FABRICATION OF FLYASH BRICKS WITH REPLACEABLE MATERIALS

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ABSTRACT

This experimental work intends to conserve exploitable natural elements such as sand and locally accessible rock resources by fabricating bricks using recycled building and industrial waste materials.In this experimental investigation, flyash, lime, gypsum, GGBS & steel slag, and recycled aggregate were used to make E-blocks. In addition, because sand is a natural resource, it is being substituted to examine the performance of strength and durability characteristics of FaL-G bricks by substituting quarry dust and sand with ceramic waste powder, steel slag, and recycled aggregate. If used consistently for building, it may deplete. Quarry dust, rather than sand, can be utilized as a basement filling material. Ceramic waste powder, steel slag, and recycled aggregate, on the other hand, cannot be utilized in places where sand and quarry dust are used.As a consequence of this issue, we propose to create FaL-G bricks from these waste materials. We chose these waste materials since a huge number of them are generated in our nation each year. According to the Indian Power stations Association, "Indian power plants generate approximately 600,000 tones of fly ash per day. Following the casting of the bricks, their strength characteristics will be evaluated in accordance with IS: 3495 (Part I to IV) 1992.Part 1 describes how to calculate compressive strength. Part 2 discusses the method of determining water absorption, and Part 3 discusses the way of determining efflorescence.

I. INTRODUCTION

FaLG bricks come in many sizes and forms, including solid and hollow blocks, and may be used in both load bearing and non-load-bearing walls. They are frequently utilized in residential and commercial building projects, as well as in infrastructure projects including as bridges, tunnels, and dams. FaLG bricks have a low water absorption rate, a high compressive strength, and good insulating qualities. They are also environmentally friendly because they are made from fly ash, a by product of coal combustion that would otherwise be discarded as waste. This project involving the use of fly ash, recycled concrete aggregate, GGBS, and steel slag can also be applied to the production of bricks. By using these materials, a more sustainable and eco-friendly alternative to traditional clay bricks can be created. Fly ash can be used as a partial replacement for the clay component in traditional brick-making, reducing the amount of clay needed and the energy required for firing the bricks. Recycled concrete aggregate can be used as a substitute for traditional aggregates in the production of brick making concrete mixtures. This reduces the amount of waste sent to landfills and conserves natural resources. Ground Granulated Blast Furnace Slag (GGBS) offers great durability, reducing the likelihood of concrete thermal cracking, and it improves concrete's resistance to damage from alkali-silica reaction, sulphates and chlorides Steel slag can be used as a substitute for natural aggregates in the production of brick-making concrete mixtures. This provides additional strength and durability to the bricks, while also reducing waste and conserving natural resources. Overall, using these materials in the production of bricks can result in a more sustainable and eco-friendly building material that has enhanced mechanical properties. This type of project aligns with sustainable development goals and contributes to a more circular economy.

Objectives:

1. To find the strength parameter like compression strength of a FAL-G brick
2. To find the durability of a FAL-G brick
3. To make a cost effective brick.
4. To compare the obtained experimental results with that of conventional bricks.
5. To make bricks Eco friendly.
6. Utilizing fly ash, a waste byproduct of coal-fired power plants, to reduce waste and conserve natural resources.
7. Reducing greenhouse gas emissions by using fly ash in the production of bricks instead of disposing of it in landfills.

8. Lowering the carbon footprint of building materials by using FaLG bricks instead of traditional clay bricks.
9. Enhancing the mechanical properties of bricks by adding lime and gypsum, resulting in a stronger and more durable building material.
10. Providing a cost-effective solution for construction projects due to the lower production costs of FaLG bricks.
11. Reducing energy consumption in brick manufacturing due to the absence of the firing process.
12. Improving the thermal insulation of buildings due to the higher insulating properties of FaLG bricks.
13. Reducing water absorption in buildings by using FaLG bricks, resulting in a lower risk of water damage and mold growth.
14. Decreasing transportation costs due to the lighter weight of FaLG bricks compared to traditional clay bricks.
15. Supporting the development of the circular economy by using waste materials in the production of building materials.
16. Increasing the lifespan of buildings by using a durable building material like FaLG bricks.
17. Reducing the need for maintenance in buildings due to the durability of FaLG bricks.
18. Enhancing the fire resistance of buildings due to the higher melting point of FaLG bricks compared to traditional clay bricks.
19. Providing a solution for affordable housing by using cost-effective FaLG bricks.
20. Reducing the environmental impact of construction projects by using sustainable building materials like FaLG bricks.
21. Supporting the United Nations' Sustainable Development Goals, including Goal 12: Responsible Consumption and Production.
22. Reducing the use of virgin clay in brick manufacturing, conserving natural resources.
23. Providing a sustainable solution for the construction industry that can be used in various applications.
24. Encouraging the use of locally sourced materials in construction projects by using fly ash from local coal-fired power plants.
25. Supporting the development of the circular economy by using the waste materials from one industry (coal-fired power plants) to create a resource for another industry (construction).

II. LITERATURE REVIEW

[1] ***"Influence of recycled powder derived from waste concrete on mechanical & thermal properties of foam concrete." by Jianzhuang xiao. et.at., (2022).*** Energy is utilized by each and every organism in the universe for its survival. As in this fast moving world, the population is increasing day by day and the conventional energy sources are lessening. The extensive usage of energy has resulted in an energy crisis over the few years. Therefore to overcome this problem we need to implement the techniques of optimal utilization of conventional sources for conservation of energy. In this paper it is mainly considered on generating the electricity in the suspension system of the automobile and store the energy in the battery or alternator as conventional method by simply driving the vehicle. Current sports bikes are normally without kickers and this power generation method can be used to charge the battery within short span of time.

[2] ***"On the use of flyash-lime-gypsum (FaLG) bricks in the storage facilities for low level nuclear waste" by Baltej Singh Sidhu a , A.S. Dhaliwal b , K.S. Kahlon b , Suhkpal Singh.*** For an energy range of 0.015 MeV to 15 MeV and at various penetration depths up to 40 mfp, EBFs of FaLG samples have been computed.To evaluate the effectiveness of FaLG bricks as a radiation shielding material, relative dose distribution and exposure dosage rateX, decreased exposure rateX utilising produced FaLG bricks as absorber have also been computed. The study of the findings might lead to the following conclusions.EBFs of FaLG samples show tiny values in both the low and high energy ranges, but have substantial values in the middle of the energy spectrum.It was also discovered that EBFs increased with increasing penetration depth and reached their maximum value at 40 mfp, which is the deepest penetration that can be calculated at this time.It was discovered that archaeological FaLG samples have superior shielding abilities compared to concrete. So, extremely low and low level activity nuclear waste materials may be stored using these cost-effective, environmentally friendly bricks in order to estimate photon dosage and provide radiation protection.

[3] ***"TECHNO-ECONOMICAL STUDY OF FAL -G BRICKS A CASE STUDY" by Rajiv Bhatt, Dr. F S Umrigar , Indrajit Patel, Jayesh Pitroda.*** The term "FAL-G Bricks" refers to fly ash, lime, and gypsum bricks. Bricks made of FAL-G are steadily taking the place of traditional clay bricks in wall building. It is made of eco-friendly, green materials. Real sustainable development requires FAL-G bricks, which are the essential component. According to one calculation, a 10% switchover to fly ash bricks would consume 30 million tonnes of fly ash annually, conserve coal and the environment, and produce 300 crores worth of savings in brick production costs. 19 distinct FAL-G brick mixes are investigated in the current study for characteristics such crushing strength, weight, density, water absorption, and cost. The experimental research recommends three potential combinations of constituent proportions for FAL-G bricks to meet two constantly at odds goals: affordability, durability and quality

[4] ***"Experimental Studies on Fly Ash Based Lime Bricks" by Arati Shetkar, Nagesh Hanche, Shashishankar.*** The experimental investigations reveals the following conclusions .FaL-G compressed masonry bricks can be conventionally prepared economically by using industrial wastes like fly ash, lime, gypsum, Sand. Due to lower water penetration seepage of water through bricks is considerably reduced. In view of the above, it can be concluded that FaLG masonry units can effectively replace conventional masonry units. Due to uniform size of bricks mortar required for joints & plaster reduces almost by 50% and because of high strength, practically there will be no breakage during transport & use. The results shows the FaL-G bricks are more safe, economical and having higher strength compare to conventional bricks. it can be understood that fly ash bricks are better alternative to conventional burnt clay bricks in structural, functional and economic aspects, By use of this aspect we can convert waste into wealth.

[5] ***"A Review of Ecofriendly Bricks by Using Fly Ash " by Pravin P. Gadling*, M.B. Varma.*** Bricks are the most often used component in building, along with concrete, steel, and other materials. As masonry walls are frequently utilised as partitions, a lot of brick components are needed while creating a structure. In this essay, Brick production processes of all kinds were investigated. The ideal proportion of fly ash utilising different combinations of brick materials, such as lime, cement, and clay, are examined, and their impact on various brick qualities has been explored. Compressive strength, water absorption, and durability of bricks made with fly ash are the factors that were taken into consideration for this study and were compared to the regulations for brick components. 1. Fly ash is used during the production of bricks, which is environmentally benign. 2. The use of 70 to 80 percent fly ash in the production of bricks helps to boost compressive strength. 3. Fly ash and lime work well together to strengthen the brick element's longevity. 4. Brick production costs are decreased by using fly ash in bricks.

[6] ***" An Experimental Study on Fal-G Brick " by M.Selva Priya, C.Chella Gifta.*** The experimental study's findings about the strength behaviour of fal-g brick allow for the following inferences: The goal of the study was to determine the ideal fal-g brick mix %. Nevertheless, the 230 mm x 110 mm x 90 mm brick specimens were cast with varying amounts of fly ash (15 to 40%), gypsum (2%), lime (5 to 30%), and quarry dust (48 to 53%). The specimens, however, have undergone seven mix proportion tests. For various mix proportions and curing ages, mechanical parameters including compressive strength were examined. From the findings, it was deduced that, among the seven ratios, the ideal mix percentage of Flyash-15% Lime-30% Gypsum-2% Quarry dust-53% yields the greatest optimised compressive strength of 7.91 N/mm2. Water soaking up 10.9% is the ideal blend percentage. That falls below the average figure of 12%. Also, it was noted that only adequate water absorption yielded maximal strength.

[7] ***"A Comparision Study on the Fesibility of FaL-G and QuFaL-G Bricks " by Vellingiri Anusuya.*** The goal of the current study is to determine the most efficient technique to use fly ash and quarry dust as waste products while making bricks. The following inferences are made from the trials done for this purpose. A high compressive strength of 8.8 to 9.5 N/mm2 and 9.1 to 9.8 N/mm2 is noted for the FaL-G and QuFaL-G bricks, respectively. Similar to this, bricks tested after sulphate intrusion only exhibit a little reduction in strength between 0 and 4% and 4 to 8%.The strength, however, is more than that of regular ordinary bricks.The greatest water absorption in the FaL-G brick QuFaLG brick during the water absorption test was 16% and 11%, respectively. It is inferior to a typical burned clay brick. the FaLG and Strong sulphate conditions are better resisted by QuFaL-G bricks. Similar to ordinary brick, these bricks may be moulded into any form and size based on the needs. As a result, the FaL-G and QuFaL-G

[8] ***"Fly Ash Bricks Masonry: An Experimental Study" by Prof. Sameer Mistry, Prof. Samip Patel, Prof. J.J. Bhavsar, Dr. F.S. Umrigar, Dr. L. B. Zala and Jayesh Pitroda.*** For the past five years, fly ash utilisation in the nation has stayed below 10%, and it may take some time to accomplish the ultimate target of 100% usage. India produces over 70 million tonnes of ash annually, of which the NTPC units alone account for roughly 22 million tonnes.We must take the appropriate steps on the part of both the government and the non-government sectors in order to make use of such a large amount of ash. According to the findings of the experiments performed on FaL-G brick prism masonry, the compressive strength measured after 14 days is 85.05 kg/cm2 for cement mortar (1:6) and 88.83 kg/cm2 for fly ash mortar (1:6).Comparing the compressive strength of prisms to traditional brick masonry At 28 days' strength, it ranges from 13.75 kg/cm2 to 121.80 kg/cm2. Yet, in just 14 days, the FaL-G brick prism strength is 88.83 kg/cm2 for cement mortar and 85.05 kg/cm2 for fly ash mortar. After 28 days, it can be raised to 135 to 145 kg/cm2.The findings demonstrate that FaL-G bricks are stronger, safer, and more cost-effective than traditional bricks.According to a case study, using fly ash bricks with traditional masonry techniques results in a 28% cost savings over using regular red brick with traditional masonry techniques. When using fly ash bricks for masonry construction, the innovative RatTrap bond technique results in a 33% cost reduction over conventional bricks.

[9] ***"Strength and Durability of Fly Ash, Cement and Gypsum Bricks" by Nitin S. Naik, B.M.Bahadure, C.L.Jejurkar.*** Burnt clay brick is a traditional building material used for homes in both urban and rural areas of India. Good plastic clay, which comes from agricultural land, is used to make these bricks. When agricultural land is overused for this clay, rich fertile soil is lost and the land is diverted to make bricks. Bricks were burned with coal during the brickmaking process. Bricks burned with coal emit greenhouse gases that harm the environment. It is possible to efficiently replace ordinary bricks with fly ash bricks as an alternative to conventional bricks. Researchers have examined a variety of these bricks' qualities and discovered that they may be utilised for building of residences around a thermal power plant that are reasonably priced. This is to investigate the strength and tenacity of bricks made from fly ash, cement, and phosphogypsum.

[10] ***"An Experimental Study On Mechanical Properties Of Fly-Ash-Gypsum Bricks" By T. U. Ahmed, M. Ashikuzzaman & Z. Alam.*** Bricks are a type of material that cannot be used to build a house. Clay bricks that have been burned are typically used to achieve the goal; however doing so requires removing a lot of dirt from the area. This study examines the mechanical characteristics of fly ash bricks made with various ratios of fly ash, gypsum, sand, and a set quantity of cement.

[11] ***"The Use of Recycled Concrete Aggregate I N Structural Concrete Around South East Queensland" By Miss K w Ong Man K Aren Chiu.*** This project seeks to establish the most cost-effective method of reducing the environmental impact in South East Queensland by using recycled aggregate in structural concrete. Thus, this project's goal is to examine the hardness characteristics of recycled Slump, density, compressive strength, tensile strength, elastic modulus, and drying shrinkage of concrete aggregate. This is also done to compare the quality and cleanliness, durability, and permeability of the material to 100% natural aggregate from pits in South East Queensland that is supplied by local businesses for use in high strength concrete up to 60MPa. By examining the impact of 100% recycled aggregate in concrete, it was possible to determine the aforementioned characteristics of the recycled aggregate. The laboratory tests were carried out to look into thePossibility of replacing a portion of the cement in concrete with 100 percent recycled aggregate (20mm, 14mm, and 10mm) and 25 percent fly ash (low amount of 20% fly ash is the minimum needed per MainRoads requirements). By consulting with local technical experts and associated businesses, the project has also investigated the costs for the most practical method of producing recycled aggregate for high-quality concrete in South East Queensland in order to expand the use of RCA for structural concrete in the Australian concrete industry.

[12] ***"Strength and Durability Evaluation of Recycled Aggregate Concrete" by Sherif Yehia, Kareem Helal, Anaam Abusharkh, Amani Zaher, and Hiba Istaitiyeh.*** In order to fulfil the durability and strength criteria for various applications, this article analyses the appropriateness of creating concrete with 100% recycled aggregate. Concrete's strength and durability are influenced by a variety of physical and mechanical properties, including aggregate strength, gradation, absorption, specific gravity, form, and texture. In general, the loading and exposure conditions of the demolished structures affect the quality of recycled aggregate. As a result, the experimental program's main goal was to evaluate the recycled aggregate's mechanical and physical characteristics throughout the course of six months. Also, the characteristics of both fine and coarse recycled aggregate-produced concrete were assessed. 100% recycled aggregates were used in many concrete mixes.

[13] ***"A Study On Fly Ash Bricks By Using Lime And Gypsum " By Rutuja Ananda Deshpande, Priyanka Prabhakar Mane, Pragati Vilas Balande, Shradha Pandurang Sonale, Udaykumar Bhaskarrao Khamkar.*** Large amounts of fly ash are created as a byproduct when fossil fuels are burned to produce energy thermally. Currently, 10-15% of Australia's fly ash production is used in the production of cement and the concrete industry, with the bulk of the leftover waste requiring expensive disposal procedures. The management of fly ash has developed into a significant problem for the power generation sector as a result of increased environmental concerns and the requirement for cleaner production. Due to this, several researchers are actively seeking for novel and enhanced approaches to solving the fly ash waste disposal issue, notably by proving its practical and cost-effective application. The use of fly ash in cement is one such instance that is generating a lot of attention throughout the world in the production of brick. This study looks at the possibility of employing Queensland Class F fly ashes as key ingredients in the production of typical residential construction bricks. Using different ratios of fly ash, sand, hydrated lime, sodium silicate, and water, smaller pressed bricks were created. Compressive strength, tensile strength, water absorption, and durability were all evaluated for both burnt, oven-dried and air-cured bricks. The test results are examined in the study together with the influence of other factors.

[14] ***"EXPERIMENTAL STUDY ON FLYASH BRICKS BY USING GRANITE AND MARBLE POWDER" by Mr. G. Ramachandran1, Aarthi. M, Arthi. S, Ishwarya. S and Kokila. S.*** The backbone of India's infrastructure development is the construction industry. Indian businesses create a variety of byproducts that contribute to pollution. It significantly contributes to the nation's better environment. Several mixtures of fly ash, granite, and marble powder are used in the fly ash bricks. Large amounts of fly ash and granite dust are produced in India by thermal power stations and the granite industry. Industrial waste is toxic by nature, making its disposal a significant issue. A reasonable answer to the environmental problems is recycling such trash and using them as construction materials. The goal of this study is to examine and evaluate the strength of bricks made with various amounts of fly ash and waste from granite sawing powder. Investigative work was carried out utilising different mix ratios and laboratory tests including the compression test and the water absorption test. By comparing the features of compressive strength of bricks, the results for strength characteristics indicated a steadily increasing compression strength and good water absorption values in blocks. Industrial by-products including class F fly ash, granite dust, and marble dust powder were used as components in an effort to produce bricks using a different method. The experimental examination of fly ash bricks utilising marble and granite is presented in this work. Each 10% of the marble and granite is used. The ceramic product is blended in brick form in percentages of 5%, 10%, and 15% of each mix.

[15] ***"High Performance Flyash Bricks" By Mr.G.Krishnaraaju,M.E, S.Divya Bharathi, Mohamed Dilshad Ashiq, E.Endhiran, P.R.Jyothish.*** Every year, the coal field thermal power station produces a huge amount of fly ash. Bricks are mostly made of clay in India and are often manufactured in factories. Small-scale, traditional, unorganized industries. The use of red clay bricks in greater quantities causes land degradation and top soil loss. Every year, large amounts of land are lost, particularly in industrialized nations, owing to the collection of dirt from a depth of roughly 1 to 2 m from agricultural land. Despite its strength and solidity, red brick is porous and absorbs moisture. Long-term shrinking occurs in clay bricks. When a substantial volume of clay is extracted from agricultural land, good rich soil is lost.

[16] ***"An Experimental Study On Utilization Of Fly Ash And Slag In The Production Of Compressed Bricks" By Dayananda N, Keerthi Gowda B S.*** The purpose of this research is to look at the use of fly ash and granulated blast furnace slag in compressed bricks. The methods for making the mix, molding, and curing are all detailed. Bricks were created by preparing a semidry material, placing it in moulds, and compacting it with a pressing machine. The bricks were treated in three different ways. The first condition involved spraying water on the bricks for 28 days, while the second and third conditions involved immersing the bricks in alkaline and acidic water for 28 days, respectively. To examine the variation of attributes, the tests were done in two periods. The following parameters were observed: dry compressive strength, wet compressive strength, density, initial rate water absorption, water absorption, efflorescence, and pH of the material. Bricks that have been compacted. The cement is maintained constant in the first phase, but the percentages of fly ash and granulated blast furnace slag vary, whereas in the second phase, the fly ash is totally replaced by granulated blast furnace slag and the cement is kept constant. After 7 days, 14 days, and 28 days of drying, the compressed bricks were evaluated. In the first phase, fly ash is replaced by granulated blast furnace slag in the proportions of 30%, 40%, 50%, and 60% by weight of materials, while the 10% cement amount remains constant. The fly ash is totally replaced by granulated blast furnace slag (90%) in the second step, while the 10% cement remains constant. Dry compressive strength and wet compressive strength increase with increasing slag in both circumstances.

[17] ***"Manufacture of Fly Ash Brick using Steel Slag and Tapioca Powder" by V. Aravind1 , K. Dayanithi2 , S. Vignesh3 , V. Bijin Nath4 , M. Selvakumar.*** In fast growing today's world development of new building materials and processing and utilization of industrial waste is being important to be reduced for achieving safe environment and conservation of scarce resources and materials. Although the use of fly ash has many advantages, its low hydration at early stage causes the strength to be low. In this study, the experimental investigation was carried out to find the optimum mix percentage of some other materials with fly ash brick. However the brick specimen of size 230mm x 110mm x 70 mm were cast for different mix percentage of Fly ash (45%), Gypsum (5%), Lime (10%), Quarry dust (20 to 30%) and SSTP Mix (10 to 20% (mix made of Steel Slag–50%)) and Tapioca powder50%)).

III. METHODOLOGY

Fly ash-Lime-Gypsum bricks involve several steps and methodologies. Here's a brief overview of the methodology of FaLG bricks:

- **Collection and testing of fly ash:** Fly ash is collected from coal-fired power plants and tested for its quality and composition. The fly ash is then stored in a designated area for use in the production of FaLG bricks.
- **Mixing of ingredients:** The ingredients for FaLG bricks, including fly ash, lime, and gypsum, are mixed in a specific ratio using a mixer. The mixture is stirred continuously until it forms a homogeneous paste.
- **Molding:** The paste is then poured into brick-shaped molds and compacted using a hydraulic press to remove excess air and to ensure uniformity in the bricks' shape and size.
- **Curing:** The molded bricks are left to cure for a specific period, depending on the climate and atmospheric conditions. During the curing process, the bricks gain strength and durability.
- **Drying:** The cured bricks are then dried in a kiln or under the sun to remove excess moisture and increase their strength and durability.
- **Quality testing:** The final step in the production of FaLG bricks is quality testing. The bricks are tested for their strength, durability, and other properties to ensure they meet the required standards. The methodology of FaLG bricks involves a combination of materials, including fly ash, lime, and gypsum, to produce a sustainable building material that is strong, durable, and eco-friendly.

IV. MATERIALS USED

Fly ash:

Fly ash is commonly used as a raw material in the manufacturing of fly ash bricks, also known as FAL-G (Fly Ash-Lime-Gypsum) bricks. FAL-G bricks are eco-friendly building materials that are made by mixing fly ash, cement, lime, and gypsum in appropriate proportions and compressing the mixture in a brick-making machine at high pressure.

Figure 1 Fly ash

Lime (CaCo3):

Lime is a key ingredient in the manufacturing of FAL-G (Fly Ash-Lime-Gypsum) bricks, as it helps to bind the fly ash and gypsum together to form a strong and durable building material.

Figure 2 lime

Gypsum:

In the making of FAL-G bricks, gypsum is added to the mix of fly ash and limes in order to aid improve the hardening and curing of the bricks. Gypsum functions as a setting agent and helps to minimize the time necessary for the bricks to set and dry, which can boost the efficiency of the production process. Gypsum also improves the workability of the brick mixture, making it simpler to shape and mould the bricks into the required form and size. This can assist to increase the uniformity and quality of the bricks while also reducing waste throughout the manufacturing process. Another significant advantage of employing gypsum in FAL-G bricks is that it can aid in the reduction of cracking and shrinkage during the drying process and curing process, resulting in a product that is more resilient and long-lasting.

Figure 3 gypsum

GGBS (Ground Granulated Blast-furnace Slag):

GGBS (Ground Granulated Blast-furnace Slag) is a cementitious material whose main use is in concrete and is a by-product from the blast-furnaces used to make iron. Blast-furnaces operate at temperatures of about 1,500°C and are fed with a carefully controlled mixture of iron ore, coke and limestone.

Figure 4 GGBS

Steel Slag:

Steel slag is a byproduct of the steel making process that occurs when molten steel is rapidly quenched or cooled, either by immersion in water or by air. This process creates a granulated material that consists of various minerals and metals, including iron, calcium, silicon, manganese, and aluminum.

Figure 5 steel stag

Recycled aggregate:

Recycled aggregates are produced by processing and reusing materials that have been previously used in construction, such as concrete, asphalt, brick, and glass. The materials are crushed, screened, and sorted to produce aggregates that can be used in a range of applications.

Figure 6 Recycled aggregates

V. MACHINERY USED

***Mixing equipment*:**

A FALG (Fly Ash Lime Gypsum) brick mixing pan is a specialized piece of equipment used in the production of FALG bricks. It is designed to mix the raw materials, including fly ash, lime, gypsum, and water, into a homogeneous mixture that can be formed into bricks

Figure 7 mixing equipment

Trolley:

Trolleys are an important piece of equipment used in the manufacturing process of FALG (Fly Ash Lime Gypsum) bricks. They are used to transport raw materials and finished bricks between different stages of the production process.

Figure 8 Trolley

Hydraulic Press:

Hydraulic machines play an important role in the manufacturing process of FALG (Fly Ash Lime Gypsum) bricks. These machines are used to compress and mold the raw materials into the desired shape and size of the brick.

Figure 9 hydraulic press

VI. BLOCKS

Existing FaL-G Blocks:

Fly ash bricks are a form of construction material composed of fly ash, a byproduct of coal-fired power plants, sand, and cement. These bricks are a good alternative to regular clay bricks because of their strength, longevity, and thermal insulation. Fly ash bricks are created by combining fly ash, sand, cement, and water and then compressing the material under high pressure into moulds. Before being employed in construction projects, the bricks are cured and dried. The need for FaL-G bricks depends on the specific project requirements and design considerations. Here are some potential advantages of using flag bricks:

- **Durability:** FaL-G bricks are known for their strength and durability, making them a good choice for areas with heavy foot or vehicle traffic.
- **Aesthetics:** FaL-G bricks come in a variety of colors, textures, and sizes, making them a versatile choice for different design styles.
- **Maintenance:** FaL-G bricks are relatively easy to maintain and can be cleaned with soap and water or pressure washing.
- **Cost:** FaL-G bricks can be a cost-effective option for outdoor paving, as they are generally less expensive than natural stone

Material	Mass
Fly ash	60%
Sand/ Stone dust	30 %
Portland Cement or Lime	10%

Table 1 Material mix production of fly ash brick

Proposed FAB Blocks:

Fly ash brick (FAB) is a type of construction material that contains class C or class F fly ash and water. The bricks can withstand more than 100 freeze-thaw cycles after being compressed at 28 MPa (272 atm), cured for 24 hours. The brick is regarded as "self-cementing" because to the high concentration of calcium oxide in class C fly ash. And is generally 20% less expensive than traditional clay brick manufacture. Raw materialsʋ a possible material mixes for the production of fly ash brick:

Name of the Material	Percentage
Fly ash	30%
Lime	20%
Gypsum	1%
GGBS	5%
Steel Slag	20%
Recycled Aggregate	24%

Table 2 Material mix production of fly ash brick

Figure 10 Proposed Block

Name of Materials	Proportion -01	Proportion -02	Proportion -03
1.Fly ash	30%	30%	25%
2.Lime	15%	10%	20%
3.Gypsum	1%	1%	1%
4.GGBS	5%	5%	10%
5.Steel Slag	15%	15%	20%
6.RecycledAggrigate	35%	40%	24%

Table 3 design of proportions

V. WORKING PRINCIPLE

FAL-G (Fly Ash-Lime-Gypsum) bricks are manufactured by mixing fly ash, lime, and gypsum in a specific proportion, followed by compacting the mixture using a hydraulic or mechanical press. The mixture is then cured by air drying or steam curing. The working principle of FAL-G bricks is based on the chemical reaction between fly ash, lime, and gypsum, which forms a cementitious compound called calcium silicate hydrate (CSH) when mixed with water. This reaction is similar to the process of cement hydration, where water is added to Portland cement to form a paste that hardens over time. The fly ash used in FAL-G bricks is a waste product generated by coal-fired power plants. By using fly ash in the brick- making process, it is possible to reduce the amount of waste that is produced and also to conserve natural resources such as clay and sand, which are commonly used in traditional brick-making. The use of FAL-G bricks also has environmental benefits, as it reduces the carbon footprint associated with brick making. The production process of FAL-G bricks requires less energy compared to traditional brick-making methods, resulting in lower emissions of greenhouse gases.

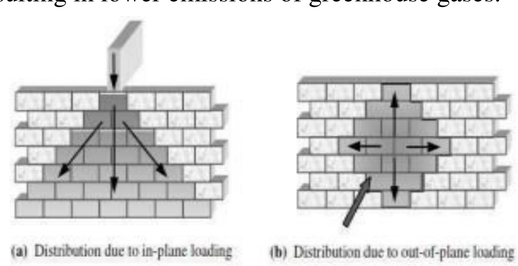


Figure 11 Distribution of Load

VI. EXPERIMENTS CONDUCTED

Compression Test:

Compression testing is a common method used to evaluate the strength and durability of building materials, including flag bricks. The compression testing process involves applying a compressive force to a brick until it fails, and then measuring the maximum force that the brick can withstand before breaking. This information can be used to determine the load-bearing capacity and durability of the brick.

Figure 12 Compression test and tested block

Types	Comprassive strength (mpa)		
	For 07 days	For 14 days	For 28 days
Proportion – 01	8.60	10.75	14.2
Proportion – 02	7.07	9.25	12.5
Proportion – 03	8.0	9	10.5
Local FaLG Blocks	5.30	6.00	7.8

Table 4 Compressive Strength Values

Water Absorption Test:

Water absorption testing is a common method used to evaluate the porosity and durability of building materials, including flag bricks. The water absorption test involves measuring the amount of f water that a brick can absorb, which can provide an indication of its resistance to weathering and frost damage.

Figure 13 water absorption test

Types	Water absorption (%)		
	For 07 days	For 14 days	For 28 days
Proportion - 01	1.8	2.5	2.9
Proportion - 02	2.6	2.7	3.1
Proportion - 03	3.2	2.9	3.3

Table 5 Water absorption test Values

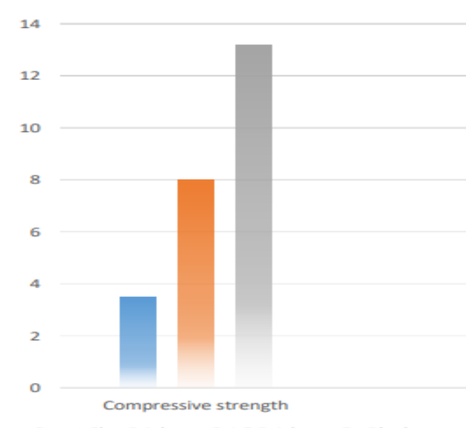
Efflorescence Test:

Efflorescence is a common issue that can occur with building materials, including flag bricks, which can affect their appearance and durability. The efflorescence test involves measuring the amount of soluble salts that are present on the surface of the brick, which can provide an indication of the potential for efflorescence to occur.

Figure 14 efflorescence test

VII.COMPARISON BAR CHART MATERIAL:

Flag bricks are composed of sand, cement, and other aggregates, whereas E - Blocks are composed of fly ash, lime, gypsum, and various industrial waste materials, which are then molded using a hydraulic press and cured. 0 2 4 6 8 10 12 14 Compressive strength Brunt Clay Brick FaLG Brick E - Block



Graph 1 Strength Comparison

- **Appearance:** E - Blocks are greater in size than burned clay bricks. They are not available in a variety of colors.
- **Strength:** Using the compression test results, we may deduce that E - Blocks are stronger than flag bricks.
- **Cost:** Due to the use of industrial waste materials, E-Blocks are often less costly than alg bricks.
- **Environmental impact:** Because they must be burnt in a kiln, burned clay bricks need a substantial amount of energy to make. This can increase greenhouse gas emissions and have other negative effects on the environment. Flag bricks and E-Blocks, on the other hand, are often seen as more ecologically friendly, as they are frequently produced from recycled materials and take less energy to manufacture.

S.No	Name of Material	Quantity(Kg)
1	Fly Ash	2
2	Lime	1
3	Gypsum	1/2
4	GGBS	1
5	Steel Slag	5
6	Recycled Aggregate	3
7	Labours	2 no's

Table 6 bill of materials

S.No	Name of the Materials	Cost(Rs)
1	Fly ash	22
2	Lime	50
3	Gypsum	7
4	GGBS	70
5	Steel Slag	5
6	Recycled Aggregate	2
7	Electrical Charges	10
8	Labour Charges	22
	Total Amount	188

Table 7 cost estimation

VIII. CONCLUSION

The initiative's purpose is to create the blocks out of industrial waste. The blocks should be sturdy while being reasonably priced. Because they are lighter in weight than FaLG bricks, they reduce the dead load of the building, cutting the overall cost of construction. Because of the homogeneous size of the bricks, the amount of mortar required for joints and plastering is reduced by over 50%, and the great strength virtually eliminates breaking during transport and usage. The various proportions of the E-bricks combination yield reasonable results. More bricks should be investigated to find relationships between the properties. Considering all of the test results, it is feasible to infer that E- Blocks may be used as a building material to reduce soil extraction from the earth (Brunt Clay Bricks).Switching from FaLG Bricks to E - Blocks might save us up to 20% in expenditures. These blocks are constructed of industrial waste and are environmentally friendly.

Future scope:

In India, the need for fly ash bricks is expanding. People increasingly prefer fly ash bricks over traditional burned bricks due to economic and environmental benefits. India is reliant on coal-fired power plants. These plants generate a huge amount of fly ash.

Business scope on commercial and productivity of fly-ash bricks According to a Khadi and Village Industries Commission (KVIC) research, the cost of beginning this firm might reach Rs 20 lakh. You'll need at least 20,000 to 50,000 square feet of land and 15 to 20 employees. The fly ash brick-making machine is available in a variety of types and capacities, ranging from 1000 to 10000 bricks per hour. This equipment costs between Rs 10 and Rs 13 lakh. A single brick costs about Rs. 15. Every year, over 80,000 bricks are sold for Rs. 12 lakhs, with a profit margin of Rs. 5 lakhs.

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