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

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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.

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

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.

Properties of Good Sand:-

1) Should be completely inert.
2) Grains should be sharp, strong & angular.
3) 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.

2.1.5 Lime

It is generally It is generally desirable to use a high calcium lime of proper purity as it is the most important ingredient that reacts with silica and alumina etc. present in fly ash so that binder can be formed under hydrothermal conditions other charred limes are not desirableas it does stake readily. Lime particles should be fine 15 enough to deliver well and coat the 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 high-purity quartz with carbonaceous materials like coal, cok wood-chips, in electric arc furnaces in the production of silicc and ferrosilicon alloys.

3. Manufacturing Method

The bricks prepared in the industries have plane surfaces and are manufactured in the machines, which has reduced the labour cost, increasing the affordability to the lower income group. The plane surfaces reduce the plaster holding capacity, hence we in our work have modified the mould to improve this property.

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 the fly ash and fine aggregates are added and mixed 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.

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

Table -1: Result and Discussion

Compressive strength

3 Days Curing / Existing brick

I. Small brick

Existing

Name of the brick	Size of small brick	Applied load	Compressive strength	Average
S_1	230mm×100mm	123500N	5.36	
S_2	230mm×100mm	102400N	4.50	5.26
S_3	230mm×100mm	136300N	5.92	

Modifed brick

Name of the brick	Size of the small brick	Applied load	Compressive strength	Average
S_1	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

Name of the brick	Size of big the brick	Applied load	Compressive strength	Average
B_1	230mm×150mm	229400N	6.65	
B_2	230mm×150mm	304900N	8.84	6.50
B_3	230mm×150mm	138300N	4.00	

Modified brick

Name of the brick	Size of the big brick	Applied load	Compressive strength	Average
B_1	230mm×150 mm	280500N	8.13	
B_2	230mm×150 mm	282600N	8.19	8.16
B_3	230mm×150 mm	281800N	8.16	

28 days curing

I. **Small brick**

Existing brick

Name of the brick	Size of the small brick	Applied load	Compressive strength	Average
S_1	230mm× 100mm	198600N	8.63	
S_2	230mm× 100mm	170800N	7.43	9.09
S_3	230mm× 100mm	158200N	11.22	

Modified brick

Name of the brick	Size of the small brick	Applied load	Compressive strength	Average
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	

I. **Big brick**

Existing

Name of the brick	Size of the big brick	Applied load	Compressive strength	Average
B_1	230mm×150 mm	310800 N	9.00	
B_2	230mm×150 mm	301300 N	8.73	8.30
B_3	230mm×150 mm	247000 KN	7.16	

Modified brick

Name of the brick	Size of the big brick	Applied load	Compressive strength	Average
B_1	230mm×150 mm	348040N	10.31	
B_2	230mm×150 mm	352030N	10.21	10.34
B_3	230mm×150 mm	362400N	10.50	

Water Absorption Test:-

I. **Small brick**

Existing 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%	

Modified brick

Name of the brick	Oven dried weight	Moist weight	(W2-W1/W1)X100	Average
S_1	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

Name of the brick	Oven dried weight	Moist weight	(W2-W1/W1)X100	Average
B_1	4.610	5.210	11.51%	
B_2	4.160	4.920	18.26%	15.56%
B_3	4.260	4.980	16.90%	

Modified brick

Name of the brick	Oven dried weight	Moist weight	(W2-W1/W1)X100	Average
B_1	5.250	6.620	26.09%	
B_2	4.710	5.910	25.48%	25.96%
B_3	4.600	5.810	26.30%	

1. **Compressive strength**

The average compressive strenght of existing brick after

3 days - 5.26N/mm² & 6.50N/mm².

28 days – 8.63 N/mm² & 8.30 N/mm².

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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