International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 05 | May-2018 www.irjet.net p-ISSN: 2395-0072

# EXPERIMENTAL INVESTIGATION BY INCORPORATION OF FLY ASH, STP SLUDGE,LIME,GYPSUM AND QUARRY DUST IN BRICK MAKING

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***ABSTRACT:*** *In fast growing today's world development of new building materials and Processing & utilization of waste is being given the top priority in the program of building research at a very high rate. Brick is one of the most important masonry unit as a building material due to its properties. Many attempts have been made to incorporate wastes into the production of bricks. In this paper we describe the recycling of the waste products like STP Sludge, Quarry dust and Fly ash by incorporating them into bricks. In general bricks are made by top fertile agricultural soil but by using fly ash, 28 percent of top fertile agricultural soil is saved. Among all disposal options, the use of sludge in producing constructional elements is considered to be the most economic and environmentally sound option. This paper reviews the recycle of sewage treatment plant sludge and Fly ash against fired clay bricks.*

***Keywords: STP sludge(STP-Sewage treatment plant),Fly Ash,Gypsum,quarry dust.***

## 1. INTRODUCTION

### 1.1GENERAL

Shelter is a basic human need and owning a house becomes a life long struggle as majority of Indians find housing costs prohibitively expensive. This problem becomes even more acute when considering the low income families who accounts for about 60-70% of Indian population. This brings out the need to reduce the cost of the housing and make it affordable for the booming population. Burnt clay bricks are being used extensively and the most important building material is the construction industry. In India the building industry consumes about 20000 million bricks and 27% of the total natural energy consumption for their production. In addition to this, Clay bricks available in certain region are poor in quality and have lower compressive strength, higher water absorption, high efflorescence etc., which have forced engineers to look for better materials capable of reducing the cost of construction. In this contest search for an alternative building material to clay bricks, various government agencies and research institutions have repeatedly recommended the use of waste materials such as fly ash, Rise husk ash (RHA),STP Sludge, Ground granular blast furnace slag (GGBS) etc., as an alternative building material in making bricks, blocks and tiles etc. Logically the unlimited use of clay is harmful to the society, as all the conventional clay bricks depend on good quality clay available from agriculture fields. Presuming a weight of 3 kg per brick, the total clay is taken out from agriculture lands per year for such brick works out to over 300 million tones.

## 2. AIM OF INVESTIGATION

### 2.1 GENERAL

The basic aim of this project is to evaluate the strength of bricks with Fly ash and STP Sludge. The aim has been achieved through covering the following specific objectives.

### OBJECTIVE

To study the feasibility of using STP Sludge in the manufacturing of fly ash bricks by conducting standard tests.

- Compressive strength
- Water absorption
- Density

## 3. EXPERIMENTAL INVESTIGATION

### 3.1 EXPERIMENTAL MATERIALS

The bricks produced according to the patent have been given name Fly ash bricks and STP Sludge bricks. Essentially the only solid ingredient of the brick is the Fly ash and STP Sludge and the main liquid ingredient is water. Other ingredients thatfar are commercially protected are only minor in quantities. The process of manufacturing fly ash to form calcium silicate hydrates (C-S-H) which binds the ingredients to form a brick. The quality of bricks obtained is highly dependent on the quality of Fly ash and STP Sludge. These raw materials are requiring for manufacturing bricks.

### 3.2MATERIALS

### 3.2.1 FLY ASH

Fly ash is finely divided residue resulting from the combustion of powdered coal, transported by the flue gases and collected by electrostatic precipitators. Its proper disposal has been a cause of concern since long, which otherwise leads to pollution of air, soil and water. Fly ashcan be referred as either pozzolonic or cementious. A cementious material is one that hardens when mixed with water. It also improves workability and reduces internal temperature.

**EXPERIMENTAL PARAMETERS**

Table 2.1 Section Type: As per IS: 12894 2002

| S.No | DESCRIBTION | SIZE (L x B x H) |
|---|---|---|
| 1 | Size of Fly ash brick | 230 x 110 x 75 mm |
| 2 | Size of Fly ash brick replaced by STP Sludge | 230 x 110 x 75 mm |

### 3.2.2 STP SLUDGE

Sludge refers to the residual, semi-solid material left from industrial wastewater, or sewage treatment processes. It can also refer to the settled suspension obtained from conventional drinking water treatment, and numerous other industrial pro-cesses. The term is also sometimes used as a generic term for solids separated from suspension in a liquid this 'soupy' material usually contains significant quantities of 'interstitial' water.

### 3.2.3 LIME

Lime is obtained from calcium carbonates such as lime stone, chalk, kanker and sea shells.

On burning, calcium carbonate decomposes into carbon dioxide and calcium oxide.

$CaCO3 + Heat \rightarrow CaO + CO2$

The calcium oxide, called quick lime, is obtained in the form of lumps by the heat process and is very reactive to moisture. Quick lime, when exposed to moisture, absorbs water and swells and breaks into powder form.

$$CaO + H_2O \rightarrow Ca(OH)2 + Heat$$

The powder thus obtained is calcium hydroxide and it is called slaked lime or hydrated lime. The process of obtaining slaked lime is called slaking or hydration. Lime is important ingredient for manufacturing of fly ash brick. It is produced in the form of calcium hydroxide sludge.

Lime should satisfy the following requirements:

- Availability of CaO should minimum of 60%.
- During lime slaking, it should not attain less than 600° C temperatures and slaking time should not be more than 15 minutes.

### 3.3 PHYSICAL PROPERTIES OF MATERIAL

#### 3.3.1 Bulk density test

The determination of bulk density of the each material was carried out as per standard practice. The following Table 3.1 shows the bulk density of materials used in the casting of brick.

**Bulk density = Weight / Volume**

Table 3.1 Bulk density of materials

#### 3.3.2 Specific gravity test

The determination of specific gravity of the each material was carried out as per standard practiced. The following Table 3.2 shows the specific gravity of materials used in the casting of brick.

| Mix ID | Fly Ash (%) | STP Sludge (%) | Quarry Dust (%) | Lime (%) | Gypsum (%) |
|---|---|---|---|---|---|
| R 1 | 60 | 0 | 25 | 10 | 5 |
| R 2 | 50 | 10 | 25 | 10 | 5 |
| R 3 | 40 | 20 | 25 | 10 | 5 |
| R 4 | 30 | 30 | 25 | 1 | 5 |

Specific gravity = $(W_2-W_1)/ [(W_2-W_1)-(W_3-W_4)]$
$W_1$ - Weight of pycnometer
$W_2$ - Weight of pycnometer with material
$W_3$ - Weight of pycnometer with material and distilled water
$W_4$ - Weight of pycnometer with distilled water

| Materials | Trail I | Trail II | Result |
|---|---|---|---|
| Fly ash | $2/(1.8975\times10^{-3}m^3)$ = 1054 | $1.6/(1.8975\times10^{-3}m^3)$ =843 | 948kg/m³ |
| STP Sludge | $0.4/(1.8975\times10^{-3}m^3)$ = 210 | $0.8/(1.8975\times10^{-3}m^3)$ = 421 | 315 kg/m³ |
| Quarry dust | $1/(1.8975\times10^{-3}m^3)$ = 527 | $1/(1.8975\times10^{-3}m^3)$ = 527 | 527kg/m³ |
| Lime | $0.4/(1.8975\times10^{-3}m^3)$ = 210 | $0.4/(1.8975\times10^{-3}m^3)$ = 210 | 210 kg/m³ |
| Gypsum | $0.2/(1.8975\times10^{-3}m^3)$ = 105 | $0.2/(1.8975\times10^{-3}m^3)$ = 105 | 105kg/m³ |

| Materials | Trail I | Trail II | Result |
|---|---|---|---|
| Fly ash | (450-320)/((450-320)-(1250-1185)) =2 | (470-320)/((470-320)-(1270-1185)) =2.3 | 2.15 |
| STP Sludge | (405-320)/((405-320)-(1205-1185)) =1.30 | (410-320)/((410-320)-(1215-1185)) =1.5 | 1.4 |

| | | | |
|---|---|---|---|
| Quarry dust | (465-320)/((465-320)-(1230-1185)) =1.45 | (485-320)/((485-320)-(1250-1185)) =1.65 | 1.55 |
| Lime | (435-320)/((435-320)-(1210-1185)) =1.27 | (445-320)/((445-320)-(1220-1185)) =1.38 | 1.3 |

### 3.4 EXPERIMENTAL METHODOLOGY

The modular brick samples of size 230 mm x 110 mm x 75 mm were casted as per IS 12894- 2002 using various mix proportions. The mix proportions are arrived by using Fly ash, STP Sludge, Lime, Gypsum and Quarry dust content. Four mix combinations were arrived by changing the STP Sludge proportion. The table 3.3 shows the details of the different mix proportions. The evaluation of STP Sludge for use as a replacement of Fly ash material begins with the brick testing. Brick contains Fly ash, STP Sludge, Gypsum, Lime and Quarry dust.

## 4. RESULT AND DISCUSSION

### 4.1 TESTING OF SPECIMEN

#### 4.1.1 Compressive strength test

The determination of compressive strength of the prepared samples was carried out as per standard practiced. The following Table 4.1 shows the compressive strength of various mix proportion of samples after testing. The specimen was tested after 21 days of curing.

**Compressive strength = Compressive load/ Area**

Area = (230 x 110) $mm^2$

**Table 4.1 Compressive strength test result for 21 days**

| Mix ID | | Weight of each brick (kg) | Maximum load (kN) | Compressive Strength ($N/mm^2$) | Avg. Compressive strength (N/mm²) |
|---|---|---|---|---|---|
| $R_1$ | 1. | 4.0 | 177.4 | 7 | 7.88 |
| | 2. | 3.8 | 209.8 | 8.29 | |
| | 3. | 3.9 | 211.4 | 8.36 | |
| $R_2$ | 1. | 3.8 | 104.8 | 4.14 | 4.01 |
| | 2. | 3.6 | 100.7 | 3.99 | |
| | 3. | 3.6 | 101.7 | 4.01 | |
| $R_3$ | 1. | 3.7 | 85.2 | 3.39 | 3.56 |
| | 2. | 3.5 | 82.5 | 3.26 | |
| | 3. | 3.5 | 101.7 | 4.04 | |
| $R_4$ | 1. | 3.8 | 67.9 | 3.86 | 3.02 |
| | 2. | 3.7 | 71.1 | 2.82 | |
| | 3. | 3.6 | 60.2 | 2.39 | |

#### 4.1.2 Water Absorption test

The determination of water absorption of the prepared samples was carried out as per standard practiced. The following Table 4.2 shows the water absorption of various mix proportions of samples after testing. The specimen was tested after 21 days of curing.

$$\text{Water absorption (\%)} = \frac{\text{wet weight} - \text{dry weight}}{\text{Dry weight}}$$

#### 4.1.3 Density test

The determination of density of the prepared samples was carried out as per standard practiced. The following Table 4.3 shows the density of various mix proportions after testing.

**Density = Weight/ volume**

Volume = (0.23 x 0.11 x 0.075) = 1.8975 x $10^{-3}$ $m^3$

**Table 4.3 Density test result**

| Mix ID | | Weight of brick kg | Volume of brick ($10^{-3}$) $m^3$ | Density $kg/m^3$ | Average density $kg/m^3$ |
|---|---|---|---|---|---|
| $R_1$ | 1. | 3.76 | 1.8975 | 1981 | 1981 |
| | 2. | 3.71 | 1.8975 | 1955 | |
| | 3. | 3.81 | 1.8975 | 2007 | |
| $R_2$ | 1. | 3.36 | 1.8975 | 1770 | 1779 |
| | 2. | 3.45 | 1.8975 | 1818 | |
| | 3. | 3.32 | 1.8975 | 1749 | |
| $R_3$ | 1. | 3.05 | 1.8975 | 1607 | 1658 |
| | 2. | 3.21 | 1.8975 | 1692 | |
| | 3. | 3.18 | 1.8975 | 1676 | |
| $R_4$ | 1. | 2.99 | 1.8975 | 1575 | 1558 |
| | 2. | 2.95 | 1.8975 | 1555 | |
| | 3. | 2.93 | 1.8975 | 1544 | |

#### 4.1.4 Efflorescence test

The determination of efflorescence of the prepared samples as carried out as per standard practiced. The following Table 4.4 shows the efflorescence of various mix proportion samples after testing.

## 5. CONCLUSIONS

- Bricks made with 10%STP Sludge , 50% Fly ash, 25% Quarry dust, 10% Lime and 5% Gypsum gives a compressive strength of 4.01 N/$mm^2$ which is

greater than the requirement of third class bricks i.e. 3.5 N/mm$^2$ (as per IS 1725-1982).

- As the percentage of the STP Sludge increases, the compressive strength of the brick decreases.
- As the percentage of the STP Sludge increases, the water absorption of the bricks increases.
- The density of bricks is within the range of 1500-1800 kg/m$^3$.
- As the percentage of the STP Sludge increases, density of the bricks decreases.
- When the bricks are immersed in water and dried, white patches are not formed, so the results of efflorescence for bricks are nil.
- These bricks can be utilized for the construction of low height walls where loads are less, construction of sheds, boundary wall and huts with roofs other than RCC.
- Bricks are used in areas that are not exposed to rain.
- It is used for construction of non-load bearing walls.

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