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Manufacturing of Modified fly Ash Brick to Improve Plaster Holding Capacity and Water Absorption Ability

D.S.Janhavi ¹, S.R.Pranita ², S.A.Shaad ³, G.D.Shweta ⁴

^{1, 2, 3 & 4} Final Year students of Guru Gobind Singh College of Engineering & Research Centre, Nashik, Department of Civil Engineering.

Abstract – The day to day increase in the demand of power in the Nation, has increased the burden of Fly Ash storage. The substitution use of this ash, is a way to protect the environment. Manufacturing of Fly Ash bricks is one of the ssimportant way to consume the fly ash.

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It has been seen that there are some field difficulties in the use of fly ash bricks, like plaster holding ability, water absorption, etc.

This paper has on improving the field difficulties, by modifying the casting mould and by adding silica fumes to the fly ash bricks.

Key Words: Fly ash bricks, fertile soil, environment, water absorption, Plaster holding capacity.

1. INTRODUCTION

The main aim of this project is to study and improve plaster holding capacity and water absorption ability of Fly ash bricks. Main ingredients include fly ash, water, sand, gypsum, silica flume and lime. Gypsum acts as a long-term strength gainer. Fly ash is a material that is used in construction work. It is also used for making Fly ash bricks. Fly ash is obtained as waste material from the thermal power stations as a waste product. Considering the increasing generation rate it will be the environmental challenge to consume and utilize this waste. A planned program has to be chalked out for the same.

One of the way to consume this waste product is manufacturing of fly ash bricks as substitute to the fertile soil in order to protect the environment. Fly ash brick has smooth surface than conventional brick. Hence these bricks are weak in holding the plaster finish. Also the water absorption capacity is lower than the red bricks and are comparatively heavier.

In our research we have focused on increasing the plaster holding capacity and improving water absorption ability. Other than this we are also studying the various properties and manufacturing processes, materials, tests on fly ash bricks to promote the fly ash brick as best alternative for traditional red brick.

The fly ash brick making is a very profitable business in India as requires less resource than common burnt bricks. The demand for fly ash bricks in India is increasing. As the cost and environmental benefits, people prefer more and more fly ash bricks over common burnt bricks. India depends on the coal-based power plant. These plants produce a very large amount of fly ash. This generated waste has to properly utilized

For this we are modifying the fly ash bricks to work on improving the plaster holding capacity. As we know in conventional red brick plaster holding capacity is more than fly ash brick so that in construction industry more priority is given to the red brick, as it is customer friendly so in order to make fly ash reliable and customer friendly, we are improving this property. Water absorption ability

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is one of the essential property because dampness flakiness of the brick wall can be avoided by adding proper percentage of waterabsorbing reagent to the brick. To improve this property some materials are added.

2. Body of Paper

2.1 Material and method

2.1.1 Black fly ash

Fly ash is produced by coal-fired electric and steam generating plants. Typically, coal is pulverized and blown with air into the boiler's combustion chamber where it immediately ignites, generating heat and producing a molten mineral residue. Boiler tubes extract



heat from the boiler, cooling the flue gas and causing the molten mineral residue to harden and form ash. Coarse ash particles, referred to as bottom ash or slag, fall to the bottom of the combustion chamber, while the lighter fine ash particles, termed fly ash, remain suspended in the flue gas. Prior to exhausting the flue gas, fly ash is removed by particulate emission control devices, such as electrostatic precipitators or filter fabric bag houses



2.1.2 Sand

Geo polymerized sand is prepared by mixing a quantity of fly ash, sodium hydroxide, sodium silicate and water. The mixture is then heated at a particular temperature to get a semi solid material. It is then heated further to remove excess moisture. The granules formed are collected and sieved to get the sand.

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Properties of Good Sand:-

- 1) Should be completely inert.
- 2) Grains should be sharp, strong & angular.
- Should not contain any hygroscopic salts (i.e., CaCl2, MgCl2, etc.).
- 4) Should not contain clay & silt; usually 3-4% clay & silt is ordinarily permitted forpractical reasons.

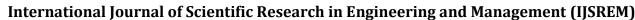


2.1.3 Cement

In Fly ash brick percentage of cement is 10% - 20%. The type of cement is based on industry (OPC or PPC). Grade of cement is 43 as per IS 8112 (or) Grade of cement is 53 as per IS 12269. We are using 53 Grade cement.

2.1.4 Gypsum

Gypsum accelerates the gain in strength for lime-stabilized fly ashes, particularly in the initial curing periods at about optimum lime content. At high lime contents gypsum attributes very high strength after curing for long periods mainly due to the alteration of fly ash lime reaction compounds. Gypsum not only improves the reduction in the loss of strength due to soaking even at low curing periods but also improves the durability of stabilized fly ashes due to repeated cycles of wetting and drying.



SIIF Rating: 8.176

2.1.5 Lime 3. Manufacturing Method

It is generally It is generally desirable to use a high calcium The bricks prepared in the industries have plane surfaces lime of proper purity as it is the most important ingredient that and are manufactured in the machines, which has reduced reacts with silica and alumina etc. present in fly ash so that the labour cost, increasing the affordability to the lower binder can be formed under hydrothermal conditions other income group. The plane surfaces reduce the plaster charred limes are not desirableas it does stake readily. Lime holding capacity, hence we in our work have modified the particles should be fine 15 enough to deliver well and coat the mould to improve this property. grain of the mixture. Lime should conform to class C hydrated lime of IS: 712-1973.

For making these bricks, 70-80% fly ash is used



along with small quantities of sand andhydrated lime.

Hydrated lime or a plasticizing agent (either in powdered or liquid form) is often added toimprove the physical properties of the mortar in its fresh or hardened states. A colouring agent may also be included to improve the overall appearance of the masonry.

2.1.6 Silica fume

Silica fume is a byproduct in the carbothermic reduction of high-purity quartz with carbonaceous materials like coal, cok wood-chips, in electric arc furnaces in the production of siliccthe fly ash and fine aggregates are added and mixed and ferrosilicon alloys.



3.1 Manufacturing Process

Fly Ash Bricks are being manufactured by the use of waste material originated from power plants. As far as the manufacturing is considered it contains two ingredients, the powered ash and the second is water. Apart from the above two ingredients Fly-Ash brick is added with silica that forms calcium silicate hydrates(C-S-H) which binds the ingredients to firm brick and act as a binder material. The superior quality of bricks is highly dependable on the quality of fly ash.

The process of manufacturing of fly ash Brick as follows:

- 1) The water to cement ratio has to 0.6%. This manufacturing process of brick contains the ingredients like fly ash, fine aggregate, lime and gypsum that is mixed with a proper proportion of water.
- 1) Initially lime (100gm) and gypsum (300gm) are added and mixed properly in an container.
- 2) After complete proper mixing is done to which thoroughly in a required quantity (i.e. 1.8kg & 1.6gm respectively for this experiment).
 - 3) Then water is added to the above mixture of fly ash, fine aggregate so that a vibrant stage of that mix can be achieved.

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International Journal of Scientific Research in Engineering and Management (IJSREM)

Volume: 07 Issue: 06 | June - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

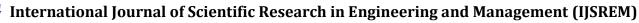
- 4) Now the mix is used to prepare the bricks.
- 5) Moulds that are used in this experiment are of 3" X 4"X 9" and 4"X 6"X 9"same as the size of Standard and Nominal size of bricks according to B.I.S Code.
- 6) The placing of mixture in the mould is done in three layer with tamping it 25 timed so that to settle in it that mould.
- 7) Then the mould is properly placed at a safe corner in order to avoid any breakage of the mould.
- 8) Before placing the mixture in the mould, the mould is rinsed with grease oil to avoid any sticking of mixture with the mould.
- 9) Then the mould is tighten with the bolt which is being provided at both the sides of the mould being used in this experiment.
- 10) After that the mould is being left for 24 hours and then it is being separated.
- 11) The placing of brick is done carefully in order to avoid breaking due to pressure applied over the bricks
- 12) The same process of being repeated for 18 bricks that are being used up for this experiment in order to get more bricks for compressive testing.
- 13) Water curing is done for 24 hours and required strength of the bricks is being checked in the Compression Test.

Compression test (IS 3495-Part 1)

This test is actually carried out after the curing period of 3 & 28 days. The Compressive Strength of fly ash Brick is three times more than the strength of red bricks or clay bricks. Clay bricks minimum compressive strength is 3.5N/mm2 which is much smaller than the fly ash bricks i.e., 10-12 N/mm2.

Water absorption test (IS 3495-Part 2)

Water absorption of fly ash brick: 6-12% Water absorption of normal/red clay brick: 20-25% Fly ash Bricks should not absorb water more than 12%. The bricks to be tested should be dried in an oven at a temperature of 105 to 115 C till attains constant weight cool the bricks to room temperature and weight (W1). Immerse completely dried and weighed W1 brick in clean water for 24 hrs at a temperature of 27±20 Degree Celsius. Remove the bricks and wipe out any traces of water and weigh immediately (W2). Water absorption in % by weight = (W2 – W1/W1) x 100



SJIF Rating: 8.176

Table -1: Result and Discussion

Compressive strength

3 Days Curing / Existing brick

I. Small brick

Existing

Modifed brick

ISSN: 2582-3930

| Na me of the bri ck | Size of small brick | Applied load | Compressi ve strength | Av era ge |
|------------------------------------|------------------------|-----------------|-----------------------------|-----------------|
| Sı | 230mm×100m m | 123500N | 5.36 | |
| S ₂ | 230mm×100m m | 102400N | 4.50 | 5.2 6 |
| S ₃ | 230mm×100m m | 136300N | 5.92 | |

| Na me of the bri ck | Size of the small brick | Applied load | Compressiv e strength | Aver age |
|------------------------------------|----------------------------|-----------------|-----------------------------|-------------|
| Sı | 230mm×100 mm | 153500N | 6.68 | |
| S ₂ | 230mm×100 mm | 192000N | 8.35 | 6.80 |
| S ₃ | 230mm×100 mm | 123200N | 5.35 | |

II. Big brick

Modified brick

| Na me of th e bri ck | Size of big the brick | Applied load | Compressi ve strength | Aver age | Na me of the bri ck | Size of the big brick | Applied load | Compres sive strength | Aver age |
|--|--------------------------|-----------------|--------------------------|-------------|------------------------------------|--------------------------|--------------|-----------------------------|-------------|
| Bı | 230mm×15 0mm | 229400N | 6.65 | | Bı | 230mm×150 mm | 280500N | 8.13 | |
| B ₂ | 230mm×15 0mm | 304900N | 8.84 | 6.50 | B ₂ | 230mm×150 mm | 282600N | 8.19 | 8.16 |
| Вз | 230mm×15 0mm | 138300N | 4.00 | | В3 | 230mm×150 mm | 281800N | 8.16 | |



SJIF Rating: 8.176

28 days curing

Small brick I.

Modified brick

Existing brick

| Na me of the bri ck | Size of the small brick | | Compressi ve strength | Avera ge |
|------------------------------------|-------------------------|---------|-----------------------------|-------------|
| Sı | 230mm× 100mm | 198600N | 8.63 | |
| S ₂ | 230mm× 100mm | 170800N | 7.43 | 9.09 |
| S ₃ | 230mm× 100mm | 158200N | 11.22 | |

| Na me of the bri ck | Size of the small brick | Applied load | Compress ive strength | Aver age |
|------------------------------------|-------------------------|--------------|-----------------------------|----------|
| S ₁ | 230mm×100 mm | 221600N | 9.6 | |
| S ₂ | 230mm×100 mm | 213700N | 9.25 | 9.4 |
| S ₃ | 230mm×100 mm | 215600N | 9.34 | |

Big brick I.

Modified brick

Existing

| Na me of the bri ck | Size of the big brick | Applied load | Compressiv e strength | Avera ge |
|------------------------------------|--------------------------|--------------|-----------------------------|-------------|
| В1 | 230mm×150 mm | 310800 N | 9.00 | |
| B ₂ | 230mm×150 mm | 301300 N | 8.73 | 8.30 |
| В3 | 230mm×150 mm | 247000 KN | 7.16 | |

| Na me of the bri ck | Size of the big brick | Applied load | Compres sive strength | Aver age |
|------------------------------------|--------------------------|--------------|-----------------------------|-------------|
| Bı | 230mm×150 mm | 348040N | 10.31 | |
| B ₂ | 230mm×150 mm | 352030N | 10.21 | 10.3 |
| Вз | 230mm×150 mm | 362400N | 10.50 | |

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International Journal of Scientific Research in Engineering and Management (IJSREM)

Volume: 07 Issue: 06 | June - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Water Absorption Test:-

I. Small brick

Existing Brick:-

Modified brick

| Name of the brick | Oven dried weight | Moist weight | (W2- W1/W1)X100 | Average |
|-------------------------|-------------------------|-----------------|--------------------|---------|
| S ₁ | 3.070 | 3.510 | 14.33% | |
| S ₂ | 3.010 | 3.440 | 14.28% | 14.52% |
| S ₃ | 2.940 | 3.380 | 14.96% | |

| Name of the brick | Oven dried weight | Moist weight | (W2- W1/W1)X100 | Average |
|-------------------------|-------------------------|-----------------|--------------------|---------|
| Sı | 2.190 | 2.620 | 19.63% | |
| S ₂ | 2.270 | 2.810 | 23.79% | 20.75% |
| S ₃ | 2.625 | 3.120 | 18.85% | |

Big brick Modified brick

| Name of the brick | Oven dried weight | Moist weight | (W2- W1/W1)X100 | Average |
|-------------------------|-------------------------|-----------------|--------------------|---------|
| Bı | 4.610 | 5.210 | 11.51% | |
| B ₂ | 4.160 | 4.920 | 18.26% | 15.56% |
| Вз | 4.260 | 4.980 | 16.90% | |

| Name of the brick | Oven dried weight | Moist weight | (W2- W1/W1)X100 | Average |
|-------------------------|-------------------------|-----------------|--------------------|---------|
| В1 | 5.250 | 6.620 | 26.09% | |
| B ₂ | 4.710 | 5.910 | 25.48% | 25.96% |
| В3 | 4.600 | 5.810 | 26.30% | |

SJIF Rating: 8.176

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1. Compressive strength

The average compressive strenght of existing brick after

3 days - 5.26N/mm² & 6.50N/mm².

 $28 \ days - 8.63 \ N/mm^2 \ \& 8.30 \ N/mm^2.$

Where as the average compressive strength of modified brick after .

3 days - 6.80 N/mm² & 8.16 N/mm².

28 days - 9.4 N/mm² & 10.34 N/mm².

2. Water absorption

Water absorption of existing brick 14.52% & 15.56%,

Where as water absorption of modified brick 20.75% & 25.96%.



Fig:- Modified mould



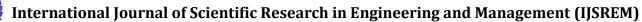
Fig ;- Modified brick

3.CONCLUSIONS

Here an attempt has been done to study the behaviour of fly ash based brick using lime & gypsum as binder material. Further studies have been made by the application of cement as binder material. Based on the result obtained from the experimental studies it can be concluded that , Fly ash based brick developed sufficient strength using both the hydride lime and the cement as binder material .Based on the obtained results and the discussion arrived with help further conclusion is proposed. The sole objective of this paper is to encourage the usage of fly ash

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