Light Weight Flyash Brick using Expanded Polystyrene (EPS)
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Abstract—This study has been carried out on development of light weight bricks using fly ash, GGBS (Ground Granulated Blast Furnace Slag), EPS (Expanded polystyrene) and cement. Bricks are widely used in building construction as the most common building materials. Expanded Polystyrene (EPS) is a light weight material that has been used in 1950s. The density of EPS is about hundredth of that of soil. As compared to medium clay the properties like Thermal insulation, Stiffness and Compressive strength of EPS is good. Its strength, Durability and light weight nature makes it a versatile and popular building product. GGBS, fly ash, and EPS are discarded in large amount and increased chances of environmental issues. Therefore, this paper introduces efforts of the combined used of GGBS, fly ash, EPS and cement for the production of light weight bricks. Bricks were casted in industrial site with various proportions and from these best mix was choose for experimental properties like Compressive Strength, Effloresces test, Water Absorption, Density etc.

Key words: Light weight brick, EPS, GGBS, Fly ash, Cement, Compressive Strength

I. INTRODUCTION

A. General:
The heavy weight of brick considered for the great mass of constructions and thus causes less protection against earthquake. Therefore, it is tried to reduced the weight of brick and density as well as improve thermal insulation. Nowadays cement bricks have been introduced in to the industry providing better alternatives to the clay brick. The cement consumes more amount of cement and it is not ecofriendly. Recently engineers and researchers are mainly focuses on the alternative materials for bricks from the various industrial waste product.

B. Objectives:
The main objective of the project is to replacing fly ash and cement brick by EPS, GGBS and cement and fly ash brick, which satisfies following points,

- Cost effective
- Environmental friendly
- Less weight
- Less water absorption
- Easily available

II. MATERIAL USED

In this project following materials are used for produced building brick.

A. EPS(Expanded polystyrene):
Expanded polystyrene (EPS) is an good packaging material which made of 98% air. EPS is mostly used in construction because of its light weight nature, strong and good insulating properties. In this project we used the light weight EPS balls of two different sizes 1mm and 2mm. It has been found from the research paper which shows that compressive strength depend, on size of EPS beads, smallest the size of EPS beads higher the result. EPS used in this project from R. K. Industries, Lihigaon, Bhandara road, Nagpur.

Fig. 1:

Fig. 2:
C. **Fly Ash:**
Fly ash is generated from combustion of coal in thermal power plant is a major environmental concern. As of now about 25 millions tones fly ash is generated from thermal power plant. Fly ash classified into three types-
- Fly ash collected from Thermal Power Plant.
- Pond ash stored in Pond.
- Bottom ash collected from boiler which contain high concentration of carbon Fly ash is a fine gray powder which is rich in silica and alumina. Fly ash contains characteristics like-
  - Fine particle size
  - Better finish
  - Reduce shrinkage
  - Increased long term strength
  - Spherical in shape
  Nowadays, fly ash is widely used in construction of building, pavements, compound wall panel etc.

![Fly Ash Image](image)

**Fig. 3:**

1) **Advantages of fly ash bricks:**
- Lower water absorption
- Dimensional accuracy
- High strength to weight ratio
- High compressive strength
- Consumption of less mortar in construction
- Conservation of natural resources like soil, sand etc.
Fly ash powder was collected from, it is grayish colour in appearance.

2) **Physical properties of flyash:**
- Specific Gravity -2.54 to 2.65gm/ cc
- Bulk Density- 1.11 gm/cc
- Fineness- 350 to 450 m²/kg

3) **Chemical Properties of Fly ash:**
- Silica 35-70%
- Alumina 10-33%
- Calcium Oxide 0.2-2%
- Loss on ignition 0.1-2%
- Sulphur 0.5-1.5%
- Iron 2-7%
About 50-80% may be used for production of fly ash brick.

D. **Cement:**
Ordinary Portland cement of 53 grade (OPC-53) confirming to IS : 8112-1989 was used in this project brand name as Altratech Cement. Cement used in this project as a binding material. In today’s construction world cement is a best binding material.

E. **Water:**
Water is an important ingredient for brick making. It helps in chemical reaction with cement. Water used in this project is free from organic material and the Ph value was 6 to 7. It was tested permissible limit as per IS:456-2000. Properties obtained are:

<table>
<thead>
<tr>
<th>Solids</th>
<th>Result (mg/l)</th>
<th>Permissible limit (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>Inorganic</td>
<td>1250</td>
<td>3000</td>
</tr>
<tr>
<td>Sulphate</td>
<td>80</td>
<td>400</td>
</tr>
<tr>
<td>Suspended matter</td>
<td>700</td>
<td>2000</td>
</tr>
<tr>
<td>pH</td>
<td>6.9</td>
<td>&gt;6</td>
</tr>
</tbody>
</table>

**Table 2:**

III. **EXPERIMENTAL PROCEDURE**

A. **Manufacturing Of Bricks:**
As we all are very much clear about the process of manufacture of bricks, and there is no difficult procedure of casting the brick. The brick was manufactured by conventional method.

B. **Mould Preparation:**
Mould was prepared of size (19x9x9) cm after collecting the required materials. This Mould was made up of non-porous material like metal of Standard size 190mm length, 90mm wide and 90mm deep. Frog was also provided. Metal mould was prepared in such a way that all parts of the mould are disassembled for demolding of brick. For avoid leakage problem joints were made without any hole or gap.

![Mould Image](image)

**Fig. 4:**

C. **Mixing Ratio:**
For the std, size of brick mould( 19x9x9 )cm required mixer of 2000 gm. Following mixes was taken-

![Mixing Ratio Image](image)

**Fig. 5:**
**Light Weight Flyash Brick using Expanded Polystyrene (EPS)**

**A. Weight:**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Sample Identification</th>
<th>Fly ash %</th>
<th>EPS %</th>
<th>Dry Wt. kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>79.25</td>
<td>0.75</td>
<td>1.687</td>
</tr>
<tr>
<td>2</td>
<td>A2</td>
<td>79</td>
<td>1</td>
<td>1.667</td>
</tr>
<tr>
<td>3</td>
<td>A3</td>
<td>78.75</td>
<td>1.25</td>
<td>1.52</td>
</tr>
</tbody>
</table>

**B. Water Absorption Test:**

The bricks were tested in accordance with the procedure laid down in IS 3495 (Part 2) after immersion in cold water for 24hr shall have average water absorption not more than 20% by mass up to class 12.5 and 15% by pass for higher classes. The brick is weaker when the water absorption capacity is more and vice versa. Water absorption value of bricks greatly affected by the bond between brick and mortar.

**C. Compressive strength:**

The minimum average compressive strength of brick shall not be less than that specified for each class in 5.1 when tested as described in IS 3495 (Part 1):1976.

The following steps were followed for Compression testing-

- In the universal testing machine the brick was placed centrally on the bottom plate.
- Then without any movement the upper plate of the universal testing machine was lowered down up to the brick was hold tightly.
- Then at a uniform rate the load was applied axially.
- Till the half of the brick this load was applied.
- For calculation of average compressive strength three bricks from same proportion were tested every time.
- Compressive strength was calculated by this formula-
- Compressive strength = (load/surface Area)/N/mm²
- Compressive strength of light weight brick at 3days, 7days and 14 days are shown in following table-

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Sample Identification</th>
<th>Fly ash%</th>
<th>EPS%</th>
<th>Compressive strength in N/mm² 3Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>79.25</td>
<td>0.75</td>
<td>1.1</td>
</tr>
<tr>
<td>2</td>
<td>A2</td>
<td>79</td>
<td>1</td>
<td>1.93</td>
</tr>
<tr>
<td>3</td>
<td>A3</td>
<td>78.75</td>
<td>1.25</td>
<td>2.43</td>
</tr>
</tbody>
</table>

Table 5:

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Sample Identification</th>
<th>Fly ash%</th>
<th>EPS%</th>
<th>Compressive strength in N/mm² 7Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>79.25</td>
<td>0.75</td>
<td>3.3</td>
</tr>
<tr>
<td>2</td>
<td>A2</td>
<td>79</td>
<td>1</td>
<td>4.98</td>
</tr>
<tr>
<td>3</td>
<td>A3</td>
<td>78.75</td>
<td>1.25</td>
<td>6.8</td>
</tr>
</tbody>
</table>

Table 6:

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Sample Identification</th>
<th>Fly ash%</th>
<th>EPS%</th>
<th>Compressive strength in N/mm² 14Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>79.25</td>
<td>0.75</td>
<td>5.1</td>
</tr>
<tr>
<td>2</td>
<td>A2</td>
<td>79</td>
<td>1</td>
<td>6.9</td>
</tr>
<tr>
<td>3</td>
<td>A3</td>
<td>78.75</td>
<td>1.25</td>
<td>8.1</td>
</tr>
</tbody>
</table>

Table 7:

D. Soundness Test:
The bricks of having same proportion were taken and they were struck with each other. The bricks were not broken and clear metallic or ringing sound was produced. So the bricks are good.

E. Hardness Test:
In this test, the scratch was made on the surface of brick. For all the three proportions of brick this test was carried out. Very light finger nail impression was left on the light weight brick while the scratch was made with the help of figure nail on the brick. So, this test results that light weight brick are sufficiently hard.

F. Presence of Soluble Salt:
Due to the presence salt in brick it will cause efflorescence effect. In this test light weight brick were immerse in water for 24 hrs. Then bricks were taken and allowed for drying. And there was no any gray or white deposite on the brick surface. It results that the bricks are free from soluble salts.

G. Structure Test:
In this test, the structures of brick were tested by breaking of bricks, whether they were free from any defect such as, holes lumps etc. In this test light weight brick were cut into two equal parts. The light weight brick piece structure was homogeneous, compact and free from defect.

V. CONCLUSION
- Flyash and cement brick are light weight brick as compared to conventional brick and this lightweight bricks are light weight than cement and flyash brick.
- Light weight brick is economical as compared to the Fly ash and Cement brick.
- Light weight brick are suitable for non-load bearing walls only.
- The weight of this brick is 1/3rd to 2/5th less than Demanded brick.
- This brick can be used in inner partition walls and wall panels.
- The replacement by using EPS is a best alternate non structural building material and it is best way for best disposal.
- Dead load of the building is reduced due to the less weight of this brick.
- The light weight brick are shock absorbent and good sound absorbent.
- Light weight brick is used when the load bearing capacity of the soil is low.
- The Moisture capacity of this brick is high.
- It will reduced the landfill and pollution since, waste material are used.

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