

UTILIZATION OF WASTE PLASTIC IN MANUFACTURING OF BRICKS

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Abstract- Modern world is facing a serious situation of waste management, especially plastic waste. Everyday thousands of tonnes of plastic are dumped to the garbage but there is no enough method to treat and recycle the plastic world. A large amount of plastic is been discarded or burned daily which leads to the contamination of environment and air. Accumulation of plastic waste in the environment is hazardous to both plant and animal life. The plastic waste in the form of PET (Polyethylene terephthalate) has an important environmental challenge and its recycling faces a big problem due to its non-degradable nature. The large volumes of materials required for infrastructure construction is potentially a major area for the reuse of waste materials. Thus, to overcome this problem the plastic waste is been treated with Soil to make brick for construction purpose. This project studies the properties of bricks manufactured by mixing soil and waste plastic and its suitability as a building unit. The waste plastic and soil are batched properly and waste plastic is given heat from below. Soil was added in 1:2 & 1:1 (plastic and soil respectively) proportions into the molten plastic paste for the manufacturing of plastic soil bricks and is poured into moulds of required size. This alternatively saves the quanta of sand/clay that has been taken away from the precious river beds/mines, and is the one of the best ways to avoid the accumulation of plastic waste which is non-biodegradable pollutant.

1. INTRODUCTION

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.

Plastic soil brick possesses more advantages which includes cost efficiency, resource efficiency, reduction in emission of greenhouse gases, etc., Plastic soil 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 soil bricks, the water absorption presence of alkalis was highly reduced. Owing to numerous advantages further research would improve quality and durability of plastic soil bricks.

2. MATERIALS USED

2.1. Waste plastic

We are using Low Density Polyethylene Waste Plastic (LDPE) in this project because the High-Density Polyethylene Plastic become powder when heated or melted. But the LDPE plastic become liquid when heated and in atmospheric temperature it again hardens and act like a binding material in manufacturing of soil bricks

Low-density polyethylene (LDPE) is a thermoplastic made from the monomer

ethylene. It was the first grade of polyethylene, produced in 1933 by Imperial Chemical Industries (ICI) using a high-pressure process via free radical polymerization. Its manufacture employs the same method today. The EPA estimates 5.7% of LDPE is recycled. Despite competition from more modern polymers, LDPE continues to be an important plastic grade. In 2013 the worldwide LDPE market reached a volume of about US\$33 billion.

According to UN estimates, every year the world uses 500 billion plastic bags while half of the plastic used is of single use or in disposable items such as grocery bags, cutlery and straws. Each year, at least eight million tonnes of plastic end up in the oceans, the equivalent of a full garbage trucks every minute.

We collected waste plastic by municipal town panchayat which is collected by cleaning our city every day and also some amount of plastic is collected by cleaning our campus

2.2. Soil

Soil is a mixture of organic matter, minerals, gases, liquids, and organisms that together support life. Earth's body of soil, called the pedosphere, has four important functions:

- * as a medium for plant growth
- * as a means of water storage, supply and purification
- * as a modifier of Earth's atmosphere
- * as a habitat for organisms

All of these functions, in their turn, modify the soil.

Soil is a major component of the Earth's ecosystem. The world's ecosystems are impacted in far-reaching ways by the processes carried out in the soil, from ozone depletion and global warming to rainforest destruction and water pollution. With respect to Earth's carbon cycle, soil is an important carbon reservoir, and it is potentially one of the most reactive to human disturbance and climate change. As the planet warms, it has been predicted that soils will add carbon dioxide to the atmosphere due to increased biological activity at higher temperatures, a positive feedback

We dig some soil near our college and graded it by sieving it which is 4.75mm passing and 90 μ , lesser than 90 μ particles of soil will form lumps and does not bind properly which affect the strength of the bricks, the particles greater than 4.75mm will creates voids which also affect the strength of the soil.



Figure 1: Sieves used to sieve the soil

3. MIX PROPORTION

Mix design can be defined as the process of selecting suitable ingredients of plastic soil bricks and determining their relative proportions with the object of producing bricks of certain minimum strength and durability as economically as possible

We can use only 1:2 or 1:1 (Plastic: Soil) proportion in manufacturing of plastic soil bricks to get proper strength and shape because if we use lesser proportion than 1:2 the soil and molten plastic will not bind properly and we will not get good strength, if we use greater proportion than 1:1 the error due to shrinkage will be more which may reduce the size and change the shape of the bricks.

4. METHOD OF CASTING BRICKS

4.1 COLLECTION OF MATERIALS

4.1.1 PLASTIC

We collected waste Plastic by cleaning our campus and we meet municipal town panchayath engineer and collected waste plastic which has been collected daily morning by municipal town panchayath labour



Figure 2(a): Collection of plastic by cleaning campus



Figure 2(b): Solid waste management plant soraba

4.1.2 SOIL

We dig some soil near our college and graded it which is 4.75mm passing and 90 μ retaining



Figure 3: Collection of soil



Figure 4: Weighing of graded soil

4.2 BATCHING

In general batching is the process of measuring and combining the ingredients as per the proportion.

There are two types of batching

1. Volume batching
2. Weigh batching

4.2.1 VOLUME BATCHING

Volume batching is not a good method for proportioning the material because of the difficulty it offers to measure granular materials in terms of volume. The amount of solid granular materials in a cubic metre is an indefinite quantity. Because of this, for quality concrete material have to be measured by weigh only.

4.2.2 WEIGH BATCHING

Strictly speaking, weigh batching is the correct method of measuring the materials. For important works, invariably, weigh batching system should be adopted. Use of weight system in batching, facilitates accuracy, flexibility and simplicity.

We have used weigh batching process here because in the preparation of bricks using plastic, plastic acquires more space compared to soil for example in a bag of 50kg we can fill 50kg of soil, but we can fill only 2-2.5kg of plastic which shows more error to reduce this we have adopted weigh batching method

4.3 MELTING

Since we are using LDPE plastic as binding material in manufacturing of bricks it needs melting of plastic. we melted plastic in a pan by using fire & wood. The melting point of plastic is 120°C -180°C.



Figure 5: Melting of plastic

4.4 MIXING

Immediately after melting of plastic we should pour the graded soil (which is 4.75mm passing and 90 μ retaining) into the pan and mix it properly by using trowel. Proper protective equipment should be used because the mix is nearly at a temperature of 200°C which is harmful if we touch it with bare hand. The soil and plastic should be properly batched according to the required proportion before melting process



Figure 6: Mixing of molten plastic and graded soil

4.5 MOULDING

Immediately after mixing process we should pour the mix into mould. Because immediately after mixing the mix starts cooling and it get hardens so the quickly the mix should be poured into the mould and compacted. The size of mould which we have used is 190mm X 90mm X 90mm which is the standard modular size of the bricks according to IS 1077:1992



Figure 7: Moulding and compacting the mix of plastic and soil



Figure 8: Giving Finishing to the brick surface

4.6 CURING

Since immediately after moulding the bricks cools and hardens in atmospheric temperature the process of curing is not required. The brick itself leave the mould after 30 minutes and it automatically cooldown after 1hour to 1.5 hour.

5. REQUIREMENTS OF GOOD BRICK

5.1. COLOUR

The colour of good bricks should be uniform. Uniformity of colour indicates uniformity of chemical composition. The colour of plastic soil bricks dark black but it is having uniform colour

5.2. WATER ABSORPTION

No brick should absorb water more than 20% of its dry weight when kept immersed in water for 24 hours. Plastic soil bricks do not

absorb water hence water absorption of plastic soil bricks is 0%

5.3. CRUSHING STRENGTH

No brick should have the crushing strength below 5.5N/mm². The plastic soil bricks have the compressive strength of 7.46 N/mm².

5.4. SHAPE

Bricks should be uniform in shape with all its edges sharp, straight and at right angles to each other. All the faces should be true in shape.

5.5. SIZE

Size of the bricks should be standard as prescribed by Indian standards.

5.6. TEXTURE AND COMPACTNESS

The bricks should have fine, dense, compact and uniform texture. Fractured surface of the brick should not show lumps of lime, loose grit, fissures and cavities.

5.7. SOUNDNESS

Two bricks should give clear ringing sound when struck against each other.

5.8. HARDNESS

The bricks should be so hard that finger nail should not be able to make any impression on its surface when scratched.

5.9. Bricks should be sound proof and also of low thermal conductivity

5.10. Bricks should not break when dropped flat on hard ground from a height of about 1m

6. PHYSICAL PROPERTIES

6.1 SHAPE

The standard shape of a brick is truly rectangular. It has Well defined and sharp edges. The surface of the bricks is regular and even.



Figure 9: Plastic Soil Brick

6.2 SIZE

In India, the recommended standard size of an ideal brick is 19 x 9 x 9 cm which with mortar joint gives net dimensions of 20 x 10 x 10 cm. The

dimension may vary according to our requirements. Locally 24 x 11 x 7.5cm size bricks are used.

19 x 9 x 9cm dimensions have been found very convenient in handling and making quantity estimates. Five hundred such bricks will be required for completing 1m³ brick masonry.

6.3 COLOUR

The colour of bricks is Dark black colour. Which is unpleasant but when the plastic is melted it turns into black colour and makes the colour of the bricks as black colour.

6.4 DENSITY

The density of bricks or weight per unit volume depends mostly on the type of soil used and the method of brick moulding.

The density of bricks we have made is 1621.183 kg/m³

6.5 WEIGHT OF BRICKS

The weight of the plastic soil bricks which we have prepared is 2.50 kg on an average. The weight of the 1st class burnt bricks is 2.30 kg to 2.40kg



Figure 10: Weighing of Plastic Soil Brick

7. TEST ON BRICKS

Following tests are conducted on bricks to determine its suitability for construction work.

7.1 ABSORPTION TEST

Absorption test is conducted on brick to find out the amount of moisture content absorbed by brick under extreme conditions. In this test, sample dry bricks are taken and weighed. After weighing these bricks are placed in water with full immersing for a period of 24 hours. Then weigh the wet brick and note down its value. The difference between dry and wet brick weights will give the amount of water absorption.

The plastic soil bricks do not absorb water since the plastic materials will cover the soil particles and plastic material does not absorb any

water so that the water absorption of plastic soil bricks is 0%



Figure 11: Water absorption test on Plastic Soil Brick

7.2 CRUSHING STRENGTH TEST

Crushing strength of bricks is determined by placing brick in compression testing machine. After placing the brick in compression testing machine, apply load on it until brick breaks. Note down the value of failure load and find out the crushing strength value of brick.

The average compressive strength of the bricks which we have prepared is 7.46N/mm²

Samples	Load taken by specimen	Compressive strength
Specimen-1	105 KN	6.14 N/mm ²
Specimen-2	115 KN	6.73 N/mm ²
Specimen-3	120 KN	7.02 N/mm ²
Specimen-4	170 KN	9.94 N/mm ²
Average	127.50 KN	7.46 N/mm ²

Table 2: Compressive test results of plastic soil bricks



Figure 12(a): Compressive test on Plastic Soil Brick



Figure 12(b): Compressive test on Plastic Soil Brick

7.3 HARDNESS TEST

A good brick should resist scratches against sharp things. So, for this test a sharp tool or finger nail is used to make scratch on brick. If there is no scratch impression on brick then it is said to be hard brick.

The bricks we have prepared is scratched by Finger nail but no impression is there on the brick so the plastic soil brick is hard

7.4 SHAPE AND SIZE

Shape and size of bricks are very important consideration. All bricks used for construction should be of same size. The shape of bricks should be purely rectangular with sharp edges. Standard brick size consists length x breadth x height as 19 x 9 x 9 cm.

To perform this test, select 20 bricks randomly from brick group and stack them along its length, breadth and height and compare. So, if all bricks similar size then they are qualified for construction work.

7.5 COLOUR TEST

A good brick should possess bright and uniform colour throughout its body.

7.6 SOUNDNESS TEST

Soundness test of bricks shows the nature of bricks against sudden impact. In this test, 2 bricks are chosen randomly and struck with one another. Then sound produced should be clear bell ringing sound and brick should not break. Then it is said to be good brick.

7.7 STRUCTURE OF BRICK

To know the structure of brick, pick one brick randomly from the group and break it. Observe the inner portion of brick clearly. It should be free from lumps and homogeneous.

When brick is broken there is no lumps and the brick is homogenous

7.8 PRESENCE OF SOLUBLE SALTS (EFFLORESCENCE TEST)

A good quality brick should not contain any soluble salts in it. If soluble salts are there, then it will cause efflorescence on brick surfaces.

To know the presence of soluble salts in a brick, placed it in a water bath for 24 hours and dry it in shade. After drying, observe the brick surface thoroughly. If there is any white or grey colour deposits, then it contains soluble salts and not useful for construction.

These bricks do not contain any soluble salts in it, therefore there is no white or grey colour deposits on the surface of the bricks after brick is in a water bath of 24 hours and dried in a shade.



Figure 13: After efflorescence test on Plastic Soil Brick

8. ADVANTAGES AND DISADVANTAGES

8.1 ADVANTAGES

- * The compressive strength of the brick is greater than burnt bricks
- * It is a technique of plastic waste management
- * We can reduce the impact of plastic waste on the environment
- * These bricks do not absorb water so that we can achieve damp proof construction
- * After dismantling we can again melt the bricks and prepare new bricks which can be used for construction of temporary structures, sheds etc...
- * We can use this type of bricks as pavers or we can manufacture pavers using same methodology
- * These bricks are economical than burnt bricks
- * Since plastic is non-biodegradable the durability of the bricks is more
- * Very suitable in coolest places where there is heavy rain fall and snow fall
- * Less skilled labour can be adopted
- * Since the strength of the bricks is higher than burnt bricks we can use it for parking places
- * The bricks will not absorb water from mortar after construction

8.2 DISADVANTAGES

- * These bricks are not fire resistant if the temperature is greater than 150°C the structure collapse
- * Since the colour of the bricks is dark or black it gives unpleasant appearance to the structure
- * After construction plastering to the masonry is very difficult
- * Release harmful gases at the time of preparation which is very dangerous
- * The manufacturing process is very dangerous and protective equipment should be used
- * The manufacturing process is tedious
- * We can use these bricks for only interior or partition walls because exterior walls are exposed to sun light which may reduce the strength of the brick

9. CONCLUSION

Plastic soil brick possesses more advantages which includes cost efficiency, resource efficiency, etc., Plastic soil 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 burnt bricks. By use of plastic soil bricks, the water absorption presence of alkalis was highly reduced.

This method is suitable for the countries which has the difficult to dispose /recycle the plastic waste. The natural resources consumed for the manufacturing of Plastic soil bricks are very much less when compared to its counterparts. Owing to numerous advantages further research would improve quality and durability of plastic soil bricks.

10. REFERENCES

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