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# An Alternate Solution in Brick Making using Mineral Admixtures

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***Abstract:*** **The present work deals with the addition of silica fume to the fly ash bricks. Fly ash has many has many advantages, its low hydration at early stage causes the strength to be low. In this study, the experimental investigation was carried out to find the compressive strength & water absorption of fly ash brick. However the brick specimen of size 290 mm x 120 mm x 130 mm were cast for different mix percentages of Fly ash (20%), Gypsum (5%), Lime (0 to 15%). The results show the variation of compressive strength for different mix proportion of materials mentioned at 7, 14, 21, 28 days. Here for proper grinding of raw materials pan mixer and hydraulic press machine (moulds are inserted into the machine) is used. Gypsum and lime plays a key role to achieve more compressive strength results of have declared that use of silica fume has significantly increases the compressive strength of bricks and water absorption of bricks also decreases.**

***Key words: Fly ash, Gypsum, Stone dust, Silica fume, Lime, Hydraulic Bricks machine (Press Machine), Pan mixer, Compressive strength and water absorption.***

## 1. INTRODUCTION

Since Ancient Days from Stone Age to modern age man needs Food, Cloth and Shelter out of three needs of Man Shelter that means house building is placed a prominent need. To build a house building man choose many types of materials for the construction but during the time course since olden days according to the house building after developed some civilization man built a dams canals along with house buildings.

All these built to modern construction main item and materials is the brick in time to time making of brick man developed some Sophisticated Technologies. Basically in making of brick clay and soil is the main material and ever standard materials but in modern days we making cement brick by using and mixing some chemical admixtures and formulas, and in recent age we are using light weight cement bricks for the structures of the building. These light brick are most used for the building of Multi storied building.

An effort for an alternative investigation the manufacturing of the brick was accomplished. By using industrial byproducts like Fly-ash, Silica fume, lime, gypsum, Stone dust as key ingredients. In India thermal power plants are generating Fly-Ash in large quantities. Industrial waste are Hazardous in Nature, Their disposal is of Major concern. Recycling such a waste by utilizing them in to building materials is a modern solution for the pollution issues. Much of an emphasis is laid on energy saving and economy. Industrial waste like Fly-Ash which is creating environmental problems is mainly used as building material due to its low cost and easy availability. But the main disadvantage of these bricks is its low strength of these produce Fly-Ash composite bricks which will have higher compressive strength.

## 2. EXPERIMENTAL PROGRAM

### *2.1 Materials Used:*

In this research work various materials are used like Fly ash, Silica fume, Lime, Gypsum, Stone dust, Water, Silica fume is used.

### *2.1.1 Fly ash:*

Fly ash, also known as “pulverised fuel ash” in the U.K. is one of the residues generated by coal combustion, and is composed of the fine particles that are driven out of the boiler with the flue gases. Ash that falls in the Bottom of the boiler is called Bottom ash. Generally fly ash collected from 1st & 2nd field of ESP’s meet the requirement of Grade 2 of IS : 3812. As per the information collected, the minor variations in quality of dry ash & pond ash does not affect the quality of the brick significantly. Fly ash should preferably be collected from 1st/2nd field of ESP.

Fig 1 : Fly Ash

### *2.1.2 Silica fume:*

Silica fume is a by product of producing silicon metal (or) ferro silicon alloys. One of the most beneficial uses for Silica fume is in brick making. Because of its chemical and physical properties, it is a very reactive pozzolan.

a. Premium – white
b. Standard – grey

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Fig 2 : Silica fume

*2.1.3 Lime:*

Lime is an important binding material in building construction. Calcium hydroxide, traditionally called slaked lime, is an inorganic compound with the chemical formula $Ca(OH)_2$. It is a colourless crystal (or) white powder and is obtained when calcium oxide (called lime (or) quick lime) is mixed, (or) "slaked" with water. Use of sludge lime also gives good quality bricks. However following problems have been noticed while using sludge lime.

i. The sludge lime contains extraneous materials.
ii. It is generally wet
iii. It contains lumps
iv. It is difficult to know the % of available lime (as CaO)

Based on the experience of sites, the following is recommended for use of good quality sludge lime. Sludge lime shall be free of extraneous materials, lumps etc. To the extent possible.

Fig 3 : Lime

*2.1.4 Gypsum:*

Gypsum should be free of lumps. Lumps, if any, should be screened and remainder over the screen should be crushed and re-screened before use.

Gypsum should be tested for its purity as per IS 1288-1982. Its purity should be above 80%. However, in case of variation in purity, percentage of Gypsum in the mix should be adjusted to obtain desired quality of finished bricks.

Gypsum is a non-hydraulic binder occurring naturally as a soft crystalline rock or sand. Gypsum have a valuable properties like small bulk density, incombustibility, good sound absorbing capacity, good fire resistance, rapid drying and hardening with negligible shrinkage, superior surface finish, etc. In addition it can strengthen material or increase viscosity. It has a specific gravity of 2.31 grams per cubic centimetre. The density of gypsum powder is 2.8 to 3 grams per cubic centimetre.

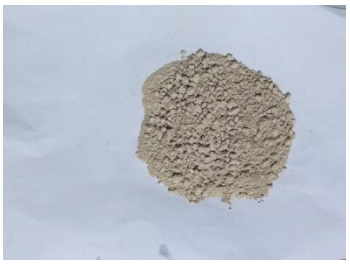

Fig 4 : Gypsum

*2.1.5 Stone dust :*

Stone dust is used available from local quarry industries. Deleterious materials such as in sand/stone dust shall not be more than 5%. Field test with the help of measuring cylinder to ascertain percentage of deleterious materials/silt content should be carried for every truck load of sand/stone dust.

Fig 5 : Stone dust

*2.2 MIX PROPORTION:*

To make the fly ash brick the following mix proportions were used.

Table 1 Various mix proportions:

| Proportions | Fly ash (%) | Lime (%) | Gypsum (%) | Stone dust (%) | Silica fume (%) |
|---|---|---|---|---|---|
| I | 20 | 15 | 5 | 60 | 0 |
| II | 20 | 10 | 5 | 60 | 5 |
| III | 20 | 5 | 5 | 60 | 10 |
| IV | 20 | 0 | 5 | 60 | 15 |

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Table 2: Quantity of material used

| Proportions | Fly ash (kg) | Lime (kg) | Gypsum (kg) | Stone dust (kg) | Silica fume (kg) |
|---|---|---|---|---|---|
| I | 2.166 | 1.33 | 0.5 | 6.66 | 0 |
| II | 2.166 | 1.08 | 0.5 | 6.66 | 0.54 |
| III | 2.166 | 0.541 | 0.5 | 6.66 | 1.08 |
| IV | 2.166 | 0 | 0.5 | 6.66 | 1.66 |

## 3. PREPARATION AND TESTING OF SPECIMENS

*3.1 Location of Materials:*

Fly ash - Vijayawada (NTPC)

Stone dust – Perecherla, Nallapadu (Guntur Dist)

Lime – Piduguralla (Guntur Dist)

Gypusm – Visakhapatnam (Vishakapatnam Dist)

Silica fume – Astrra chemicals Chennai (Tamilnadu state)

*3.2 Equipment used:*

*a) Pan mixer*

Pan mixer of adequate capacity should be used for mixing/grinding various raw materials. The total quantity of raw materials proposed to be loaded in the pan mixer for each mix should not exceed the rated capacity of the mixer.

When sludge lime and gypsum are used as binding material, first sludge lime and gypsum (in required quantity) is wet grinded in a pan mixer with some water till the mix becomes a paste without lumps. Stone dust, silica fume and fly ash shall then be added along with required quantity of water and mixing/grinding shall be continued to get a homogeneous mix.

In case hydrated lime and gypsum is used as binding material, the required quantity of stone dust, fly ash, hydrated lime and gypsum are initially dry mixed and then required quantity of water is added to get homogeneous mix.

Mixing should be carried out till such time uniformity in colour and homogeneous mix is obtained. This is likely to take about 5 minutes time. The mixing time should be adequate to ensure uniform and homogeneous mix without lumps.

Fig 6 : Pan mixer

*b) Hydraulic brick machine [moulds are inserted and attached into the machine]*

Properly mixed raw material is generally transported through a belt conveyor to the press feed hopper. The mix is then fed to hydraulic rotary press, where the moulds are automatically filled in. Set of 2 moulds each are located $120^0$ apart at the rotary table. Bricks are formed at a pressure of 150-200 kg/cm$^2$. The pressed bricks are taken manually and laid on wooden pallet in 4-5 layers. Brick laden pallets are transported on hydraulic trolley from press area to stackyard. Finished bricks are then air-dried for 1-2 days.

Fig 7 : Hydraulic Brick Machine

*c) Moulds*

Moulds are inserted into the hydraulic machine. Moulds are used to cast the bricks with the standard size of 290 mm x 120 mm x 130 mm. They were cast according to the standard procedure with various mix proportions arrived.

*d) Trolleys*

Trolleys are used to take the homogeneous mix materials from pan mixer to the hydraulic machine.

Fig 8 : Trolleys

*3.3 Casting of bricks:*

The hydraulic press machine (moulds are inserted into the machine) is used to cast the bricks with the standard size of 290 mm x 120 mm x 130 mm. They were cast according to the standard procedure with various mix proportion arrived.

*3.4 Results and Discussions:*

The investigation was carried out to determine various percentage of fly ash brick admixed with lime, gypsum, stone dust and silica fume and also determine the water absorption.

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*3,5 Arriving proportions*

Mix proportions are arrived by referring the articles and data collecting from local manufacturing Brick companies and industries. For the various proportions arrived bricks are casted and the following tests were conducted.

## 4. TESTS ON BRICKS

*General*

To know the quality of bricks following 7 tests can be performed. In these tests same are performed in laboratory and the rest are on field.

*a. Compressive strength test:*

This test is done to know the compressive strength of brick. It is also called crushing strength of brick. Generally 5 specimens of bricks are taken to laboratory for testing and tested one by one. In this test a brick specimen is placing on crushing machine and applied pressure till it breaks. This ultimate pressure at which brick stars broken is taken into account. All five brick specimens are one by one and average result is taken as bricks compressive/crushing strength.

*b. Water absorption test :*

In this test bricks are weighted in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion those are taken out from water and wipe out with cloth. Then brick is weighed in wet condition. The difference between weights is the water absorbed by brick. The percentage of water absorption is then calculated.

-- The less water absorbed by brick the greater its quality. Good quality brick doesn't absorb more than 20% water of its our weight.

*c. Efflorescence test :*

The presence alkalis in bricks is harmful and they from a gray (or) which layer on brick surface by absorbing moisture to find out the presence of alkalis in bricks this test is performed. In this test a brick is immersed in fresh water for 24 hours and then it's taken out from water and allowed to dry in shade.

-- If the whitish layer is not visible on surface it proofs that absence of alkalis in brick.

-- If the whitish layer visible about 10% of brick surface then the presence of alkalis is inacceptable range. If that is about 50% of surface then it is moderate.

-- If the alkalis presence is over 50% then the brick is severely affected by alkalis.

*d. Hardness test :*

In this test a scratch is made on brick surface with a hard thing. If that doesn't left any impression on brick then that is good quality brick.

*e. Size, Shape and Colour test:*

In this test randomly collected 20 bricks are staked along length wise, width wise and height wise and then those are measured to know the variation of sizes as per standard. Bricks are closely viewed to check if its edges are sharp and straight and uniform in shape. A good quality brick should have bright and uniform colour throughout.

*f. Soundness test:*

In this test two bricks are held by both hands and struck with one another. If the bricks given clear metallic ringing sound and don't break then those are good quality bricks.

*g. Structure test:*

In this test a brick is broken (or) a broken brick is collected and closely observed. If there are any flows, cracks (or) holes present on that broken face then that is it good quality brick.

*a) Compressive strength test:*

Table 3: Compressive Strength of Mix Proportions

| Proportions | Strength in Mpa | | | |
|---|---|---|---|---|
| | 7 days | 14 days | 21 days | 28 days |
| I | 7.18 | 12.35 | 13.7 | 16.66 |
| II | 7.27 | 13.5 | 14.6 | 17.24 |
| III | 7.29 | 14.36 | 15.5 | 16.86 |
| IV | 6.32 | 9.77 | 10.6 | 13.50 |

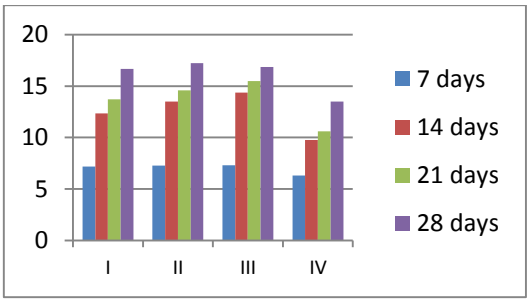


Fig 8 : Graphical representation of Compressive strength and various mix proportions

Fig 9 : Test for compressive strength.

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***b)*** *Water absorption test :*

Table 4: Calculation of Water Absorption value (%)

| Proportions | W1 (KG) | W2 (KG) | (W2-W1) | (W2-W1)/ W1 | (W2-w1/w1 X100 |
|---|---|---|---|---|---|
| I | 13.565 | 14.289 | 0.724 | 0.053 | 5.3 |
| II | 12.065 | 12.869 | 0.804 | 0.066 | 6.66 |
| III | 12.705 | 13.125 | 1.05 | 0.086 | 8.69 |
| IV | 12.470 | 13.897 | 1.427 | 0.114 | 11.44 |

Water absorption = (W2-W1)/W1 x 100
= [14.289 – 13.565)/13.565] x 100
= [0.724/13.565] x 100
= 0.053 x 100
= 5.3%

From the result obtained from various mix percentages is 5.3%, 6.66%, 8.69%, 11.44%. It is lesser than the standard value of 12%.

*c) Efflorescence test (No salts and alkalis)*

Ist mix - Nil
IInd mix - Nil
IIIrd mix - Nil
IVth mix - Nil

*d) Hardness test*

Ist mix - Good quality of Brick
IInd mix - Good quality of Brick
IIIrd mix - Good quality of Brick
IVth mix - Good quality of Brick

*e) Size, shape and colour test*

Size - 29 cms x 12 cms x 13 cms
Length - 290 mm
Breadth - 120 mm
Height - 130 mm
Shape - Block rectangular shape
Colour - Greyish colour

*f) Soundness test*

Ist mix- Metallic sound is observed (1st class brick)
IInd mix- Metallic sound is observed (1st class brick)
IIIrd mix- Metallic sound is observed (3rd class brick)
IVth mix- Metallic sound is observed (3rd class brick)

*g) Structure test*

Ist mix- There is no flaws cracks (or) holes
IInd mix- There is no flaws cracks (or) holes
IIIrd mix- Slightly there is some cracks (holes) pores
IVth mix- Good quality brick (no cracks, holes, flaws)

## 5. CONCLUSION

- The study of experimental results has specified that effect of silica fume on mechanical properties like compressive strength, durability and water absorption is greatly improved.
- Lime and gypsum plays a great role in achieving good compressive strength of bricks.
- We can improve the engineering properties of bricks such as workability, plasticity and water tightness.
- We improved the compressive strength and water absorption of the brick.
- We maintain the uniform size and shape of fly ash bricks and to reduce the plastering thickness.
- Silica fume having more fineness and small particle size.
- We can arrest the cracks, pores in bricks using silica fume.
- The weight and density of the brick maintains neutral using silica fume.

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