Experimental Investigation on Bricks in Replacement of Soil by Waste Plastics

N.Siva [1], M.Anitha [2], P.S.Lakman prabu [3], A.Mahadur Banu [4], K.P.Ravikumar [5]
[1, 2, 3, 4] UG student, Department of Civil Engineering, Shivani Engineering college, Tiruchirappalli, India.
[5] Head of the Department, Civil Engineering, Shivani Engineering College, Tiruchirappalli-620009, India.

Abstract – The main objective of this study is to investigate the potential use of various plastic wastes for producing construction materials. In this paper the study of some of plastic waste materials which we can reuse by certain processing and use it in the production of bricks. The discussed materials have many advantages over conventional/ traditional materials of bricks. This paper discusses the environmental implications caused by the generation of various plastic wastes, and highlights their recycling potentials and possible use for producing construction materials like bricks. The conducted study on recycling of plastic waste and blending it with soil to make a brick and compare with the environmental and economic conditions. Some of these materials are relatively cheaper and provide more strength as compared to traditional brick materials. This project will come up with useful information and creating awareness amongst the learner in the industry regarding waste material. So that one can have a step towards further detailed information about these materials and thus be able to implement on field which will definitely improve the level of construction.

Index Terms – Plastic Waste, Soil.

1. INTRODUCTION

Plastic is a non-bio-degradable 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). This paper is based on the comprehensive review of waste plastic materials in molten form which is mixing with soil.The soil-plastic bricks are lightweight and present a waxy surface.

It is observed that soil plastic bricks have low water absorption, low apparent porosity and high compressive strength as compared to conventional bricks. To safeguard the environment, many efforts are being made for the recycling of different types of plastic wastes with a view to utilizing them in the production of various construction materials. Plastic is everywhere in today's lifestyle.

It is used for packaging, protecting, serving, and even disposing of all kinds of consumer goods. With the industrial revolution, mass production of goods started and plastic seemed to be a cheaper and effective raw material. Today, every vital sector of the economy starting from agriculture to packaging, automobile, building construction, been virtually revolutionized by the applications of communication or InfoTech has plastics. Plastic in different form is found, which is toxic in nature. It is commonly collected both urban and rural areas. It creates stagnation of water and associated hygiene problems. Plastic waste hazard to the environment. Plastic waste can be reused productively in the construction materials.

1.1 THIS STUDY IS A SMALL STEP TOWARDS

- Use of Waste Plastics
- Better Brick Production
- Saving of Soil
- Cost Less
- Job for Self Helping Group
- Reduction of Plastic Wastes

1.2 OBJECTIVES:

- Investigate the potential use of molten plastic waste blending with soil.
- 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.

2. PLASTICS

Plastic is one of the recent engineering materials which have appeared in the market all over the world. It is a material consisting of a wide range of synthetic or semi-synthetic organic compounds that are malleable and can be molded into solid objects. Plastic waste is increasing day by day throughout the world.

Recycling the plastics has advantages since it is widely used worldwide and has a long service life, which means that the waste is being removed from the waste stream for a long period. Reuse of waste plastics has environmental benefits not only related to the safe disposal of bulk waste, but also to the reduction of environmental impacts that arises due to burning of plastics.

2.1 TYPES OF PLASTIC:

- Thermoset Plastic
- Elasto meters
- ThermoPlastics

2.2 ADVANTAGES OF PLASTICS IN PRODUCTION OF BRICKS:

- High-Impact resistance.
- High Compression Strength.
- High Tensile Strength.
- Chemical resistant.
- Aesthetically superior finishes hard crystalline or rubber surface options.
- Its also act as Earth Quake Resistant bricks.
- High ductile in nature.

2.3 WHY PLASTICS ARE USED?

Polymers have a number of vital properties, which exploited alone or together make a significant and expanding contribution to construction needs.

- Durable & corrosion resistant.
- Good insulation for cold, heat & sound saving energy and reducing noise pollution.
- It is economical and has a longer life.
- Maintenance free.
- Hygienic & problems.
- Ease of processing/ installation.
- Light weight.

Commercial Plastic Materials	Nature of Plastics	Thickness µ	Softening Point ˚C
Cup	Poly ethylene	70	100-120
Carry bag	Poly ethylene	10	100-120
Parcel cover	Poly ethylene	50	100-120
Milk Pouch	LDPE	60	100-120
Film	Poly ethylene	50	120-130
Foam	Poly ethylene	NA	100-110
Chocolate Covers	Polyester+ Poly ethylene + Metalised Polyester	20	155
Supari Covers	Polyester+ Poly ethylene	60	120-135
Biscuit covers	Polyester+ Poly ethylene	40	170
Water Bottle	PET	210	170-180
Cool Drinks Bottle	PET	210	170-180
Decoration Papers	BOPP	100	110
Foam	Polystyrene	NA	110

Table -1Some of the Polymer resins used in this study

*The source taken from Dr.Vasudevan sir's (Plastic Road Project)

Table -2 Polymer Resins under code are used

Resin code	Polymer Resin	General Applications
1	Polyethylene Terephthalate	• Plastic drinking bottles • Food jars
2	High Density Polyethylene	• Shampoo, dish, laundry and house cleaning bottles • Shipping containers
3	Polyvinyl Chloride	• Packing materials • Pipes, fencing • Blood bags, medical tubing

4	Low Density Polyethylene	• Bags for dry cleaning and newspapers • Shrink wrap, film
5	Polypropylene	• Medicine bottles • Bottle caps • Automotive parts
6	Polystyrene	• Disposable cups, utensils, food containers • Foam containers
7	Others	• 3 and 5 Gallon reusable water bottles • packaging

*Except PVC all resins are used for plastic-soil brick

Table -3 THERMAL BEHAVIOUR BASED ON TGA MEASUREMENT

Polymer	Softening Temperature in ˚C	Products reported	Decomposition Temperature in ˚C	Products reported	Ignition Temperature range in ˚C	Products reported
PE Film	100-120	No Gas	289-335	CH_4,C_2H_6	>700	CO,CO_2
PP	140-160	No Gas	271-329	C_2H_6	>700	CO,CO_2
PS	110-140	No Gas	300-350	C_6H_6	>700	CO,CO_2
PE foam	120-125	No Gas	309-385	CH_4	>700	CO,CO_2
Tea Cup	130-150	No Gas	313-420	C_2H_6	>700	CO,CO_2

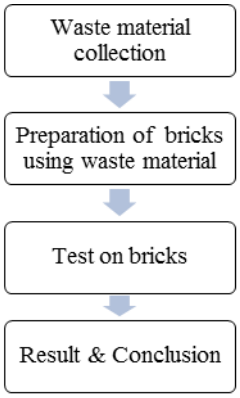
2.4Dry clay soil

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

Table -5 Dry clay soil test

S.No	Test	Results
1	Specific gravity	2.62
2	Bulk density	1690kg/m^3
3	Fineness modulus	2.91

3. METHODOLOGY



a) Raw materials used :

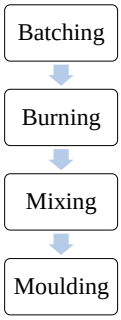
1. Dry Clay soil

2.shredded Plastic Waste

b) Materials used

1. Steel mould
2. Thermometer

c) Procedure for casting plastic-soil bricks



3.2 PROCESS OF MANUFACTURING

a) Batching

Plastic

Dry Clay Soil

The collected waste bags are shredded into pieces and then weighted. The soil was sieved by using 2.30mm sieve. The soil and the plastic bags were weighed in various proportions

among which the plastic were taken for burning process. During batching process the weight of waste plastics pieces are kept as constant and decreasing the soil content for different proportions.

Table -6 Mix proportions for plastic soil bricks

NO.OF SAMPLES	DRY CLAY (in Kg)	PLASTIC WASTE (in Kg)
S1	1.5	3
S2	0.75	3
S3	3.375	3

b) Burning of plastic

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 under 170^0c to 180^0c which is also called softening temperature of plastics. According to TGA measurements of the thermal behavior of plastics. The softening temperature product reported no evolves of toxic gases.

c) Mixing:

The plastic pieces 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 soil is added to it. The soil added is mixed time. Hence mixing process should not consume more time.

d) Moulding:

The mixture is then poured into the brick mould. 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 2 hours. The mould is used for preparing brick inuniform shape. The size of mould is 190×90×90 mm. The mould were assembled and placed on the base plate.The faces must be thinly coated with mould oil to easily remould after casting.

Mixing of Plastic and soil

Moulding

Plastic-Soil Brick

4. TESTING OF PLASTIC SOIL BRICKS

4.1 Compressive Strength

Crushing strength of the brick is measured by using the compression testing machine. The bricks to be tested is placed in the compression testing machine and the load is applied till the brick breaks. As per IS:1077:1957, the minimum compression strength of the brick is 3.5N/mm^2.

Compressive strength

=Maximum load/Area of the specimen

= P/A

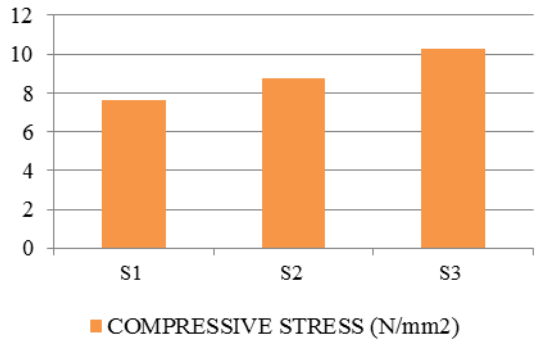
Where,

P -Maximum load (KN)

A - Area of the specimen (mm^2)

These bricks are classed as class A bricks because of it crushing strength ranges between 7-14 N/mm^2 .During compression test the brick doesn't failed fully. It shows that the bricks having very high ductile characteristics so it can be very useful in earthquake resistant one.

4.2Water Absorption

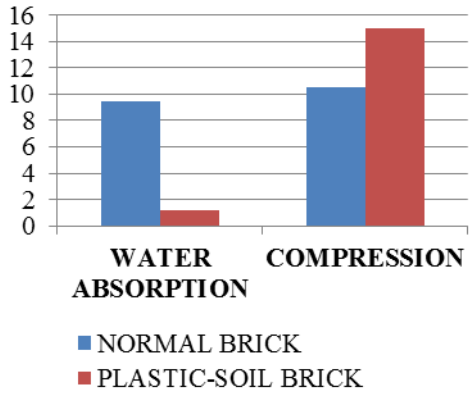


In this test, bricks are weighed in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion, those are taken out from water and wipe out with cloth. Then, brick is weighed in wet condition. The difference between weights is the water absorbed by brick. The percentage of water absorption is then calculated. The less water absorbed by brick the greater its quality. Good quality brick doesn't absorb more than 20% water of its own weight.

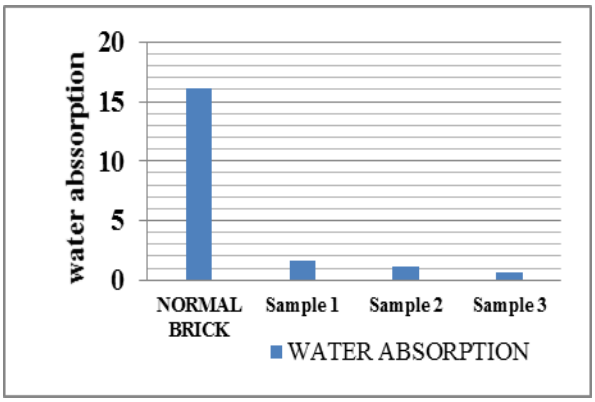
Water absorption in % by weight $= \frac{W2 - W1}{W1} X\ 100.$

Where, W1 =Weight of dry brick (kg)

W2 = Weight of wet brick (kg)



Water absorption test of Plastic soil bricks possessing various ratios



4.3 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.

Table -7 Efflorescence test ratio

S.NO	MIX RAIO	TRACES
1	1.5:3	Nil
2	0.75:3	Nil
3	0.375:3	Nil

4.4 Soundness Test for brick

This sound is carried out to find out that a clear ringing sound is produced or not when the two bricks are struck with each other without breaking any of thetwo bricks. If the two bricks are not broken after striking with each other and a clear ringing sound is produced, then it means that the bricks aresufficiently sound. In this project, plastic soil bricks gives clear ringing sound produced.

4.5 Crushing Strength Test

This is the main test conducted to test the suitability.

4.6 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.

4.7 Fire resistance test

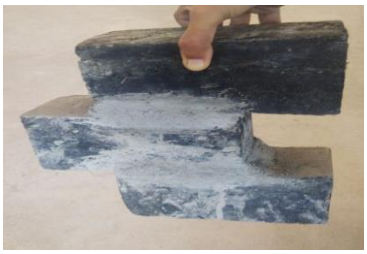
The Plastic is highly susceptible to fire but in case of Plastic soil bricks/Paver blocks the presence of soil imparts insulation. There is no change in the structural properties of block of bricks up to 160ºC-170˚C above which plastics are soften and the bricks deteriorate with increase in temperature.

4.8 Shape and Size test

As per Indian Standard, 190mm*90mm*90mm sized bricks are used in India. The Surface and edges of the plastic-soil bricks are sharp, square, smooth and straight. It is uniform in shape and free from cracking. The cost of a brick is lower than other classes of bricks.

4.9 Binding test

Due to the high usage of plastic content in the brick. It is having very smooth surface so the binding test is carried out with a cement mortar ratio of 1:6. The test result shows good binding property between the two plastic-soil bricks.



4.10 Weight of the brick

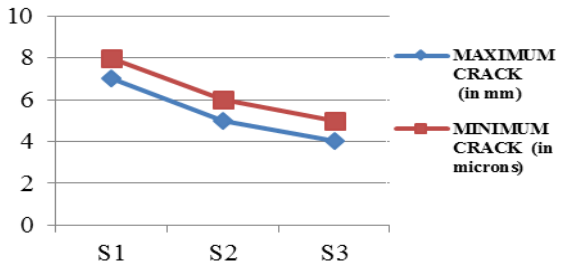
The weight of the brick decreases by increasing the percentage of plastic to the soil brick. The light weight building materials are sometimes used for earthquake resistant building. Buildings may also be constructed to able to withstand a great amount of vibration. The average weights of the traditional bricks are 3 to 3.5 Kg.

4.11 Colour of the brick

Due to melting of plastic pieces the brick coloured as black.

4.13 Microscopic Test

Due to high binding between the plastic and soil. The microscopic test results are



4.14 Ductility Test of the Bricks

The Ductility of the brick is found to be very high. After attaining maximum compression value the plastic soil bricks didn't tends to break completely. The wrong bonding between the plastic and soil makes the brick to act as ductile in nature.

5. CONCLUSION

The main concept of this study includes a molten plastic is a very good binder by this we can add any type of soil or soil to make a brick as construction material however by doing these process in mechanized form like pre -fabrication structures it is even more easy to produce large quantity of bricks with in short period of time. The Plastic-soil brick possess 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 used for construction purposes. It increases the compressive strength when increasing the plastic content with decreasing the soil. 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. These bricks are highly ductility so it can be used in earth quake resisting construction material.

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