# A CHARACTERISTIC STUDY ON COMBINED PROPERTIES OF FLYASH AND GGBS BRICKS USING INDUSTRIAL FOUNDRY WASTE & CRUSHER DUST

**s.Cynthia priyadharshini, M.Persis seljah , M.Ponmalar, Reshma Simon, *B.Suja**

*UG Students, *Assistant Professor*
*SKR engineering college, Chennai, India.*
*s.cynthiaselva3@gmail.com,persis.seljah15@gmail.com,*
*malarmano21@gmail.com,reshmasheba@gmail.com, sujabala1992@gmail*

***Abstract*—** Nowadays implementation and utilization of new building materials and industrial waste is being practiced. Due to immense increasing quantities of waste material from industries can be used for the purpose of economical construction and in concern of reducing waste disposal. In general bricks are made by top fertile agricultural soil but by using fly ash, few percent of top fertile agricultural soil is saved. Use of fly ash in brick making also is beneficial in diverse ways. When compared to conventional clay bricks fly ash bricks are stronger, more durable and yet more economical. Also, the manufacturing process of fly ash bricks results in lesser pollution. About GGBS it is a by-product of manufacturing iron it can be partially replaced by cement which will increase the strength of bricks. Foundry waste consists primarily of steel waste and dust from steel industry. Foundry waste can be used in concrete to improve its strength and other durability factors.

In the present study the combined properties of brick by partially replacing ground granulated blast furnace slag(GGBS) and fly ash in terms of cement and industrial waste such as foundry waste and crusher dust also used as a filler material which is passed through 150 microns. Quantity of material taken is in terms of parts. Bricks were casted in lab from the best mix obtained and mechanical properties like compressive strength and water absorption were noted.

**Keywords— GGBS, Fly ash, compressive strength, foundry waste, mechanical properties.**

## I. INTRODUCTION

The vast demand from housing industry due to population explosion has nonnegotiable the need for sustainable building materials especially bricks. Literati have tried to incorporate fly ash, ground granulated blast furnace slag (GGBS), , rice husk ash, crusher dust and other waste products into bricks so as to enhance its sustainability. The clay bricks are used in construction have some disadvantages to overcome this GGBS bricks are manufactured. This is eco-friendly bricks using GGBS and non-degradable waste material that proves to be both economical and possessing high compressive strength than the normal clay bricks. And about fly ash is generated as a byproduct of coal combustion and is used as a replacement for cement in concrete. Fly ash is posses unique characteristics that allow it to be used ton-for-ton as a alternate for Portland cement in making concrete.

Crusher dust compacts well, creating a stable surface. Instead of dumping as waste, it is used make walkways, bike paths and parking lots, supportive level surface, concrete sand, aggregate and glass. It is used in filling trenches and around water tanks. It's a grey or brown in colour and size is perfectly fine. It is used as cement aggregate to form a specific texture.

The main objective of our project is to manufacture eco-friendly bricks for economical construction and to provide better strength to the structure compared to normal bricks.

- To manufacture low cost GGBS bricks.
- To optimize mix proportion using GGBS and industrial foundry waste.
- To determine water absorption test of GGBS brick
- To determine compressive strength of GGBS brick
- To effectively utilize the foundry waste which is hard to dispose.
- To manufacture low cost GGBS bricks.
- To optimize mix proportion using GGBS and industrial foundry waste.
- To determine water absorption test of GGBS brick

- To determine compressive strength of GGBS brick
- To effectively utilize the foundry waste which is hard to dispose.

## II. EXPERIMENTAL INVESTIGATION

### DETAILS OF MATERIALS USED:

**CEMENT:**

Ordinary Portland Cement (OPC) of 53grade is used.

**FINE AGGREGATE:**

Crusher dust is used as a fine aggregate which passed through 4.75mm

Sieve.

**COARSE AGGREGATE:**

Foundry waste is used as coarse aggregate which passed through 12.5mm

Sieve.

**ADMIXTURE:**

Super plasticizer CONXL PCE DM 108 is used as a admixture to gain workability.

**WATER:**

Water is taken from the laboratory and the water to binder ratio is taken as 0.76 and 0.7

**FLY ASH:**

Fly ash of class I is used as binder material.

**GGBS:**

Ground Granulated Blast furnace Slag (GGBS) is used. Ground Granulated Blast furnace Slag is acquired from molten iron slag from a blast furnace in water or steam, to produce a glassy, granular product that is then ground into a fine powder. The properties of ground granulated blast furnace slag are

**Table-1 Properties of GGBS**

| | | |
|---|---|---|
| Colour | | Off- white powder |
| Relative density | | 2.85 – 2.95 |
| Normal consistency | | 29.5% |
| Specific Gravity | | 2.9 |
| Setting time | Initial | 170 min |
| | Final | 265 min |

**CRUSHER DUST:**

In the process of removing quarry materials, create a large amount of dust that is made from very small stone particles, known as crusher dust.

**Table-2 Properties of crusher dust**

| | |
|---|---|
| Maximum dry density | 2.00 - 2.15 tonnes/$m^3$ |

| | |
|---|---|
| Optimum moisture | 10 – 13% |
| Particle density (dry) | 2.70 – 2.80 t/m$^3$ |
| Particle density (SSD) | 2.75 – 2.85 t/m$^3$ |
| Water absorption | 2.5 – 3.5% |
| Ph | 10-12 |

**FOUNDRY SAND**

Foundry sand is the byproduct of ferrous and non-ferrous metal casting industry, where sand has been used for centuries as a moulding material because of its unique engineering properties. It can be recycled and reuse.

**Table-3 Properties of foundry sand**

| | |
|---|---|
| Specific gravity | 2.39 - 2.55 |
| Bulk relative density | 2590 (160) kg/m$^3$ (lb/ft$^3$) |
| Water absorption | 0 |
| Moisture content | 0.12 – 10.1% |
| Plastic index | non- plastic |

**FLY ASH:**

Fly ash is one of the coal combustion products, and it is composed of the fine particles that are driven out of the boiler with the flue gases. It includes substantial amounts of Silicon-dioxide($SiO_2$), Aluminium oxide($Al_2O_3$) and Calcium oxide(CaO), the main mineral compounds in coal-bearing rock strata.

**BRICK DETAILS:**

Size of brick - 230x115x75 mm

Number of bricks - 16

- Ordinary Brick - 8
- Eco-friendly brick – 8

## III. EXPERIMENTAL PROCEDURE:

**Table-4 Ratio of Mix Ingredients for mix 1**

| OPC + FLY ASH + GGBS | Crusher Dust | Foundry slag | Water to Binder ratio | Super plasticizer CONXL PCE DM 108 |
|---|---|---|---|---|
| 1 Part | 3.5 Parts | 4 Parts | 0.76 | 1000ml/100kg of binder |

**Table-5 Ratio of Binders for mix 1**

| OPC | Fly Ash | GGBS |
|---|---|---|
| 1 Part | 1.5 Parts | 2.5 Parts |

**Table-6 Ratio of Mix Ingredients for mix 2**

| OPC + FLY ASH + GGBS | Crusher Dust | Foundry slag | Water to Binder ratio | Super plasticizer CONXL PCE DM 108 |
|---|---|---|---|---|
| 1 Part | 3.0 Parts | 4.0 Parts | 0.70 | 800ml/100kg of binder |

**Table 7 Ratio of Binders for mix 2**

| OPC | Fly Ash | GGBS |
|---|---|---|
| 1 Part | 0.4 Part | 0.8 Parts |

**PROCESS OF WORK**

**MOULD**

The mould which is used to cast brick is shown below in fig

**Formwork for moulding of bricks**

**MIXING , CASTING AND DEMOULDING OF BRICKS:**

The ingredients are mixed in two proportions and are casted using mould as shown in fig

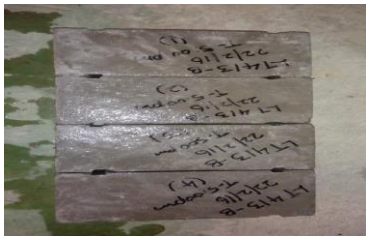
**Mixing**

**After de-moulding of bricks**

**CURING OF BRICKS:**

Bricks are then placed into curing tank as shown in fig

**Curing of bricks**



**Bricks taken out from curing tank**

**TEST CARRIED FOR BRICKS:**

**COMPRESSION STRENGTH TEST:**

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

**Compression strength test for brick**

**Table-9 Comparative compression strength results observed for mix-1 and mix-2**

| Sample Number | Compression Strength |
|---|---|
| Sample 1 | 17.2 |
| Sample 2 | 17.3 |
| Sample 3 | 17.25 |

| Sample Number | Compression Strength |
|---|---|
| Sample 1 | 18.3 |
| Sample 2 | 18.4 |
| Sample 3 | 18.37 |

**WATER ABSORPTION TEST:**

- In this test bricks are weighed 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 own weight.

**RESULTS OBSERVED:**

For mix-1 the average value of water absorption capacity of brick is 7.5% For mix-2 the average value of water absorption capacity of brick is 7.8%

**TEST FOR ALKALI SALT (EFFLORESCENCE TEST):**

- The presence of alkalies in bricks is harmful and they form a gray or white 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 alkali's presence is over 50% then the brick is severely affected by alkalies.

Hence there is no formation of efflorescence on brick in both mixes.

**TEST FOR HARDNESS:**

- 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.
- Hence the brick is found to be hard and it doesn't left any impression on brick in

both mixes.

**TEST FOR SHAPE SIZE AND COLOUR:**

- In this test randomly collected 20 bricks are staked along lengthwise, 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.

Hence the brick is found to be equal in size as per standards, its sharp, straight and uniform in shape and uniform in colour in both mixes.

**TEST FOR STRUCTURE:**

- In this test a brick is broken or a broken brick is collected and closely observed.

Hence there is no formation of either cracks or holes and no breakage too on bricks in both mixes.

**SOUNDNESS TEST:**

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

Hence the bricks produce metallic ringing sound when it is struck with one another in both mixes.

**MIX 1:**

Compression strength = 17.2 MPa

Water absorption = 7.5%

**MIX 2:**

Compression strength = 18.3 MPa

Water absorption = 7.8%

**NON-DESTRUCTIVE TEST RESULT:**

Non-destructive test results for both the mixes are as follows Alkali or Efflorescence – No formation of efflorescence on bricks Hardness test - No impression left on bricks

Shape, size and colour – Perfect in shape and size, uniform in colour Structure - No formation of cracks and no breakage in bricks Soundness - Produces metallic ringing sound

**CONCLUSION**

From the study we have come to the conclusion that

- The bricks thus manufactured were found to be economical and observed that there is a noticeable increase in compressive strength.
- It was found that the compressive strength this brick was thrice that of the conventional clay bricks.
- It also ensures proper utilization of industrial waste.

***REFERENCES***

*[1] Billie j. Lindsay and Terry j. Logan, Agricultural Reuse of Foundry Sand, Journal of Residuals Science & Technology, Vol. 2, No.1, January 2005, School of Natural Resources, The Ohio State University, 1-12.*

*[2] Tarun R. Naik and Shiw S. Singh, Flowable slurry containing foundry sand,*

*Journal of materials in civil Engineering, May1997, 93-102.*

*[3] Lingling, Xu, et al. "Study on fired bricks with replacing clay by fly ash in high volume ratio." Construction and Building Materials 19.3 (2005): 243-247.*

*[4] Malhotra, S. K., and S. P. Tehri. "Development of bricks from granulated blast furnace slag." Construction and Building Materials 10.3 (1996): 191-193.*

*[5] Dass. Mohan, "New Substitutes of Bricks", Civil Engineering and*

*Construction, June 1992, PP22.*

*[6] Gupta P. C. and Ray S. C., "Commercialisation of Fly ash", The Indian*

*Concrete Journal vol- 167, now. 1993, PP 554-560.*

*[7] Prakash Rao D.S., V. Giridharkumar., Investigations on concrete with stone crusher dust as fine aggregate, The Indian Concrete Journal, July 2004, pp 45-50. [8] Misra V.N., Use of stone dust from crushers in cement-sand mortars, The Indian Concrete Journal, August 1984, Vol 58, No.8, pp 219-223.*

*[8] Babu, K.K.Radhakrishnan, R and Nambiar E.K.K. Compressive strength of brick masonry with alternative aggregate mortar, Civil Engineering and Construction Review, September 1997, Vol 10, No.9, pp 25-29.*