Manufacturing And Testing Of Plastic Sand Bricks

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Abstract- Plastic is a non-biodegradable substance which takes thousands of years to decompose that creates land as well as water pollution to the environment. The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. It is estimated that the rate of usage is double for every 10 years. The Plastic usage is large in consumption and one of the largest plastic wastes is polyethylene (PE). The utilization of earth based clay material resulted in resource depletion and environmental degradation. As amount of clay required for brick is huge, in this project these waste plastics are effectively utilized in order to reduce the land space required to dump these wastes. This creates the prevention from various harmful diseases. Polyethylene (PE) bags are cleaned and added with fine aggregate at various ratios to obtain high strength bricks that possess thermal and sound insulation properties. This is one of the best ways to avoid the accumulation of plastic waste. It also helps to conserve energy, reduce the overall cost of construction and hence in this project, an attempt is made to manufacture the plastic sand bricks by utilizing the waste plastics.

Key words
Plastic waste, low density polyethylene, polyethylene properties, plastic sand brick, bricks.

INTRODUCTION
1.1 General
Plastic is one of the daily increasing useful as well as a hazardous material. At the time of need, plastic is found to be very useful but after its use, it is simply thrown away, creating all kinds of hazards. Plastic is non-biodegradable that remains as a hazardous material for more than centuries.

The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. It is estimated that the rate of expansion is double for every 10 years. This is due to rapid growth of population, urbanization, developmental activities and changes in life style which leading widespread littering on the landscape. They are non-biodegradable and also researchers have found that the plastic materials can remain on earth for 4500 years without degradation. In India approximately 40 million tons of the municipal solid waste is generated annually, with evaluated increasing at a rate of 1.5 to 2% every year.

Hence, these waste plastics are to be effectively utilized. Today, it is impossible for any vital sector to work efficiently without usage of plastic starting from agriculture to industries. Thus we cannot ban the use of plastic but the reuse of plastic waste in building constructions, industries are considered to be the most practicable applications.

1.2 SPECIFICATIONS
1.2.1 Cement

Cement is made by heating limestone (calcium carbonate) with small quantities of other materials (such as clay). In this project Ordinary Portland cement of 53 grade conforming to IS456-2000 was used. Tests were carried out on various physical properties of cement and the results are shown in test data of materials. cement will act as a binding material.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Test</th>
<th>Obtained Result</th>
<th>Standards (IS:8112)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initial setting time</td>
<td>32 minutes</td>
<td>30 minutes</td>
</tr>
<tr>
<td>2</td>
<td>Final setting time</td>
<td>580 minutes</td>
<td>600 minutes</td>
</tr>
<tr>
<td>3</td>
<td>Fineness</td>
<td>96 %</td>
<td>Not Less than 90%</td>
</tr>
<tr>
<td>4</td>
<td>Specific gravity</td>
<td>3.14</td>
<td>3.10 – 3.15</td>
</tr>
<tr>
<td>5</td>
<td>Standard consistency</td>
<td>34%</td>
<td>30 – 35%</td>
</tr>
</tbody>
</table>

1.2.2 Oxides

<table>
<thead>
<tr>
<th>S. No</th>
<th>Oxide</th>
<th>Present (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CaO</td>
<td>60-67</td>
</tr>
<tr>
<td>2</td>
<td>SiO₂</td>
<td>17-25</td>
</tr>
<tr>
<td>3</td>
<td>Al₂O₃</td>
<td>3.0-8.0</td>
</tr>
<tr>
<td>4</td>
<td>Fe₂O₃</td>
<td>0.5-6.0</td>
</tr>
<tr>
<td>5</td>
<td>MgO</td>
<td>0.1-4.0</td>
</tr>
<tr>
<td>6</td>
<td>Alkalies (K₂O, Na₂O)</td>
<td>0.4-1.3</td>
</tr>
<tr>
<td>7</td>
<td>SO₃</td>
<td>1.3-3.0</td>
</tr>
</tbody>
</table>

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Fig 1.1 Ordinary Portland Cement

1.2.2 Sand

Natural river sand was used as a fine aggregate. The properties of sand were determined by conducting tests as per IS: 2386 (Part-1). The results are shown in the test data of materials. The results obtained from sieve analysis are furnished. The results indicate that the sand conforms to zone 11 of IS: 383-1970.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Tests</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specific Gravity</td>
<td>2.62</td>
</tr>
<tr>
<td>2</td>
<td>Bulk Density</td>
<td>1690 kg/m³</td>
</tr>
<tr>
<td>3</td>
<td>Fineness Modulus</td>
<td>2.92</td>
</tr>
</tbody>
</table>

1.2.3 Water

Water used for mixing and curing of concrete shall be clean and free from oils, acids, alkalies, salts and organic materials or other substances the may be deleterious to concrete or steel. Portable water shall be used for mixing of concrete. Suspended solid matter in the water shall not exceed more than 200mg/l. The pH value of the water shall not be less than 6.

1.2.4 Fly ash

Fly ash is a residue resulting from combustion of pulverized coal or lignite in thermal power plants. About 80% of the total fly ash is in finely divided form which is carried away with flue gases and is collected by electrostatic precipitator or other suitable technology.

1.4 Physical Properties of Fly Ash

<table>
<thead>
<tr>
<th>S. No</th>
<th>Tests</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specific Gravity</td>
<td>2.67</td>
</tr>
<tr>
<td>2</td>
<td>Fineness</td>
<td>84%</td>
</tr>
</tbody>
</table>

1.5 Chemical composition of Fly ash

<table>
<thead>
<tr>
<th>S. No</th>
<th>Components</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SiO₂</td>
<td>35 – 59</td>
</tr>
<tr>
<td>2</td>
<td>Fe₂O₃</td>
<td>0.5 – 2</td>
</tr>
<tr>
<td>3</td>
<td>Al₂O₃</td>
<td>20 – 33</td>
</tr>
<tr>
<td>4</td>
<td>CaO</td>
<td>5 – 16</td>
</tr>
<tr>
<td>5</td>
<td>MgO</td>
<td>1 – 5.5</td>
</tr>
<tr>
<td>6</td>
<td>So₃</td>
<td>0.5 – 1.5</td>
</tr>
<tr>
<td>7</td>
<td>Loss on ignition</td>
<td>1 – 2</td>
</tr>
</tbody>
</table>

1.1.5 Waste plastics

Plastics are commonly used substances which play an important role in almost every aspect of our lives. The widespread generation of plastics waste needs proper end-of-life management. The highest amount of plastics is found in containers and packaging’s (i.e. bottles, packaging, cups etc.), but they also are found in durables (e.g. tires, building materials, furniture, etc.) and disposable goods (e.g. medical devices). Diversity of plastics applications is related with their specific properties, low density, easy processing, good mechanical properties, good chemical resistance, excellent thermal and electrical insulating properties and low cost (in comparison to other materials). Post-production and post-consumer plastics are utilized in a wide range of applications.

1.6 Waste Types

<table>
<thead>
<tr>
<th>Waste plastic</th>
<th>Available as</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poly-ethylene terephthalate (PET)</td>
<td>Drinking water bottles etc.</td>
</tr>
<tr>
<td>High Density Polyethylene (HDPE)</td>
<td>Carry bags, bottle caps, house hold articles etc.</td>
</tr>
<tr>
<td>Low Density Polyethylene (LDPE)</td>
<td>Milk pouches, sacks, carry bags, bin linings, cosmetics and detergent bottles.</td>
</tr>
<tr>
<td>Poly propylene (PP)</td>
<td>Bottle caps and closures, wrappers of detergents, biscuit etc.</td>
</tr>
<tr>
<td>Urea formaldehyde</td>
<td>Electrical fittings, handles and Knobs</td>
</tr>
<tr>
<td>Polyester resin</td>
<td>Casting, bonding fibers (glass, Kevlar, carbon fiber)</td>
</tr>
</tbody>
</table>
Results were taken from Chennai central institute of plastic engineering and technologies.

1.7 Plastic properties

<table>
<thead>
<tr>
<th>S.no</th>
<th>Properties</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Density at 23˚C</td>
<td>0.958</td>
</tr>
<tr>
<td>2.</td>
<td>Elastic modulus</td>
<td>9</td>
</tr>
<tr>
<td>3.</td>
<td>Tensile creep strength</td>
<td>8</td>
</tr>
<tr>
<td>4.</td>
<td>Bending creep modulus</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>Tensile strength at 23˚C</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>Elongation at break (%)</td>
<td>&gt; 600</td>
</tr>
<tr>
<td>7.</td>
<td>Thermal conductivity</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>Ignition temperature</td>
<td>3</td>
</tr>
</tbody>
</table>

1.3 OBJECTIVES

- To develop an efficient way to effectively utilize the waste plastics and that plastic wastes acts as a great threat for the sustainment of ecological balance.
- To reduce the consumption of earth based material as clay for the manufacturing of brick that resulted in resource depletion, environmental degradation.
- To reduce the waste plastic quantities on the land and water to avoid land and water pollution.
- To reduce the dumping area of waste plastics
- To produce the cost effective materials
- To prevent the people health from harmful diseases

1.4 MIX DESIGN

In order to find the plastic soil bricks that they possess high compressive strength with various mix proportions are made and they are tested using compressive testing machine [CTM]. The mix proportions were in the ratio of (1:3, 1:4, and 1:5). These are the ratio which represents the plastic, river sand respectively.

1.5 Methodology

2.1 PROCEDURE OF CASTING FLYASH BRICKS

2.1.1 Batching

The measurement of materials for making brick is termed as batching. Use of weigh system in batching facilitates accuracy, flexibility and simplicity.

<table>
<thead>
<tr>
<th>Quantity (kg)</th>
<th>For 1 brick(kg)</th>
<th>For 10 brick(kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly ash</td>
<td>1.01</td>
<td>10.1</td>
</tr>
<tr>
<td>Cement</td>
<td>0.248</td>
<td>2.48</td>
</tr>
<tr>
<td>Sand</td>
<td>0.81</td>
<td>8.1</td>
</tr>
</tbody>
</table>

2.1.2 Mixing

Mixing of materials is essential for the production of uniform and strengthens brick. The mixing should ensure that the mass becomes homogeneous, uniform in color and consistency. Generally there are two types of mixing, Hand mixing and machine mixing. In this project, we adopted hand mixing.
2.2 Fly Ash Brick Mixing Percentages

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly ash</td>
<td>60%</td>
</tr>
<tr>
<td>Cement</td>
<td>10%</td>
</tr>
<tr>
<td>Sand</td>
<td>30%</td>
</tr>
</tbody>
</table>

2.1.3 Moulding

The mould is used for preparing brick in uniform shape. The size of mould is 230x100x75 mm. The mould were assembled and placed on the base plate. The faces must be thinly coated with mould oil to easily demould after casting.

2.1.4 Curing

The test specimens after compaction were allowed to dry for a period of 24 hours. The specimens were kept in ordinary curing tank and allowed to cure for a period of 7, 14 and 28 days.

2.2 Procedure of Casting Plastic Sand Bricks

2.2.1 Batching

The collected waste bags are cleaned with water and dried to remove the water present inside the plastic and then weighted. The sand were sieved by using 600 micron sieve. The sand and the plastic bags were weighed in various proportions among which the plastic were taken for burning process.

2.2.2 Burning

After batching the plastic bags were taken for burning in which the plastic bags are thrown one by one into the drum and allowed to melt. The first step of burning process includes the arrangement of stones, drum and the required firewood. The stones are arranged to hold the drum and the firewood is placed in the gap between stones and it is ignited. The drum is placed over the setup and it is heated to remove the moisture present in it.

2.2.3 Mixing

The plastic bags are added one by one into the drum, until the entire plastic content required for making bricks of one mix proportion is added into it. When these plastic thoroughly by using trowel before it hardens. The mixture has very short setting bags are turned to molten state, the river sand is added to it. The sand added is mixed time. Hence mixing process should not consume more time.

2.2.4 Moulding

The mixture is then poured into the brick mould and is compacted by using tamping rod or steel rod. The surface is finished by using trowel. Before placing the mixture into the mould, the sides of the mould are oiled to easy removal of bricks. Mould removed after 24 hours.

2.3 Batching of Plastic Sand Brick

<table>
<thead>
<tr>
<th>Mix ratio</th>
<th>1:3</th>
<th>1:4</th>
<th>1:5</th>
</tr>
</thead>
<tbody>
<tr>
<td>For 1 brick (gram)</td>
<td>1000:3000</td>
<td>800:3200</td>
<td>670:3350</td>
</tr>
<tr>
<td>For 4 brick (grams)</td>
<td>4000:12000</td>
<td>4000:12000</td>
<td>2680:1300</td>
</tr>
</tbody>
</table>

2.3 Tests on Brick

2.3.1 Compression strength test

The cube specimens was placed in compression testing machine and the load is to be applied without shock.
and increased continuously at a rate of approximately 140 kg/cm\(^2\) min until the resistance of the specimen to the increasing load breaks down and no greater load can be restrained. The maximum load applied to the specimens is to be recorded and the appearance of the brick and any unusual features in the type of failure is noted.

\[
\text{Compressive strength} = \frac{\text{Maximum load}}{\text{Area of the specimen}} = \frac{P}{A}
\]

Where,
- P - Maximum load (kN)
- A - Area of the specimen (mm\(^2\))

### 2.4 Comparison of compressive strength of Plastic sand bricks possessing various ratios

<table>
<thead>
<tr>
<th>Mix Ratio</th>
<th>Plastic Sand Ratio</th>
<th>Compressive Strength (N/mm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1:3</td>
<td>4.49</td>
</tr>
<tr>
<td>2</td>
<td>1:4</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>1:5</td>
<td>5.56</td>
</tr>
</tbody>
</table>

### 2.5 Comparison of compressive strength of Plastic sand bricks with its counterpart

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Type of Brick</th>
<th>Compressive Strength (N/mm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fly ash</td>
<td>3.83</td>
</tr>
<tr>
<td>2</td>
<td>Plastic Sand brick</td>
<td>5</td>
</tr>
</tbody>
</table>

### 2.6 Water absorption test of Plastic sand bricks possessing various ratios

<table>
<thead>
<tr>
<th>S. No</th>
<th>Mix ratios</th>
<th>Water absorption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1:3</td>
<td>0.935</td>
</tr>
<tr>
<td>2</td>
<td>1:4</td>
<td>0.727</td>
</tr>
<tr>
<td>3</td>
<td>1:5</td>
<td>1.033</td>
</tr>
</tbody>
</table>

### 2.7 Comparison of compressive strength of Plastic sand bricks with its counterpart

<table>
<thead>
<tr>
<th>S.No</th>
<th>Type of Brick</th>
<th>Water absorption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fly Ash</td>
<td>6.97</td>
</tr>
<tr>
<td>2</td>
<td>Plastic sand</td>
<td>1.033</td>
</tr>
</tbody>
</table>

### 2.3.3 Efflorescence test

The presence of alkalis in bricks is harmful where it forms 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. Then, it is 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 in acceptable 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 alkalis

### 2.8 Efflorescence Test Results

<table>
<thead>
<tr>
<th>S. No</th>
<th>Mix ratios</th>
<th>Nil</th>
<th>Slight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F.A</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>2</td>
<td>1:3</td>
<td>✔</td>
<td>̶</td>
</tr>
<tr>
<td>3</td>
<td>1:4</td>
<td>✔</td>
<td>̶</td>
</tr>
<tr>
<td>4</td>
<td>1:5</td>
<td>✔</td>
<td>̶</td>
</tr>
</tbody>
</table>
2.3.4 Hardness test

In this test a scratch is made on brick surface with steel rod (any hard material can be used) which was difficult to imply the bricks or blocks were hard. This shows the brick possess high quality.

2.3.5 Fire resistance test

The Plastic is highly susceptible to fire but in case of Plastic sand bricks/Paver blocks the presence of sand imparts insulation. There is no change in the structural properties of block of bricks up to 180°C above which visible cracks are seen and the bricks deteriorate with increase in temperature.

2.3.6 Soundness test

The soundness test is also done in the field. After the manufacturing of the brick are allowed to dry in air for 2days.Then the bricks are made to hit each other the ring sound produced during the process, which denotes the quality of the brick that it is good. Good quality bricks produce the clear ringing sound. In our project both fly ash bricks and plastic sand bricks clear ringing sound produced.

3. CONCLUSION

Plastic sand brick possess more advantages which includes cost efficiency, resource efficiency, reduction in emission of greenhouse gases, etc, Plastic sand brick is also known as “Eco-Bricks” made of plastic waste which is otherwise harmful to all living organisms can be used for construction purposes.It increases the compressive strength when compared to fly ash bricks. By use of plastic sand bricks, the water absorption presence of alkalies was highly reduced. Owing to numerous advantages further research would improve quality and durability of plastic sand bricks.

REFERENCES


