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Reusing Waste HDPE Plastic in Manufacturing of HDPE – Sand Brick

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ABSTRACT: Plastic is used in day today life at present nearly 56 lakhs ton of plastic waste produced in India per year. Plastic is generally non-degradable hence; they may take centuries to decay. This is due to the intermolecular bonds that constitutes plastic, whose structure ensure that the plastic neither corrode nor decompose. Plastic dispose of indecently get washed away to water reservoirs. They clog waterways and float on reservoir, polluting and making them unsightly. The use of waste plastics in brick is a partial solution to the environmental and ecological challenges associated with the use of plastics. The aim of this project is to reduce environmental pollution by using waste plastic to produce Plastic Sand Brick. The plastic material is first shredded and melted in a container at a temperature range of 250 °C - 260 °C and the natural sand were added in their respective ratios (1:1) From the above findings, plastic sand brick has a good strength and can therefore be used for specific requirement namely compound wall, footpaths, parking areas etc. Hence the project is helpful in reducing plastic waste in a useful way. The best ratio of natural sand and plastic which leads to higher strength to plastic sand brick. The plastic sand bricks were prepared and tested and results were compared with burnt clay brick and fly ash bricks.

KEYWORDS: HDPE, plastic, brick, pollution, environment.

I. INTRODUCTION

Sustainable construction means using recyclable and renewable materials in building projects and minimizing energy consumption and waste production. The primary goal of the sustainable construction method is to reduce its impact on our environment.

“Green” or “sustainable” buildings use key resources like energy, water, materials, and land more efficiently than buildings that are just built to code. With more natural light and better air quality, green buildings typically contribute to improved employee and student health, comfort, and productivity.

The reuse of waste HDPE plastic will lead to one step toward sustainable construction. It will become part of green building if we focus on its development towards as a construction material. HDPE Plastic waste can be turned into a business opportunity as it does not cost a penny to purchase it. As it is free and not in that much use of private industries because of an expensive recycling of it. The only cost to be paid is its collection cost of plastic. And this is an interesting point to be consider as to use it to manufacture bricks of it. In India, the first-class brick generally cost between 8 Rs to 10 Rs. The brick manufacture from HDPE plastic and sand cost between 5 Rs to 7 Rs if mass production is done. As the HDPE plastic qualify all the property of brick to be used in construction like compressive strength, water absorption and etc. we can use it to make HDPE Sand Brick.

II. RELATED WORK

The HDPE Plastic has been used from 1960's and with its majority uses cases in different sector and low hazardous product quality, the world forgets about the mountain of garbage made year on year in which HDPE contribute a large percentage of part. It is HDPE plastic is currently considered a low-hazard plastic with a low risk of leaching but the issue is the land covered by its landfill.

The research on use of waste HDPE to save the environment is started from late 1990's. Due to high recycling cost, idea of recycling of waste HDPE has been thrown out of mind by industrialist. During 2000's, the first use of Waste

HDPE in construction industry has been discovered as a construction brick. Many researchers and engineer have studied about use of HDPE plastic as a brick, some of them implemented their idea into practical result like HDPE plastic – Cement brick, HDPE plastic – PP plastic brick, HDPE plastic – Sand brick and etc. Due to some technical and economical reason, their research had got a paused. The method used by many of research to cast HDPE plastic – Sand brick is either injection moulding (Costly Method) or Kiln Burning (Brick loose some of its properties). These are some reasons a world transition idea toward green constriction is get ignored.

We had understood and analyse all the problem related to manufacturing and use of HDPE Plastic – Sand Brick. And came with an idea of a different technique to manufacture brick which will achieve its all the required properties. We had just made a little change in its manufacturing, we heated sand first which absorb the heat and when we put plastic in it. The recyclization of HDPE plastic is started within few minutes, which make it ductile in nature while casting and harden as concrete when get prepared. By this small step we achieved the required properties and economy in manufacturing.

III. METHODOLOGY

We had done the research work to select a suitable type of plastic for brick, selection of material for brick, selection of method of casting brick, collection of materials, arrangement of equipment and instrument, casting of bricks, curing and measurement, at last test performed on HDPE Sand Bricks.

In this project in manufactured HDPE-Sand brick which can replace common burnt clay building bricks with all the quality of common burnt clay building bricks.

3.1 Materials

A) HDPE Plastic (High-density polyethylene):

High density polyethylene is a thermo-plastic polymer. Its monomer unit is ethylene. Ethylene, also known as ethene, is a C_2H_4 hydrocarbon. PEHD (polyethylene high density), polythene alkathene, are all names for high density polyethylene. High-density polyethylene (HDPE) or polyethylene high-density (PEHD) is a thermoplastic polymer produced from the monomer ethylene. It is sometimes called "alkathene" or "polythene" when used for HDPE pipes. With a high strength-to-density ratio, HDPE is used in the production of plastic bottles, corrosion-resistant piping, geomembranes and plastic lumber. HDPE is commonly recycled, and has the number "2" as its resin identification code.

The properties of HDPE Plastic are as follows:

- Tensile Strength = 0.20 - 0.40 N/mm².
- Notched Impact Strength no break Kj/m².
- Thermal Coefficient of expansion $100 - 220 \times 10^{-6}$.
- Max Continues Use Temp = 65 °C.
- Density = 0.944 - 0.965 g/cm³.
- Melting point ~135°C.
- Maximum allowable stress at 20°C.
- Compressive Strength = 14–32 MPa

B) Natural Sand:

Natural sand is produced by natural forces, such as river sand, sea sand, and mountain sand. Generally, mountain sand is more weathered, containing more mud, organic impurities and light substances.

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO₂), usually in the form of quartz.

The general properties of Sand are as follows:

- Grade of sand = Well grade.
- Specific gravity = 2.65.
- Water absorption = 0.25%.
- Density = 14450 gm/cc.
- Fineness modulus = 2.74

3.2 Proportion:

The proportion of plastic sand brick is taken as 1:1 (Plastic: Sand) of Plastic and Sand. All the ingredient are dry. Bulking of sand is minimal. Weight batching is done.

The calculation as follow: -

Total weight of brick - 2.560 Kg

$$1x + 1x = 2.560 \text{ Kg}$$

$$2.x = 2.560 \text{ Kg}$$

$$x = 2.560/2 \text{ kg}$$

$$x = 1.28 \text{ kg}$$

So, Weight of plastic is $1x = 1 \times 1.28 = 1.280 \text{ Kg}$.

Weight of sand is $1x = 1 \times 1.28 = 1.280 \text{ Kg}$.

As we had only taken 1:1 proportion for making plastic sand brick because

- Below 1:1, brick become uneconomical due to more plastic get used so the sand quantity get reduced which generally used to reduce cost.
- Above 1:1, casting of brick is not possible as less quantity of plastic get in contact of O₂, it starts evaporating very rapidly so the time required to harden is longer than evaporation rate \.
- 5 Specimen of 1:1 (Plastic: Sand) are used to get a more accurate result as per IS code guidelines.

3.3 Mixing:

1. First heating of sand is done for 10 minutes until the heat waves from sand comes out.



Fig no. 1 – Heating sand

2. Then plastic is added in heated sand so it can melt easily as sand has already absorbed heat. The plastic is heat up to 5 minutes until it caught small fire due to melting of HDPE and settling at bottom which is inflammable. Now it is ready to cast into mould.



Fig no. 2 – Mix is ready to cast

3.4 Casting

1. The casting of Plastic Sand brick is done in mould of size 19 x 9 x 9 cm. The moulds are locked by the stirrup of size 20x10x10 cm to avoid the leakage through corner of mould during compacting of specimen.



Fig no. 3- Moulds of size 19x9x9 cm

2. The casting of mould is done in three layers to avoid voids while casting. A wooden base is provided to proper casting of brick. Tamping of each layer is done by tamping rod. The leveling of top surface is done by tamping rod.

IV. EXPERIMENTAL RESULTS

Under this heading, we performed the required tests for the bricks as per IS 1077: 1992 (Reaffirmed 2002) for the 1:1 Plastic Sand brick. The performed test was use to analysis and finding brick with optimum result.

- Result of all tests performed
- As per IS 1077: 1992 (Reaffirmed 2002)

1. Compressive Strength:

Plastic Sand brick sample of proportion 1:1 (Plastic: Sand) is used to calculate compressive strength as per IS 1077: 1992 (Reaffirmed 2002). Results are shown in table no. 1

Table no. 1 - Compressive Strength

Sample ratio (plastic: sand)	Specimen No.	Compressive strength (N/mm ²)	Average compressive strength (N/mm ²)
1:1	1	23.92	24.38
	2	25.02	
	3	24.80	
	4	24.30	
	5	23.86	

- In this result we got Mean Compressive Strength Plastic Sand Brick (1:1) is 24.38 N/mm² which is 143% more than First Class Burnt Clay brick.
- Generally, the first-class brick gives strength up to 10 N/mm² and second-class brick give strength between 7 – 10 N/mm²
- The Plastic Sand brick of proportion (1:1) achieve higher strength from Burnt Clay Brick

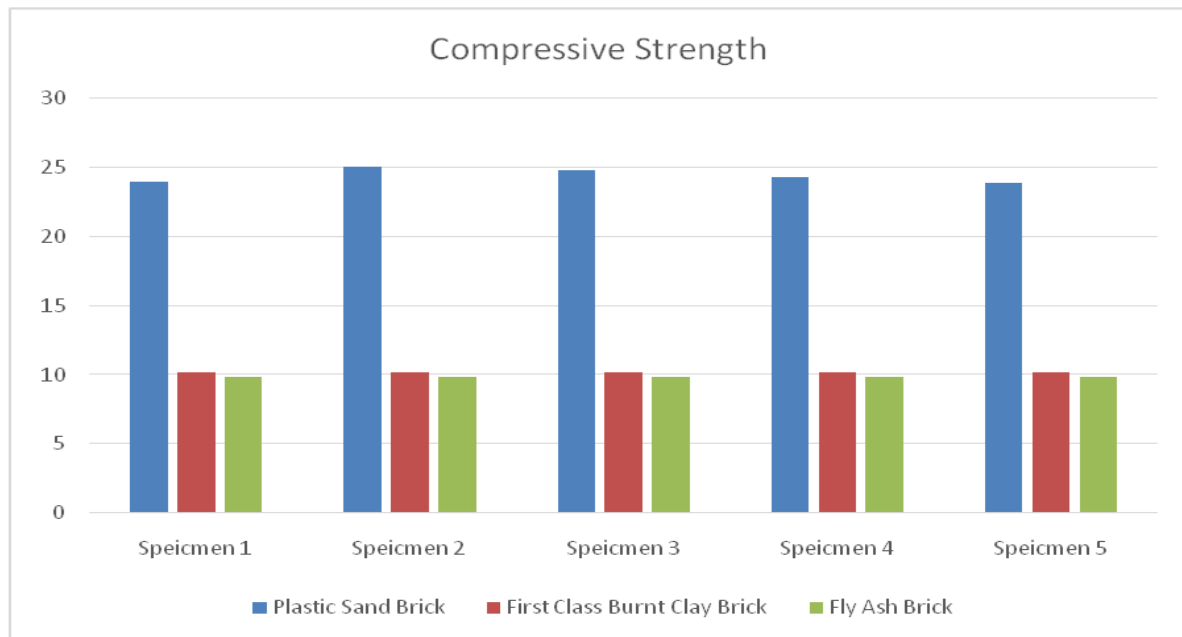


Fig no. 4 - Compressive Strength comparison

2. Water Absorption Test:

Plastic Sand brick sample of proportion 1:1 (Plastic: Sand) is used to calculate water absorption of brick as per IS 1077: 1992 (Reaffirmed 2002). Results are shown in table no. 2

Table no. 2 - Water Absorption

Sample ratio (plastic: sand)	Specimen No.	Initial Weight (Kg)	Final Weight (After 24 hrs) (Kg)	Water Absorption (%)	Average water Absorption (%)
1:1	1	2.542	2.560	0.708	0.66
	2	2.584	2.598	0.546	
	3	2.520	2.534	0.580	
	4	2.562	2.578	0.646	
	5	2.528	2.548	0.820	

- The Mean Water Absorption of 1:1 Plastic Sand brick is 0.66 % which is far lower than First Class Burnt Brick.
- The Water Absorption of First-Class brick is generally between 10% -15%.

- The Plastic Sand brick of proportion (1:1) gives very minimal water absorption as compare to first class burnt brick.

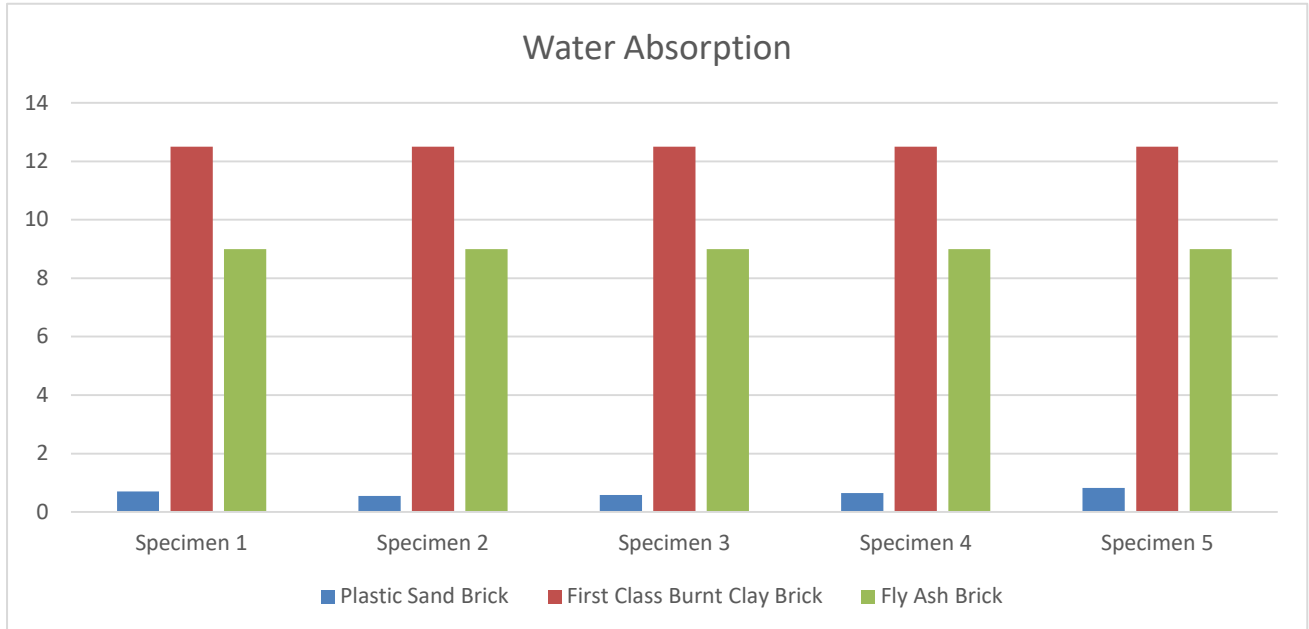


Fig no. 5 - Water Absorption comparison

3. Efflorescence Test:

- The liability of efflorescence in Plastic Sand Brick is NIL.
- Efflorescence is a crystalline deposit of salts that can form when water is present in or on brick. It is usually white but can also appear yellow, green or brown. It is caused by a number of soluble salts including the sulphate or carbonate compounds of calcium, sodium, potassium and magnesium.
- In Burnt Clay Brick it is found because of natural clay is used which is reactive with soluble salts.
- But in Plastic Sand Brick, it is not reactive with any type of salt. Hence efflorescence is NIL.

➤ Field test performed on Brick

1. Hardness

- The Plastic Sand Brick is scratched using finger nail. There is no visible crack seen on surface of brick.
- So, we can say that brick has passed the hardness test.

2. Colour Test;

- The Plastic Sand Brick is observed by naked eyes. The colour of brick is uniform (Black) due to plastic colour.
- So, we can say that brick has passed the colour test.

3. Soundness Test:

- 2 Plastic Sand Bricks are chosen randomly and struck with one another. There is no clear ringing sound or metallic sound.
- Clear ringing sound is property of burnt clay brick which indicate that it is properly baked or burnt. Hence it is invalid for plastic sand brick because we don't bake it during manufacturing.

4. Shape and Size:

- The all the edges of plastic sand brick are sharp and undamaged.
- All the dimension of plastic sand bricks are bricks are accurate.
- Hence, we can say that brick has passed the shape and size test.

5. Impact Test;

- The Plastic Sand Brick is drop from one-meter height. It does not break after taking impact. Also, there are not cracks or damages in it.



- Hence, we can say that brick has passed the Impact test.

From the above testing, we can say that Plastic Brick of proportion 1:1 (Plastic: Sand) has passed all the test mentioned in IS 1077: 1992 (Reaffirmed 2002) and all the field test performed on construction site. Hence, we can say that Plastic Sand Brick with proportion of 1:1 (Plastic: Sand), we achieved highest compressive strength and lowest water absorption as compared to First Class Burnt Clay Brick and Fly Ash Brick. The Plastic Sand brick qualify all the parameters required to use as a building material.

V. CONCLUSION

From the above study on Plastic Sand Brick, we can conclude that,

- The Plastic Sand Brick are far better than Burnt Clay Brick and Fly Ash Brick in all manner.
- It has better compressive strength, water absorption and other properties which make it special in term of use as building bricks.
- The costing of Plastic Sand Brick is around 5 Rs - 7 Rs which is cheaper than First Class Burnt Clay Brick which cost around 11 Rs.
- Plastic Sand Brick gives better quality than First Class Burnt Clay Brick at 50 % less cost. It has some special properties that make it more durable and useful like chemical resistant, ductile in nature, high wear and tear resistant, etc. which can be helpful in different harsh environment.
- It can be a small step towards green and sustainable construction. And may be helpful to make earth a better place.

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