Exploring the Experimental Advancements of Gypsum-Enhanced Fly Ash-Sand-Lime Bricks

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by

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DECLARATION

I hereby declare that the work presented in this report entitled **“Exploring the Experimental Advancements of Gypsum-Enhanced Fly Ash-Sand-Lime Bricks"**, I carried out the action. For the award of any other degree or diploma from any other University or Institute, I have not submitted the matter embodied in this report.

I have diligently acknowledged and attributed the words, concepts, pictures, graphics, computer programs, experiments, and findings to their respective original authors or sources. This is not my initial endeavor, as I have made previous attempts to ensure proper crediting. To demonstrate my respect for the original writers and sources, I have enclosed quoted sentences within quotation marks.

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CERTIFICATE

This is to certify that the thesis entitled **"Exploring the Experimental Advancements of Gypsum-Enhanced Fly Ash-Sand-Lime Bricks"**This document is a true record of the research Raja Babu Sharma did while working for me. She sent it to the Rajshree Institute of Management and Technology in Bareilly as part of the requirements for getting a Master of Technology in Civil Engineering. The content of this thesis has not been presented in full or in part to another university or institute for a degree or diploma.

Signature

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Abstract

The exploration of sustainable building materials has become a significant focus in the construction industry. This study investigates the experimental advancements in gypsum-enhanced fly ash-sand-lime bricks as an alternative to traditional clay bricks. The incorporation of gypsum into fly ash-based bricks has the potential to enhance their mechanical properties and overall performance.The objective of this study is to explore the effects of gypsum content on the compressive strength, water absorption, microstructure, and other relevant properties of the bricks. Different proportions of fly ash, sand, lime, and gypsum are mixed and compacted under optimized conditions. The resulting bricks are subjected to comprehensive testing and analysis. The results of this study provide valuable insights into the feasibility and advantages of gypsum-enhanced fly ash-sand-lime bricks. The inclusion of gypsum as a binder is expected to enhance the cohesion and strength of the bricks, making them suitable for structural applications. Additionally, the utilization of fly ash and gypsum reduces the environmental impact associated with clay brick manufacturing. The findings of this research contribute to sustainable building practices by promoting the efficient utilization of industrial by-products and reducing waste. The development of gypsum-enhanced fly ash-sand-lime bricks has the potential to support the transition towards greener and more sustainable construction practices.

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

The construction industry is increasingly recognizing the need for sustainable and environmentally friendly building materials. Traditional clay bricks, while widely used, have significant environmental impacts due to the extraction of clay and the energy-intensive firing process. As a result, there is growing interest in developing alternative building materials that utilize industrial by-products and reduce the ecological footprint of construction.
One such alternative is the use of fly ash, a residue generated from thermal power plants, as a key ingredient in brick production. Fly ash possesses pozzolanic properties and has been successfully incorporated into various construction materials. However, the low reactivity and limited strength of fly ash-based bricks have hindered their widespread adoption.

To address these challenges, researchers have explored the incorporation of gypsum into the composition of fly ash-sand-lime bricks. Gypsum, a mineral commonly used in construction materials, has been found to exhibit properties that can enhance the performance of fly ash-based bricks. Gypsum acts as a binder, improving the cohesion and strength of the bricks, making them more suitable for structural applications. The objective of this study is to explore the experimental advancements related to gypsum-enhanced fly ash-sand-lime bricks. By incorporating gypsum into the composition, it is anticipated that the mechanical properties, durability, and overall performance of the bricks can be enhanced. The study aims to investigate the effects of varying gypsum content on the compressive strength, water absorption, microstructure, and other relevant properties of the bricks.

The nations of the world are named (a) created, (b) creating, and (c) immature. India's position is that of the evolutionary phase. India is a country with a conventional "squanders reusing" practice. Be that as it may, nowadays, under the affection of globalization, new "expendable" thoughts, India is losing its customary culture, offering a path to the advancing philosophies and way of life of the West. Since India is a creating country, the principle vitality is adequate, sheltered, and modest. This vitality is significant because India must ensure "nourishment for all" and build up the segment. The wellspring of monetary life is hydroelectric and warm energy created in India. Friendly vitality creation has side effects, such as fly ash, which must be discarded securely by releasing and reusing the environment.

The current task tends to fly ash and the potential arrangements that are the waste produced by warm force plants. Fly ash has a few negative consequences for the environment, and the age is impressive.

1.2 GENERALITIES

Business block making produces a great deal of air pollution. The technology used to create fly ash bricks is environmentally well disposed. In contrast to conventional bricks, there is no compelling reason to create fire fighting exercises. Coal exists among the customary wellsprings of fossil fuels in amounts equipped for fulfilling a huge piece of the country's vitality needs. That is the reason the Indian power area is a significant coal shopper in India and will remain so distant for a long time. The burning of coal in thermal force plants not just creates steam to work the power created by the turbine, yet in addition delivers an enormous number of results, for example, fly ash, and so on. In India, around 80 thermal force plants are fly ash sources, where almost a huge number of huge amounts of coal are utilized every year. India at present creates hundred millions tons of flue ashes every year which produces nearly thirty millions tons of unused fly ash per year. This game plan requires a huge capacity of land, which can cause more prominent environmental irregularity. This waste material is effortlessly evacuated in the encompassing zones as a watery suspension. This sort of removal changes over valuable farming area into badlands, yet in addition represents a danger to environment nature. The human improvement of the United Nations evolution Program proposes that eighty three to hundred and sixty three million hectare of land in India have been eroded every year, bringing about creation misfortunes of around 4 to 6.3% of all out horticultural creation of $ 2.4. Billion. Hence, the utilization of flue ashesas a structure medium has never taken on extraordinary significance. Different investigations have been directed the world over to try to useflue ashesin numerous structural designing activities because of its solid properties as a solid component.

1.3 MARKET NEEDS

The nations expends around one hundred eighty billions tons of bricks, depleting around three forty billion tonns of clay per year and making around 5,000 sections of land of top soil sterile for a significant stretch of time. With regards to gigantic lodging needs, the administration is genuinely worried about soil disintegration because of the creation of enormous amounts of bricks. The magnificent designing feature and strength of the flue ashes block expands its range of activity for the development and improvement of framework, the development of pavements, dams, reservoirs, submerged works, coating of canals and water system works, and so on. In all states, there are huge amounts of fly ash accessible in and around thermal force plants. The interest for bricks can be fulfilled by introducing little entitiesclose toheat force plants and fulfilling nearby interest at lower transport costs.

1.4 HISTORY

Generally, bricks were made by blending virgin assets, shaping bricks, dry them and afterward tossing them [7] - [8]. The recent pattern in block creation places incredible emphasis on use after the customer squander and mechanical results in the initial procedure. A significant part of the work has improved the surface and properties of clay bricks by joining clay with different reused squander materials, for example, foundry sand, rock sawdust squander, port silt, sugar stick ashes, clay debris and powderd boron squander, waste water ooze, basic glass squander from the dividers. What are more, different squanders [9] - [10]. What's more, it has been chipped away at to fabricate bricks from totally dispensable utilities without utilizing any sort of natural properties to complete manageability.

They utilized waste altogether on bricks that delivered squander treatment, rock squander, paper slime, straw strands, squander treatment muck, fly ash and other waste [11] - [12]. The traditional technique for making bricks has caused genuine environmental pollution because of the colossal greenhouse gas (GHG) emissions, bringing about abnormal changes in the atmosphere, for example, smog, corrosive downpour and a worldwide temperature alteration. What's more, vitality as fuel and power during conventional block making demonstrated exceptional utilization which prompted profoundly economic costs. Subsequently, huge backwoods are as of now deforested to use their timberlands and plants as a vitality origin in the block creation phase. Hence, the reusing of waste in block creation is by all accounts a reasonable arrangement for environmental pollution, yet in addition an economic choice for the plan of ecological structures. Be that as it may, the chronic issue of (GHG) and vitality utilization has not yet been adequately tended to, as most past work has commonly centered around reusing block squander. Various examination considers have concentrated on the measure of emissions (GHG) and their contextual effects, just as on vitality utilization [12] - [13]. Not many examinations have stepped up to the plate in creating ecological bricks in the context of an environmental economic examination. [14]-[15].

1.5 PRACTISE OF MAKING OF FLUE ASHES BRICKS

Flue ashes bricks could be readied utilizing different self-loader and programmed machines, utilizing molds pre-introduced in machines, where the utilization of manual molds in the creation strategy prompts visit changes in the size of the block and can prompt helpless outer nature of the bricks. Around all ash block creation plants use machines to deliver ash bricks, bringing about less work and expenses per ash block, which are effectively available for lower and high society families.

1.6 MANUFACTURING PROCESS OF ASH BRICKS

Fly ash bricks were bricks created from the byproducts of several industrial processes. Powdered ash is the principal solid fixing while water is the predominant liquid fixing in the block. Many financially managed hardware items are currently in short supply. Lime reacts with silica in fly ash to form calcium silicate hydrates (C-S - H), which binds the ingredients together and acts as a limiting material in the fly ash block manufacturing process. The fly ash's composition determines the final brick's properties. [18] Follow the manufacturing process:-

1. Brick manufacturing process requires proper mixing of fly ash, sand / stone dust, lime and gypsum.
2. Firstly, Lime and gypsum are finely grounded as a dry mixture via hydraulic mixer.
3. After this the mixture is fully and uniformly stopped machine grinding.
4. Then, , the quantity of flue ashes and sand stone is selected andAshes and stone dust are supplied to the mixture to obtain a homogenous mixture.
5. The water is added in a set quantity as the mixture should be in a proportion to be able to meld into the brick.
6. When material is in lesser quantity, they need to be go through labs.
7. If the mixture amount is higher, a conveyor belt may be used to move the material to the mould.
8. Hydraulic machine has three brick mould pairs.
9. Melds can vary according to available machines.
10. After transferring the mixture to the brick mould site , it is important to fill in the holes given in the machine representing the brick mould.

11. The mould is often produced at the circular table, which can rotate in clockwise direction.
12. After materials are filled in the mould,, the table can rotate in CW direction and then it remains below the machine's closed portion.
13. When bricks are removed, they are shifted to the Planck
14. The transfer of the bricks should be done with great care to remove the chances of break due to the pressure on it.
15. When certain brick ratios are done for reference purposes, they must be inked over the brick.
16. When the bricks fill the Planck, the Planck lifter will take them for air drying where the bricks are dried air for 2 to 3 days.
17. H2O treatment for appropriate days is done to have needed strength.

1.7 MATERIALS SELECTION OF INGREDIENTS

Fly ash is a finely isolated accumulation produced when coal powder is burned, transported via the combustion gases, and collected via electrostatic precipitation [24]. Powdered fuel ash, otherwise called fly ash, conforms to IS 3812 evaluation 1 or evaluation 2. The level of fly ash is commonly 60-80 %, contingent upon the nature of the crude materials, for example, ash. Flyers must be gathered from the first and second ESP field (electrostatic precipitation) which meets the required IS 2 evaluation: 3812. Fly ash shifts in shading, immaculate size and mineral components relying upon the combustion of coal. Indian fly ash contains higher unbent carbon content (10 to 16 percent) while, like American fly ash, it is lower (about 5 percent) [23]. The coal combustion process produces coal ash, 80% of which has a very fine nature and is therefore known as fly ash, which is very harmful for both the atmosphere and for humanity, since it has many effects on human health such as asthma. Therefore, it must be used for different purposes. It has been studied that if the intake per person causes the similaroutcome as one person who smokes one lakh cigarettes at a instant, he will have the following effect:

Lowercontraction

It will have lubricating properties which will lead in dry Shrinkage reduction.

1.8 FLUE ASH USES

As with volcanic ash, natural rock, Portland cement, etc., these other earth components primarily consist of silica, alumina, iron, etc. These qualities make it a great option for the ceramic industry, where it may help conserve scarce raw materials.

Fly ash in bricks

Fly ash bricks have a lot of advantages surrounded by white traditionally built clay. Oblong tiles may be found in footpaths as well. There is a need for public education and policy will have special opportunities for all of this.

Fly ash in manufacture of cement

When combined with water, bottom ash can produce a concrete molecule with some of the same properties as Portland cement. Due to still another similarity, fly ash can be used to replace some cement in concrete, which has many practical benefits. Due to its higher density, concrete makes for a more watertight and aesthetically pleasing coating.

1.9 KINDS OF FLY ASH BRICKS

1. **C class fly ash**

Class C flue ashes are often produced by burning brown coal or sub bituminous coal and can include up to 10% CaO.Class C fly ash possesses cementations properties in addition to the pozzolanic ones. Specific gravity for fly ash is 2.19 (class C) [24]. In addition to pozzolanic qualities, the ash generated from burning the newest lignite or sub bituminous coal also possesses some self-cementing properties. Adding water to Class C fly ash causes it to harden and thicken. Lime (CaO) concentrations in Class C fly ash are higher than 20%. Class C self-cementing fly ash can be used without an activator, unlike Class F fly ash. Class C fly ash often contains more alkalis and sulfate than other classes.

2. **F class flue ash**

Fly ash, which is commonly produced from the burning of anthracite or bituminous coal, typically contains around 5% CaO. This type of fly ash is known as Class F fly ash and possesses only pozzolanic properties. It is often found inhaled by the general public. The specific fly ash being referred to in this context has a pozzolanic composition and CaO concentrations of less than 20%. Class F fly ash contains glass silica and alumina, which exhibit pozzolanic characteristics, requiring the addition of a binding agent such as Portland cement, quicklime, or hydrated lime, along with water, to form cementitious compounds. Alternatively, class F ash can be utilized in the creation of a geopolymer by incorporating a chemical activator like sodium silicate (commonly known as water glass).

Lime

Lime is an essential information for constructing adhesives. In its natural affiliation to magnesium oxide (MgO) it's indeed essentially calcium oxide (CaO). Lime responds at normal temperature to fly ash and develops a substance that has cementation property. Calcium silicate hydrates were also generated just after responses among lime and fly ash which have been willing to take responsibility for the cell's high resistance. Hydrated lime can be used to make fly ash bricks that would follow the class C grade listed in IS: 712:1984. The CaO's lime strength will not even be or less 85%, That can only be studied and the results and getting the lime supplier's check certificate. It appears to respond in the midst of precipitation with both the CO2 existing in the soil, which produces CaCO3 that has no loading capacity which destroys the consistency of both the lime used during fly ash bricks. Quick lime or hydrated lime or even the structure of it can be combined. Lime must have 40 per cent minimum CaO content. The slaked lime which is available on the market is filtered and also used. As a loss it can also be widely available in many fields. Commercially accessible chemically pure lime obtained from industry (CaCO3). Lime is an essential component in the development of brick ash, which functions only as a connecting material. Lime should meet the following conditions.

Quarry Dust

It's a by-product of the granite extraction process. The high expense of transporting river sand from its natural origins makes it too expensive for local use. Large-scale depletion from these sources also becomes an environmental issue as a result. Building with river sand is becoming less desirable, so a suitable alternative must be found for the concrete industry. Use of which has become problematic because to rising costs, limited supply, and negative effects on the environment. Quarry rock dust can be used as a low-cost substitute for river sand in this situation. In addition to its usage in the manufacturing of hollow blocks and prefabricated lightweight concrete parts, quarry rock dust is commonly utilized on highways as a surface finishing material. After processing, the particles utilized here have a diameter of less than 4.75 micrometers. It was a term for the leftovers produced when widely available coarse aggregates are sprayed.

Stone dust

Concrete plants produce these. It is necessary to be strictly aware that the selected powder should not contain more than 5 percent of harmful materials, such as slit and field testing, using a measuring cylinder to determine the slit and particle percentage of clay throughout the powder during each forklift loading.

Polymer

TBA (tertiary butyl acrylate) polymer is used as a polymeric material for making flue ash bricks. Polymer is one of the wastes generated in the chemical industry.

Gypsum

Gypsum Is a non-hydraulic binder, which grows naturally when classic rock or crystalline sand. Gypsum have useful features such as low density, fire resistant , high noise reduction ability, better fire tolerance, easy drying or short distance shrink hardening, superior end milling etc. It could also help strengthen the product or a nearby gradient. It appears to have a specific gravity of 2.31 g/cc. The density of gypsum powder is between 2.8 and 3 grams per cubic centimetre. Hydrated calcium sulphates are known as chalk. ($H2O$ + $CaSO4$). Plaster's purity must be at least 35%; anything from 5% to 15% is acceptable. It is purchased from businesses. The gypsum used in the production of fly ash bricks must be free of lumps and must undergo analysis in accordance with standard IS 1288-1982. It's important to keep in mind that its purity ought to be higher than 80%, and that any changes in purity will necessitate adjusting the plaster percentage in the combination to ensure a high-quality brick.

1.10 CONVERSIOIN FROM CLAY BRICKS TO ASH BRICKS

Traditionally, brick These were made from the mixture of virgin materials, brick formation, drying and cooking. That new development of brick manufacturing illustrates the use in the production process of post-consumer waste or factory by-products. Most studies have already found that combining clay with other recycled materials, such as foundry sand, granite sawmill waste, port sediment, sugar cane ash, clay waste, and trash, improves the efficiency and qualities of clay bricks. Boron, sewage sludge, glass from structural walls, and other garbage. As a result, efforts were made to manufacture bricks with wholly expendable materials, without resorting to any renewable activities, in order to achieve sustainability. They exclusively employed discarded bricks, rubbish from the treatment of garbage, granite, paper sludge, straw fibers, waste sludge, and flue ash. Smog, acid rain, and global warming are just some of the unexpected results of the traditional brick production process's massive greenhouse gas (GHG) emissions. However, energy as fuel and electricity has shown dramatic consumption during conventional brick making, resulting in highly economic expenditure. As a result, large forests are currently deforested to use their forests and trees as an energy source in brick production. Therefore, the recycling of waste in brick production seems to be a valid alternative Also carbon emissions from of the ecosystem but an economic choice and for design of ecological buildings. Even so, the persistent (GHG) problem and energy usage still have not been sufficiently addressed, because most recent research has primarily concentrated on brick resource recovery. Numerous studies cantered emission quantities (GHGs) and their effect mostly on both context and energy consumption[12]-[13]. Few works took steps to develop environmentally friendly bricks during an economic climate [14] - [15].

1.11 ADVANTAGES

Flue ash bricks of this type use 50 % fly ash, but no clay. The mechanics feature of flue ash bricks exceed those of ordinary bricks. The study propose that the ash / electrostatic precipitators (ESP) of the chemical industry could be used effectively for making bricks. Including fly ash in brick working also helps reduce waste; this approach can also preserve natural resources such as air, water and soil. Fly ash It can also boost their mechanical properties for bricks, however the addition of polymer or lime improves their strength capacity through their ability to lower pollution and conserve energy. The performance of both the construction has enhanced, thanks to both the homogenety of both the fly ash bricks. The composition of the wall is unique; before masonry, you may raise the plastering costs, and the layers of each brick show the straight line. [18]. Thanks to the high opposition, it is extremely shielded from fire, virtually without breaking all through transport and then use, due because of its standard thickness of mortar besides bricks needed besides joints and joints. Such bricks don't really require 24 hours of submergence throughout water, spraying water is sufficient prior to actually use though, Red bricks, but at the other hand, include several drawbacks, along with high water holding capacity, an excellent thermal composer and lower strength properties.

1.12 FLY ASH BRICKS SUPERIORITY OVER RED BRICKS

Using semi-automatic and automated machines, fly ash bricks are manufactured, in this type of machine there is a hydro pressing system with pre-installed mold. About 10 laboratories are expected to use this machine and the machine will produce 10,000 bricks in 8-9 hours. After training, 3 brick healings are performed for up to 15 days. Due to the use of cow, coal and wood manure at 1100 ° C, the bricks are dried in the sunlight after modelling the clay bricks in the kilns.

1.13 ENERGY UTILISATIOIN AND FLY ASH GENERATIONIN INDIA

Energy is the key advancement asset of any nation. The country's energy utilization per capital is a file of the organization's way of life. After the principal mechanical revolution in Europe and America, the overall energy the board is expanding. It is Interestingly, I will take note of that 75% of the energy in the country originates from 25% of the populace in created nations and the other way around (Pachauri et al 1998). Power is viewed as unrivaled and economic between various energies. Since it very well may be shipped effectively in a brief time-frame, it very well may be changed over to some other wanted form absent a lot of misfortune and time, and there is no sullying at the purpose of utilization. The cutting edge hardware is intended to utilize electric energy. Hence, the worldwide interest for power is expanding enormously. To meet the growing demand for energy, large power plants are being built all over the world. The thermal energy is the main source of the production of electricity in India, supplying 60% of its electricity. From 2010, the production of energy from India increased to 7% CAGR. The installed power generation capacity of 334.4 gig watts (GW or 1,000 megawatts) installed in the country in January 2018 is the fifth largest in the world.

In 1947, the power of the company was of 1,331 MW in 1998 and exceeded 89,167 MW. However, there is no peace. The demand still surpasses the offer. The India is currently the main source of carbon to generate electricity, which is considered to be the economic point of view for the generation of nuclear energy. The central thermoelectric producer produces 65% of the parrot electricity.

1.14 ENVIRONMENTAL MATTERS DUE TO FLY ASH

Flue ash particles These are very small (< 0.2 micron) and are very easy to scatter. As is often mixed with soil and water sources, and distributed with considerable production time mostly in atmosphere. Particles of fly ash are breathed to humans and animals that live near power plants.

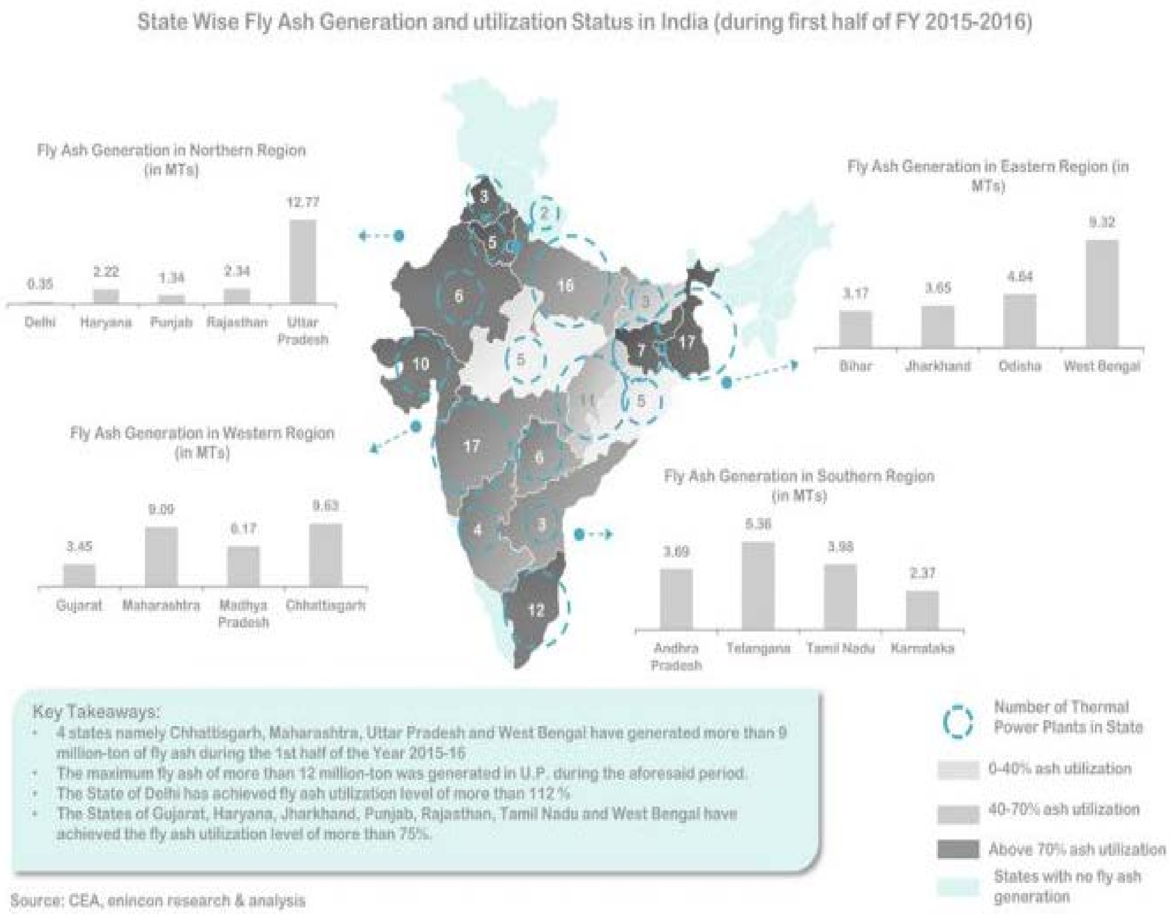

Figure 1.1: Fly ash use in India

Descriptions	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-16	2016-17
TPPs	88	124	138	143	145	151	155
Installed capacity (MW)	80458	105925.3	120312.30	133381.30	138915.80	145044.8	145044.8
Coal consumed (MTs)	407.61	437.41	482.97	523.52	549.72	536.4	536.4
Average ash content (%)	32.16	33.24	33.87	33.02	33.50	32.94	33.22

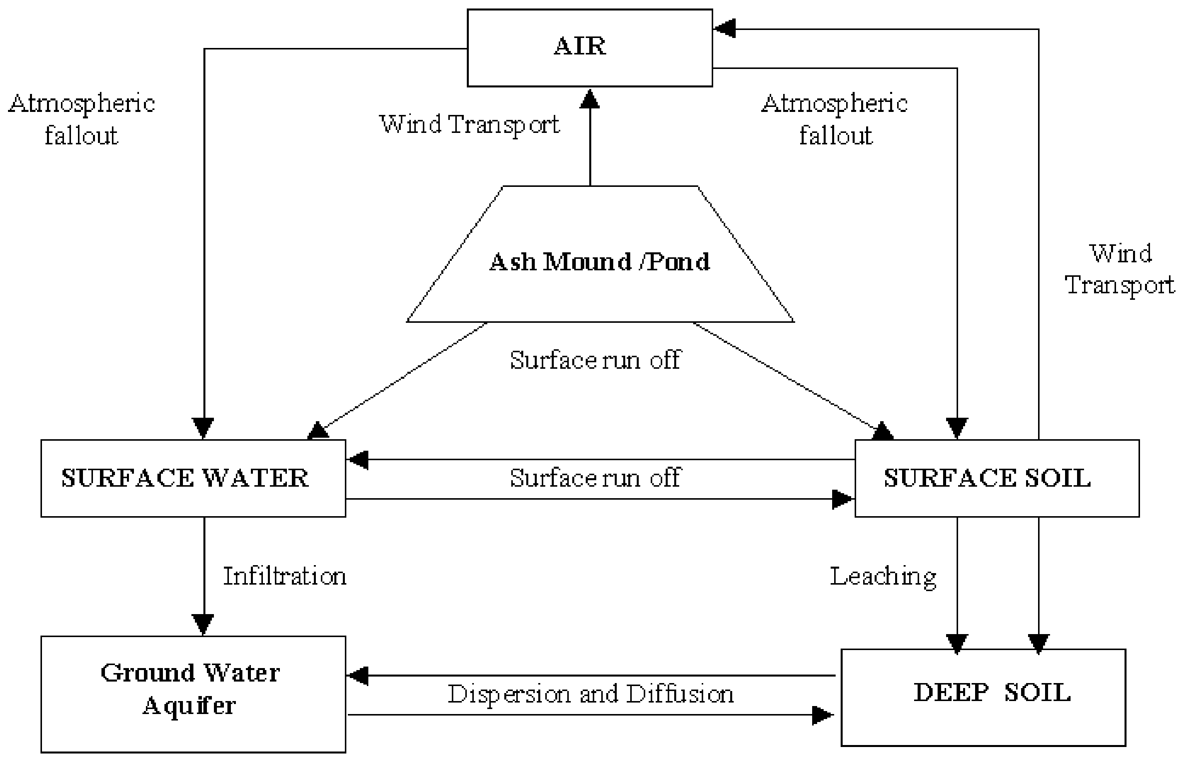

Figure1.2 Pathways of pollutant movement around ash disposal facility

1.14.1 RESULT ON SOIL

Fly ash it can contain Toxic chemicals include nickel, vanadium, arsenic, beryllium, cadmium, barium, chrome, copper, molybdenum, zinc, mercury, selenium, radio, etc. Once fly ash falls in the soil, it is consumed by plants. That heavy metals will then enter the food chain, meet the human body and cause long-term toxicity or disruption. That fly ash concentration with magnesium can improve the chemical or chemical properties of the soil. Excess fly ash could even boost the pH and electrical reflectivity of soil as well as affect soil.

1.14.2 CONSEQUENCE ON WATER

Fly ash Debris collected earth seems to be able to belong to neighbouring surface waters whilst also washing thru the rainwater or through applying a thin film due owing settlement mostly on water surface. Areas similar to fly ash production can also have deposits of ash accumulated to deeper ocean in drinking homes as well as other uses. Conveying fly ash also wants to expand because of the wind. Thus heavy metals are becoming part including its air and water in fly ash. Fly ash may contain minerals and may infiltrate groundwater too though.

1.14.3 REACTION ON AIR

Exhaust gases from thermal power plants creates overwhelming fly debris. On the off chance that they are not captured by a suitable air contamination control gadget, they will arrive at the atmosphere.

The breeze raises the ashes and ventures significant distances. Ashes noticeable all around can fall into surface water, anthropological destinations or to the ground and can contaminate them. The grouping of particulate issue in the atmosphere increments and the decrease in imperceptibility around power plants happens when atmospheric humidity forms aerosols with fine debris. The conceived air aggregates for the most part in plants. At the point when close by creatures eat vegetation, it joins the natural food chain.

1.14.4 REACTION OF FLUE ASH ON HEALTH OF HUMANS

Nearly 81 million individuals lived in regions that don't meet national particulate air quality necessities. Once breathed in by humans or animals, this fly ash causes numerous infections and allergies, including silicosis, fluoridise, as recorded by skin contact with fly debris. Fly debris likewise results in respiratory issues, asthma and bronchitis. Ingested, fly debris gives the body overwhelming metals. Substantial metals can collect in the heart, lungs, liver, and kidneys and step by step decimate their capacities. They couldhave adjust the working of the focal nervous system.

1.15 FLY ASH REUSABILITY

Real, ash from flying is just not a waste, but a luxury. This can find use for re-use in various Serves to protect. Several of which include agricultural recycling; recycling in the manufacture of lime bricks, recycling in the manufacture of clay bricks and yet reprocessing throughout the development of cement substitutes.

CHAPTER 2
REVIEW OF LITERATURE

2.1 PAST WORK REVIEW

T. U. Ahmed et al. (2018) Discloses this same mechanical properties of flue ashes bricks which assume external facts of fly ash, plaster, sand and cement. For the this inquiry a number of chemicals were carried out, i.e. strength properties, moisture content, unit weight, porosity, open pore as well as waterproof pore throughout the laboratory. They was using the components to manufacture bricks of four proportions “(50%, 55%, 60%, 65%), chalk (12%, 9%, 6%, 3%), sand (28%, 26%, 24%, 22%) In addition to the standard 10% cement ratio. After thoroughly mixing the two heavy components in a combining tub, 80 ml of water is added to account for the whole thickness of the brick mold. Again, a mold measuring 9.5 by 4.5 by 2.75 centimeters was used to cast bricks using the mortar. This is the standard brick size in Bangladesh. The ASTM code of ethics was used to evaluate the entire project. Bricks used as an alternative to traditional burnt clay ones are shown to have the same high quality in Report 1, the authors conclude.

Md. Md. Ashikuzzaman et al. (2018) Crushing capacity, water absorption, and unit volume weight were all investigated as a function of brick shape load huge pile size. Similarly, variations in the percentages of fly ash (from 50 to 65% in 5% increments), plaster (12% to 3% with 3% decreases), sand (28% to 22% with 2% decreases), and cement (10%) were incorporated into the brick design. After everything was mixed up, it was put into a mold measuring 9.5 by 4.5 by 2.75 centimeters. Bricks formed by similar shaping charges had the same mechanical properties. High-quality bricks were proposed to be made from "fly ash, gypsum, sand, and cement" in this research.

S. Kanchidurai et al. (2018) That tests of both the compressive power or tensile strength among fly ash bricks were faced with such an inclusion of less costly plastic waste (FAB-P). India used low-lime pulverized fuel ash (Cao <10 percent) and fly ash, 10 % cement, 20-40 percent standard round plastic waste, portable water. The FAB-P mold for dimensions 220 x 103 x 103 mm. Price, water absorption, compressive strength, impact resistance of the brick fall hammer, fly ash brick with factory setting (FAB-F); FAB compared to plastic waste. FAB-P aggregate plastic has 200 percent greater impact resistance than other bricks.

Propellers-Quesada et al. (2018) Numerous proportions of CFA (80–30 per cent weight) – G (20–70 per cent weight) were analyzed. The raw materials was imprinted in boiling water for 28 days at 10 MPa. The findings demonstrate which the formation of CFA by weight of up to 20 per cent generated fired clay bricks Different mechanical and barrier properties to the debris free brick power. The addition of even a larger quantity for residues (30-50 percent through weight) has, however, resulted but in a much more substantial decrease of mechanical properties (between 25-50 percent) due to the increased porosity. The scientific study of silicon dioxide-fireless calcareous bricks showed the The perceived density or moisture content amounts decline as when the carbon fly ash content improves. Fresh silica limestone bricks made up of 40 to 60 percent CFA had the best 46-43 MPa compressive strength levels. Such rugged silica-calcareous tiles, 60CFA-40 G, 50CFA-50 G and 40CFA-60 G, had the maximum admixtures value Products (SiO2 and Al2O3) including carbon but calcium hydroxide fly ash in geosilex, that lead to the growth of calcium silicate hydrates with aluminium and calcium hydrates, phases involved in building material mechanical resistance. CFA clay fired bricks and untreated CFA-Geosilex silica bricks have already shown optimum performance characteristics that follow consistency requirements.

Joglekar et al. (2018) presented alternative building materials that use industrial and agricultural waste such as “cotton waste, recycled paper mill waste and rice husk ash”. This study attempts at conducting a thorough review of rammed earth and clay bricks acquired from industrial and agricultural waste for use in a low-cost brick house. The assessment criteria are economic, environmental, social and technical aspects of brick production and the use of various bricks for bricks. Determine a life cycle appraisal approach (LCA) Criteria for the setting. The specific index of sustainability (SI) is determined on the basis of both the specific parameters which use the MIVES method. The comparatively SI clay bricks were 0.25 and 0.26, respectively. In particular, bricks from factory and agricultural waste for both the best SI for cotton bricks (0.94) tend to become more durable. Analysis of tolerance as well verified that waste brick was most durable unlike brick or fly ash brick.

Manish Kumar Sahu and Lokesh Singh (2017) explained how modern fly ash bricks are made and why they're so useful in construction. The benefits of fly ash bricks over traditional mud or red bricks, as well as the process for creating fly ash bricks, are outlined in this repository. Bricks in India are often made of earth and distributed through traditional, unorganized, low-scalability companies. Bricks are significant structure materials and the block industries produce around 250 billion bricks for every year. The assembling of red mud bricks devours enormous amounts of dirt, prompting soil expulsion and soil degradation. Huge territories of land are crushed each year, particularly in creating countries, because of the assortment of soil from a profundity of around 1-2 m from farming area. A noteworthy advance in the creation of bricks is to shoot bricks in block kilns, which cause genuine health issues and environmental pollution. Consuming bricks fundamentally influence indoor greenhouse gas fixations. This causes genuine air pollution and furthermore the laborers of the block industries are inclined to respiratory sicknesses, to stay away from all these environmental dangers, bricks created from squander from squander as residues of various industries and factories, This kind of bricks are called bricks of fly ash made of various materials, for example, lime, chalk, sand, fly ash, etc.

Vijay Bhatt et al. (2017) performed scientific experiments For optimal energy efficiency, it is important to identify the ideal proportions of fly ash to cement while making construction bricks. The dimensions of the brick samples used for the "compressive strength, water absorption, and efflorescence test for different sizes" are 230 mm x 100 mm x 90 mm, and the mixture of fly ash (10-30%), chalk (3%), lime (25-25%), and sand (45-55%) is mandated by the Indian code. Compressive strength, water absorption, and efflorescence tests at 1000oC, 1100oC, and 1200oC for varying mixture ratios of the aforementioned materials indicate variances. Based on the available data, it can be said with confidence that "Flyash 10% Lime 35% Gypsum 3% Quarry dust 52%)" yields the highest anticipated compression intensity.

Shivasheesh Kaushik et al (2017) That study sought to determine the percentage including its full mix of fly ash bricks so that fly ash would be used but recycled for even the most suitable outcome possible for brick production. For bricks that sample dimension is 230 mm x 100 mm x 90 mm. Under the Indian norm for various mixing ratios of fly ash (10 to 30%), plaster (3 %), cement (25-35 %) and coarse aggregate (45-55 %) 3D steering wheels of ash particles 425 microns, 600 microns, 825 microns, compressive energy, water retention, efflorescence test for specific mixing percentages. The results show the differences within compression strength, water absorption or efflorescence test for both the different mixing percentages of a various metals mentioned In above various hardening periods of 7 days, 14 days, and 21 days. Through earlier research-based tests, it really was apparent that over the ideal mixing percentage of Fly ash-10 % Cement-35 % Gypsum-3 % coarse aggregate powder the absolute acceptable mechanical properties will be reached-52%.

S.P. S.P. Salma Begum (2017) A most straightforward as well as qualitative documentation on bricks and fly ash plants, their characteristics as well as utilizes was described. Many experimental studies with fly ash brick specimens are now in these projects to test concrete strength power and water absorption.

Abbas et al. (2017) presented bricks produced with fly ash and conventional land materials. The coal-fired power plant has acquired fly ash. The bricks were made the central brick manufacturing. The proportion is its principal component throughout this analysis of fly ash (i.e. 0-25% clay). Reports suggest that bricks containing fly ash were less compressive than clay bricks without fly ash. However, the compressive strength of bricks containing up to 20 percent of fly ash met the minimum specifications of the Pakistan Building Code. Weight reduction was also observed in fly ash bricks, which would have resulted in an overall reduction in the weight of the structures. Also, less efflorescence was found on the fly ash bricks. Therefore, it can be concluded that clay bricks that incorporate fly ash can help produce more sustainable bricks that lead to an economic solution.

K. Muhammad Nisham et al (2016) The toughness and strength feature of bricks made using fly ash, cement, met kaolin or quarry dust was tested. The effect of met-kaolin material throughout class F fly ash cement brick was also evaluated by innovative studies based on test methods as well as error blending. The studies are performed in two steps to measure the effect, namely tensile force as well as the moisture content fly ash from the concrete bricks. In both stages, “cement (10%) and quarry dust (35%, 30 %,) are kept constant and fly ash (55%, to 35%,, 60%, to 40%,) is up to 20 percent it is replaced by white met kaolin”s. Fly ash cement bricks are tested in the Institute's advanced concrete research laboratory after 7 days, 14 days and 28 days of polymerization. The test results showed that the maximum compression intensity optimized for an optimal mixing percentage of fly ash class F 40%, cement 10%, quarry dust 35% and met kaolin 15% is obtained. In both phases of the experiment, a decrease in the water absorption rate of the fly ash brick was observed during the use of met kaolin powder.

Nitin S. Naik et al. (2016) studied bricks prepared with fly ash, cement and phosphor-plaster for greater strength and durability. Several researchers have studied various properties of these bricks and Discovered that such bricks can also be used to build low-cost houses close a thermal power plant throughout the region.

Tarun Gehlot and SS Sankhla (2016) The impact with joint opposition mostly on strength properties with brick masonry as well as the tensile strength of concrete brick prism was investigated to fly ash with a 1: 6 and 1: 8 percentage difference of Recron cement mortar.

Mann et al. (2016) presented fly ash with a high clay replacement rate Characteristics of both the bricks throughout radiation shielding. A few other communication parameters of a fly ash bricks "(mass attenuation coefficients, average value layer, actual atomic number, effective electron density as well as effectiveness of absorption)" have been calculated to 661.6 keV, 1,173.2 keV and 1,332 , 5 keV NaI (Tl) detector. To investigate their protective behaviour, fly ash bricks were modelled with a clay mixture. For both the calculations a small state of both the beam geometry has been used. The observed parameters were estimated using theoretical calculations. Using an energy dispersive X-ray fluorescence spectrometer, these same compositional compositions of a clay fly ash bricks have been analysed. Those measurements of real atomic numbers and actual electrical densities for chosen frequencies display a really small variance with the formulation of the fly ash. That would seem to because of the resemblance with their elementary composers. Additionally, to research the effect of different mostly on nuclear safety properties of clay bricks, the calculated results have been evaluated with concrete. Clay fly ash bricks besides moderate gamma rays demonstrated excellent protective effects. Accordingly, such bricks were also feasible as well as environmentally friendly associated with conventional clay bricks used during development.

Wang et al. (2016) demonstrated through experimentation a novel process for producing bricks with a fly ash content of 50% to 80%, so demonstrating the potential for increased recycling of this waste product. The article details the ingredients, manufacturing procedure, and quality checks for raw ash bricks. It demonstrates how to optimize the mixture of characteristics and boost the device's performance by modifying the technical parameters of the mechanical device used to produce the current brick. To make bricks with a high percentage of fly ash, manufacturers select wet fly ash from power plants, mix in aggregates and additives in appropriate proportions and at appropriate doses, and conduct experimental research on the properties, production technology, and selection of production equipment parameters of the finished goods. National standards for the construction sector have been met across the board for strength, freeze-thaw resistance, and other characteristics of the bricks investigated.

Basha et al. (2016) presented a The reinforced concrete (RC) lateral load reaction system of fly ash brick masonry; Analysis indicate that perhaps the chassis yielded pretty decent lateral strength , rigidity, fracture and evaporation of energy. A parametric analysis was performed to use an analytical model built from of the observational data to evaluate that Through use of fly ash or burnt clay brick masonry in RC structures has an effect. Whereas the frames full with fly ash brick masonry displayed marginally less lateral strength and stiffness, owing to both the fragile nature of both the fly ash bricks, the post-peak degradation for lateral load storage capacity were markedly higher. Eventually, to explore the major reasons for both the poor but delicate Situations with fly ash bricks, 3 kinds of assesses have been calculated to evaluate their chemical and mineralogical composition: X-ray fluorescence analysis, electron microscope scanning combined to dispersion spectroscopy energy and X-ray diffraction technique these were reached the conclusion that the fly ash bricks have been weak as well as soft because of fly ash bricks Cement response to physically remove. These were suggested that activators be added to enhance the latter's stiffness as well as compressive when needed.

Shri Krishna Gurlhosur (2015) explained in the most illustrative, breezy, and to-the-point fashion the understanding of the qualities and applications of Ash Ash bricks. Compression power, water absorption, acid test, and alkaline test samples have all been tested in the lab. Researchers have looked into the best ratios of "fly ash, lime, sand, and super plasticizer (Master Glenium SKY 8233)". On days 7, 14, and 21, the mixture with the C2 mixing ratio (Flyash 50%, Sand 30%, Lima 20%, and Superplasticizer 3 ml) had the highest compressive strength. Similarly, after 24 hours of exposure, water absorption was determined to be 3.48%, but it would not have exceeded 15%. The compressive strength was "11.5 and 10 N / mm2 respectively" after being subjected to acid and alkali. After 24 hours of treatment, the pressure temperature of the specimen declines as the alkalinity and acidity of the solution increases.

Robiul Islam (2015) investigated Opportunity to use fly ash as a partial replacement with Bangladesh 's existing technology-based brick fabrication. It was studied the effect of fly ash with different substitution ratios (0 percent, 20 percent, 30 percent, 40 percent, and 50 percent by volume) of clay on the brick's properties. The bricks were produced on the field in conjunction with the ordinary bricks labelled of a certain amount to differentiate their at theTime for Research. After furnace combustion no physical alteration is found in the fly ash tile. Laboratory test results suggest also that compressive strength of the brick declines as fly ash increases as well as the peak compressive strength for fly ash is 19.6 MPa at 20 % .

Therefore, the fly ash brick's moisture content decreases only with rise in fly ash. There is already analysis of both the abrasion intensity and thus the particular weight of the coarse aggregate produced with bricks with fly ash, or the findings of this research suggest whether 20 percent of fly ash can indeed be regarded as the enhancing effect of fly ash for brick production. Better output of new technologies.

M. The Narmatha et al. (2014) the project is to strengthen Condensed fly ash bricks containing gritty ironies. The green movement has impacted open environment design and production around the globe. A greater interest in providing high-performance building devices. The American community of fenced buildings echoed this view in 2008 A formal project which illustrated this same links among energy efficiency, durability as well as interior availability was launched. The main focus of the paper relies on quality “best by constructing more durable and resilient wall structures cantered on use of the pressed fly ash bricks through applying the certain percentage of mixture Ironies materials of crushed fly ash bricks. Through a comparative test, we will show greater resistance in fly ash bricks.

Rinku Kumar and Naveen Hooda (2014) this same influence of fly ash on brick characteristics was researched, and even the conduct of fly ash bricks was applied to different burnt clay bricks. Those unique properties of fly ash bricks are being evaluated with two materials. The property examined moisture content, toughness, efflorescence, solidity, form and thickness, crush resistance as well as the prism 's basic tensile power usespecific mixtures of mortars, generally mortars of concrete and sand 1: 3, 1: 4 and 1: 5. Bricks are generally made from the most fertile agricultural land, but fly ash protects 28 percent of the most fertile agricultural land.

Abhijit Chakraborty (2014) presented the suggestion of using the VE principle to develop a new method for combining fly ash brick components that is much effective than older bricks. The crucial reason for every fly ash company's performance is its ability to deliver the commodity which satisfies customer expectations and at the same time offering a premium valuation which increases brand appeal and development protection.

Tahmina Banu et al. (2013) The thermal power plant Barapukuria has successfully produced lightweight structural bricks using fly ash as a key ingredient. Extensive research was conducted to identify an optimal mixture consisting of fly ash, sand, hydrated lime, and gypsum, while also optimizing the pressure applied during brick formation. The ideal composition was found to be 55% fly ash, 30% sand (or 15% hydrated lime), and 14%

gypsum. Various properties of the ash bricks, including compressive strength, microstructure, restraint properties, unit weight, initial absorption rate, absorption efficiency, apparent porosity, open pores, and impermeable pores, were carefully evaluated. Additionally, a sand-lime-plaster mixture was developed using different pressures during brick formation, incorporating the optimized composition. The bricks developed under optimized conditions also studied efflorescence and radioactivity. Subsequently, the influence of different healing processes and the variability of the curing time were studied. The results of this study indicated that the Barapukuria thermal power plant could produce good quality lightweight structural bricks without fire from coal fly ash.

Shakir et al . (2013) a study of bricks made with fly ash (FA), quarry dust (QD), and balance (BS) via an unorthodox method was provided. The ingredients are mixed with cement and water, and the bricks are shaped into molds without being compressed. With substantial environmental and ecological benefits, the modern method of brick manufacture avoids the use of clay and shale, as well as baking molds and ovens at high temperatures. Positive and encouraging findings regarding mechanical properties have been obtained. The best mix of billet to fly ash is 1:1, while the best mix of billet to quarry dust is also 1:1. The study's bricks are recommended as a feasible replacement for standard bricks.

Singh et al. (2013) The "physical, chemical and mineralogical" properties of LD steel slag, as well as its potential usage in commercial brick making, were carefully evaluated using multiple evaluation technologies, as indicated. The results of an LD slag identification revealed that the pH and ionic resistivity of the specimens were extremely high, indicating a large concentration of various lime and ionic existence salts. The unit weight and bulk density of the LD slag samples were found to be high, especially when compared to a fly ash sample.X-ray microanalysis using EDS revealed that the LD slag samples primarily consist of O and Ca. The X-ray fluorescence investigation uncovered the key ingredients. There are traces of CaO, FeO, and SiO_2 in the LD slag. The endothermic peak temperature determined by the DTA curve was 450.7 ° C. Samples of Form A bricks were tested, and they were found to be compressive (fly ash 35%, LD slag 30%, chalk 5%, quarry stone 20%, lime 9.75% +).After 14 days of seasoning, the density of bricks treated with a 0.25 percent solution of $CaCl_2$ (above 100 kg/cm2) was significantly higher than the density of regular red clay bricks (50-70 kg/cm2).

Parashar et al. (2012) Conducted a comparison of the strength properties of bricks for which 4%, 8%, 12% and 16% by weight has been added individually and therefore the mechanical properties of bricks has been added individually, so a comparison of the strength properties of bricks made from rice husk, wood ash and clay using the graph. A few material prior to actually making the bricks (clay, wood ash, rice husk, cement, and fly ash)now undergoing testing, particularly concrete mix. Since making and curing the bricks throughout the sun and curing some bricks, then used the compression testing machine (C.T.M.), the concrete strength size was observed specifically. These were inferred from that kind of study throughout this project whether wood ash had been the waste material, giving its greater tensile strength. The effects of adding rice husk (for combustion) and mixtures of wood ash mixed with clay percentage were also studied. The blends were added by weight in various combinations of proportions (4-16 percent). The ash wood mixture could contribute to obtain thicker compressive products, higher softening coefficients, lower water absorption rates, lower saturation.

Naganathan et al . (2012) Effects of materials such as brick from bottom ash but fly ash were recorded. Built from specific bottom ash, fly ash or lime, the bricks was. Size of aggregates, density, strength, water, as well as ultrasonic pulse velocity (UPV) tests were done. The findings indicate that the concrete strength power differed from Brick strength increases as fly ash, moisture content, and UPV increases linearly fly ash. The conclusion would be that decent quality bricks could be managed to make with quarry dust and fly ash, that also leads to sustainable development.

Chen et al. (2012) presented The analysis of geopolymer paste developed utilizing fluidized ash (CFBC) at the base of a roof. The vector quantization, sodium hydroxide, potassium hydroxide, and lithium hydroxide solutions were all used as alkaline activators in the synthesis. The possible impact of alkaline activators on compressive strength was also investigated in this study. "XRD, FT-IR, and SEM / EDS" were used to study the chemical process. The compressive strength of a brick is influenced greatly by the alkaline activator used and the sodium silicate control module. The maximum tensile strength was reached when the module was "1.5, which could attain 16.1 MPa (7 days within a week of construction) and 21.9 MPa (28 days after manufacture). When comparing the effects of stress on ideal alkaline structures, "10 M KOH > 10 M NaOH > 5 M LiOH > 5 M KOH > 5 M NaOH" holds true. After the reaction, no other crystalline phases besides quartz were found in the original lower powder. The primary degrading component has been an amorphous calcium silicate gel, however SEM analysis has revealed a trace crystalline phase.

2.2 SUMMARY OF PAST WORK

With the increase in the number of migrants entering the city, the need for housing becomes irrelevant. The construction sector has grown rapidly. As a developing country, India has seen many ongoing infrastructure projects such as the development of roads, housing plans. The increase in housing and industrial growth requires more material, such as brick, concrete and sand. Many additives and additives enrich the structure of stone. Few also use local fly ash efficiently throughout the manufacture of cement and discovered it suitable dimensions throughout brick manufacturing.

2.3 BASIS OF CURRENT WORK: PROBLEM SELECTION

Everything just demonstrates through some kind of bibliographic questionnaire that sporadic, location-specific as well as local issues had also compelled officials for using fly ash. There seems to be no sustainable development or outcomes development in many other locations as yet. So it needs additional work or tests. Fly ash must be deemed a "resource" and just cannot really be "discarded" but it must be "fruitfully utilised. “Here is an extract of President APJ Abdul Kalam's Speech to both the Nation mostly on eve including its 56th Independence Day 2006: "As people know, any use of coal besides energy production means implies change in the total of fly ash produced up to 100 MMT / year. Every effort is required to be using this fly ash for not only the environmental protection but to also prevent unnecessary its use of soil for both the release of fly ash.So there has been significant progress in use of fly ash since 1990, we do have a long way to go in terms the goal that use fly ash 100 per cent. The rise in farm wheat is about 15 percent, green vegetables 35 percent, and tuber 50 percent, as fly ash combines with the crop. By manipulating them to manufacture green building materials, highways, agriculture, etc., fly ash may become a wealth producer. The effective utilization of both the transformer would then create employment potential for 300,000 people but also result throughout turnover exceeding Rs. 4 Billion rs.

CHAPTER 3
PROBLEM STATEMENT

3.1 PROBLEM IDENTIFICATION

Today flue ashes is used in all types of buildings, including skyscrapers, dams, bridges, power plants, etc. This is used on the Tremic Seal and Bandra-Worli Sea Connection Mumbai Pylon Cap.

The construction of the control frame, the induced draft cooling tower, the pump body, the turbine frame, etc. Since the Kaiga project (ongoing), the units of the Atomic Power project of Rajasthan, the units of the Atomic Power Tarapur project have used concrete containing flue ashes ranging from 20% to 50%. Large construction projects such as the Delhi Metro Rail Corporation use concrete flue ashes from the ready-mix concrete factory (RMC). The Allahabad ring road of India's national highway authorities used 6.7 million tons of ash from the NTPC Feroz Gandhi Unchahar thermoelectric power plant, while in 2 years approximately 2 million tons of ash were used on the Great Noida Expressway from the power plant Badurpur thermal power station.

The Indian government withdrew entirely the excise duty on flue ashes products and issued the GR from the Ministry of Road and Motorway Transport on July 30, 2003, n. RW / NH-33044/30/2001-S & R (R) Addressed by the IRC Guidelines: SP-58-2001 to all Secretaries of State, Chief Engineers of PWD (Roads) on the use of flue ashes in the construction of elevated roads and embankments.

The use of flue ashes in road construction has shown Larson and Turbo Ltd. to have the following advantages: reduced hydration heat, better Specific gravity but also convenience of pumping, superior micro - structural resulting in low permeability, longer durability, higher quality in aggressive environments and greater electrical coercively to lower corrosion chances. For such a reason, flue ashes is used in building construction industry India increase from “3% in 1994 to 38% in 2005”; while the generation of flue ashes has increased threefold.

The literature review demonstrates which sporadic, location-specific as well as local issues pressured flue ashes to be used against officials. Little longevity and profitability growth in other regions. Consequently, better work and experimentation is needed. Flue ashes should be considered a "resource", so not only can it be "discarded", but "used fruitfully.'

The following is taken from President Abdul Kalam's speech to the nation on the eve of the 56th Independence Day 2006:

“Flue ash output has increased to as much as 100 million metric tons per year due to the use of coal for energy generation. Using these flue ashes is important for both environmental reasons and to prevent fly ash from being discharged into the soil. The utilization of flue ashes has increased steadily since 1990, but we still have a ways to go before we reach our goal of using just flue ashes. When flue ashes are mixed with soil, crops like wheat, green vegetables, and tubers all see increases of between 15 and 50 percent. By using it to make environmentally friendly materials for construction, roads, agriculture, etc., flue ashes can become a source of revenue in their own right. When generation supplies are fully utilized, approximately 4,000 rupees in revenue can be generated and 300,000 individuals can find work.”

3.2 PROBLEM STATEMENT

The problem statement of the study revolves around the exploration of experimental advancements in the development of gypsum-enhanced fly ash-sand-lime bricks. Despite the increasing demand for sustainable and environmentally friendly construction materials, there is still a need for research and innovation in the field of brick production. Traditional clay bricks have significant environmental impacts due to the extraction of clay from the earth and the energy-intensive firing process. Therefore, there is a growing interest in developing alternative building materials that utilize industrial by-products, such as fly ash, a residue obtained from thermal power plants. However, the utilization of fly ash as a sole ingredient in brick production poses certain challenges, including its low reactivity and limited strength. This is where the incorporation of gypsum comes into play. Gypsum, a mineral often used in construction materials, has been found to possess beneficial properties that can enhance the performance of fly ash-based bricks. Gypsum has the potential to improve the binding properties, increase the strength, and enhance the durability of the bricks, making them more

suitable for structural applications. The main objective of this study is to explore and investigate the experimental advancements related to gypsum-enhanced fly ash-sand-lime bricks. The researchers aim to evaluate the effects of incorporating gypsum into the composition of these bricks on various aspects, including mechanical properties, durability, water absorption, and microstructure. By conducting a series of experiments and comprehensive analyses, the study seeks to provide insights into the potential advantages and feasibility of utilizing gypsum-enhanced fly ash-sand-lime bricks as a sustainable alternative to traditional clay bricks. Addressing this problem has significant implications for the construction industry and sustainable building practices. If successful, the development of gypsum-enhanced fly ash-sand-lime bricks could contribute to reducing the environmental impact associated with brick manufacturing. Additionally, it could promote the efficient utilization of industrial by-products and provide an economically viable solution for the construction sector. Ultimately, this research aims to contribute to the advancement of environmentally friendly construction
materials and support the transition towards more sustainable building practices.

3.3 OBJECTIVES

The objective of the study is to explore and investigate the experimental advancements related to gypsum-enhanced fly ash-sand-lime bricks. The researchers aim to examine the effects of incorporating gypsum into the composition of these bricks and assess its impact on various properties and characteristics. The study aims to analyze parameters such as compressive strength, durability, water absorption, microstructure, and other relevant properties of the bricks. By conducting comprehensive experiments and evaluations, the researchers aim to provide insights into the potential benefits and feasibility of utilizing gypsum-enhanced fly ash-sand-lime bricks in construction applications.

CHAPTER 4

RESULTS AND DISCUSSION

The entire section explains its methods followed again for manufacture of bricks, necessary processes throughout the produce of raw resources, detailed component parts, laboratory research seen in the associated IS codes. It takes a snapshot of the methodology's essential moves. Such pictures are often seen in chapter.

Experimental findings for the following cases-

1. 1. Adding flue ashes with diversepercentage from 50 - 65%,
2. 2. Adding lime with diversepercentagefrom 10 % - 25%,
3. 3. Adding sand with diversepercentagefrom 15 - 30%,
4. 4. Adding gypsum with diversepercentagefrom 2% - 8%,
5. 5. The bricks are selected as per conventional IS code (size 19 x 9 x 9 cm) and are test in the lab according to IS code 1077 -1970 and 3595-1974.

The fundamental requirement in every analysis is the classification of the raw material utilized. The raw materials used throughout the laboratories include fly ash, cement, lime and gypsum.

4.1FEATURES OF MATERIALS USED

The laboratory is used to analyze bricks and flue ashes to identify their important physical and chemical qualities. In the results and discussions section, we have summarized its key points. Using these criteria, we may categorize and rank the many types of flue ashes that are put to good use. Common terms for describing fly ash include these.

The chemical arrangement of the dirt determines the viability of brick creation. As per Rangwala (2006) (an) if the excess of alumina the bricks shrink and disfigure, (b) if the excess of silica, (c) if the lime is excessive, the brick loses its shape and break (d) excess iron oxide will change the shade of the bricks from dull blue to blackish to yellowish, and (e) excess magnesia makes the brick deteriorate. Soluble bases can contort and twist bricks and expel dampness from that of atmosphere.

4.1.1 CEMENT

Cement can indeed be described as that of the adhesive material with adhesive and cohesive characteristics, enabling this to join various building materials but also establish the compressed group. Commonplace or regular Portland cement is a popular option. Portland cement got its name in 1824 from its creator, Joseph Aspin, who noticed that, once dried, Portland cement looked and felt a lot like Portland stone. Portland, Dorset's Portland Stone is a chalky gray-white.

Ordinary Portland Cement (OPC) with a temperature of 43 degrees was used in the experiments. Dry cement was available in Bhopal's local market. The experimental study's results for the OPC's physical properties are summarized in Table 4.1.

Table 4.1: Ordinary Portland cement'sPhysical Properties

Sr. No	Property	Results
1	Fineness	3 %
2	Soundness	1 mm
3	Setting Time	Initial= 85mm, Final= 165 mm
4	Specific Gravity	3.15
5	Compressive Strength	After 3 days = 27.00 MPa
		After 7 days = 34.20 MPa
		After 28 days = 44.22 MPa

Fig. 4.1: Cement

4.1.2 FLUE ASH

Flue ash, also known as combustion ashes, consists of fine particles carried by the combustion gases and is the byproduct of combustion. Flue ashes, as used in a mechanical sense, typically refer to the ash produced during the burning of coal. Everything that is considered coal ash in this situation, along with the base ash expelled from the bottom of the stove, is collected in the flue of coal-terminated power plants via electrostatic precipitates or other particulate filtration hardware before the combustion gases arrive at the chimney. And yet, "all flue ashes contains large quantities of silicon dioxide (SiO_2) (both amorphous and crystalline) and calcium oxide (CaO), both of which are endemic fixations in numerous carbon-containing rock layers, depending on the source and composition of burnt coal," as one source puts it.

Fig. 4.2: Flue ashes used

4.1.3 Sand

Brick Sand is textured fine, and is used in brick and concrete work. Brick sand may also use it as a base above the-ground pools. Concrete sand has been primarily used in textured concrete. It is used in paver installations as well. This study utilized sand that was available locally. Specific gravity to the sand was 2, 78 and fineness was 2, 34.

Fig. 4.3: Sand used

4.1.4 GYPSUM

Yes, an important industrial sulphate mineral consisting of hydrated calcium sulphate ($CaSO_4 \cdot 2H_2O$). Actually these are named 80 miles with well formed crystals. The enormous stringy wide range does have a silky shine and has been named satin spar; it's indeed translucent as well as opalescent, acknowledged for jewelry as well as ornaments. The massive, fine-grained type named alabaster was sculpted or polished of statuary but ornamental use it when pure as well as translucent The plaster is earthy type.

Gypsum is deposited by oceanic brine after anhydrite and halite, and forms huge beds with these other minerals (especially in Permian and Triassic sedimentary deposits). In addition to its prevalence in salty lakes, Texas and Louisiana are home to salty domes covered by a rocky layer composed primarily of anhydrite-sio rock. Many layers of chalk disintegrate into anhydrite rocks because anhydrite is generated by the hydration of surface and subsurface liquids, making it very superficial. The residual anhydrite layers undergo intense creasing and sealing as a result of this replacement, leading to volume increases of 30% to 50%. Limestone, dolomitic limestone, and some schists also contain gypsum. The plaster is completely dehydrated at high temperatures to obtain a particularly hard finishing plaster, adding chemicals such as alkaline sulfate, alum or borax. Throughout the manufacture, hair or fibers, lime or clay can be applied to the hair. For some finishing paints, gypsum paints are smoothed.

Basically, the plaster does not affect the environment, man, animals and plants. It is not that soluble in water. Gypsum blocks are utilised as concrete blocks. The chalk was also collected from the research site.

Fig. 4.4: Gypsum used

4.1.4 WATER

water available Locally is used in production of brick.

4.2 MIXING OF RAW MATERIALS

The currentresearch uses mixtures of fly ash, asphalt, lime and chalk. Satish Nannavre, a brick maker "SS Bricks", contributed to this work. He used molds and ovens. The following is the mass of the sand, fly ash, cement and plaster needed for the different mixtures. A stunning set of brick. It is indeed dried out during the oven. It is approximated the weight of both the dry brick which would be comparable to something like the sand needed to implement a brick. Conversely, ash, cement, lime and plaster are often used in different ratios.

Raw materials such as fly ash, mortar, and cement were ready for blend by weight in order to manufacture bricks of a certain proportion. The materials needed have been accurately calculated by each study as well as proper weighing of the materials. The proportions for materials or weight of both the content needed of flue ashes bricks are shown in Table 4.2 by size of brick = 190 x 90 x 90 mm. Bricks are made as shown in figure 4.4:

Table 4.2:fly ash- gypsummixing proportion of raw materials and brick sample in percentage

Brick sample no.	Fly ash (%)	Cement (%)	Sand (%)	Gypsum (%)
1	50	10	28	12
2	55	10	26	9
3	60	10	24	6
4	65	10	22	3

Table 4.3: fly ash- gypsum Mixing proportion of raw materials and brick sample in grams

Brick sample no.	Fly ash (gm)	Cement (gm)	Sand (gm)	Gypsum (gm)
1	119	35	88	31
2	131	35	82	24
3	143	35	76	16
4	155	35	70	8

Table 4.4:fly ash- Lime Mixing proportion of raw materials and brick sample in percentage

Brick sample no.	Fly ash (%)	Lime (%)	Sand (%)	Gypsum (%)
1	50	10	28	12
2	55	10	26	9
3	60	10	24	6
4	65	10	22	3

Table 4.5: fly ash- Lime Mixing proportion of raw materials and brick sample in grams

Brick sample no.	Fly ash (gm)	Lime (gm)	Sand (gm)	Gypsum (gm)
1	119	35	88	31
2	131	35	82	24
3	143	35	76	16
4	155	35	70	8

4.3 TEST CONDUCTED ON BRICKS

Testing is carried out according to the relatable IS practice codes (IS 3495-1992; Standard Brick Testing Specifications 1976 1-9-2). Bricks are test for compression capacity, absorption of water, efflorescence, and finish. All brick work is carried out on three specimens, and mean price is called descriptive.

These tests have to be conducted on brick specimen.

1. test for Compressibility (as per IS-3495 (Part- 1):1992
2. Test of Absorption Of Water (as per IS-3495 (Part-2):1992
3. test for Efflorescence (as per IS-3495 (Part-3):1992
4. test for Soundness

4.3.1 COMPRESSIBILITY TEST (AS PER IS-3495(PART-1):1992

To assess the compression strength of a bricks, we had to position the brick on the smooth horizontal layer among the check machine tiles. The axial charge is fully justified until the brick fails.

Procedure

1. Place a flat-faced horizontal and mortar-filled specimen facing upwards between the test machine plates.
2. The maximum failure load can be determined by applying axial force at a constant rate of 14N / mm2 (140kg / cm2) per minute until failure occurs.
3. The failure load is the highest load at which the indicator on the testing machine no longer shows an increase in strain on the specimen.

To assess compressive strength in wet condition, as mentioned before, brick is put in water 24 hours after phase. Then they are put to drain. The failure load is then mounted on the testing machine for compression.

Outcome of compression strength test for different bricks blends are shown in the section of conclusions and recommendations.

The compression force of the brick is calculated with the formula,

Compression strength= Maximum load at failure/ mean area of the surface.

Fig. 4.5:Compressive strength test

4.3.2 TEST OFABSORPTION OF WATER (AS PER IS-3495(PART-2):1992

Dried the brick in the oven at 105-115 ° C temp, then cool it upto to room temp, and weigh it (M1). Then, at room temperature, immerse the dry brick in water for 24 hours, take out the brick from the water and rub the mud with a cloth and measure the brick (M2).

Fig. 4.6 Testof Water absorption

4.3.3 FINISHING (STANDARD SPECIFICATIONS 1976-1-9-2)

For finishing options, scale, colour, surface texture, surface smoothness and brick appearance are reported and shown in the section of outcomes and discussions.

4.3.3.1 EFFLORESCENCE TEST

The brick's efflorescence test has been determined by putting the brick side throughout the dish as well as trying to fill this same filtered water back to a plate depth of 25 mm. The entire system is rendered with well ventilated space at room temperature until the brick consumes all of the water in the dish and the surface water evaporates. Cover the platter to decrease excess evaporation. The bricks appeared dry, when the water was drained; adding a same amount in the dish helps it in evaporatinglike before.

Efflorescence is procure after 2nd evaporation.

(A) Nil: Not even a slight deposit of efflorescence
(B) Slight: if not more than 10% of the exposed brick area is covered with thin salt deposits
(C) Moderate: when particles are heavier than 'Slight' and cover up to 50% of the exposed region of the brick base, but not followed by powdering or base flaking.
(D) Heavy: when salts are heavily deposited, accomplishingmore than 50% of the area exposed of the brick surface but not accompanied by powder or flaking of the surface.
(E) Serious: when salts are heavily coated with powder and/or flaking of exposed surfaces.

4.3.4 SOUNDNESS TEST

The two bricks are separated from each other and render hit. Strong quality brick shouldn't crack and give a ringing tone.

4.3.5 HARDNESS TEST

Scratch is made with the help of a finger nail mostly on ground of a tile. If there is no assumption mostly on surface, then the brick is hard enough.

CHAPTER 5
OUTCOMES AND DISCUSSIONS

Different brick properties with different proportions are determined on the basis of the system of methodsdiscussedfor brick making and its lab test. They're being shown here. Is also provided the explanation of these findings.

5.1 COMPRESSION STRENGTH TESTING OF BRICKS

Utilisation of the raw material mentioned before and the technique discussed in section 4, bricks are produced in different proportions of clay, flue ash, cement and gypsum.

Table 5.1: showing the dry compressive strength of fly ash- gypsum bricks

Brick sample no.	Fly ash (%)	Cement (%)	Sand (%)	Gypsum (%)	Dry Compressive strength in N/mm^2
1	50	10	15	2	16.98
2	55	10	20	4	24.67
3	60	10	25	6	16.95
4	65	15	30	8	15.90

Table 5.2: Wet Compressive strength of fly ash- gypsum bricks

Brick sample no.	Fly ash (%)	Cement (%)	Sand (%)	Gypsum (%)	Wet Compressive strength in N/mm²
1	50	10	15	2	14.23
2	55	10	20	4	22.28
3	60	10	25	6	13.21
4	65	10	30	8	12.11

The compressive strength of bricks with the addition of flue ashes is observed to increase from 50 percent to 65 percent. There, 55% fly ash, 10% cement and 4% chalk tendency show a decline after 15% sand. It is also obvious that the application of up to 55 percent flue ashes by sand weight can be taken as an acceptable ratio to increase the brick's dry compressive power. Therefore using flue ashes has a negative impact on power. It's because a small amount of flue ashes fills the hole throughout the clay matrix, but decreases the sensitivity by either a greater proportion since the ash functions as both an uncreative part throughout the matrix.

Approximately sameoutcomes are for dry and wet brick compression strength.

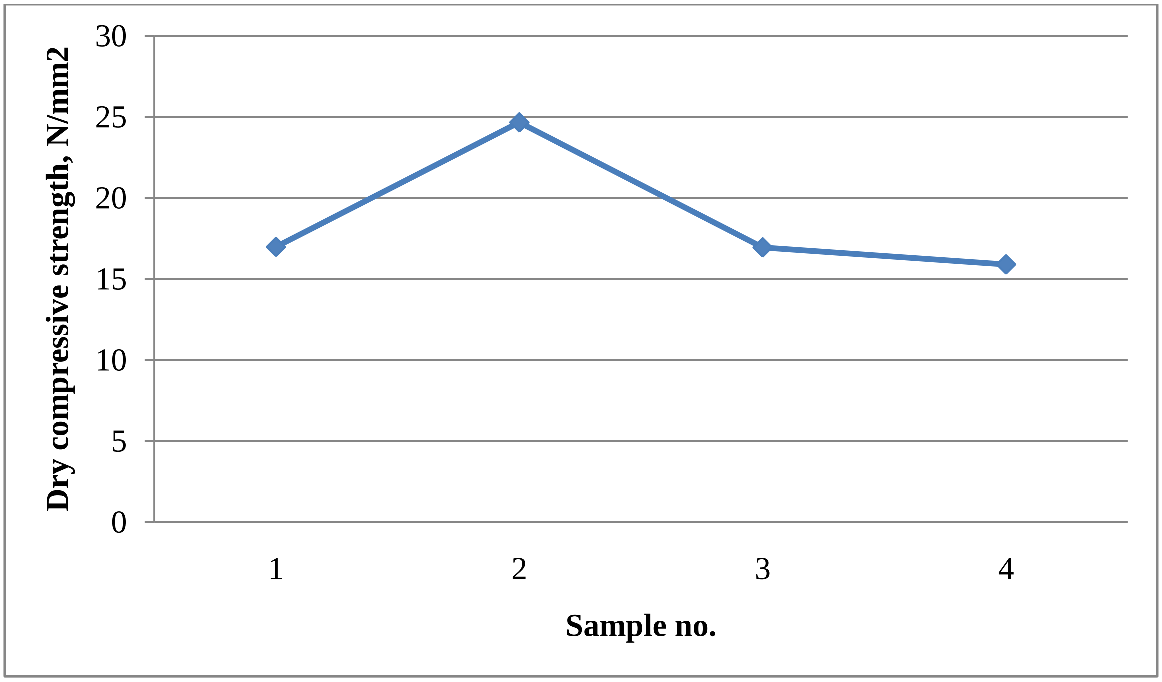

Fig. 5.1: fly ash- gypsum bricksDry compressive strengths

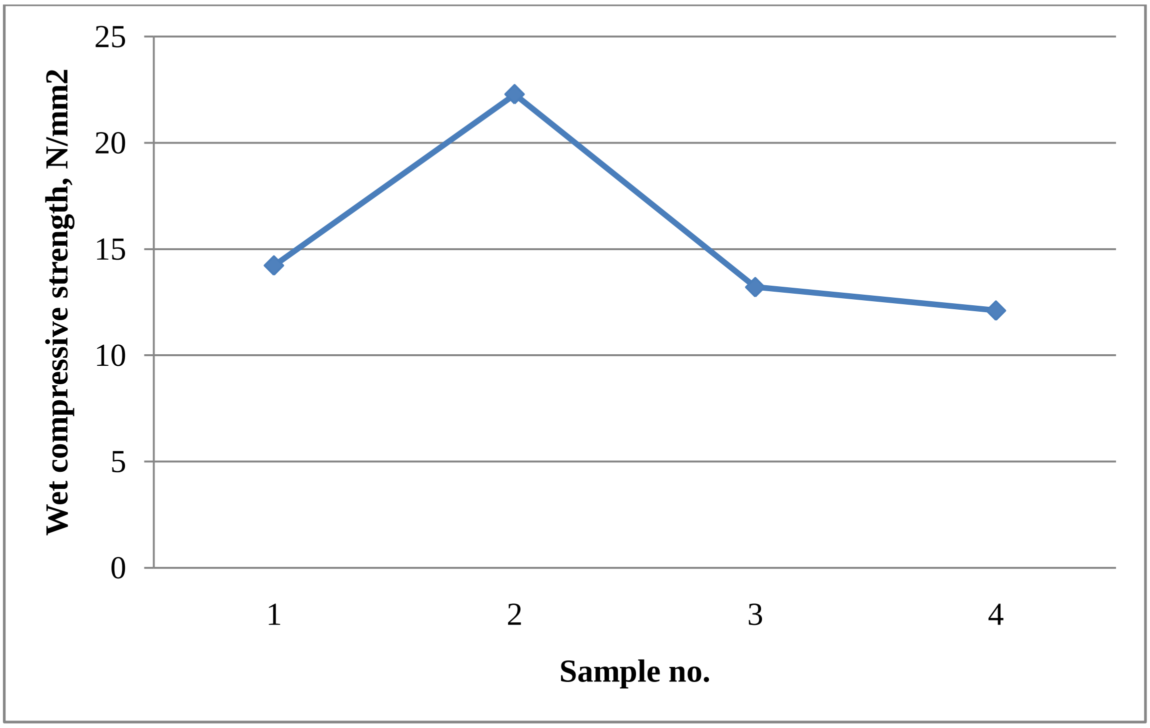

Fig. 5.2: fly ash- gypsum bricksWet compressive strength

Comparing dry and wet bricks displays certain dry compressive force. Implying that even under drying conditions 55 % flue ashes slabs could be used and they're more than that of the required minimum. It can be due by applying flue ashes fills as well as strengthens the micro pores of the clay matrix.

Table 5.3: showingfly ash- lime bricks’ dry compressive strength

Brick sample no.	Fly ash (%)	Lime (%)	Sand (%)	Gypsum (%)	Dry Compressive strength in N/mm^2
1	50	10	15	2	11.24
2	55	10	20	4	19.32
3	60	10	25	6	12.15
4	65	15	30	8	11.08

Table 5.4: fly ash- lime bricks'sWet Compressive strength

Brick sample no.	Fly ash (%)	Cement (%)	Sand (%)	Gypsum (%)	Wet Compressive strength in N/mm^2
1	50	10	15	2	10.34
2	55	10	20	4	17.24
3	60	10	25	6	11.46
4	65	10	30	8	10.66

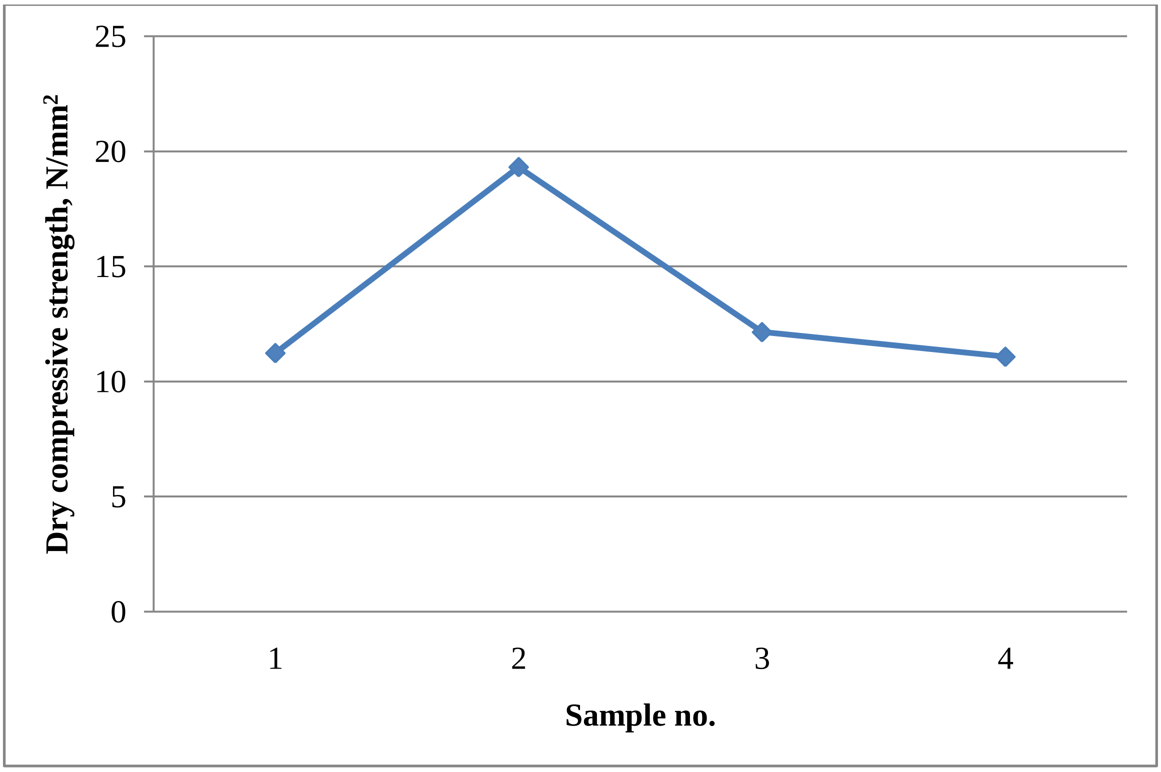

Fig. 5.3: fly ash- lime bricksDry compressive strengths

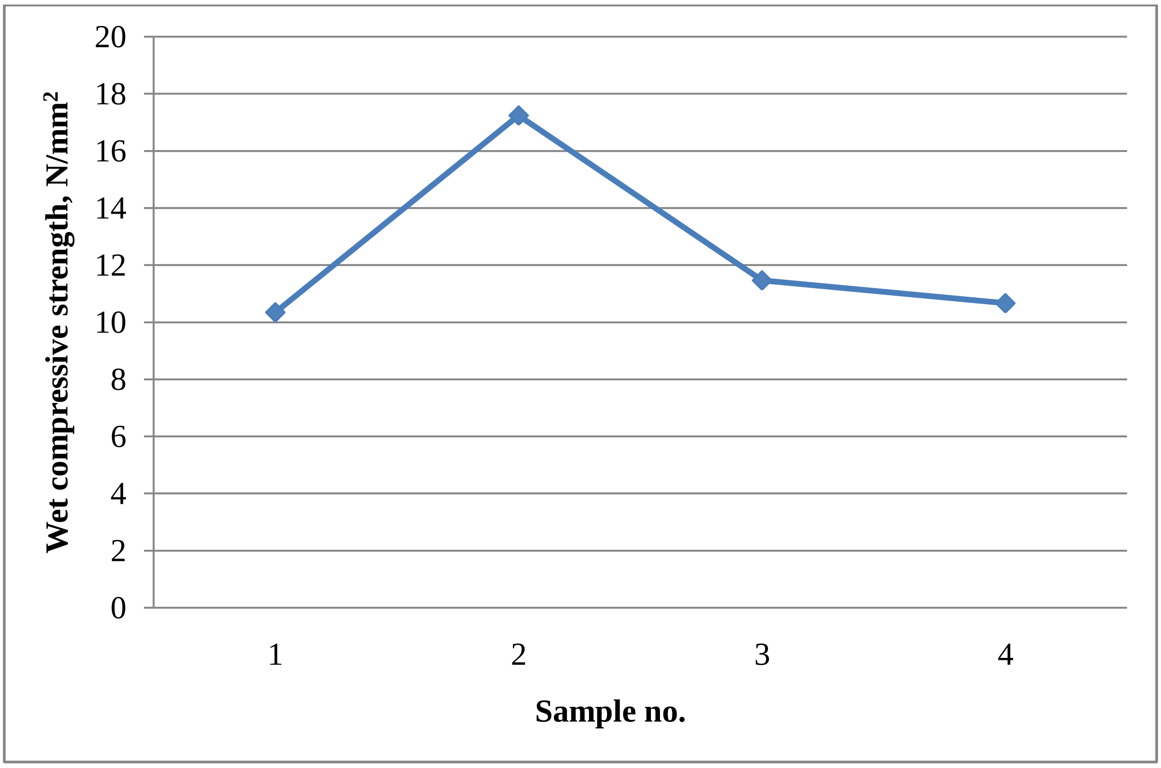

Fig. 5.4: fly ash- lime bricksWet compressive strengths

Results indicated that the application of flue ashes as well as lime in either proportion both in drying conditions has a harmful effect on compressive strength of both the brick. Neither of the variations is as strong as fly ash-gypsum bricks.

5.2 WATER ABSORPTION TESTING OF BRICKS

Water absorption is a significant feature in brick engineering. It has to be within the permissible limits set by IS codes. All brick blends were tested for water absorption except ash-stone bricks made from sand-lime-fly. Table 5.5 provides water absorption of many mixtures of clay-flue ashes bricks.

Table 5.5: fly ash- gypsum bricksWater absorption

Brick sample no.	Fly ash (%)	Cement (%)	Sand (%)	Gypsum (%)	Water Absorption (%)
1	50	10	15	2	19.22
2	55	10	20	4	18.90
3	60	10	25	6	19.64
4	65	10	30	8	23.42

Flue ashes adding flue ashes to the bricks has contributed to a small decrease For the processing of vapour. This can be ascribed to trying to check the pore stronger because of flying ash. Consequently, higher amounts of flue ashes eventually diminished moisture content due to poor binding. The addition of flue ashes to lime did not really help decrease moisture content. Instead it doubled the retention of nutrients.

It may be because adding lime results to small-crack initiation in clay bricks (Rangwala, 2006). This is due to decreased compression strength and improved water absorption of bricks.

Table 5.6: fly ash- lime bricks'Water absorption

Brick sample no.	Fly ash (%)	Lime (%)	Sand (%)	Gypsum (%)	Water Absorption (%)
1	50	10	15	2	20.623
2	55	10	20	4	21.945
3	60	10	25	6	22.520
4	65	10	30	8	20.930

Results show that higher flue ashes proportions obviously increased water absorption due to poor binding. Adding flue ashes with lime hasn't helped to low dowm water absorption. instead, it increased water absorption.

Probably because clay bricks other than lime develop very small cracks (Rangwala, 2006). This is due to the lower compressive strength and higher water absorption of lime bricks.

5.3 FINISHING OF BRICKS

Finishing with it is necessary with clay bricks to be well formed edges, straight lines and texture. Particularly when the bricks have been used before plastering for particular architectural reasons for outside rooms of the building. A quality may be modified throughout furnace combustion due to its chemical activity of a brick component. For sand and lime bricks hardened by that of the chemical hydration reaction, this dimension isn't relevant. The brick finish was however documented using various mixtures in table 5.7 and 5.8.

Table 5.7: fly ash- gypsum bricksGeneral appearance

Sample	Size	Texture	Edges
1	19 x 9 x 9 cm	Smooth	Sharp and regular
2	19 x 9 x 9 cm	Smooth	Sharp and regular
3	19 x 9 x 9 cm	Slightly rough	Slightly irregular
4	19 x 9 x 9 cm	Slightly rough	Slightly irregular

Clearly, adding flue ashes has not affected brick finishing. Also, adding A smaller percentage of gypsum didn't affect the completion of up to 7.5% lime but a larger proportion of flue ashes negatively affected its completing of bricks and observed a production of white spots mostly on surface which influenced the colour of even greater than 4% gypsum. Neither edge smoothness nor sharpness is often affected by the substance of gypsum due to non-binding material. It's a famousphenomenon that lime excess damages brick finishing (Rangwala, 2006).

Table 5.8: General aspect of fly ash- lime bricks

Sample	Size	Texture	Edges
1	19 x 9 x 9 cm	Smooth	Sharp and regular
2	19 x 9 x 9 cm	Smooth	Sharp and regular
3	19 x 9 x 9 cm	Slightly rough	Slightly irregular
4	19 x 9 x 9 cm	Slightly rough	Slightly irregular

Clearly, the addition of flue ashes did not affect the brick finish. In addition, the involvement of a small percentage of lime did not affect the finish up to 55% of lime, but a greater percentage of flue ashes negatively The appearance of both the bricks influenced but white spots surface morphology which colour that with much more percentage of lime. Since because of non-binding material that smoothness or sharpness of both the edges is often determined either by lime materials. This is a common phenomenon which harms excess lime the brick finish (Rangwala, 2006).

5.4 EFFLORESCENCE IN BRICKS

Efflorescence is the appearance of white stains on bricks surface due to more independent lime in the brick.This influences the look and renders the bricks unfit for use on external surfaces. Efflorescence is measured in Tables 5.9 and 5.10 for clay flue gas and clay-fly ash limestone.

Table 5.9: Efflorescence in fly ash- gypsum bricks

Brick sample no.	Fly ash (%)	Cement (%)	Sand (%)	Gypsum (%)	Efflorescence
1	50	10	15	2	Nil
2	55	10	20	4	Nil
3	60	10	25	6	Slight
4	65	10	30	8	Slight

Table 5.10: fly ash- lime bricks' Efflorescence

Brick sample no.	Fly ash (%)	Lime (%)	Sand (%)	Gypsum (%)	Efflorescence
1	50	10	15	2	Nil
2	55	10	20	4	Slight
3	60	10	25	6	Moderate
4	65	10	30	8	Heavy

Table 5.10displays Data analysis of the efflorescence. Comparison was made with the efflorescence with gypsum bricks and lime fly ash. This testing indicates a negligible degree of efflorescence for all gypsum flue ashes brick mixtures. Efflorescence of lime occurs.

When lime ratio decreases, it decreases. That is because of the brick's free salts (especially lime). Efflorescence for the bricks is unacceptable.The above spoils outward surface profile. It helps to make the plaster hard as well as, surrounded by white time, the plaster is peeling (Rangwala, 2006).

5.5 SOUNDNESS TEST

Throughout this experiment we tested the bricks for sudden impact to verify their soundness. Take the two bricks and slap them together. Good quality brick is not supposed to break and ring out sound. With the enhanced lime content, brick ringing continues to decline. For fly ash-gypsum brick two ringing sound is very good. Ringing tone for brick sample (fly ash-lime) is considered to be two fewer since brick porosity.

5.6 HARDNESS TEST

Scratch is decided to make on the surface of the brick and use a finger nail. If there is no ground suggestion the brick is hard enough. The first two samples show positive results and the last two specimens showed poor results for flue ashes bricks.

5.7 ECONOMIC ANALYSIS

They did some research on the quality of both the bricks after all of the checks on the ricks. The quality of a brick is calculated based of both the four variables.

1. Rate of sand

2. Rateof lime

3. Rateof fly ash

4. Rateof gypsum

5. Rateof cement

6. Labour cost

They collected dirt, gypsum, lime, gravel , sand and flue ashes for bricks, depending on the mix pattern calculation. Considering that water is available to a large degree in India, its costs can be overlooked. The latest research reveals that ash-gypsum fly bricks can be made from 55 per cent, 10 per cent lime, 20 per cent sand and 4 per cent gypsum. The consistency of the bricks is evaluated as follows:

For flue ashes – gypsum bricks

"Base: 1,000 bricks per day

Dimensions: 190 mm x 90 mm x 90 mm

Weight 1 brick = 2.75 kg

Mixing ratio:

Ash - 55%, cement - 10%, sand - 20% and gypsum - 4%

1. Labor costs = 250 × 6 members = R 1 500 / -

2. Electricity = Rs. 65 / -

3. Flour ash = Rs 700 per ton = Rs 0.7. It's per kilogram

Each brick requires 131 grams of ash

Per 1000 bricks = 131 grams * 1000 = 131 kg

Cost of ash from dough = 0.7 * 131 = Rs. 91.7 / -

4. Gypsum = 24 grams for each brick

Per 1,000 bricks = 24 x 1,000 = 24,000 grams = 24 kg

25 kg gypsum = Rs. 225 / -

Plaster cost = 225 * 24/25 = Rs. 216

5. Sand: 1 tractor = 5 tons = 5,000 kg = 3,500 / - Rs.

82 grams of sand are needed for each brick

Per 1000 bricks = 82 grams * 1000 = 82 kg

Sand cost = 82 * 3500/5000 = Rs. 57.4 / -

Cement cost = Rs. 450 / - per 50 kg

35 grams of cement are needed for each brick

Per 1,000 bricks = 35 grams * 1,000 = 35 kg

Cement cost of brick = 35 * 450/50 = Rs. 315 / -

Total cost per 1000 bricks = 1500 + 91.7 + 216 + 57.4 + 1500 + 65 + 315 = Rs. 3745,1 / -

Price of each brick = 3745.1 / 1000 = Rs. 3.74 / -

Production costs for each brick = Rs. 3.74 / -

Lime ash - lime

Base: 1,000 bricks per day

Dimensions: 190 mm x 90 mm x 90 mm

Brick weight = 2.75 kg

mixing ratio":

"Ash - 55%, lime - 10%, sand - 20% and gypsum - 4%

1. Labor costs = 250 × 6 members = R 1 500 / -

2. Electricity = Rs. 65 / -

3. Flour ash = Rs 700 per ton = Rs 0.7. It's per kilogram

Each brick requires 131 grams of ash

Per 1,000 bricks = 131 g * 1,000 = 131 kg

Cost of ash from dough = 0.7 * 131 = Rs. 91.7 / -

4. Lime = 35 grams per brick

Per 1,000 bricks = 35 x 1,000 = 35,000 grams = 35 kg

10 kg of lime = Rs. 60 / -

Plaster cost = 35 * 60/10 = Rs. 210

5. Sand: 1 tractor = 5 tons = 5,000 kg = 3,500 / - Rs.

82 grams of sand are needed for each brick

Per 1000 bricks = 82 grams * 1000 = 82 kg

Sand cost = 82 * 3500/5000 = Rs. 57.4 / -

Total cost per 1000 bricks = 1500 + 91.7 + 210 + 57.4 + 1500 + 65 = Rs. 3424.1 / -

Price per brick = 3424.1 / 1000 = Rs. 3.42 / -

Production costs for each brick = Rs. 3.42 / -

from cost analysis it is noticed, the cost of flue ashes – lime brick is cheaper by 8.5 % than flue ashes – gypsum brick".

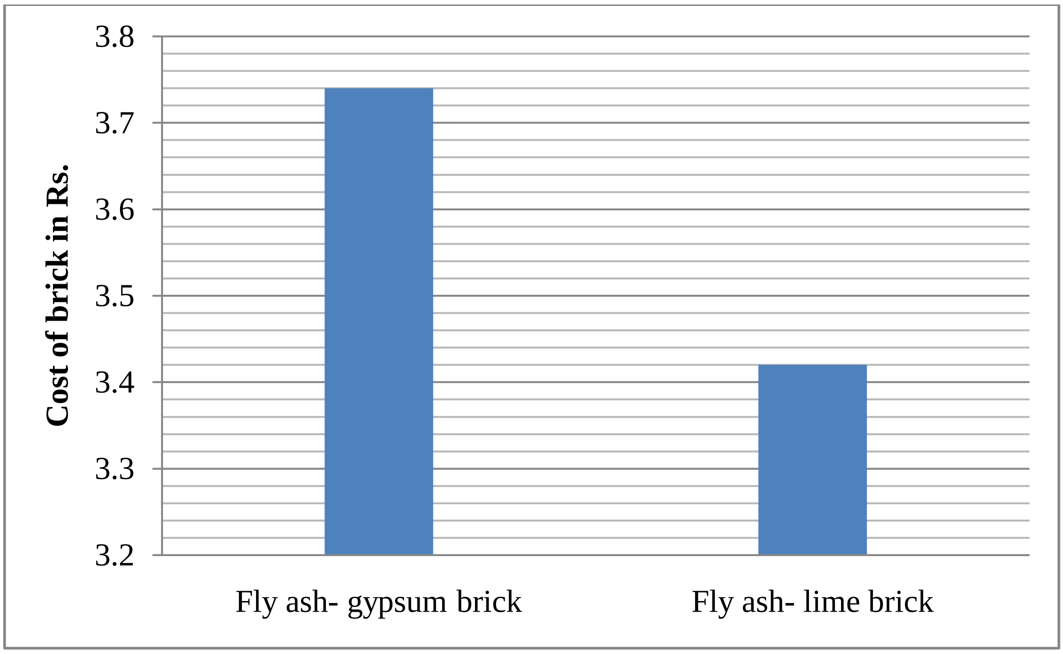

Fig. 5.5: Cost analysis

CHAPTER 6
CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

In conclusion, the exploration of experimental advancements in gypsum-enhanced fly ash-sand-lime bricks holds significant promise for sustainable and environmentally friendly construction practices. This study aimed to investigate the effects of incorporating gypsum into the composition of fly ash-based bricks and evaluate its impact on various properties and characteristics.Through comprehensive experiments and analyses, it was found that the addition of gypsum to the fly ash-sand-lime mixture yielded positive results. The inclusion of gypsum enhanced the binding properties of the bricks, leading to improved strength and durability. The mechanical properties, such as compressive strength, were significantly enhanced, making the bricks suitable for structural applications. The addition of gypsum also influenced the microstructure of the bricks, enhancing their resistance to water absorption and improving their overall performance. The findings of this study have important implications for the construction industry. The development of gypsum-enhanced fly ash-sand-lime bricks offers a sustainable alternative to traditional clay bricks, which have significant environmental impacts. By utilizing industrial by-products such as fly ash and incorporating gypsum, the study demonstrates a viable pathway towards reducing waste and optimizing resource utilization in brick production.

The adoption of gypsum-enhanced fly ash-sand-lime bricks can contribute to energy efficiency, as their manufacturing process requires lower firing temperatures compared to traditional clay bricks. This not only reduces energy consumption but also lowers greenhouse gas emissions associated with brick manufacturing. The exploration of gypsum-enhanced fly ash-sand-lime bricks represents a significant advancement in sustainable building materials. The findings of this study provide valuable insights into the feasibility and potential benefits of utilizing these bricks in construction applications. The successful implementation of gypsum-enhanced fly ash-sand-lime bricks has the potential to contribute to a more sustainable and environmentally conscious construction industry, promoting resource efficiency, reducing environmental impacts, and supporting the transition towards greener and more sustainable building practices.

6.2 FUTURE SCOPE

The exploration of gypsum-enhanced fly ash-sand-lime bricks opens up avenues for future research and development. Building on the findings of this study, several areas can be explored to further enhance the understanding and application of these sustainable building materials.

Optimization of gypsum content: Future work can focus on determining the optimal percentage of gypsum to be added to the fly ash-sand-lime mixture. By conducting a systematic investigation of different gypsum levels, researchers can identify the ideal proportion that maximizes the desired properties of the bricks, such as strength, durability, and water resistance.

Long-term durability studies: Conducting long-term durability studies is crucial to assess the performance of gypsum-enhanced fly ash-sand-lime bricks over extended periods. It would involve subjecting the bricks to accelerated aging tests, exposure to harsh environmental conditions, and monitoring their structural integrity, dimensional stability, and resistance to degradation over time.

Characterization of microstructure: Further research can delve deeper into the microstructural properties of the gypsum-enhanced bricks. Advanced imaging techniques, such as scanning electron microscopy (SEM) and X-ray diffraction (XRD), can be employed to analyze the formation of mineral phases, pore structure, and interfacial bonding within the bricks. This would provide valuable insights into the mechanisms behind the improved properties and guide further optimization efforts.

Comparative life cycle assessment: Conducting a comprehensive life cycle assessment (LCA) of gypsum-enhanced fly ash-sand-lime bricks compared to traditional clay bricks and other alternative building materials would provide a holistic understanding of their environmental impact. This analysis would consider factors such as raw material extraction, manufacturing processes, transportation, use, and end-of-life scenarios, helping to quantify the sustainability benefits and guide decision-making in construction projects.

Scale-up and field testing: Future work should focus on scaling up the production of gypsum-enhanced fly ash-sand-lime bricks and conducting field testing to validate their performance in real-world construction applications. Collaboration with industry partners and construction professionals would be crucial in implementing these sustainable building materials on a larger scale and gathering feedback on their practicality and feasibility. By addressing these areas of future work, researchers can further refine and optimize the use of gypsum-enhanced fly ash-sand-lime bricks, expanding their potential applications in the construction industry and advancing sustainable building practices.

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