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Utilization of Waste Plastic for Manufacturing of Bricks Along With Quarry Dust and M-Sand

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ABSTRACT: There has been a substantial imbalance between the availability of conventional building materials and their demand is also more in present conditions. On the other hand, the laterite quarry waste is highly available and the disposal of waste plastics (PET, PP, etc.) is a biggest challenge, as repeated recycling of Poly ethylene terephthalate (PET) bottles poses a potential danger of being transformed to a carcinogenic material which causes cancer and only a small proportion of PET bottles are being recycled. In this work an attempt has been made to manufacture the bricks by using waste plastics in range of 60 to 75% by weight of laterite quarry waste and M-sand. The gypsum was added 5% for increasing the fire resistance capacity and 60/70 grade bitumen was added 2% by weight of soil in molten form and this bitumen- plastic resin was mixed with laterite quarry waste to manufacture the bricks. The bricks manufactured possess the properties such as neat and even finishing, with negligible water absorption and satisfactory compressive strength in comparison with red burnt brick to satisfy the increasing demand of conventional building materials.

Keywords: Plastic bricks, Poly ethylene terephthalate (PET), Laterite quarry waste, Bitumen, M-sand, Gypsum, and Improvement of fire resistance capacity.

1. Introduction

Today, the generation of plastics waste is a measure issue, as the plastics are not biodegradable, the waste today can be produced wherever human footprints have existed, and remind him that they have not chosen the appropriate method of exploitation of nature at present. The concept of manufacturing plastic bricks was we utilize the plastics waste, which is generated by people door to door, also the construction industry takes huge market in the current scenario, utilization of waste in such construction industry may play a major role. The main important thing while using the waste in plastic bricks was it cannot be made by recycling but just burn to plastic waste without adding any additives and it can also be used for at least 30-40 years in construction industry.

Plastic could be a quite common material that's currently wide utilized by everyone within the world. Plastic plays a predominant role in reusable during this age, because it is compact and lightweight in weight. Common plastic things that area unit used area unit covers, bottles, and food packages. The nice downside with plastic is its decomposition. Plastic is created of compound chemicals and that the area unit was non-biodegradable. This suggests that plastic won't decompose once it's placed on earth. Plastic could be a helpful material that's versatile, robust, and rigid they become waste once their use and that foul the air and land. Utilization is the process used waste materials into new merchandise to stop the waste of probably helpful materials. The rise in the quality of victimization eco-friendly, low-value, and light-weight construction materials within the building trade have caused the requirement to research however this may be achieved by benefiting the atmosphere also as maintaining the fabric needs and their standards. From the benefits of plastic utilization, the procedure is employed. The assembly of plastic bricks is Associate in nursing best methodology for dominant the matter by decomposition of plastic waste and additionally, it prices economical for the assembly of building materials.

In this study, plastic waste from factories will be used to incorporate with M sand and quarry dust of sufficient bitumen & Gypsum to produce plastic bricks. The bricks will then be tested to study the compressive strength, efflorescence, water absorption, and fire resistance test. In the recent past analysis, the replacement and addition are through with the direct inclusion of polythene, polythene terephthalate (PET) bottles in chopped type, with chemicals treated polyethylene-fiber, PET in tiny particles type by substitution sand and quarry mud. Most of the replacements are done by volume calculation and showed a decrease in compressive strength because of the accrued plastic waste. During this study, recycled plastic wastes are introduced within the style of tiny items, and this check increasing the fireplace resistance by employing an ample percentage of mineral. The replacement of plastic waste matter has been done by weight.

2. Literature Review

Ismail and Al-Hashmi, (2008) presented the chance of victimization varied plastic wastes, containing close to eightieth synthetic resin and 2 hundredths vinyl benzene, as fine aggregates, up to 4.75 millimeters in concrete. By increasing the plastic waste content, the compressive tests showed the tendency for compressive strength values of plastic waste concrete to decrease below

the reference concrete at every natural process age. The concrete with 100 percent of plastic waste displayed the bottom compressive strength at twenty-eight days natural process age, regarding half-hour less than that of the reference concrete mixture. Also, the study found five-hitter, 7%, and 8.7% lower densities of concrete combine containing 100 percent, 15%, and 2 hundredth plastic aggregates severally.

R. Siddique et al. 2008 investigated the result of plastic aggregates on the majority density of concrete. For this purpose, they created twelve concrete mixes with totally different w/c containing varying percentages (0%, 10%, 30%, and 50%) of plastic aggregates. Angular post-consumer plastic aggregates having the most size of thirteen millimeters were used. They ended that: (i) bulk density of concrete bated with the rise in plastic aggregates content; (ii) reduction in bulk density was directly proportional to the plastic aggregates content; and (iii) density of concrete was reduced by a pair of.5%, 6%, and thirteen for concrete containing 100 percent, 30%, and five hundredth plastic aggregates, severally. Reduction in density was attributed to the lower unit weight of the plastics.

Albano et al. (2009) administrated a study that embraces concrete with 100 percent of recycled PET exhibits a compressive strength that meets the quality strength values for concrete with moderate strength between twenty-one and thirty MPa for a solidification age of twenty-eight days. It the rumored that the compressive strength at the age of twenty-eight days is close to the values for sixty days. Several factors were taken into thought like the sort of failure and also the formation of honeycombs, low workability, particle size, that area unit chargeable for lower compressive strength of concrete containing PET mixture than concrete containing natural aggregate. The reduction in compressive strength was additional in concrete containing a larger flaky PET mixture than a smaller one.

Hannawi et al. (2010) investigated the result of the exploitation of Non-biodegradable plastic aggregates manufactured from polycarbonate (PC) and polythene terephthalate (PET) waste as partial replacement of natural aggregates in mortar. numerous volume fractions of sand three-D, 10%, 20%, and five-hundredths are replaced by a similar volume of plastic. The authors found a decrease in compressive strength once the plastic aggregates' content will increases. The drop in compressive strength looks to be not proportional to the quantity fraction of sand replaced by plastic aggregates. a decrease of nine.8%, 30.5%, 47.1% and sixty nine for mixtures with, severally, 3%, 10%, 2 hundredth and five hundredth of PET-aggregates, and of 6.8%, 27.2%, 46.1% and 63.9% for mixtures containing, severally, 3%, 10%, 2 hundredths, and five-hundredths of Aggregates is ascertained. In line with the authors, the come by compressive strengths thanks to the addition of plastic aggregates is attributed in the main to the poor bond between the matrix and plastic aggregates. The study has given the variations within the flexural strength of various mixtures as a function of the proportion of sand (in volume) replaced by a similar volume of plastic aggregate.

Aditya Singh Rawat1, R. Kansal, (2014) this paper proposes the use of waste plastic PET bottles as a construction entity to standardized bricks. As plastics are non-biodegradable its disposal has always been a problem. Waste plastic bottles are the major cause of solid waste disposal. Polyethylene terephthalate is commonly used for carbonated beverages and water bottles. This is an environmental issue as waste plastic bottles are difficult to biodegrade and involve processes either to recycle or reuse. Today the construction industry needs to find cost-effective materials for increasing the strength of structures. This project deals with the possibility of using waste PET bottles as a partial replacement. It can be concluded that the benefit of the use of PET bottles includes both improved ductilities in comparison with raw blocks and inhibition of crack propagation after its initial formation. The solution offered in the paper is one of the answers to the long-standing menace of waste disposal.

Jayaprakash M C1, Deeksha I M2 and Soumya M R, (2016) this paper proposes the utilization of waste plastic PET (Poly-ethylene Terephthalate) bottles as a construction entity to standardized bricks. As plastics are non-biodegradable its disposal has invariably been a retardant. This can be an Associate in Nursing environmental issue as waste plastic bottles are troublesome to biodegrade and involve processes either to recycle or reprocess. The inexperienced building might represent a chronic method wherever there's Associate in Nursing improvement and restoration of the positioning and its close surroundings. The best “green” project preserves and restores surround that's important for sustaining life and becomes an internet producer and businessperson of resources, materials, energy, and water instead of being an internet client.

Mardiha Mokhtar1, Suhaila Sahat1, Baizura Hamid1, (2015) discussed on Wall structures which plays a necessary role in supporting the superstructures, separates areas in buildings into sections, and delineates an area within the exterior. Most of the development of homes in Asian countries use bricks and mortar that consists of cement, aggregates, and water because the materials to create the structure of the wall. However, materials like cement and brick producing methods can contribute to high emissions of greenhouse emissions (CO2) which can cause heating. Therefore, the target of this paper is to seek out an alternate answer to cut back on this risky environmental downside. the choice manner which will solve the matter is by substitution the utilization of bricks in building construction with plastic bottles full of sand as we tend to refer to as it plastic bottle greenhouse.

Z Muyen, TN Barna, MN Hoque, (2013) With world solid waste generation rates rising quicker than ever, urban development specialists warn that the expansion can peak this century and cannot begin to say no while not transformational changes in

however we tend to use and recycle materials. This report conjointly calculable the per capita world solid-waste generation rate would rise from quite three.5 million tons per day in 2010 to quite a half-dozen million tons per day in 2025. The „bottle brick" is one such invention. Waste polythene Terephthalate (PET) bottles filled with different dry solid wastes or sand and earth have been with success employed in many countries around the world. This study looked into the strength properties of waste PET bottles full of fine sand.

Saikia and Brito, (2014) conferred the results of the scale and form of recycled polythene terephthalate (PET) mixture on the contemporary and hardened properties. 3 sorts of PET mixture, collected from a plastic industrial plant, 2 were sliced and separated fractions of comparable sorts of PET bottles and one was a heat-treated product of equivalent PET bottles with sieve size from zero.5-11.2mm. 5%, 10%, And 15 August 1945 in a volume of the natural mixture within the concrete mixes were replaced by an equal volume of 3 otherwise formed and sized PET aggregates with regardful W/C ratios. Take a look at results showed that the density of contemporary concrete bated because the content of the plastic mixture exaggerated. Variations within the size and form of PET-aggregates affect the slump of contemporary concrete mixes, which ultimately amendment the mechanical behavior. The study conferred the abrasion behavior of concrete specimens (depth of the damage and weight loss) containing numerous varieties and contents of PET-aggregate, and therefore the reference concrete. during this paper, 5%, 10%, And 15 August 1945 in the volume of the natural mixture within the concrete mixes were replaced by an equal volume of 3 otherwise formed and sized PET aggregates.

Swati Dhiman, Harvinder Singh 2018 investigated on the replacing of coarse aggregate with Polyethylene Terephthalate in Light Weight Concrete. The purpose of this study is to determine the compressive strength of light concrete of PET plastic waste as coarse aggregate and influence of aggregate gradations towards the compressive strength of concrete that is produced. They mentioned the concrete with PET plastic waste can be used not only as an effective plastic waste management practice but also as an strategy to develop more economic and sustainable building materials in the future.

3. Materials Used And Its Properties

The present investigation the following materials were used:

1. Waste plastic
2. Quarry dust
3. M-sand
4. Bitumen
5. Gypsum
6. Water

3.1. Waste plastic

By definition the plastics can be made to different shapes when they are heated in the closest environment it exists in different forms such as cups, furniture's, basins, plastic bags, food, and drinking containers, and they become waste material. Accumulation of such wastes can result in hazardous effects on both human and plant life. Therefore, the need for proper disposal, Waste management in respect to plastic can be done by recycling. If they are not recycled then they will become a big pollutant to the environment as they do not decompose easily and also not allow the water to percolate into the soil and they are also poisonous. And, if possible, the use of these wastes in their recycled forms occurs. Waste plastic will not absorb any moisture at any time any source. So, it will helps to restrict the absorption of water in the brick.. Not only the absorption of water it will also increase the strength of brick. This will increase the life span of brick more than normal type of brick. Generally, effloresсence will takes place due presence of sodium and calcium present in brick. It is restricted by plastic. This can be done through a process of plastic management. The different sources of origin of plastics will be given below.

Table 1: Origin of plastics

Waste plastic	Available As
Poly ethylene terephthalate (PET)	Drinking water bottles etc.
High Density Poly ethylene (HDPE)	Carry bags, bottle caps, house hold articles etc.
Low Density Poly ethylene (LDPE)	Milk pouches, sacks, carry bags, bin linings, cosmetics and detergent bottles.
Poly propylene (PP)	Bottle caps and closures, wrappers of detergents, biscuit etc.
Urea formaldehyde	Electrical fittings, handles and knobs
Polyester resin	Casting, bonding fibres (glass, Kevlar, carbon fibre)

Figure 1: Waste plastic

3.1.1. Poly ethylene terephthalate (PET)

Bottles made of polyethylene terephthalate (PET, sometimes PETE) can be used to make lower grade products, such as carpets. To make a food grade plastic, the bottles need to be hydrolyzed down to monomers, which are purified and then re-polymerized to make new PET. In many countries, PET plastics are coded with the resin identification code number "1" inside the universal recycling symbol, usually located on the bottom of the container. PET is used as a raw material for making packaging materials such as bottles and containers for packaging a wide range of food products and other consumer goods. Examples include soft drinks, alcoholic beverages, detergents, cosmetics, pharmaceutical products and edible oils. PET is one of the most common consumer plastics used. Polyethylene terephthalate can also be used as the main material in making water-resistant paper. The physical properties of the PET are listed in Table – 2

Table 2: Properties of PET

Coefficient of Thermal Expansion	7×10^{-3}/ºC
Long Term Service Temperature	115 - 170ºC
Melting point	260ºC
Specific Gravity	1.3 – 1.4
Water Absorption	0.07 – 0.10%

3.2. Quarry dust

Quarry dirt that stuff from mixture crushers might replace sand. Construction of pavements and building materials in expansive soils creates a lot of issues for civil engineers, stabilization with industrial waste like quarry dirt offers results. AP state's new capital is solely a black cotton soil space that ends up in the issues of swelling and shrinkage. It's found that the swelling of expansive soils is controlled and improvement in soil properties is discovered by adding quarry dirt. The actual properties area unit is given in table-3.

Table 3: Properties of quarry dust

Property	Values
Specific Gravity	2.54-2.60
Bulk Relative Density (Kg/M3)	1720-1810
Absorption (%)	1.20-1.50
Moisture Content (%)	Nil
Fine Particles Less Than 0.075mm (%)	12-15

Figure 2: Quarry dust

3.3. M-sand

Manufactured Sand (M-Sand) is sand produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges. It is then washed and graded with consistency to be used as a substitute of river sand as a construction material. The table-4 shows the properties of m-sand.

Table 4: Properties of M-sand

S.NO	PROPERTIES	M-SAND
1	TEXURAL COMPOSITION	
	COARSE SAND (4.75-2.00mm)	28.1
	Medium sand(2.00mm-0.425mm)	44.8
	Fine sand (0.425-0.075)	27.1
2	Specific gravity	2.63
3	Bulk density	15.1

Figure 3: M-sand

3.4. Bitumen

Bitumen could be a common binder employed in construction. it's primarily obtained as a residual product in rock oil refineries when higher fractions like gas, petrol, kerosene, and diesel, etc., area unit removed. Indian customary establishment defines hydrocarbon as a black or dark brown non-crystalline soil or viscous material having adhesive properties derived from rock oil crude either by natural or by works processes Indian Oil produces hydrocarbon from its refineries and markets it in bulk likewise as packed in steel drums. Indian Oil conjointly markets changed hydrocarbon CRMB and Emulsion. The properties of hydrocarbon as shown in table -5.

Table 5: Properties of bitumen

Experiments	Results
Penetration (mm)	67.5
Ductility (cm)	59
Softening point (◦c)	58
Specific Gravity	1.01

Figure 4: Bitumen

3.5. Gypsum

Gypsum could be a soft sulfate mineral composed of salt dehydrate, with the chemical. Selenite may occur in an exceedingly slick, fibrous kind, during which case it's usually referred to as "satin spar". Finally, it should even be granular or quite compact.

Gypsum uses include: the Manufacture of flat solid, cement, plaster of Paris, soil acquisition, a hardening retarder in hydraulic cement and bricks. Styles of the mineral called “satin spar” and “alabaster” area unit used for a range of decorative purposes; but, their low hardness limit their sturdiness. hearth rated mineral drywall is additional hearth-resistant as a result of it contains fiber reinforcement and alternative additives at intervals its specially developed mineral core to assist it impediment longer to a hearth exposure. Chemical formula of gypsum: CaSO4-2(H2O), (Hydrated Calcium Sulphate).

3.6. Water

The water used for experiments was potable water Fresh portable water free from organic matter and oil is used in mixing the preparation of plastic bricks. Water in required quantities were measured by graduated jar and added to the quarry dust and M-sand mix. The rest of the material for preparation of the mix was taken by weigh batching. The pH value should not be less than 7.

4. Mix Design

The main objective of this analysis work is to develop associate economical thanks to effectively utilize the waste plastic that may be a nice treat for the maintenance of ecological balance, With the dirt quarry waste and M-sand to manufacture another artifact by that each the queries of scientific disposal of waste plastic yet because the insufficiency of ancient building materials will be answered. The dirt quarry waste was collected from the closest place of our society. Once the dirt stone is cut from the quarry nearly 15-20% of dirt waste is obtained. This waste was crushed victimization rammers and sieved in an exceedingly a pair of.36mm IS sieve. This sieved dirt soil was delivered to the laboratory for the preparation of bricks. This soil was preserved to cut back the water content. A mold of size 19x9x9cm was ready. Bricks of various combine proportions were ready, for every brick 3kg of the dirt quarry mud and M-sand was accessorial with variable hydrocarbon content of twenty-two at the side of variation in proportion 0,60,65,70,75% of plastic waste and five-hitter of the mineral was accessorial for increasing the fireplace resistance capability. Bricks were ready by compacting through vibration. 9kg of unpolluted sieved dirt quarry waste is collected. At the ultimate stage, a pair of hydrocarbon and five-hitter of mineral by weight of soil are accessorial and mixed for uniform distribution to organize three bricks. The recent combine is poured into the molds so compacted by vibration.

The bricks are remolded when thirty min and dry for an amount of 24hr for correct chilling. Of every combine, proportion bricks were ready and tested for compressive strength within the compressive testing machine (CTM).

Table 6: Mix design

S.no	% of plastic replaced with quarry dust and m-sand	% of quarry dust & m-sand	% bitumen 60/70	% gypsum
1	0	100	2	5
2	60	40	2	5
3	65	35	2	5
4	70	30	2	5
5	75	25	2	5

5. Experimental Investigations And Results:

5.1. Compressive strength

This test is conducted to determine the compressive strength of the specimen. The compressive strength of the specimen shall be calculated after the age of 7 days of curing, the compressive strength test performed on the five varied brick specimens. Then place the specimen flat-wise on the base of the compressive testing machine, plywood sheets are used to hold the brick in the correct position while testing. Then apply the load axially on the specimen at the rate of 14 N/mm^2 (140 kg/cm^2) per minute gradually till the brick specimen get starts breaking.

Figure 5: Finding the compressive strength of brick using compressive testing machine

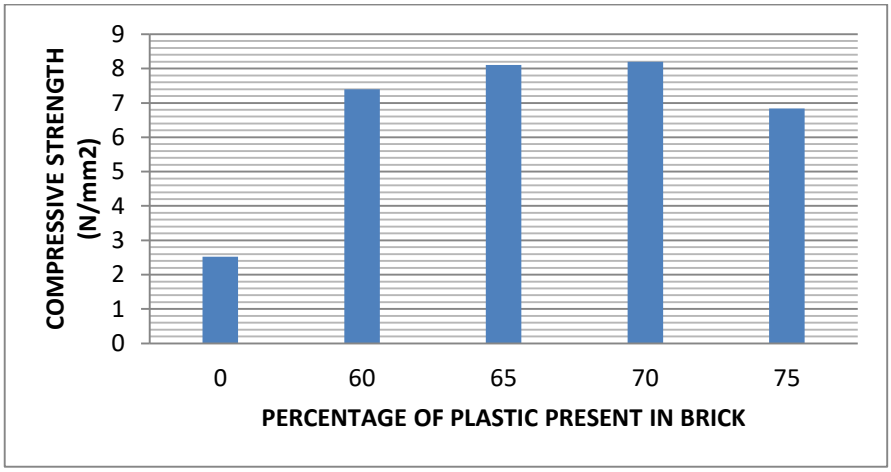

Figure 6: Variation of compressive strength of plastic brick

5.2. Water absorption test

The water absorption test is done as per IS 3495 (Part2) 1992 was performed. Firstly the brick specimen weighted on a digital weighing scale (M_1) and is dried at a room temperature then the specimen is immersed in the distilled water at a temperature of 27+ 2º C for a 24 hours. The specimens were removed after the 24 hours of immersion and wiped out the water with dried cloth. And each specimen is weighed (M_2), compute it by using the formula. The good qualities of the brick do not absorb more than the 20% of its self-weight. The percentage of water absorption is determined by the formula.

$$W = [(M_2 - M_1) / M_1] * 100$$

Table 7: Tabulation of water absorption

S.no	% of plastic	Dry weight (kg)	Wet weight (kg)	Water absorption (%)
1	60	3.1	3.18	2.4
2	65	2.97	3.02	1.6
3	70	3.06	3.09	0.8
4	75	2.93	2.95	0.6

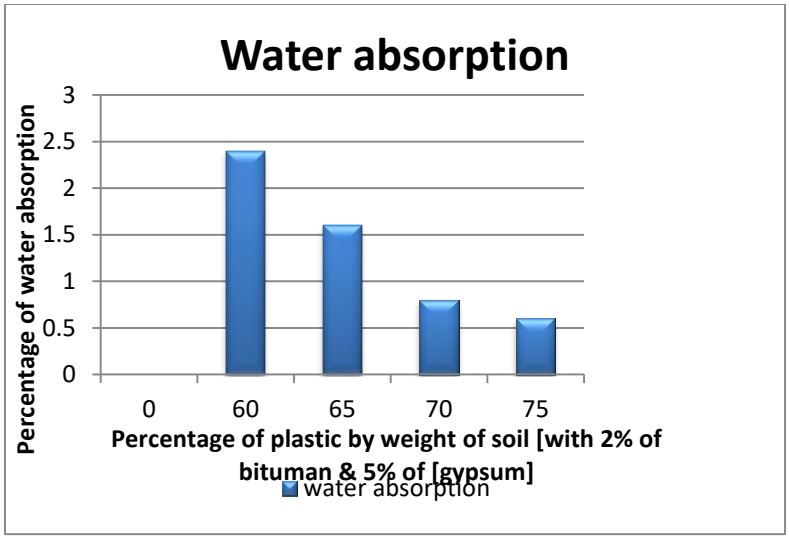

Figure 7: Percentage of water absorption of variation of plastic brick

5.3. Efflorescence test:

A whitish crystalline deposit or foggy salts on bricks consisting of calcium sulfate, magnesium sulfate, carbonate of sodium and potassium is called efflorescence. The built up of alkalis in bricks is harmful to the structure.

The efflorescence test also showed the excellence performance of the plastic brick. There is absence of gray or white deposits were shown on its bricks surface for the 65 and 70 percentage. It was showed alkali and soluble salts 75 percentage.

Table 8: Variation of efflorescence test

S. No	Specimen	Nil	Slight	Moderate	Heavy	Serious
1	0			✓		
2	60	✓				
3	65	✓				
4	70	✓				
5	75		✓			

Figure 8: Performing efflorescence test at home

5.4. Hardness test:

This test is performed to determine the hardness of the brick. In this test a sharp tool or finger nail is used to make scratch on the surface of the brick, if no impression is left on the surface, then the brick is taken enough heard. In this test we observe that there is no impression is left on the surface of all the five varied brick specimens due to the plastic waste which acted as a binder as well as the M-sand and quarry dust as fillers. Thus, all the brick specimens were considered hard.

6. Conclusions:

The compressive strength test result for plastic bricks with 70% plastic content by the weight of soil with the binder material (bitumen) content of 2% by the weight of soil will give a compressive strength of 8.18 N/mm^2which is higher than the red burnt brick (7.18). it has a lesser water absorption (0.8654%) than conventional brick (12.58). So, it can be a better alternative building material from the compressive strength test result of bricks for 25 of binder (bitumen) content & 5% of gypsum by the weight of soil with constant plastic content of 70% by weight of soil. The fire resistance capacity is also similar to the clay brick. The efficient usage of waste plastic-soil bricks has resulted in efficient usage of plastic waste and thereby can solve the problem of safe disposal of plastics, also avoid its wide spread littering. And utilization of quarry waste has reduced to some extent the problem of its disposal. On the basis of result obtained during the experimental investigation, following conclusion was drawn Making brick from sand and waste plastic can be an alternative to the available traditional clay bricks. Sand plastic bricks have lower water absorption, bulk density, and apparent porosity when compared with those of normal clay bricks. Waste plastic which is available everywhere may be put to an efficient use in brick making. Plastic bricks can help to reduce the environmental pollution thereby making the environment clean and healthy.

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