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# Utilization of Fly-Ash in Sustainable and Ecofriendly FaL-G Brick

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**ABSTRACT**

Fly Ash bricks 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 than common clay bricks. Since fly ash is being accumulated as waste material in large quantity near thermal power plants and creating serious environmental pollution problems, its utilization as main raw material in the manufacture of bricks. will not only create an opportunities for its proper and useful disposal but also help in environmental pollution control to a greater extent in the surrounding areas of power plants. Also 175 billion tones of common burnt clay bricks are consumed annually approximately 335 billion tones of clay- about 4500 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. The above problems can be reduced some extent by using fly ash bricks.The object of this study is to represent the information regarding Fly Ash bricks and its properties and their uses in a most concise, compact and to the point manner and some of them are Compressive strength study, water absorption study etc.

**Keywords:** Fly-ash ,thermal power plant, clay brick,FaL-G

## I. INTRODUCTION

Production of burnt clay bricks requires consumption of coal leading to greenhouse gas emissions. The primary raw material used for bricks is the soil, which is often taken from prime agricultural land, causing land degradation as well as economic loss due to diversion of agricultural land. Use of traditional technologies in firing the bricks results in significant local air pollution. The burnt clay brick industry in our country produces over 175 billion clay bricks annually with a strong impact on soil erosion and unprocessed emissions. At the same time, the thermal power plants in India continue to produce a huge amount of fly ash, disposal of which poses significant challenges for the power plants. Production of building materials, particularly bricks using fly ash is considered to be one of the solutions to the ever-increasing fly ash disposal problem in the country. Although there exist several technologies for producing fly ash bricks, the one that is gaining popularity is the FaL-G technology. FaL-G is a ground blend of fly ash (Fa), lime (L) and gypsum (G) in suitable proportions which, upon hydration, yields strengths in the range of 6 - 38 MPa, rendering a highly water impervious hard matrix, with the formation of mineralogical phases during hydration similar to those of Ordinary Portland Cement The FaL-G technology works with the strength of fly ash, lime and gypsum chemistry.


**Figure 1.** Flyash brick V/S Ordinary Clay brick

The ingredients of the FaL-G bricks and blocks, fly ash, lime, and gypsum, are well-known minerals that are widely used in industries. All these materials are available in form of wastes and bi-products from industrial activities and are available in adequate quantities in the areas, where the project activities are located. The technology is proved to be environmentally safe and sound. Fly ash- lime-gypsum (FAL-G) is not a brand name but it is duct name. Fly Ash bricks 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 than common clay bricks. Since fly ash is being accumulated as waste material in large quantity near thermal power plants and creating serious environmental pollution problems, its utilisation as main raw material in the manufacture of bricks will not only create ample opportunities for its proper and useful disposal but also help in 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 demand for Fly Ash Bricks has picked up. Bricks made of fly ash can be classified into following groups (1) Clay Fly ash bricks (2) Fly ash lime bricks (3) Mud Fly ash bricks

**1.1 Clay Fly-Ash Bricks:** Brick industry is large field in which fly ash can be utilised as a major raw materials because both clay and fly ash are of not much differences in respect of their chemical composition. Further more, the residual carbon content in fly ashes bring about an economy in fuel consumption during firing of bricks.In the process of bricks manufacturing from fly ash, about 25 to 75 % of clay can be replaced by fly ash and the bricks are produced by conventional or mechanised processes. The green bricks after drying in open air or drying shed are fired in conventional or high draught kiln to obtain finished red clay fly ash bricks. The bricks thus produced are lighter as the bulk density of fly ash is about one half of the clay. Logistic problem of getting fly ash at the brick kiln or getting land near power stations to make bricks there have prevented large scale commercialisation of technology.

**1.2 Fly-Ash Lime Bricks:** In presence of moisture, fly ash reacts with lime at ordinary temperature and forms a compound possessing cementitious properties. After reactions between lime and fly ash, calcium silicate hydrates (C-S-H) are produced which are responsible for the high strength of the compound. This process involves homogeneous mixing of raw materials (generally fly ash, sand and lime), moulding of bricks and then curing of the green bricks. Some technologies call for usage of chemical accelerator like gypsum. These processes are almost similar and vary slightly from water curing to steam curing at low pressure or autoclaving at 10-14 kg/cm 2 . Bricks made by mixing lime and fly ash are, therefore, chemically bonded bricks. These bricks are suitable for use in masonry just like common burnt clay bricks. These bricks possess adequate crushing strength as a load-bearing member and are lighter in weight than ordinary clay bricks. Generally, dry fly ash available from power plants meets the properties specified in IS: 3812 and is suitable for manufacture of Fly Ash –lime bricks in accordance with the requirements of IS: 12894.

**1.3 Water Absorption:** The bricks, when tested in accordance with the procedure laid down in IS 3495 (Part 2), after immersion in cold water for 24 hr, shall have average water absorption not more than 20 percent by mass up to class 12.5 and 15 percent by mass for higher classes.

**1.4 FaL-G Technology:** Fly ash- lime-gypsum (FaL-G) is not a brand name but it is duct name, christened to the mix for easy identification of its ingredients. FaL-G technology is based on the principles namely, that fly ash lime pozzolanic reaction does not need external heat under tropical temperature condition, and strength of fly ash-lime mixtures can be greatly augmented in the presence of gypsum. FaL-G technology was developed by institute of solid waste research and ecological balance, Vishakhapatnam. Fly

ash lime mix in different proportions, is mixed in pre-determined proportions with calcined gypsum which produces FaL-G having strong binding properties and can be used as cement. It can be mixed with sand and/or aggregate to produce building blocks of any desired strength.

## II. RAW MATERIALS

The raw material that is used for fly ash brick are:

**2.1 Fly-Ash:** Pulverized fuel ash commonly known as 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 thequality of raw materials.

**2.2 Sand or Stone Dust:** Deleterious materials, such as clay and silt in sand, shall preferably be less than 5 percent. About 10 to 20% may used Bottom ash used as replacement of sand shall not have more than 12 percent loss on ignition when tested according to IS 1727.

**2.3 Lime:** Quick Lime or hydrated lime or both can be mixed in the composition. Lime should have minimum 40% CaO content.

**2.4 Gypsum:** Hydrated calcium sulphates are called gypsum. ($CaSO_4$ $2H_2O$). Gypsum should have minimum 35% purity and 5 to 15% may be used.

## III. ADVANTAGES OF FLY-ASH BRICKS:

**3.1 Appearance:**
These bricks have a pleasing colour like cement, are uniform in shape and smooth in finish, also, they require no plastering for building work. The bricks are of dense composition, uniformly shaped with/without a frog, free from visible cracks, warp-age, organic matter, pebbles and nodules of free lime. They are lighter in weight than ordinary clay bricks and less porous too. The colour of fly ash bricks can be altered with the addition of admixtures during the process of brick making. They come in various sizes, but generally are similar to the sizes of clay bricks.

**3.2 Structural Capability:**
These bricks can provide advantages being available in several load-bearing grades, savings in mortar plastering, and giving smart looking brickwork. High compressive strength eliminates breakages/wastages during transport and handling, the 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. Due to its comparable density the bricks do not cause any extra load for design of structures and provides better resistance for earthquake loads due to panel action with high strength bricks.

**3.3 Thermal properties:**
Thermal conductivity is 0.90-1.05 W/m $^2$ ºC (20-30% less than those of concrete blocks). These bricks do not absorb heat; they reflect heat and gives maximum light reflection without glare.

**3.4 Sound insulation,Durability,moisture and Fire resistance:**
It provides an acceptable degree of sound insulation. These blocks are highly durable, after proper pointing of joints, the bricks can be directly painted in dry distemper and cement paints, without the backing coating of plaster. Rectangular faced with sharp corners, solid, compact and uniformly Water absorption is 6-12% as against 20-25% for handmade clay bricks, reducing dampness of the walls. Fly ash bricks have a good fire rating. It has no problems of vermin attacks or infestation.

**3.5 Toxicity and Breath-ability:**
There are no definite studies on the toxic fume emissions or the indoor air quality of structures built with fly ash bricks, though claims of radioactive emissions by these blocs have been made at some scientific forums. Fly ash as a raw material is very fine and care has to be taken to prevent from being air-borne and causing serious air pollution as it can

remain airborne for long periods of time, causing serious health problems relating to the respiratory system. Though block manufactured from fly ash has no such problems.

### 3.6 Sustainability and Applicability: ( Environmental impacts )

Fly ash is one of the numerous substances that cause air, water and soil pollution, disrupt ecological cycles and set off environmental hazards. It's also contains trace amounts of toxic metals –silica, aluminium, iron oxides, calcium, magnesium, arsenic, mercury, and cadmium, which may have negative effect on human health and plants. But the brick is better off, for fly ash changes into a non-toxic product when mixed with lime at ordinary temperature as the calcium silicate hydrates and forms a dense composite inert block. Thus having the potential as a good building material, while offsetting about 100million tonne's of fly ash annually produced in India by the numerous thermal power plants, which could cause serious contamination of land, groundwater and air. The blocks being available in several load bearing grades are suitable for use: - Load bearing external walls, in low and medium size structures. Non-load bearing internal walls in low and medium size structures. Non-load bearing internal or external walls in high-rise buildings.

### 3.7 Buildability, availability and cost:

The blocks have an easy workability and high compressive strength eliminates breakages/wastage during handling giving a neat finish, with lower thickness of joints and plaster. The construction technique remains the same as regular bricks ensuring easy change of material, without requiring additional training for the masons. Though these bricks are abundantly 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.

## IV. CONCLUSION

Fly ash utilization in the country has remained less than 30% during the past 5 years and it might take several years to reach the final goal of cent percent utilization. It is estimated at present nearly 160 million ton fly ash is produced every year, out of which hardly 40- 50 % is used in all possible applications. To utilize such a huge quantity of ash, we have to take necessary actions from government side and from nongovernment side for utilisation point of view. Based on the results for the experiments done on Fly ash lime brick, Compressive strength = 54.20 kg/cm $^2$ % Water absorption = 19.25 % The results shows the FaL-G bricks are more safe, economical and having higher strength compare to conventional bricks. Comparison of Fly ash bricks and ordinary red clay bricks are shown in below table. Further Fly ash bricks have many advantages like – Lightweight, Economical, Environmental friendly, Saving of fertile land, pure water,More compressive strength,Use of wastage etc. Thus, Fly ash brick is one of the best uses of fly ash. It may be concluded that the use of fly ash in brick manufacturing industry is techno-economically viable, if utilized by application of optimum technologies, which are available with commensurate levels of automation and capacity generation. Fly ash brick manufacturing is a potential field of application wherein large-scale utilisation of fly ash is possible. From the previous chapters it can be understood that fly ash bricks are better alternative to conventional burnt clay bricks in structural, functional and economic aspects. This industry has the potential to consume at least 50% of the ash production in India. By use of this aspect we can convert waste into wealth. After looking into all the facets of fly ash brick industry and its different applications in the previous chapters, in the end it is a request to all the government and nongovernment organizations involved in generation, research and development and utilisation of fly ash, to extend all possible help in terms of technology, resources or finance to the entrepreneurs who are trying to come forward to set their plants in spite of tough

competition and numerous set back in marketing. If this much could be done, it will prove to be a big stepping stone towards the present need of sustainable development.

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