EXPERIMENTAL INVESTIGATION ON FLYASH BRICKS BY USING GRANITE SAW DUST

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ABSTRACT

Construction industries are the backbone for infrastructure development in India. The various By-products produced from industries causes pollution in India. It has a major impact in the healthier environment ofthe Nation. The combinations of fly ash bricks have different percentage of the fly ash, granite dust and Lime.In India thermal power plants and granite industries are generating fly ash and granite dust in large quantities. Industrial waste are hazardous in nature, their disposal is of major concern. Recycling such wastes by utilizing them into building materials is a moderate solution for the pollution issues. Much of an emphasis is laid on energy saving and economy.

The scope of this project is to determine and compare the strength of the blocks by using different percentage of flyash and granite sawing powder waste. The investigation was carried out by various mix ratios using the laboratory test likes compression test, water absorption test. For strength characteristics, the results showed that a gradually increase in compression strength, water absorption values in blocks was good while comparing the characteristics compressive strength of blocks

INTRODUCTION

1.1 GENERAL

In the present scenario in the construction industry, use of economic and environmental friendly material is of a great concern. One of the main ingredients used is cement. It is observed from various studies that the heat emitted from cement accounts to a greater percentage in global warming. Cement industries account to a greater emission of CO_2 and they also use high levels of energy resources in the production of cement. In order to minimize these effects, replacement of cement with some pozzolanic materials such as fly ash, can have an improving effect against these harmful factors. In this work, identified the optimum mix of fly ash (major ingredients) generated at Thermal Power Plant, Msand, hydrated lime and Granite dust and also optimized the brick forming pressure.

Energy requirements for the developing countries in particular area get energy from coal. The disposal of the increasing amounts of thermal waste from coal-fired thermal power plants, this disposal of the thermal waste is called fly ash. Fly ash is composed of the non-combustible mineral portion of coal consumed in a coal fuelled power plant. 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 F and Class C. Granite cutting industry produces solid waste in large amount and across large areas, which are expected to increase as the construction industry grows, owing that the overall production of granite industry has been increasing rapidly in recent years. It is a non-biodegradable waste that can be easily inhaled by humans and animals and is also harmful to the environment. Sludge lime being another construction waste is obtained as a residue after the hydration of lime. These wastes have been incorporated effectively into the construction industry in the form of an alternative. The usage of fly ash and granite dust for making bricks is ecologically advantageous as it helps in saving top agricultural soil as well as meets the objective of disposing these wastes which otherwise are pollutants.

1.2 Need for the Study

1. To improve the engineering properties such as workability, plasticity, water tightness, etc.
2. To improve the compressive strength to estimate the stability and durability of the brick
3. To maintain the uniform size and shape of fly ash bricks and to reduce the plastering
4. thickness

1.3 FLYASH BRICKS

Fig 1.1 FLYASH BRICKS

1.3.1 GENERATION OF FLY ASH FROM THERMAL POWER PLANT

Fly ash is the by-product of coal combustion collected by the mechanical or electrostatic precipitator (ESP) before the flue gases reach the chimneys of thermal power station in very large volumes. All fly ash contain significant amounts of silicon dioxide (Sio_2), aluminum oxide (Al_2O_3), iron oxide (Fe_2O_3), calcium oxide (CaO), magnesium oxide (MgO) however, the actual composition varies from plant to plant depending on the coal burned and the type of burner employed. Fly ash also contains trace elements such as mercury, arsenic, antimony, chromium, selenium, lead, cadmium, nickel, and zinc.

1.4 COMPOSITION OF FLYASH BRICK

1. Fly ash
2. Lime
3. Manufacturing sand
4. Granite sawdust

1. FLY ASH

Silica, Alumina and Calcium , these particles solidify as microscopic, glassy spheres that are collected from the power plant's exhaust before they can 'fly' away hence the product's name "Fly Ash".

Fly ash is finely divided residue resulting from the combustion of powdered coal, transported by the flue gases and collected by the electrostatic precipitators. Its proper disposal has been a cause of concern since long, which otherwise leads to pollution of air, soil and water. Fly ash can be referred as either pozzolonic or cementious.

1. **Bottom Ash**
   Pulverized fuel ash collected from the bottom of boilers by any suitable process.

2. **Pond Ash**
   Fly ash or bottom ash or both mixed in any proportion and conveyed in the form of water slurry and deposited in pond.

3. **Mound Ash**
   Fly ash or bottom ash or both mixed in any proportion and conveyed or carried in dry form and deposited dry

2. LIME

Lime is calcium containing inorganic material in which carbonate, oxide andhydroxide predominate. In the strictsense of the term lime is calcium hydroxide. Lime is used in building materials is broadly classified as pure, hydraulic and poor lime can be natural or artificial and may be further identified by its magnesium content such as magnesium lime. Quick Lime or hydrated lime or both can be mixed in the composition. Lime should have minimum 40% Cao content.

2. GRANITE SAW DUST

Granite is an igneous rock which is widely used as construction materials with Different forms. Granite industries produce lot of dust and waste materials. The wastes from the granite polishing units are being disposed to environment which cause health hazard. This granite powder waste can be utilized for the preparation of concrete and bricks.

3. MANUFACTURING SAND

Manufactured sand is an alternative for river sand. Due to fast growing Construction industry, the demand for sand has increased tremendously; causing Deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost. Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed. Thus the cost of construction can be controlled by the use of manufactured sand as an alternative material for construction. The other advantage of using M-Sand is it can be dust free, the sizes of m-sand can be controlled easily so that it meets the required grading for the given construction.

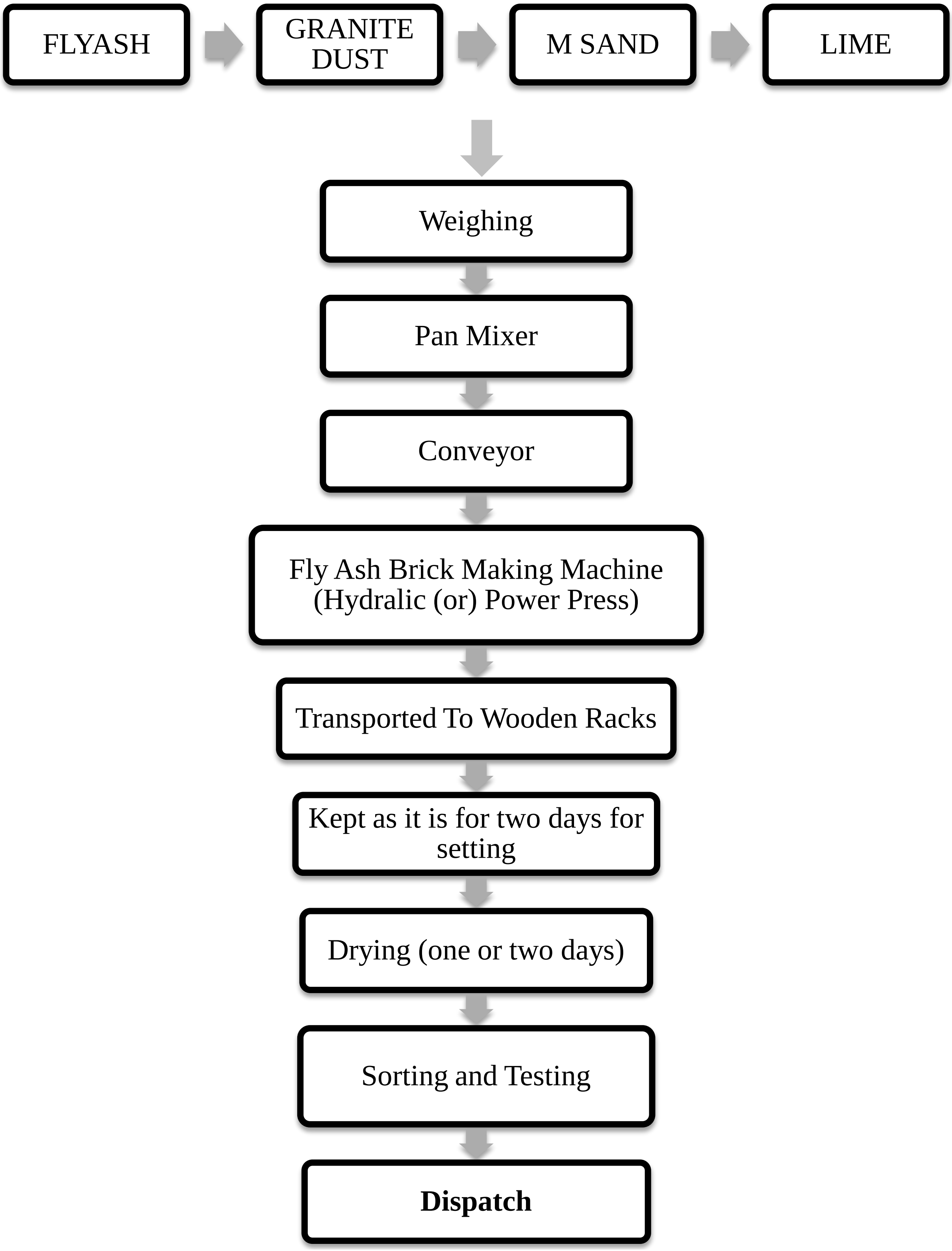
1.5MANUFACTURING PROCESS OF FLY ASH BRICKS

Fly ash, Lime, Granite dust and manufacture sand are manually feed into a pan mixer where water is added to the required proportion for homogeneous mixing. The proportion of raw material may vary depending upon quality of raw materials. After mixing, the mixture are allowed to belt conveyor through feed in to automatic brick making machine were the bricks are pressed automatically. Than 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.

1.5.1 FEATURE OF GOOD QUALITY FLY ASH BRICK

- Weight of Bricks : 2.70-3.25 kg / Brick
- Brick Size : 230 x 110 x 75 mm
- Compressive Strength : 80-120 Kg/Cm2
- Water Absorption : 12-15 %
- Shape/Size : Uniform(± 2 mm accuracy)

1.2FLOW CHARTDIAGRAM



1.5.3 THE DIFFERENT TYPES OF FLYASH

There are two common types of fly ash

- Class F
- Class C

Class F

Fly ash contain particles covered in a kind of melted glass. This greatly reduces the risk of expansion due to sulfate attack, which may occur in fertilized soils or near coastal areas. Class F is generally low-calcium and has carbon content less than 5 percent but sometimes as high as 10 percent.

Class C

Fly ash is also resistant to expansion from chemical attack. It has a higher percentage of calcium oxide than Class F and is more commonly used for structural concrete. Class C fly ash is typically composed of high-calcium fly ashes with a carbon content of less than 2 percent.

Currently, more than 50 percent of the concrete placed in the U.S. contains fly ash. Dosage rates vary depending on the type of fly ash and its reactivity level. Typically, Class F fly ash is used at dosages of 15 to 25 percent by mass of cementitious material, while Class C fly ash is used at dosages of 15 to 40 percent.

1.6 INSPECTION AND QUALITY CONTROL

The Bureau of Indian Standards has formulated and published the specifications for maintaining quality of product and testing purpose. **IS:12894:2002.**

- Compressive strength achievable: 60-250 Kg/Cm.Sq.
- Water absorption**:**5 – 12 %;
- Density**:** 1.5 gm/cc Co-efficient of softening (depending upon water consistencyfactor)

Unlike conventional clay bricks fly ash bricks have high affinity to cement mortar though it has smooth surface, due to the crystal growth between brick and the cement mortar the joint will become stronger and in due course of time it will become monolithic and the strength will be consistent.

1.6.1 POLLUTION CONTROL

The technology adopted for making fly ash bricks is eco-friendly. It does not require steaming or auto-calving as the bricks are cured by water only. Since firing process is avoided. There are no emissions and no effluent is discharged. Facial masks and dust control equipment may be provided to the employees to avoid dust pollution more over all the raw materials are kept under covered by polythene sheet to avoid air pollution.

1.6.2 ENERGY CONSERVATION

General precautions for saving electricity are followed by the unit by providing energy meter. This product is low energy consumption since no need of fire operation in the production unlike conventional bricks. Thus considerable energy could be saved not only in manufacturing activities but also during the construction.

1.6.3Environmental effects

- Utilization of fly ash is environment friendly with improved cementitious binder economics.

- Fly ash utilization reduces the requirement of clay, sand, lime stone in cement manufacturing and hence conserves natural resources.

- Fly ash utilization reduces the cement requirement and hence carbon-di-oxide liberation during cement manufacturing is reduced.

- Fly ash utilization reduces the top soil requirement for land filling / brick manufacturing and saves agricultural land.

- Fly ash utilization achieves increased strength of the finished concrete product without increasing the cement content

1.7 THE B.I.S. SPECIFICATIONS ARE AVAILABLE FOR FLY ASH BRICKS

- **IS : 12894 - 2002**

Fly Ash Lime bricks.

- **IS :13757 - 1993**

  Burnt Clay Fly Ash Building Bricks.

B.I.S. has also formulated the following Indian Standards relating to the raw materials and methods of test which can be referred to while manufacturing fly ash lime bricks.

- **IS : 3812 - 1981**

  Fly ash for use as pozzolana & admixture (first revision) Reaffirmed 1992.

- **IS: 6491 - 1972**

Method of sampling of fly ash.

- **IS: 10153 - 1982**

Guidelines for utilization and disposal of fly ash Reaffirmed 1993.

1.8 GRANITE SAWING POWDER

The Granite stone industry generates different types of waste. Solid waste and stone slurry, whereas solid waste is resultant from rejects at time of cutting or at the processing unit. Stone slurry is a semi liquid substance consisting of particles originated from the sawing and polishing machines. The slurry is stored in tanks for evaporation. To conserve water the slurry is passed through filtration and slurry compacting machine.

The compacted granite fine cracks are transported and disposed in landfills. Its water content reduced (Approx. 2%) and the granite fines resulting from this will have environment impacts. The stone slurry generated during the processing will be around 40% of the final product. Disposing of compacted granite fine slurry cakes is a major problem anywhere. The factories were used to dispose these granite fines around their own factories. These factories are situated very close to the residential areas.

As per the government regulations, any disposable waste is to be disposed minimum 2km away from the industries. Since the cities are expanding the land around the cities are very expensive leading to disposal problems. Disposal of these granite fines leads to health hazards like respiratory and allergy problems to the people around.it also decrease the fertility of soil and yield .it also causes air and water pollution. The high cost of brick used depends on the cost of the constituent materials.

Cost of bricks can be reduced through the use of locally available alternative material, to the congenital ones. This paper is on use of granite fines as an alternative to expensive and depleting sand. The worldwide consumption of clay as used in bricks production is very high, and several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing needs of in fracture development in recent years.

A situation that is responsible for increase in the price of clay, and the cost of bricks .experience and scarcity of clay which is one of the constituent material used in the production of conventional bricks was reported in India. To overcome the stress and demand for clay, researchers and practitioners in the construction industries have identified some alternatives materials namely as fly ash, limestone powder and siliceous stone powder etc.

In India the use of granite dust to place clay was reported. The rejection of very materials like clay size particles passing through the 75 microns has been common practice in the past. However, at the light of state of the art brick technology, the dimension of dust particles is compatible with the purpose of filling up the transition zone (measuring between 10 to 50 microns) and the capillary pores (which range from 50mm to 10microns) and the capillary pores (which range from 50mm to 10 microns of diameter) this acts as micro filler .hence various fine particles have been tried in product In the production of bricks.

1.8.1 USES FOR GRANITE SAWING POWDER

- Granite is among the most plentiful rocks on earth. This intrusive igneous Composite, formed by volcanic magma, makes up most of the continental crust.
- Anywhere you stand on dry land, granite is somewhere beneath your feet. It’s also all around us in daily life
- Granite has many uses in commercial construction and manufacturing, and has Long tradition in statues, headstones and carvings.
- The fabrication of granite produces large amounts of granite tailings, slurry and Dust .these remainders are processed into powdered granite for several purposes.

SUMMARY

The locally available materials of granite sawing powder waste and are used for production of bricks. The environment is affected by the waste materials of granite sawing powder waste. Hence these two waste materials can be reused for alternative production of bricks.

REVIEW OF LITERATURE

2.1 GENERAL

Various literatures were collected to study and investigate to do project about bricks. Based on these collected literatures, the type of ingredients and the addition of ingredients were proportioned and moulded.

2.2 LITERATURES

J.N Akhtar& M.N Akhtar

Bricks With Total Replacement Of Clay By Fly Ash Mixed With Different Materials.

Fly ash is a powdery substance obtained from the dust collectors in the Thermal power plants that use coal as fuel. From the cement point of view the mineralogy of Fly ash is important as it contains 80% - 90% of glass. The impurities in coal-mostly clays, shale's, limestone & dolomite; they cannot be burned so they turn up as ash. The Fly ash of class C category was used as a raw material to total replacement of clay for making Fly ash bricks. In present study the effect of Fly ash with high replacement of clay mixed with different materials were studied at a constant percentage of cement i.e 10%. Three Categories of bricks were to be studied namely Plain Fly ash brick (FAB), Treated Fly ash brick (TFAB) and Treated Fly ash stone dust brick (TFASDB).In all the above mentioned categories the quantity of Fly ash was kept constant as 80%. It is found that the compressive strength of plain Fly ash brick (15FAB) and Treated Fly ash brick (15TFAB) was found to be higher with 5% coarse sand and 15% sand combination at 10% cement. The gain i n strength continues for Treated Fly ash Stone dust Brick (10TFASDB) and found to be higher with 10% stone dust and 10% sand combination. A variation in the quantity of Fly ash was also attempted and it was found that the 25TFASDB with 50% flyash, 25% stone dust and 25% sand combination at 10% cement achieved highest compressive strength.

K. Abith› A.Mohamed Nazeem Fazil

In India the building industry consumes about 20000million bricks and 27% of the total natural energy consumption for their production. 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 contain trace amounts of toxic metals which may have negative effect on human health and on plants and the land where the fly ash decomposed not get reused. 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. All these materials are available in form of wastes and bi-products from industrial activities and are available in adequate quantities in the areas.

Samander et al., 2013

Investigation was done to study of the effect of silica fume on fly ash cement bricks. The experiments were conducted in two phases to observe the variation in properties i.e., compressive strength, density and water absorption of flyashcement brick. In first phase the fly ash, stone dust percentage are kept constant and cement is replaced with silica fume in different proportion, where as in second phase, silica fume is added as admixture in same proportion of weight of cement. The flyash cement bricksaretestedafter7days,14days and 28 days curing in fly ash material testing laboratory of the institute. The experimental results showed that in the compressive strength of fly ash cement brick decreases with increase in content of silica fumes as replacement of cement where as increases with increase in content of silica fume as addition. The water absorption % in first phase of experimentation increases whereas in second phase of experimentation decreases

D Yogesh Gowda, H G Vivek Prasad.

An effort for an alternate approach in the manufacturing of brick was accomplished by using industrial byproducts like class F fly ash, granite dust and sludge lime as key ingredients. In India thermal power plants and granite industries are generating fly ash and granite dust in large quantities. Industrial waste are hazardous in nature, their disposal is of major concern. Recycling such wastes by utilizing them into building materials is a moderate solution forthe pollution issues. Much of an emphasis is laid on energy saving and economy.

Ravi Kumar, Deepankar Kumar Ashish

Efforts has been made to study the behavior of fly ash bricks by taking different proportions of fly ash, cement, lime, gypsum and sand. Three types of fly ash bricks in the different percentage of cement such as 3%, 5% and without cement are designed and then various tests such as compressive strength test, water absorption test, efflorescence, weight test, structural test were performed in order to have comparison with conventional bricks. In the experimental study it is found that the compressive strength of fly ash brick containing 5% cement is 152.1 kg/cm2 which is more than that of class I conventional bricks by 40% approximately. Effort has been made by making different proportions of ingredients having composition of fly ash, cement, lime, gypsum, and sand.

N. Sivalingam

Pulverized fuel ash commonly known as fly ash is a useful by-product from thermal power stations using pulverized coal as fuel and has considerable pozzolonic activity. This national resource has been gainfully utilized for manufacture of pulverized fuel ash-lime bricks as a supplement to common burnt clay buildings bricks leading to conservation of natural resources and improvement in environment quality. Pulverized fuel ash-lime bricks are obtained from materials consisting of pulverized fuel ash in major quantity, lime and an accelerator acting as a catalyst. Pulverized fuel ash-lime bricks are generally manufactured by intergrading blending various raw materials are then moulded into bricks and subjected to curing cycles at different temperatures and pressures. On occasion as and when required, crushed bottom fuel ash or sand is also used in the composition of the raw material. Crushed bottom fuel ash or sand is also used in the composition as a coarser material to control water absorption in the final product. Pulverized fuel ash reacts with lime in presence of moisture from a calcium hydrate which is a binder material. Thus pulverized fuel ash – lime in presence of moisture form calcium – silicate hydrate which is binder material. Thus pulverized fuel ash – lime brick is a chemically ended bricks. These bricks are suitable for use in masonry construction just like common burnt clay bricks. Production of pulverized fuel ash-lime bricks has already started in the country and it is expected that this standard would encourage production and use on mass scale. This stand lays down the essential requirements of pulverized fuel ash bricks so as to achieve uniformity in the manufacture of such bricks.

Rushad et al., 2011

Investigated the strength and water absorption characteristic of fly ash bricks made of lime (L), local soil (S) and fly ash (FA). The experiments were conducted both on Hand moulded and Pressure moulded fly ash bricks. It was observed that none of the L-S-FA bricks satisfy all the requirements of standard codes. While some of the bricks satisfy the provisions in respect of strength only the L-FA (40: 60) bricks satisfy the requirement of Indian Standard Code in respect of strength as well as water absorption characteristics.

Patel et al., 2013

Carried out Experiments with several materials like Fly ash, lime, sand, Glass fiber for the manufacturing of the brick. The fly ashes of ‘F’ category were used as a raw material for making fly ash bricks. The combination of fiber fly ash brick have different percentage of the Glass fiber adding like 0.2% ,0.4%, 0.6%, 0.8%, 1.0%. In the testing of the fiber fly ash brick two type of the testing was done compressive strength test and water absorption test after7, 14, 21days. With changes in the percentage of the Glass fiber the compressive strength of the fiber fly ash brick increased and water absorption was found to decrease.

Vivek Tiwary et al (2014)

Researched about the sustainability of fly ash bricks in the fly ash masonry walls panels, since a lot of events were made to promote the use of fly ash industry. The test was carried out with the fly ash brick masonry wall panels made up of cement mortar as a binder, the stress strain relationship, failure mechanism was observed under the monotonic cyclic loading. Thus found the positive result of fly ash masonry wall 1.3 times stronger than that of traditional masonry wall made up of clay bricks.

Nataatmadja, Andreas. (2019)

Fly ash is produced in vast quantities as a by-product of the burning of fossil fuels for the thermal generation of electricity. At present 10-15% of the fly ash produced in Australia is utilized in cement manufacturing and concrete industry, with the remaining majority requiring costly disposal processes. Due to growing environmental concerns and the need for cleaner production, the management of fly ash has become an important issue facing the power generation industry. For that reason, many researchers are actively working to find new and improved methods of combating the fly ash waste disposal problem, particularly by establishing its useful and economic utilization. One such example that is gaining considerable interest in many parts of the world is the utilization of fly ash in brick manufacturing. This paper examines the potential for using Class F fly ashes from Queensland as major constituents in the manufacture of common residential building bricks. Scaled-down pressed bricks were made by varying proportions of fly ash, sand, hydrated lime, sodium silicate and water. Both fired, oven-dried and air-cured bricks were tested for their properties including compressive strength, tensile strength, water absorption, and durability. In the paper, the test results are analyzed and effects of variables discussed. Recommendations and conclusions as to whether or not the fly ash bricks can perform adequately alongside the clay bricks are included.

J.N.F HOLANDA

In the thermal power stations, huge amounts of coal combustion fly ashes are discarded. The fly ashes have very different chemical, mineralogical, and physical compositions, depending on factors such as source and type of coal and the combustion process. They can contain appreciable amounts of highly toxic trace elements. Because of this, the fly ashes are recognized as an environmental pollutant. A significant amount of coal combustion fly ashes produced worldwide is still disposed of in landfills and ash lagoons, costing money and causing environmental impact. Thus, disposal of fly ashes in an environmentally safe manner is a major challenge for thermal power stations using coal as a combustible. The reuse of fly ash as a partial replacement for common clay into fired clay masonry bricks appears to be a viable economic, safe, and sustainable option. This chapter focuses on the reuse of coal combustion fly ash as an alternative raw material to produce clay-based fired masonry bricks. Emphasis is given to the fly ash characteristics and its influence on the physical and mechanical properties. It also covers the durability of the clay-based fired masonry bricks.

MANISH KUMAR SAHU, LOKESH SINGH

In India, bricks are mainly composed up of clay, and are generally produced in traditional, unorganized small scale industries. Bricks are important building material and about 250 billion bricks are annually produced by the industries. Red clay bricks making consumes larger amount of clay which leads to top soil removal and land degradation. Large areas of lands are destroyed every year especially in developing countries due to collection of soil from a depth of about 1 to 2 m from agricultural land. An important step in brick making is firing of bricks in brick kilns which cause serious environmental pollution and health problems.

Brick burning largely influence the concentrations of greenhouse gases in the atmosphere. This causes serious air pollution and also workers in brick industries are prone to respiratory diseases To avoid all this environmental threats brick made of waste that is originated from the waste as a residue from the different industries and factories, this types of bricks is termed as fly ash bricks which is composed by the different materials such as lime, gypsum, sand, fly waste etc. The objective of this paper is to explain about manufacturing of fly ash bricks in present era and advantages of using it as a construction material. In this paper author explain about advantages and disadvantages and manufacturing process of fly ash brick. The main motive of this paper is to aware the people about the different devasting effect that is slowly killing our environment by the use of red clay bricks and to promote the usage of fly ash bricks.

2.3 CONCLUSION:

From the above literatures we found that the fly ash bricks are commonly used as an alternative for clay bricks and the study conducted for the addition of granite sawing powder resulted in increased strength and there are scopes for replacement of the use of quarry dust with similar other materials can result in minimizing cost.

METHODOLOGY

This study was carried out for the purpose of having a detailed understanding of the effect and uses of utilizing granite sawing powder waste in fly ash bricks and to determine the compressive strength. to achieve the objectives stated previously, several laboratory testing were conducted. By using appropriate apparatus and methods, testing was conducted on the 1required, materials

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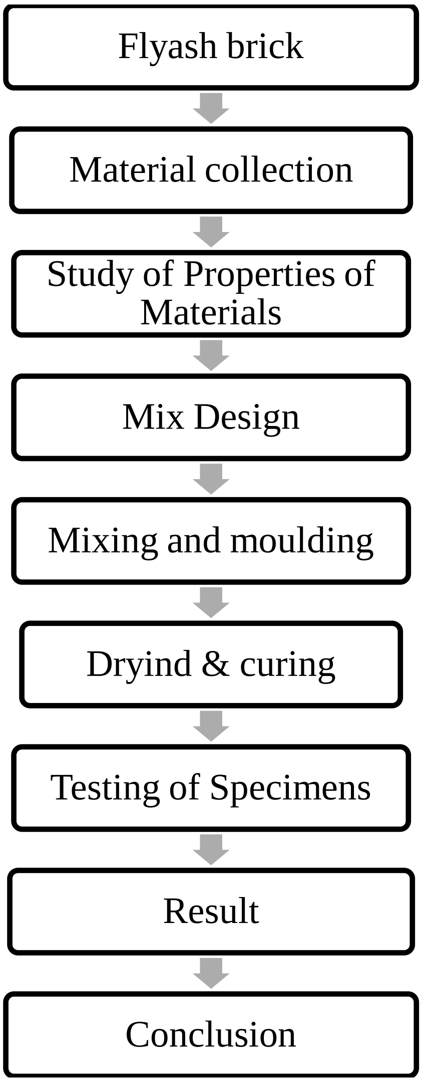


Fig 3.1 Methodology chart

3.1 Flyash brick

Ash bricks can be prepared by the use of different semi-automatic and automatic machines nu the use of moulds pre attached in machines, where using of manual moulds in the manufacturing method leads to frequent change in the size of the bricks and may results in the poor exterior quality of the bricks. Approximately every ash bricks manufacturing plant uses machines to produce ash bricks, which led to the use of less labors and makes the cost less of per ash bricks which can be easily afforded by low to high class families.

3.1.2Types of Fly ash bricks

- **Class C fly ash**

Fly ash normally produced by burning lignite or subbituminous 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. 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.

- **Class F 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. 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 geopolymer.

3.2MATERIAL COLLECTION

3.2.1 FLYASH

Fly ash is finely divided residue resulting from the combustion of powdered coal and transported by the flue gases and collected by electrostatic precipitator. Pulverized fuel ash commonly known as flyash shall conform to Grade 1 or Grade 2 of IS 3812-1989. 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 mineral constituents 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%) .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 asthma and respiratory problems. So it is must that is utilized by the means of different purposes .It is studied that when it is exposed to open air, if intake by person will cause the same effect as a single person smokes 1 lakh cigarette at a time.

3.2.2 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. Hydrated lime is used for Fly-Ash Brick making should conform 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. 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. It can be easily available from the different acctelyne industries as a waste. Commercially available chemically pure lime ($CaCO_3$) obtained from industry. Lime is important ingredient for manufacturing of fly ash brick, which acts as a binding material Lime should be satisfying the following requirement.

- ❖ During lime slaking, it should not attain less than 600^{O}c temperatures and slaking time
- ❖ Should not be more than 15 min.
- ❖ Availability of CaO should be minimum of 60%.
- ❖ MgO content should be maximum of 5%.
- ❖ Should be in fine powdered form.

Source of Lime

It is a produced from industry in the form of calcium hydroxide sludge.

3.2.3 GRANITE DUST

The Granite dust is a waste product produced in granite industry while cutting huge graniterocks to the desired shapes. About 3000 metric ton of granite dust/slurry is produced per day as a byproduct during manufacturing of granite tiles and slabs from the raw blocks. The marble and granite cutting industries are dumping these wastes in nearby pits or open lands. This leads to serious environmental pollution and occupation of vast area of land especially after the slurry dries up.

Granite is an igneous rock which is widely used as construction materials with Different forms. Granite industries produce lot of dust and waste materials. The wastes from the granite polishing units are being disposed to environment which cause health hazard. This granite powder waste can be utilized for the preparation of concrete and bricks.

3.2.4 MANUFACTRUING SAND

Manufactured sand is an alternative for river sand. Due to fast growing Construction industry, the demand for sand has increased tremendously, causing Deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost. Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed. Thus the cost of construction can be controlled by the use of manufactured sand as an alternative material for construction. The other advantage of using M-Sand is it can be dust free, the sizes of m-sand can be controlled easily so that it meets the required grading for the given construction.

3.3 Study of Properties of Materials

3.3.1 FLYASH

Fig 3.2Flyash

TABLE 3.1 PHYSICAL PROPERTIES OF FLYASH

SL.NO.	COMPOSITION	IN MASS
1	Specific Gravity	2.54 to 2.65 gm/cc
2	Bulk Density	1.12 gm/cc
3	Fineness	350 to 450 m^2/Kg

TABLE 3.2 Chemical properties of Fly Ash are tabulated below

SL.NO.	COMPOSITION	IN PERCENTAGE
1	Loss on Ignition	1 to 6.00
2	Silicon as SiO_2	45 to 65.25
3	Iron Oxide as Fe_2O_3	13 to 15.00
4	Alumina as Al_2O_3	14 to 31.10
5	Titanium as TiO_2	0.5 to 2.42
6	Phosphates as P_2O_5	0.1 to 1.90
7	Magnesium Oxide as MgO	0.1 to 2.31
8	Sulphuric oxide as So_3	0.2 to 2.3
9	alkalies as Na_2O	0.1 to 3.4

3.3.2 GRANITE SAW DUST

Fig 3.3 Granite saw dust

Physical properties of granite dust

The basic tests on granite sawing powder waste were conducted as per IS-383-1987 In terms of granites sawing powder waste physical properties, it is a unique material. These properties lend uniqueness to granite are

- **Co-efficient of material**

The co-efficient of expansion for granite vary from 4.7x10.6-9.0x10.6 (inches x inches)

- **Porosity /permeability**

Granite has almost negligible porosity range among 0.2 to 4%

- **Variegation**

Granite shows constancy in colour and texture

- **Thermal stability**

Granite is highly steady thermally, therefore shows no charge with the change in temperature .it is impervious to weather from temperature and even from the airborne chemicals .Granite is the high confrontation to chemicals to chemical erosion that makes it useful for making tanks to store highly caustic Materials

- **Hardness**

It is hardest building stone and hardness of it that lends it excellent wear

- **Specific gravity**

The specific gravity was around 2.74

- **Water absorption**

Water absorption is found to be 0.60

Table 3.3 Chemical Composition of Granite

CHEMICAL COMPOSITION OF GRANITE	IN PERCENTAGE
SiO_2	68.76
Al_2O_3	10.20
CaO	3.36
TiO_2	0.02
Fe_2O_3	2.78
MgO	2.40
MnO	0.05
K_2O	1.25
Na_2O	0.67
P_2O_5	0.03
LOI	7.98
H_2O	2.63

TOTAL	**100**

Table 3.4 Chemical Composition of Granite Sawing Powder Waste

Chemical Composition	**Percentage standard range**	**Tested samples in percentage**
SiO_2	70-77	74.3
Al_2O_3	11-14	16.3
TiO_2	<1	0.38
Fe_2O_3	1-2	0.19
MgO	0.5-1	3.36
MnO	<1	0.08
Na_2O	3-5	1.24
P_2O_5	3-5	2.24
LOI	3-6	2.16
H_2O	<1	0.03

MIX DESIGN

4.1 GOOD QUALITY FLY ASH BRICK

- Weight of Bricks : 2.70-3.25 kg / Brick
- Brick Size : 230 x 110 x 75 mm
- Compressive Strength : 80-120 Kg/Cm2
- Water Absorption : 12-15 %
- Shape/Size : Uniform(± 2 mm accuracy)

4.2 GENERAL REQUIREMENTS

- Visually the bricks shall be sound, compact and uniform in shape. The bricks shall be free from visible cracks, war page and organic matters. The bricks shall be solid and with or without log10 to 20 mm deep on one of its flat side.

- In case of non-modular size of bricks, frog dimensions shall be the same as for modular size bricks.
- Hand-moulded bricks of 90 mm or 70 mm height shall be moulded with a frog 10 to 20 mm deep on one of its flat sides
- The bricks shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour.
- Clay flyash bricks shall be hand or machine moulded and shall be made from the admixture of suitable soils and flyash in optimum soils and flyash in optimum proportions
- The flyash used for manufacture of bricks shall conform to grade 1 or grade 2 as per IS 3812:1981. The bricks shall be uniformly burnt, free from cracks and flaws as black coring, nodules of stone or free lime and organic matter. In case of non-modular size of bricks, frog dimensions shall be the same as for modular size bricks.

4.3 DIMENSIONS

TABLE4.1The standard modular size of building fly ash bricks

Length (L) (mm)	Width (W) (mm)	Height (H) (mm)
190	90	90
190	90	40

TABLE 4.2The FollowingNon Modular Size of the Bricks

Length (L) (mm)	Width (W) (mm)	Height (H) (mm)
230	110	70
230	110	30

4.4 FLYASH BRICKS SPECIFICATION

Fly ash is a useful by-product from thermal power stations using pulverized coal as a fuel and has considerable pozzolanic activity. This national resource can be gainfully utilized for manufacture of fly ash bricks as a supplement to common burnt clay building bricks leading to conservation of natural resources and improvement in environmental quality. Fly ash bricks are obtained from materials consisting of fly ash in major quantity, lime and an accelerator acting as a catalyst.

Fly ash-lime bricks are generally manufactured by inter-grinding or blending various raw materials which are then moulded into bricks and subjected to curing cycles at different temperatures and pressures. On occasions, as and when required, crushed bottom ash or sand is also used in the composition of the raw material. Crushed bottom ash or sand is used in the composition as a coarser material to control water absorption in the final product. Fly ash reacts with lime in presence of moisture to form a calcium silicate hydrate which is the binder material. Thus fly ash brick is a chemically bonded brick.

These bricks are suitable for use in masonry construction just like common burnt clay bricks. Production of fly ash-lime building bricks has already started in the country and it is expected that this standard would encourage its production and use on mass scale. This standard lays down the essential requirements of fly ash bricks so as to achieve uniformity in the manufacture of such bricks.

4.5 MANUFACTURING PROCESS

Fly ash, Lime, Granite dust and M-sand are manually feed into a pan mixer where water is added to the required proportion for homogeneous mixing. The proportion of raw material may vary depending upon quality of raw materials. After mixing, the mixture are allowed to belt conveyor through feed in to automatic brick making machine were the bricks are pressed automatically. Than 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.

4.6 MIX PROPORTION

A verity of bricks has been developed during the past years, differing in shape and size, depending on the required strength and uses. Our brick size are modular and rectangular is (230mmx100mmx70mm) and having the following mix proportions.

Length of the brick = 230mm

Breath of the brick = 100mm

Height of the brick = 70mm

Mass of each brick =3.623 Kg

Unit weight of brick masonry = 19 KN/m^3

4.7 Proportioning of raw materials

Proportioning of raw material in an important aspect of ensuring quality of ash bricks. The proportioning will depend on the quality of the raw materials and theclass of the brick required the following mix proportions in being adopted by various sizes

Table 4.3 Proportionfor Flyash, Sand, Sludge Lime and Gypsum Brick

SL.NO	MATERIALS	IN PERCENTAGE
1	Flyash	55-60
2	Sand	20-25
3	Sludgelime	15-20
4	Gypsum	5

Table 4.4 Proportionfor Flyash, Sand, Hydrated Lime and Gypsum Brick

SL.NO	MATERIALS	IN PERCENTAGE
1	Flyash	60-65
2	Sand	18-27
3	Sludgelime	8-12
	Gypsum	5

4		

Table 4.5 ProportionforFlyash, Sand, and Cement Brick

SL.NO	MATERIALS	IN PERCENTAGE
1	Flyash	50-60
2	Sand	32-40
3	Cement	8-10

The strength of bricks manufactured with the above proportions generally of the order of 7.5 to 10.0 N/sq.mm after 28 days

Mix proportion as suggested above can be used as the guide lines. Mix proportion largely depends upon the characteristics and quality of raw material Used. Based on the quantities of raw materials, the exact mix proportion may be finalized by trail mixes to produce good quality bricks of required compressive strength

TABLE 4.6 MIX PROPORTION OF FLYASH BRICKS WITH GRANITE SAWING POWDER WASTE

SL.NO	MIX	FLYASH	GRANITE SAWING POWDFER WASTE(GSP)
1	MIX 1	75	25
2	MIX 2	50	50
3	MIX 3	25	75

4.9 SUMMARY

We are partially replaced the flyash with granite sawing powder waste in flyash bricks. We gradually increase the %of granite sawing powder. The mix ingredients are flyash, granite sawing powder and water. There is no particular mix design for bricks hence the mix proportions of granite sawing powder waste brick is taken as mix proportions

EXPERIMENTAL INVESTIGATION

5.1 GENERAL

Several laboratory testing were conducted for the purpose of having a detailed understanding of the effect of utilizing granite sawing powder waste in flyash bricks The investigation was carried out to determine the optimal mix percentage of fly ash brick admixed with lime, m-sand, and granite dust and also to determine its compressive strength and as well as the other factor by using appropriate apparatus and methods.

5.2 TESTING

There are several tests which are commonly used to obtain various properties of the flyash bricks. However in the study, only two bricks test where required .the two bricks test where the determination of compressive strength of the bricks and the water absorption of the bricks.

The procedures of the testing were based on Bureau of Indian Standards Specifications of flyash bricks of IS **13757:1993**.Hence the bricks are tested as same asflyash bricks with granite sawing powder waste.

5.2.1 DETERMINATION OF COMPRESSIVE STRENGTH

The minimum average wet compressive strength ofpulverized fuel ash bricks shall not be less thanthe one specified in table below**.** When testedas described in IS 3495(Part 1). The wet compressive strength of any individual brick shall not fall belowthe minimum average wet compressive strength specified for the corresponding class of bricks by more than 20 percent.

In case any of the test results of wet compressive strength exceed the upper limit for the class, the sameshall be limited to the upper limit of the class for the purpose of averaging.

TABLE 5.1CLASSES OF FLY ASH BRICKS

CLASS DESIGNATION	AVERAGE WET COMPRESSIVE STRENGTH NOT LESS THAN	
	N/mm^2	Kg f/cm^2 (Approx)
(1)	(2)	(3)
30	30.0	300
25	25.0	250
20	20.0	200
17.5	17.5	175
15	15.0	150
12.5	12.5	125
10	10.0	100
7.5	7.5	75
5	5.0	50
3.5	3.5	35

The compressive strength of flyash brick is three times greater than the normal clay brick. The minimum compressive strength of clay brick is 3.5 N/mm^2.So as the flyash brick has compressive strength of 10-12 N/mm². Bricks to be used for different works should not have compressive strength less than as mentioned above. The universal testing machine is used for testing the compressive strength of bricks.

5.1 Figure of compressive Testing Machine

After the curing period gets over bricks are kept for testing. To test the specimens the bricks are placed in the calibrated Compression testing machine of capacity 3000 kN applied a load uniform at the rate of 2.9 kN/min. The load at failure is the maximum load at which specimen fails to produce any further increase in the indicator reading on the testing machine. In that three numbers of bricks were tested for each mix proportion. Each brick may give different strength. Hence, average of three bricks was taken.

5.2.3 TEST FOR COMPRESSIVE STRENGTH

SPECIMEN

Five whole bricks shall be taken from the samples as specimens for this test Length and width of each specimen shall be measured correct to 1mm.

APPARATUS

The apparatus consists of compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centerof which shall coincide with the Centre of the plate.

PROCEDURE

(I)Pre-conditioning

The specimen shall be immersed in the water for 24 hours at 25◦c to 29˚c. Any surplus moisture shall be allowed to drain at room temperature. The frog of the, bricks should be filled flush with mortar 1:3. 1cement: 3clean coarse sand of grade 3mm and down) and shall be kept under damp jute bags for 24 hours after that these shall be immersed in clean water for three days.Afterremoval from water, the bricks shall be wiped out of any traces of moisture.

(II)Actual testing

Specimen shall be placed with flat face3 horizontal and mortar filled face upward between 3 plywood sheets each of thickness 3mm and carefully centered between plates or the testing machine. Plaster ofParis can also be used in place of plywood sheets to ensure uniform surface.Load shall be applied carefully axially at uniform rate of 14 N/mm^2 per minute till thefailure of the specimen occurs.

(III) Reporting the Test Results

The compressive strength of each specimen shall be calculated in N/mm^2 as under.

Compressive Strength =

$$\frac{\text{Maximum load at failure in (N)}}{\text{Area of specimen in (sq.mm)}}$$

5.3 WATER ABSORPTION

Fly ash Bricks should not absorb water more than 12%. The bricks to be tested should be dried in an oven at a temperature of 105 to 115^o C till attains constant weight cool the bricks to room temperature and weight (W1). Immerse completely dried and weighed W1 brick in clean water for 24 hrs at a temperature of 27±20 Degree Celsius. Remove the bricks and wipe out any traces of water and weigh immediately (W2).

5.2 Figure for water absorption test

In the water absorption test procedure first dry the brick and obtain the weight then after a brick is put in the water pond for 24 hours. After 24 hours bricks are removed from water and after 3 minutes the weight of the bricks is measured.The bricks, when tested in accordance with the procedure laid down in IS 3495 (Part 2) : 1992 after immersion in cold water for 24 hours, water absorption shall not be more than 20 percent by weight up to class 12.5 and 15 percent by weight for higher classes.

5.3.1 TEST FORWATER ABSORPTION SPECIMEN

Five whole bricks shall be taken from samples as specimen for this test.

APPARATUS

A ba1ance is required for this test shall be sensitive to weigh 0.1 percent of the weight of the specimen.

PROCEDURE

(a) Pre-conditioning

The specimen shall be allowed to dry in a ventilated oven at an 110^o c to 115^oc till it attains a substantially constant weight. If the specimen is known to be relatively dry, this would be accomplished in 48 hours, if the specimen is wet, several additional hours may be required to attain a constant weight. It shall be allowed to cool at room temperature. In a ventilated room, properly separated bricks will require four hours for cooling, unless electric fan passes air over them, continuously in which case two hours may suffice. The cooled specimen shall be weighing (W1) a warm specimen shall not be used for this purpose.

(b) Actual Testing

Specimen shall be completely dried before immersion in the water. It shall be kept in clean water at a temperature of 27° c ± 2° c for 24 hours. Specimen shall be -wiped out of the traces of water with a, damp cloth after removing from the water and then shall be weighed within three minutes after removing from water (W2).

(c) Reporting the test results

The water absorption of each specimen shall be calculated as follows and the average of five tests shall be reported.

$$\text{Water Absorption} = \frac{W2 - W1}{W1} \times 100$$

5.4 Efflorescence Test

For this test, brick was placed vertically in water with one end immersed. The depth of immersion in water being 2.5 cm, then this whole arrangement should be kept in a warm-well-ventilated room temperature of 20-30 ^{0} C until all evaporates. When the water in the dish is absorbed by the brick and surplus water evaporates. When the water is completely absorbed and evaporated place similar quantity of water in dish and allows it to absorb and evaporate as before. Examine the brick after this and find out the percentage of white spots to the surface area of brick. If any difference is observed because of presence of any salt deposit then the rating is reported as 'effloresced'. If no difference is noted, the rating is reported as 'not effloresced'. Percentage of white spot in the brick = Nil

The bricks when tested in accordance with the procedure laid down in IS 3495 (Part 3), shall have the rating of efflorescence not more than 'moderate' up to Class 12.5 and 'slight' for higher classes.

5.4.1 TEST FOR EFFLORESCENCE SPECIMEN

Five whole bricks shall be taken as Specimen for this test.

APPARATUS

Apparatus required for this test shall be a shallow flat bottom dish. Containing distilled water.

PROCEDURE (ACTUAL TESTING)

The brick shall be placed vertically in the dish with 2.5cm immersed in the water. The room shall be warm (18° C to 30°C) and well ventilated. The brick should notbe removed until it absorbs whole water. When the whole water is absorbed and the brick appears to be dry, place a similar quantity of water in that dish and allowed it evaporate as before the bricks shall be examined after second evaporation.

REPORTING THE TEST RESULTS

The rating to efflorescence in ascending order shall be reported as NIL, SLIGHT, MODERATE, HEAVY, SERIOUS in accordance with the following.

(A)NIL

When there is no perceptible deposit of efflorescence.

(B)SLIGHT

When not more than 10 % of the area of the brick is covered with a thin deposit of salts

(C)MODERATE

When there is heavier deposit and Coveringup to 50% of the area of the brick surfacebut unaccompanied by powdering or flaking of the surface.

(D)HEAVY

When there is a heavy deposit of salts covering 50% or more of the brick surface but unaccompanied by powdering or flaking of the surface.

(E)SERIOUS

When there is heavy deposit of salts, accompanied powdering and/or flaking of the surface and tending to increase in the repeated wetting of the specimen.

5.5Drying Shrinkage

The average drying shrinkage of the bricks when tested by the method described in IS-4139:1989, beingthe average of three units, shall not exceed 0.15 percent.

RESULT AND DISCUSSIONS

6.1 GENERAL

The present chapter of his study, the difference between the experimentalResults and theoretical values was discussed based on the results obtained from the analysis of tests conducted on the standard bricks and the bricks with granite sawing powder waste.

6.2 RESULT AND DISCUSSIONS

For the test that had been on the bricks, several statements could be made based on the results obtained and observation done during the tests.

6.2.1 COMPRESSIVE TEST ON BRICK

Fig 6.1 compression test on bricks

During the compressive test on the bricks, failure could be seen occur along the horizontal middle axis of four sides of the bricks. The sides of the bricks were broken off in the from such that several layers were being peeled off from the sides of the bricks when loading was applied onto the specimens.

The surface were broken off and got into crack at the middle of the bricks. Figure 6.1 shows the brick with crack. The characteristic compressive strength of the brick obtained was 4.2N/mm^2

TABLE 6.1 COMPRESSIVE STRENGTH FOR MIX I

TRIAL NO	DIMENSION OF THE BRICKIN MM			ULTIMATE LOAD	COMPRESSIVE LOAD
	LENGTH	BREATH	HEIGHT	Load in KN	STRESS in N/mm^2

1	230	100	70	185	8.1
2	230	100	70	175	7.6
3	230	100	70	180	7.8
Average=7.8					

TABLE 6.2 COMPRESSIVE STRENGTH FOR MIX 2

TRIAL NO	DIMENSION OF THE BRICK IN MM			ULTIMATE LOAD	COMPRESSIVE LOAD
	LENGTH	BREATH	HEIGHT	Load in KN	Stress in N/mm^2
1	230	100	70	172	7.4
2	230	100	70	170	7.3
3	230	100	70	171	7.3
Average=7.3					

TABLE 6.3 COMPRESSIVE STRENGTH FOR MIX 3

TRIAL NO	DIMENSION OF THE BRICK IN MM			ULTIMATE LOAD	COMPRESSIVE LOAD
	LENGTH	BREATH	HEIGHT	Load in KN	Stress in N/mm^2

1	230	100	70	150	6.5
2	230	100	70	145	6.3
3	230	100	70	140	6.0
Average=6.2					

6.3 WATER ABSORPTION TEST

From observing the water absorption limit for bricks having different mix proportions, the dried brick was immersed completely in clean water at temperature of 12^{o}c for 24 hour. This GSP brick when tested in accordance with the procedure laid down in IS 3496 part II – 1976. The following table 6.4 shows the result obtained from the water absorption limit of blocks.

TABLE 6.4 WATER ABSORPTION LIMITS OF BRICK

Brick	Weight Of Dry Brick (M1)In Kg	Weight Of Soaked Bricks For 24 Hours (M2) In Kg	Water Absorption Limit In %
MIX 1	3.17	3.34	6.36
MIX 2	3.10	3.42	10.32
MIX 3	3.033	3.51	14.02

SUMMARY

Based on the discussion on results obtained, the optimum replacement level of granite sawing powder waste as flyash was found and from the compressive strength test, it was determined that the brick using granite sawing powder and flyash gives more are less compressive strength as the normal brick. From the absorption test, it was found that the brick using granite sawing powder waste as flyash have more or less same water absorption limit.

STATISTICAL ANALYSIS

7.1 GENERAL

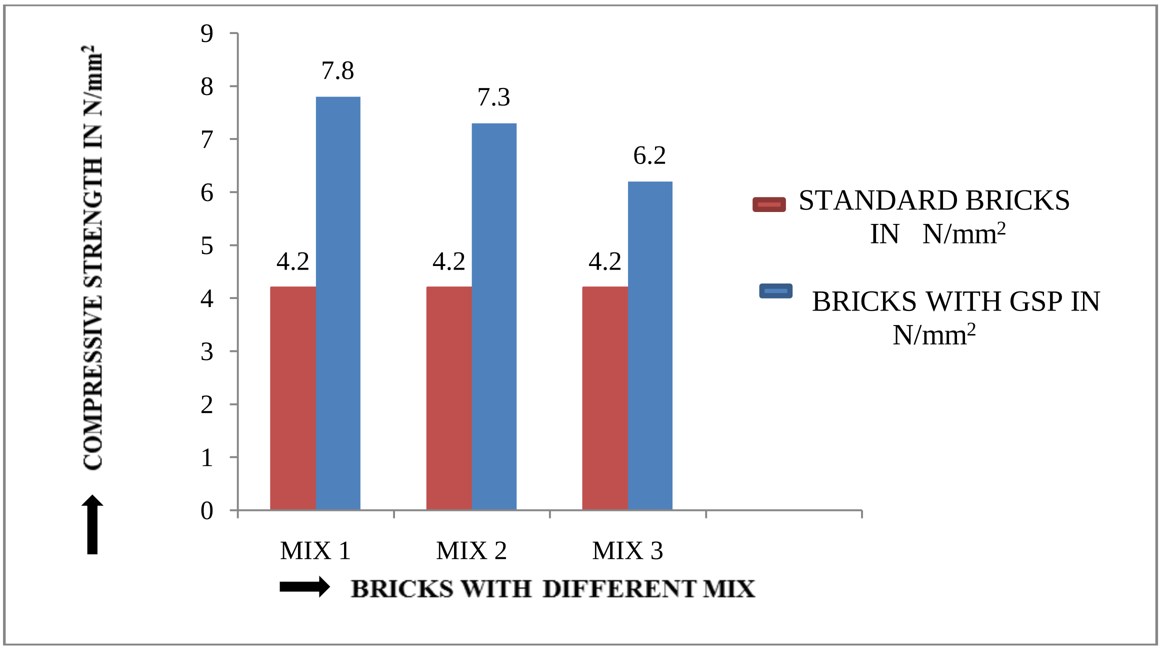
The study presents the results obtained from the experiment testing done on the standard bricks and the bricks granite sawing powder waste .analysis was done on the results obtained and presented them in the more appropriate formats, such as tables, charts or statements. Comparison among the results was also done for the purpose of evolution.

7.2 STATICAL ANALYSIS

Based on several past researches, some of the properties of the bricks (bricks with granite sawing powder waste) which required in the calculation for the compressive strength and water absorption could be obtained. The properties obtained and other required information was obtained from the results of experiment

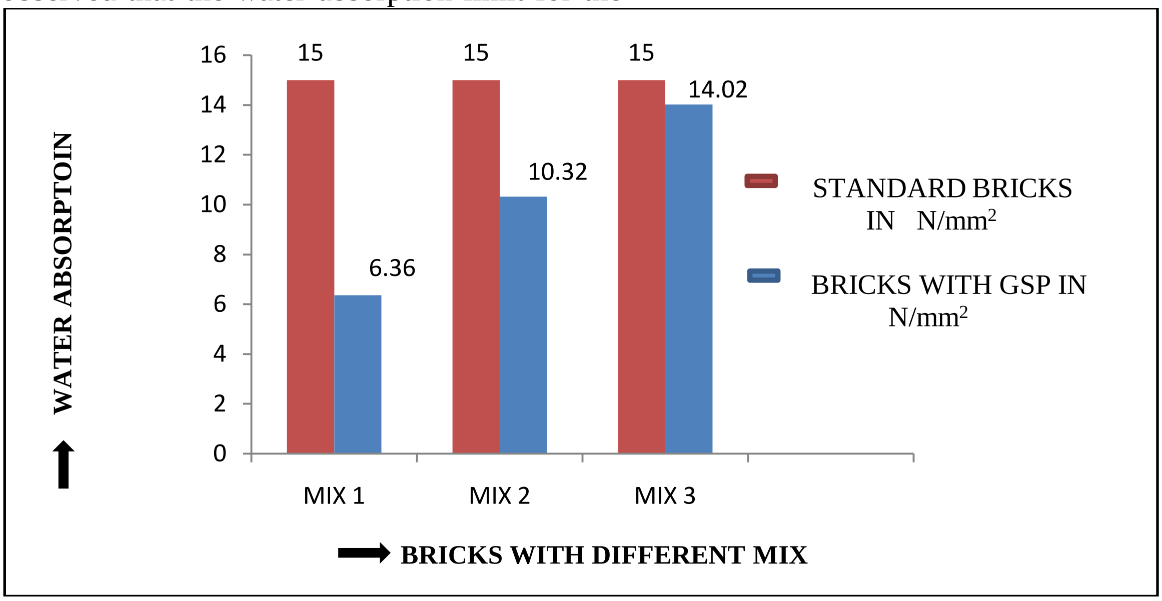
By using the various collected literatures, the compressive strength of flyash bricks was obtained and compared. The information obtained from the experimental study was shown below.

7.2.1 COMPARISON STRENGTH OF STANDARD BRIKS VS FLYASH WITH GRANITE SAWING POWDER

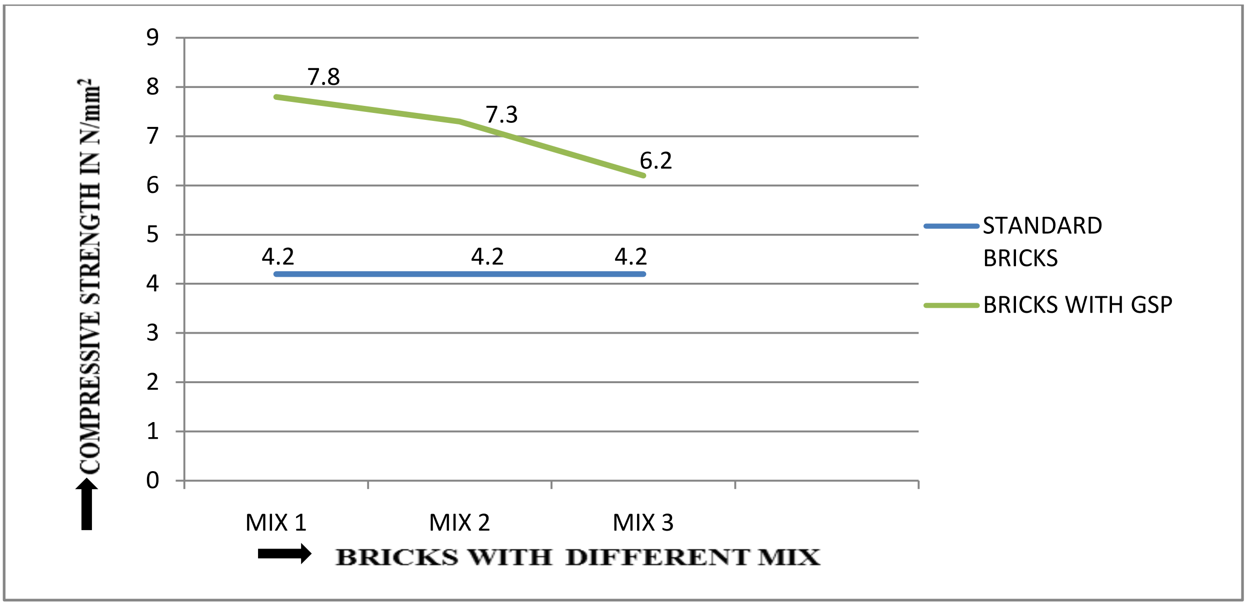


7.2.2 WATER ABSORPTION LIMIT OF STANDARD BRICK VS FLYASH BRICKS WITH GRANITE SAWING POWDER WASTE.

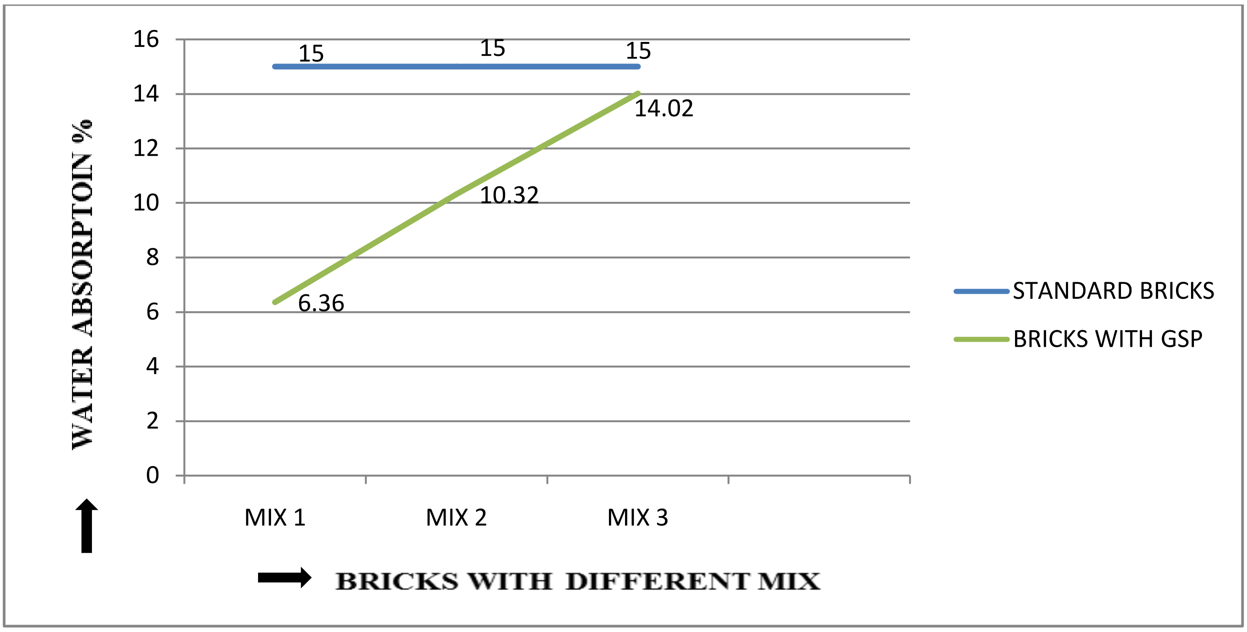
From the theoretical studies, it was observed that the water absorption limit for the standard bricks was not more than 15 to 20 % by weight .The water absorption limit for the bricks using granite sawing powder by weight taken after 24 hours.



7.2.3 Compressive Strength Variation Graph



7.2.3 WATER ABSORPTION TEST VARIATION GRAPH



7.3 SUMMARY

In our project study, we made statistical analysis betweenstandard bricks and fly ash brick with granite sawing powder.there is major difference between standard bricks and flyash brick with granite sawing powder like compressive strength value, water absorption and amount of salts presents in bricks etc.

CONCLUSION

8.1 GENERAL

Based on the scope of the investigation, the following conclusion can be drawn

- The results are indicative of the satisfactory performance of flyash bricks as loaded bearing elements. This type of bricks uses 100% flyash without mixing with clay and shale it, therefore provides a large venue for the disposal of flyash in a very efficient, useful and profitable way.

- The mechanical properties of flyash bricks have exceeded those of the standard load bearing clay bricks. Notable among these properties are the compressive strength and tensile strength. Compressive strength was 24% better than good quality clay bricks. Tensile strength was nearly three times the value for standard clay bricks

- Comparison between the bond strength of flyash bricks to mortar and that of comparable shaped and commonly used solid clay bricks showed that standard the flyash bricks have a bond that 44% higher than the standard clay brick.

- There is evidence that the microstructural features of flyash bricks is characterized by a rougher texture than that of clay bricks. The characteristics are believed to be responsible for the increased bond strength with mortar.

- The resistance of the bricks to repeated cycles of salt exposure showed zero loss of mass and indicated excellent resistance to sulphate attack.

- The density of flyashbricks is 28% less than that of standard clay bricks. This reduction in the weight 0f bricks results in a great deal of savings amongst which are saving in the raw materials and transportation costs and savings to the consumer ,that results from increased number of units and reduction in the loads on structural elements.

- The process of manufacture of flyashbricks indicate clearly that there is much saving to be done during the making of the bricks. These savingsarise mainly from the uniformity of the raw material and the reduction in firing times as well as from doing away with whole process of mining transporting mixing and grinding, that are necessary in the case of the clay and shale based bricks.

- On comparing with clay brick, its shows better results in strength and heating load. Cost wise it is best in all cases. But it does not come under light weight blocks and thermal efficient. Thus, it is the most economic choice among the building blocks we considered. Hence, it is very suitable to for both framed and load bearing buildings.
- The possibility of using innovative building materials and eco-friendly technologies, more so covering waste material like fly ash is the need of the hour. Fly ash affects the plastic properties of concrete by improving workability, reducing water demand, reducing segregation and bleeding, and lowering heat of hydration. It also increases strength, reduces permeability, reduces corrosion of reinforcing steel, increases sulphate, resistance, and reduces alkali-aggregate reaction.

- Fly ash-Granite Dust Bricks prove to be Energy efficient, lower in cost. Thus it is observed that the industrial waste materials can be successfully used in a brick for the replacement of conventional bricks.

REFERENCES

1. Gupta P.C, Ray S.C.,” Commercialization of Fly ash”, The Indian Concrete Journal, 167, 1993, 554-560.
2. Peter George Kenneth Kingth, “Pulverized fuel ash as a construction material” proceedings of institution of Civil Engineers,16, 1960, 419-432.
3. TabinRushad S, Abhishek Kumar, Duggal S.K, Mehta Experimental Studies on Lime- Soil-Fly Ash Bricks’, International Journal Of Civil And Structural Engineering Volume 1, No 4, 2011.
4. ObadaKayali ,‘High Performance Bricks from Fly Ash 2005’, World of Coal Ash (WOCA), April 11-15, 2005, Lexington, Kentucky,USA.
5. JayeshPitroda, Prof. Sameer Mistry, Dr. L. B. Zala, Prof. Samip Patel (2011) ‘Fly Ash Bricks Masonry: An Experimental Study’ National Conference on Recent Trends in Engineering & Technology May2011.
6. H N Rajendra Prasad, H G Vivek Prasad, ChetanaHamsagar (2014) ‘An

Approach for Alternative Solution in Brick Manufacturing', International Journal of Science, Environment and Technology, Vol. 3, No 3,2014.

7. Ministry of environment and forests, notification, extraordinary, part II sections 3, subsection (ii), the Gazette of India, 14 September ,1999

8. Pimraksa. K, Wihelm. M, Kochberger. M, and Wruss. W, a new approach to the production of bricks made of 100% flyash,2001 international ash utilization symposium, center for applied energy research, university of Kentucky.

9. Prabir Kumar Chaulia and Reeta Das, Process Parameter Optimization for Fly Ash Brick by Taguchi Method: Material Research; 2008.11. 159-164.

10. Tutunlu Faith, and Atalay Umit. Utilization of Fly ash in Manufacturing of Building Brick: International Ash utilization Symposium, Center for applied Engineering Research; 2001 paper 13.

11. Tahmina Banu, Md. Muktadir Billah, et al, Experimental Studies on Fly Ash-Sand-Lime Bricks with Gypsum Addition: American Journal of Materials Engineering and Technology, 2013, Vol. 1, No. 3, 35-40.

12. Parul, R. Patel, "Use of Fly ash in Brick Manufacturing", National Conference On Advances in Construction Materials, " AICM-India, 2004, 53-56.

BUREAU OF INDIAN STANDARDS FOR RELEVANT STANDARDS AS UNDER

- IS: 12894-2002 , Pulverized Fuel Ash-Lime Bricks-Specification, Bureau of Indian Standards, New Delhi.
- IS: 3495(P-I)-1976, Determination of Compressive Strength (Second Revision).
- IS: 3495 (P-II) -1976, Determination of Water Absorption (Second Revision).
- IS: 3495 (P-II)-1976, Determination of Efflioresce (Second Revision).
- IS: 1077-1992, Common Burnt Clay Building Bricks—Specification, Bureau of Indian Standards, New Delhi.
- IS: 6932-1973, Methods of tests for building lime—Specification, Bureau of Indian Standards, New Delhi .