 acres of top layer of soil dug out for bricks manufacture, soil erosion, emission from coal burning or fire woods which causes deforestation are the serious problems posed by brick industry. Continuing use of clay bricks in the construction industry will lead to extensive loss of fertile top soil [2].

This could be a devastating environmental hazard. High demand for clay bricks would result in price hike of clay bricks. To keep the cost of building materials in a reasonable range, we should opt in for alternative building materials like fly ash bricks and hollow or solid blocks. The material required for the fly ash bricks as Fly ash, lime and gypsum are available in mutual proximity in many regions. An economical alternative to conventional burnt clay bricks will be available if these materials can be used to make bricks and hollow blocks of adequate strength. Lime and gypsum are usually available either from mineral sources or may be procured from industrial wastes [4]. High fineness, low coal content, and rounded particle shape are, in general, favorable properties for use in cement and concrete. The amount of cement or lime or lime plus gypsum required to achieve a certain strength depends on the amount of free lime available in the fly ash[5].Fly ash does not modify the hydric properties of the bricks but it does make them lighter. In fact, all the bricks with fly ash have a lower density. Fly ash bricks show less damage than conventional bricks when exposed to salt crystallization cycles. This improvement is due to the reduction of the surface area of the bricks, i.e. the reduction of the volume of the smallest pores, the ones that cause the most damage to the bricks due to soluble salt crystallization. The addition of fly ash can enhance the quality of the brick, although for restoration purposes if too much fly ash (P10 wt. %) is added, this can spoil the aesthetic appearance of the buildings being restored, due to excessive color differences. Bricks with larger amounts of fly ash could, however, be considered for use in the construction of new buildings [6].

II. RESEARCH SIGNIFICANCE

Continuing use of clay bricks in the construction industry will lead to extensive loss of fertile top soil. This could be a devastating environmental hazard. High demand for clay bricks would result in price hike of clay bricks. To keep the cost of building materials in a reasonable range, we should option for alternative building materials like fly ash bricks and hollow or solid blocks. Modern Fly ash bricks are manufactured using high end pre-programmed hydraulic machines. Bricks from these machines are tested for its quality and durability and strength.

A. Experimental Procedure:

Clay Bricks: The process of making a brick has not changed much over the centuries or across geographies. The clay is mined and stored in the open. This makes the clay soft and removes unwanted oxides then mixed with water to get the right consistency for Moulding. Mixing is done manually with hands and feet. A lump of the mix is taken, rolled in sand and slapped into the mould. Initially, moulds were made of wood of size 22 X 10 X 7.5 mm (8.66 X 3.93 X 2.95 inch), now metal moulds are used. Sand is used so the brick does not stick to the mould. The mould is emptied onto the drying area, where the bricks are arranged in a herringbone pattern to dry in the sun. Every two days they are turned over to facilitate uniform drying and prevent warping. After two weeks they are ready to be burnt. The green bricks are arranged in a kiln and insulation is provided with a mud pack. Fire holes left to ignite the kiln are later sealed to keep the heat inside. This is maintained for a week. Firing like other operations also depends on the knowledge and experience of the brick maker. After the kiln is disassembled, the bricks are sorted according to color. Colour is an indication of the level of burning. Over burnt bricks are used for paving or covering the kiln while slightly under burnt bricks are used for building inner walls or burnt once again in the next kiln.

Fly Ash Bricks: Fly ash, cement, and sand are manually fed into a pan mixer where water is added to the required proportion for homogeneous mixing. The proportion of raw material may vary depending upon the quality of raw materials. After mixing, the mixture is allowed to belt conveyor through feed into automatic brick making machine where the bricks are pressed automatically. Then the bricks are placed on wooden pallets and kept as it is for two days thereafter transported to open area where they are water cured for 10 -15 days. The bricks are sorted and tested before dispatch.

B. Materials:

Fly Ash: Two types of fly ash are commonly used in concrete: Class C and Class F. Class C are often high-calcium fly ashes with carbon content less than 2%; whereas, Class F are generally low-calcium fly ashes with carbon contents less than 5% but sometimes as high as 10%. In general, Class C ashes are produced from burning sub-bituminous or lignite coals and Class F ashes bituminous or anthracite coals. Performance properties between Class C and F ashes vary depending on the chemical and physical properties of the ash and how the ash interacts with cement in the concrete Class F fly ash possess only pozzolanic properties whereas class C fly ash possess both cementitious and pozzolanic properties. Many Class C ashes, when exposed to water, will react and become hard just like cement, but not Class F ashes. Most, if not all, Class F ashes will only react with the byproducts formed when cement reacts with water. The fly ash classified by their grinding particle it also known fly ash Blaine fineness of fly ash is divided into 40F(2013ft2/lb) (4125cm2/g), 60F(3262ft2/lb) (6686cm2/g), and 90F(4700ft2/lb) (9632cm2/g) which used in replacing of cement with 15, 30 , 45 and 60% by binder mass[3].

Cement: Portland cement is the basic ingredient of concrete. Concrete is formed when portland cement creates a paste with water that binds with sand and rock to harden. Cement is manufactured through a closely controlled chemical combination of calcium, silicon, aluminum, iron and other ingredients. Ordinary Portland cement of 43 grades was used for the entire work.

Crush Sand: In a replacement of fine aggregate (sand) in fly ash bricks, crush sand there used its cost effective than the fine aggregate. There no specific grade for the crushed sand to maintain the quality of bricks.

Inspection and Quality Control: The Bureau of Indian Standards has formulated and published the specifications for maintaining the quality of product and testing purpose in IS: 12894:2002.Compressive strength achievable 870-3626 psi (6-25N/mm2).Water absorption: 5 – 12 %; Density is 12.5 lb/gal (1.5 gm./cc) Coefficient of softening (depending upon water consistency factor), Unlike conventional clay bricks Fly Ash bricks have high affinity to cement mortar though it has a smooth surface, due to the crystal growth between brick and the cement mortar.

III. Result and Discussion

A comparison between the bricks that conducted from experimental work. The fly ash bricks and clay bricks are tested on universal testing machine(UTM). The crevice occur in normal clay brick at end of brick corner which depicted figure 4 and crunch at end. However, in fly ash bricks crevice fall out less than that of clay bricks depicted figure 5. The experimental effect or response of bricks remark in table 1(see.figure 1,2,3). On study of fly ash bricks benefits as given bellow.

Experimental Set –A				
parameter	Compressive Strength psi (N/mm^2)			
Sample No.	1	2	3	4
Normal clay bricks	593.20(4.09)	522.13 (3.6)	593.20 (4.09)	1203.81(8.3)
Fly Ash Bricks	587.40 (4.05)	826.71 (5.7)	1556.25(10.73)	641.06(4.42)
Experimental Set –B				
parameter	Compressive Strength psi (N/mm2)			
Sample No.	1	2	3	4
Normal clay bricks	652.66 (4.5)	548.24 (3.78)	651.2 (4.49)	798 (5.5)
Fly Ash Bricks	1130 (7.71)	1150 (7.93)	1102.2 (7.6)	1160 (8)
Experimental Set –C				
parameter	Compressive Strength psi (N/mm2)			
Sample No.	1	2	3	4
Normal clay bricks	887.6 (6.12)	623.66 (4.31)	822.36(5.67)	677.32(4.67)
Fly Ash Bricks	1112.43(7.62)	1131.29 (7.8)	1160 (8)	1189.30(8.2)

Table 1: Compressive Strength for trial mix

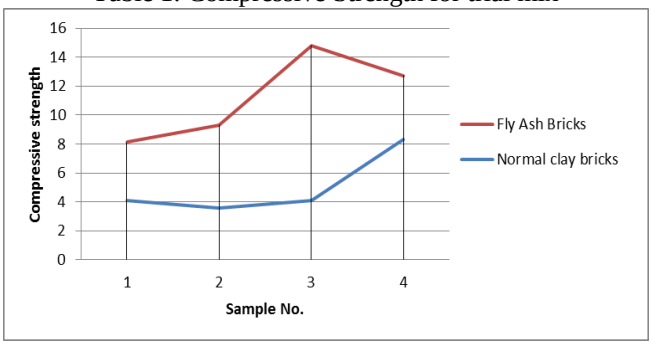

Fig. 1: Fly Ash Bricks Vs Clay Bricks-A

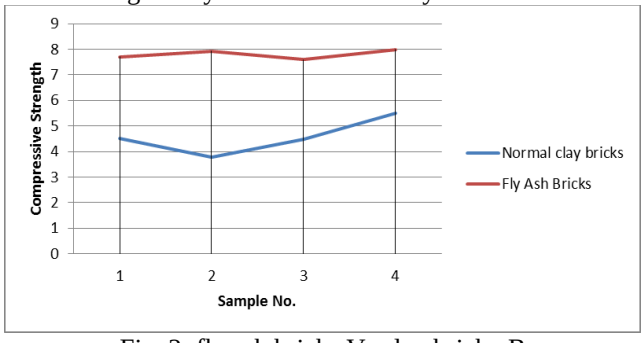

Fig. 2: fly ash bricks Vs clay bricks-B

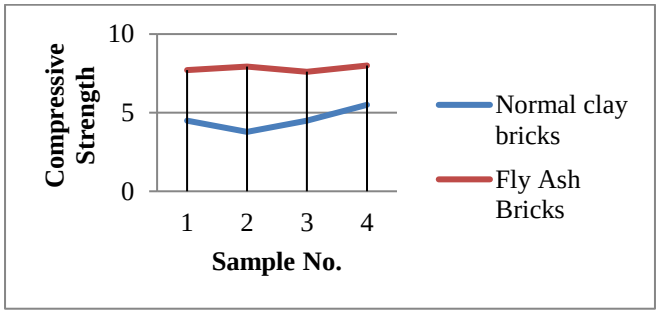

Fig. 3: fly ash bricks Vs clay bricks-C

Fig. 4: Normal Clay bricks after Test

Fig. 5: Fly Ash bricks after Test

Appearance: The bricks have the appearance which is very pleasant like cement; Due to smoothness and finish on their surface they require no plastering for building work. These are compact, uniformly shaped and free from visible cracks. They are lighter in weight than ordinary clay bricks and are less porous. The color of these bricks can be altered by the addition of admixtures during the process of brick making. The size of these bricks can vary but they are generally available in the same sizes of the normal clay bricks.

Structural Capability: These bricks do not cause any extra load on the design of structures due to its comparable density and thus provide better resistance to earthquakes and other natural calamities. The compressive strength of Fly Ash and lime bricks is average 1305 psi (9.00 N/mm2) (as against 507 psi [3.50 N/mm2] for handmade clay bricks). The bricks possess high compressive strength which eliminates breakages/wastages during transport and handling. When a structure is formed using Fly Ash bricks the possibility of cracking of plaster is reduced due to lower thickness of joints and plaster and basic material of the bricks, which is more compatible with cement mortar.

Thermal Properties: These bricks have got thermal conductivity around 0.90-1.05 Webster/m2 (20-30% less than those of concrete blocks). These bricks do not absorb heat; they reflect heat and gives maximum light reflection which causes less heating of huge structures.

Sound Insulation of Fly Ash Bricks: It provides an acceptable degree of sound insulation. The sound produced at one side of a wall made using Fly Ash bricks do not let the sound waves pass easily to the other side of the wall due to its compactness. Hence they may be considered for the abatement of the noise pollution.

Durability and Moisture Resistance: Fly Ash blocks are highly durable. When their joints are properly joined, the bricks are ready to be directly painted with the paints available in the market or with the cement paint without plaster. The bricks, usually, are rectangular faced having sharp corners, solid, compact and uniformly shaped. The bricks are said to absorb the moisture approximately 6-12% than that of 20-25% for handmade clay bricks thus they help reducing dampness of the walls.

Toxicity and Breath-ability: There are no positive evidence and studies that suggest about toxic fume emissions or the indoor air quality of structures built with Fly Ash bricks. Fly Ash as a raw material is very fine so care has to be taken while its handling and transport to avoid any kind of air pollution in the view of occupational safety. Once it is flue, it can remain airborne for long periods of time, causing serious health problems relating to the respiratory system. But block manufactured from Fly Ash has no such problems.

Sustainability: We can conclude that Fly Ash is a cocktail of unhealthy and hazardous elements like silica, mercury, iron oxides, calcium, aluminum, magnesium, arsenic, and cadmium. It poses serious environment and health hazards for a large population who live in the nearby area of the plants. But the brick is better off, during the process of brick making the toxins associated with Fly Ash gets changed into a non-toxic product. The mixing of with lime at ordinary temperature leads to the hydration of calcium silicate and formation of a dense composite insert block. Thus it has the potential of being a good building material. In India about 100 million tons of Fly Ash is produced annually by the numerous thermal power plants, which could cause serious contamination of land, groundwater, and air but due to the practice of Fly Ash bricks now it is safe and sound.

BuildAbility, Availability, and Cost: The compressive strength of Fly Ash blocks is so high that it eliminates breakages/wastage during handling and gives a neat finish, with a lower thickness of joints and plaster. The construction technique does not change in the case of Fly Ash bricks and remains as same as in the case of regular bricks which ensures an easy change of material. Masons do not require additional training while construction. Though

these bricks are abundantly and widely available closer to thermal power plants all over the country for obvious reasons, finding dealers in all major cities and towns wouldn't be a problem.

Comparison between Clay Brick and Fly Ash Brick

1) Normal clay bricks have varying color as per soil whereas Fly Ash bricks have a uniform pleasing color like cement.
2) As normal clay bricks are handmade they have an uneven shape, on the other hand, Fly Ash bricks are uniform in shape and smooth in the finish.
3) Normal clay bricks are lightly bonded whereas there is a dense composition in the case of Fly Ash bricks.
4) Plastering is required in case of normal clay bricks whereas no plastering is required in case of Fly Ash bricks.
5) Fly Ash bricks are lighter than clay bricks.
6) The compressive strength of Fly Ash bricks is more than that of clay bricks
7) Fly Ash bricks are less porous than that of clay bricks

IV. CONCLUSIONS

1) Fly ash used as wasted product and environment is directly protected by reducing solid waste disposal.
2) The average compressive strength of fly ash brick is 1305 psi (9 N/mm2)
3) In clay bricks, fly ash can also be used for the manufacturing process. The result of 40% fly ash with 60% Clay will be the good combination.
4) Fly ash used as raw material replacing of clay to make fired bricks is an effective measure of saving land and decreasing pollution. The properties of the bricks improved with the firing temperature.
5) Fly ash does not modify the hydric properties of the bricks but it does make them lighter. In fact, all the bricks with fly ash have a lower density
6) Fly ash bricks show less damage than conventional bricks when exposed to salt crystallization cycles. This improvement is due to the reduction of the surface area of the bricks.

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