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A PROJECT REPORT

ON

"EXPERIMENTAL STUDY OF PLASTIC BRICKS MADE FROM WASTE PLASTICS"

Submitted in partial fulfilment of the requirements for the award of degree of

Bachelor of Engineering

IN

CIVIL ENGINEERING

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CERTIFICATE

This is to certify that the Project work entitled "Experimental Study of Plastic Bricks Made From Waste Plastics" carried out by Mr. SACHIN JAISWAL (1SJ17CV064), Mr. IRFAN BASHIR (1SJ18CV434), Mr. VIRESH (1SJ17CV079), Ms. VINAYA KUMARI (1SJ18CV433) students of SJC Institute of Technology in partial fulfilment for the award of Bachelor of Engineering in Civil Engineering of the Visvesvaraya Technological University, Belagavi during the year 2020-21. It is certificated that all correction/ suggestions indicated for internal assessment have been incorporated in the report deposited in departmental library.

The Project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said Degree.

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ABSTRACT

This report outlines the utilization of municipal plastic waste (MPW) in construction industries. 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). The utilization of earth-based clay material resulted in resource depletion and environmental degradation

One such effort is the efficient use of waste plastic and laterite quarry waste with a small quantity of bitumen, to develop an alternative building material such as bricks with negligible water absorption and satisfactory strength in comparison with Laterite stone to satisfy the increasing demand of conventional building materials.

Utilizing MPW as construction materials especially in production of bricks is one of a promising step towards a sustainable resources and waste management. Plastic waste can substitute either partially or completely one or more of the materials in brick production. Further research based on recent research and a better understanding in utilization of plastic waste in brick is needed to produce a high durability and quality of bricks as well as to achieve the optimum balance in all aspects especially in terms of cost and functionality.

CHAPTER - 1

INTRODUCTION

1.1 DEFINITION

Plastics:

Plastics are a wide range of synthetic or semi-synthetic materials that use polymers as a main ingredient. Their plasticity makes it possible for plastics to be moulded, extruded or pressed into solid objects of various shapes. This adaptability, plus a wide range of other properties, such as being lightweight, durable, flexible, and inexpensive to produce, has led to its widespread use. Plastics typically are made through human industrial systems. Most modern plastics are derived from fossil fuel-based chemicals like natural gas or petroleum; however, recent industrial methods use variants made from renewable materials, such as corn or cotton derivatives.

1.2 Brief Introduction

Plastics are made up of synthetic organic polymers which are widely used in different applications ranging from water bottles, clothing, food packaging, medical supplies, electronic goods, construction materials, etc. In the last six decades, plastics became an indispensable and versatile product with a wide range of properties, chemical composition and applications. Although, plastic was initially assumed to be harmless and inert, however, many years of plastic disposal into the environment has led to diverse associated problems. Environmental pollution by plastic wastes is now recognized widely to be a major environmental burden, especially in the aquatic environment where there is prolong biophysical breakdown of plastics, detrimental negative effects on wildlife, and limited plastic removal options.

In many instances, sheeting and packaging plastics are disposed of after usage, however, because of their durability, such plastics are located everywhere and persistent in the environment. Research on the monitoring and impacts of plastic wastes is still at the infancy stage, but thus far, the reports are worrisome. In human occupational and residential environment, plastics made of petrol-based polymer are present in high quantity. At the end-of-life of these plastics, they are usually land-filled together with municipal solid waste. Plastics have several toxic constituents among which are phthalates, poly-fluorinated chemicals, bisphenol A (BPA), brominated flame retardants and antimony trioxide which can leach out to have adverse effects on environmental and public health. Plastics in electronic waste (e-waste) have become a serious global environmental and public health concern due to its large production volume and the presence of inadequate management policies in several countries. Reports from China, Nigeria, and India indicated that plastic hazardous substances from e-wastes can migrate beyond the processing sites and into the environment.

1.3 Global Production of Plastic and Generation of Waste Plastic

In modern life, plastics are ubiquitous. Its early usage dated back to 1600 B.C., at the time when human hands shaped natural rubber and polymerized into different useful objects in prehistoric Mesoamerica. Diverse usage and manufacturing of plastics and plastic products began in 1839 when polystyrene (PS) and vulcanized rubber were discovered. Production of bakelite which is the first truly synthetic polymer was in 1907 in Belgium, however, by 1930, bakelite was everywhere, especially in fashion, communication and electrical and automotive industries. It took a decade after this for mass production of plastics to begin and it has constantly expanded ever since.

As at 2008, the annual plastic production was estimated to be 245 million tons globally. At present, single-use packaging is the largest sector, accounting for almost 40% of the overall plastic usage in Europe, this is followed by consumer goods, materials for construction, automotive, electrical and agriculture applications at 22%, 20%, 9%, 6% and 3%, respectively. It was estimated in 2015, that the highest rate of production is in Asia (with 49% of total global output, with China as the largest world producer (28%), followed by North America and Europe at 19% each. In terms of production, the rest regions are of lesser importance although not necessarily in terms of plastic consumption.

Table 1 provides the total plastics waste consumption in India during last decade.

S.N.	Year	Consumption (Tones)
1	1996	61,000
2	2000	3,00,000
3	2001	4,00,000
4	2007	8,50,000

Source: Central Pollution Control Board; Table 1 Plastic waste consumption in India

A national plastic waste management task force in 1997 projected the polymers demand in the country. Table 2 documents the demand of different polymers in India during years 1995-96, 2001-02 and 2006-07. The comparison of demand and consumption from Table 2 and Table 1 indicates that projections are correct. More than one-fourth of the consumption in India is that of PVC which is being phased out in many countries. Poly bags and other plastic items except for PET, in particular, have been a focus because it has contributed to host of problems in India such as choked sewers, animal deaths, and clogged soils. The ways of getting rid of it are harmful; hence there is a need to find the solution to such a devastating problem.

Source: National Plastic Waste Management Task Force; Table 2 Polymers demands in India (million tons)

SN	Type of polymer	1995-96	2001-02	2006-07
1	Polyethylene	0.83	1.83	3.27
2.	Polypropylene	0.34	0.88	1.79
3.	Polyvinyl chloride	0.49	0.87	1.29
4.	Poly ethylene terephthalate	0.03	0.14	0.29

1.4 Current World Production Rate of Plastics

Globally, plastic production was estimated to be 380 million tonnes in 2018. Since 1950 to 2018, plastics of about 6.3 billion tonnes have been produced worldwide, 9% and 12% of which have been recycled and incinerated, respectively. Plastics of about 5 million tonnes are yearly consumed in UK alone, with only about one-quarter recycled, and the rest landfilled. It has been suggested by researchers that by 2050, oceans might contain more plastics than fish in terms of weight. Yearly, approximately 500 billion plastic bags are used out of which an estimated 13 million tonnes ends up in the ocean, killing approximately 100,000 marine lives.

1.5 Future Projection of Production Plastic

Plastic productions has increased in twenty-fold since 1964. Globally, approximately 311 million tonnes of plastics were produced in 2014, expected to double in about 20-year time and possibly quadruple by 2050. International Energy Agency World Energy Outlook in 2015 estimated that, the largest application, plastic packaging (26% of the overall volume), is envisaged to have continuous strong growth, which might double within 15 years, with a possibility of fourfold increase by 2050, to about 318 million tonnes yearly, which is higher than the whole plastic industry today.

1.6 Plastic Types

There are different types of plastics based on their constituents and type of materials used in their production. Table 1 shows the different types of plastics, their properties and common uses.

a. Polyethylene Terephthalate (PET)

Polyethylene terephthalate (PET) is a type of plastic which is smooth, transparent and relatively thin. It is also called stomach plastics. PET is commonly used during disposable salad dressing, juice, mouthwash, vegetable oil, cosmetics, soft drinks, margarine and water bottles production, because it is anti-inflammatory and fully liquid. PET is also anti-air, preventing entrance of oxygen into it. Antimony trioxide, an inorganic compound, is used as a catalyst for the production of PET and rubber vulcanization. Plastics made from PET must be prevented from high temperatures so as to prevent the leaching of some toxic additives such as acetaldehyde, antimony and phthalates. Antimony is a possible human carcinogen. Generally, PET is manufactured for single use only.

b. High-density polyethylene

Worldwide, the most used plastic is polyethylene. High-density polyethylene is a heat-resistant plastic produced from petroleum. It is a major constituent of refrigerators, detergent bottles, toys, milk containers, varieties of plastic grocery bags, etc. No phthalates or BPA is present in high-density polyethylene. High-density polyethylene container is generally considered safe for drink and food because it has no reported health risk even though some studies showed that a long time exposure of the plastics to sunlight can make it harmful.

c. Polyvinyl Chloride (PVC)

Polyvinyl Chloride (PVC), a type of heat-resistant polymer, is used for packaging fruit juice, cooking oil, etc. PVC is considered highly toxic due to the presence of chemical constituents like heavy metals, dioxins, BPA and phthalates. Depending on non-plasticization, PVC is flexible due to the presence of phthalates. Phthalates are harmful to humans. The entire PVC life cycle which include the production, usage and disposal are capable of causing severe environmental and public health risks, hence, its usage has considerably reduced. However, due to cost-effectiveness and versatility, PVC remains very popular in the production of consumer goods. PVC have been reported to cause chronic bronchitis, birth defects, genetic changes, cancer, skin diseases, deafness, vision failure, ulcers, liver dysfunction and indigestion.

d. Low-density polyethylene

Low-density polyethylene is heat resistant, fragile, flexible and rigid. It is commonly used in packaging of milk, frozen foods and juices. Because the plastic does not have any component that is harmful to human body, its usage is termed safe for beverages and food.

e. Polypropylene

Polypropylene, a type of plastics, is strong and semi-transparent. It is heavier and stronger than polyethylene. It is used for packaging medicine, yogurt, ketchup, beverage, etc. Plastics made of polypropylene have no harmful substances and like polyethylene, polypropylene containers are considered safe for humans as packages for food and beverages.

f. Polystyrene

Polystyrene, a type of petroleum-based plastic, contains benzene which is carcinogenic to humans. Polystyrene is commonly used in the production of insulators and packaging materials. Products from styrene are hazardous to health. Report of Dowty, et al. showed that a long-term exposure to small quantity of styrene can be neurotoxic and causing cytogenetic, carcinogenic and hematological effects. The International Agency for Research on Cancer (IARC) has categorized styrene as a human carcinogen.

g. Polycarbonate

Polycarbonates are used for packaging consumer goods such as reusable bottles. It contains BPA. Due to exposure to high temperature, BPA can be leached from polycarbonated container into the drink or food stored in them. Because BPA's health risk has been reported in several studies, the usage of polycarbonate plastics have greatly decreased.

1.7. Size of Plastics: Macro and Microplastics

Size of plastics can be used for their classification, aside the plastic types and their chemical composition. There are two major classifications of plastics at sea: 1) Macro (these are plastics higher 20 mm in diameter) and;

2) Micro (plastics which are less than 5 mm in diameter) plastics.

Of these two plastic sizes, the microplastics are the major pollutants documented for deteriorating the ecosystem. This microplastics are either produced by design and are called primary microplastics, or they are formed as a result of degradation of macroplastic called secondary microplastics.

The major issues in plastic waste centered around the microplastics due to an increase difficulty in their monitoring and a greater effect at the physical and chemical levels on environmental and public health, because of their higher volume-to-surface area ratio. Inadequate waste management and indiscriminate dumping are the major routes of entry of microplastics into the marine environment. Direct production of microplastics such as plastic pellets is common, as such are used in fabricating larger items as raw material, however, microplastics can also be produced through mechanical disintegration of larger plastics or plastic products. This is the case in the breakdown of plastic ropes to finer filaments such as microfibers.

Environmental release of large quantities of microplastics is in form of cosmetic products and cleaning ingredients such as toothpaste and microbeads in face-wash. Because of the health

effects of microplastics, countries like Canada, USA and others are now phasing out their usage in certain personal care products. Reports of recent research suggest that the detrimental effects of microplastics especially microbeads, micro plastic fibres and degraded macroplastics in aquatic environment might be higher than that of macroplastics, although studies and legislations to manage plastic pollution are still inadequate.

1.8. Urbanization and Plastic Waste

Urbanization caused a vast and rapid growth of construction industries which requires a lot of building materials that utilizes natural resources either in their production plant or as the materials itself. More recently the world concern about the demands for construction materials and the rate production of plastic that increases swiftly every year. In turn, both industries contribute in increasing the MSW. Since the rate of production is projected to double the value in every 10 years, a more sustainable and safer way is needed to be taken into action. Banning or minimizing plastic usage is not practicable to solve the problem as it is nearly impossible for different sectors to run efficiently without plastic. Mining of natural resources on the other hand is an energy waste process as only 900 million tons of raw materials is produced from 6000 million tons of waste generated. They may be differ in constitution of raw materials but posses the same in contributing to various environmental threats. Hence, utilizing plastic waste

in brick production can solve both the MPW and demands for construction materials. Previous studies showed the possibility of using plastic waste in bricks application but the bricks produced are still lacking of durability as a safe construction materials. The aim of this paper is to review the application of plastic waste in bricks.

CHAPTER- 2

LITERATURE REVIEW

2.1 OVERVIEW

1. **"Fabrication and testing of Plastic sand bricks" by S S Chauhan, Bhusan Kumar, Prem Shankar Singh, Abuzaid Khan, Hrithik Goyal, Shivank Goyal (2019).** They mixed the river sand and the PET plastic (molten form) in the ratio of 1:2, 1:3, 1:4 for mould size of (230*100*75) mm for which they found maximum compressive strength on the ratio of 1:2 mixture for the same size of the bricks. The water absorption of these bricks was observed less than 5% that is less than conventional clay bricks i.e. 15-20%. However, they failed in maintaining fire resistance property of these bricks.
2. **"Utilization of plastic waste in manufacturing of plastic sand bricks." By Arvind Singhal, Dr. Om Prakash Netula (2018).** They used the mixture of plastic and stone dust in the molten form in the ratio of 3:7 in standard brick mould for which stone dust was sieved through 4.75 mm using sieve analysis and conducted test on water absorption to be found as 0%. Compressive strength of plastic sand bricks is 5.6 N/mm2 at the compressive load of 96 KN**.**
3. **"Plastic in Brick Application." By Siti Nabilah Amir & Nur Zulaikha Yusof (2018).** The studies showed the possibility of using plastic as binder with the aid of catalyst through depolymerisation of PET to replace cement. It was observed that a significant decrease in compressive strength is observed for more than 50% replacement of binder with PET waste. With increased amount of PET, the softening point of the bricks produced was also increased. They used the different size of moulds like (150*150*150) mm, (200*100*100) mm etc.
4. **"Study of plastic dust brick made from waste plastic" by Ronak Shah, Himanshu Garg, Parth Gandhi, Rashmi Patil, Anand Daftardar (2017).** They used plastic dust as the main component of waste product which is the by – product of many industrial products such as PVC pipes and they have heated plastic dust at 220°C. The final product from plastic dust was tested for the compressive strength and it was observed as 6.66 N/mm2 which is higher than conventional bricks (3-5 N/mm^2).
5. **Muyen Z, Barna TN, Hoque MN (2016) Strength properties of plastic bottle bricks and their suitability as construction materials in Bangladesh. Progressive Agriculture 27(3): 362-368.**

6. Hiremath PM, Shetty S (2014) Utilization of waste plastic in manufacturing of plastic-soil bricks. International Journal of Technology Enhancement and Emerging Engineering Research 2(4): 2347-4289

CHAPTER – 3

OBJECTIVE

3.1 Objective

- To compare strength of plastic bricks with normal clay bricks.
- To vary the percentage of plastic in bricks to determine the strength performance.
- Cost comparison in between plastic bricks and normal clay bricks.

CHAPTER-4

COMPONENTS AND SPECIFICATION

A. 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.

Physical Properties of Cement

SL NO	TESTS	OBTAINED RESULT	STANDARDS (IS:8112)
1	Initial setting time	32 mins	30 mins
2	Final setting time	580 mins	600 mins
3	Fineness	96%	Not less than 90%
4	Specific gravity	3.14	3.10 - 3.15
5	Standard consistency	34%	30 – 35 %

Fig: Ordinary Portland Cement

B. 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 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.

Properties of Sand

SL NO	TESTS	RESULTS
1	Specific Gravity	2.62
2	Bulk Density	1690 kg/m^3
3	Fineness Modulus	2.92

Fig: Sand

C. 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 they 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.

Waste Plastic	Available as
Poly-ethylene terephthalate (PET)	Drinking Water Bottles etc
High Density polyethylene (HDPE)	Carry bags, bottle caps, household articles etc
Lowest Density polyethylene (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 resins	Casting, bonding fibres (glass, Kevlar, carbon fibre)

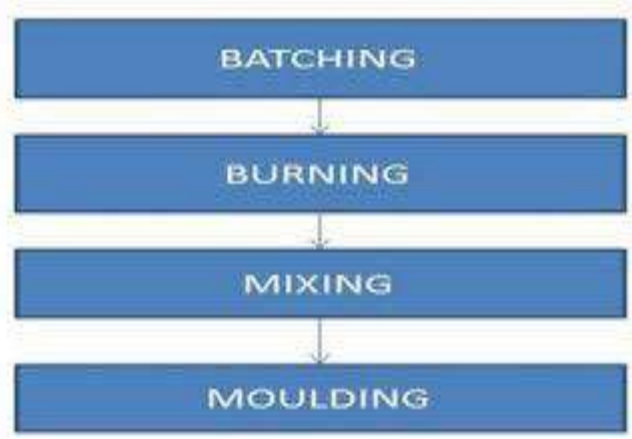
D. WASTE PLASTICS

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 endof-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.

Fig: Waste plastic

CHAPTER - 5

METHODOLOGY



5.1 Process of Casting Plastic Sand Brick

- First, we need to collect the plastic waste and separate it from other wastes.
- Second, we should dry the plastic waste if it is wet and has a content of moisture. We have to use dry plastic waste.
- Then, we crush the plastic waste in small particles by crushing machine.
- Then, the small particles crush into fine size particles.
- The ratio of plastic and stone dust which we use is 3:7.
- The stone dust which we use in manufacturing of bricks/tiles is sieved for a size less than 4.75mm using sieve analysis.
- Then, we heated the stone dust on a furnace (Bhatti).
- The fine particles of plastic waste also heated on a furnace (Bhatti) till it is in a liquid form.
- Then, we add the stone dust into melt plastic.
- Then, we can mix it properly and make a mix.
- Then, we poured the mix into moulds.
- Then keep it the mould for dry and demould it on a next day.
- The weight of the brick is 2.5Kg

5.2 Fixing the Proportion of Sand and Plastic

For the fabrication of plastic sand bricks, plastic and sand are mixed in different proportions and bricks containing different amount of plastic and sand are made. Plastic and river sand are mixed in different ratios 1:2, 1:3, 1:4.

The reason behind taking different proportions of plastic and sand is to find the optimum proportion which gives the desired results. The bricks made of these ratios will further be investigated for various desired properties.

5.3 Preparation of Brick Mould

The moulds used are wooden moulds and are made in the carpentry shop. All the sides and surfaces of the mould should be even for the brick to have better surface finish. Both fixed and movable moulds can be used for the purpose. Wooden mould will be cost effective and serve the purpose whereas if better surface finish is needed then cast-iron moulds can be used. Mould size would be (190*90*75) mm Mould.

Fig: preparation in the carpentry shop

5.4 Collection of Material

The process is incredibly simple. Put the dustbin in the canteen for collection of waste bottles. Select the plastic bottles of cold drinks and water from canteens. Bring river sand for plastic brick. IS 2386 (Part- I) The more you collect the more plastic you will divert from the landfill or clean up out of the environment.

5.5 Batching

Measurement of materials is known as batching. The waste bottles are rinsed with water and then dried after which the weights of bottles are measured. Sieving of sand is done by 600-micron sieve. and this sand will be used for making bricks. Various proportions of plastic bottles with sand is taken for bricks. The different ratios we used are 1:2,1:3 and 1:4.Fig: The

Fig: weighing of sand(left) & machine on 600u gauge.

Fig: Sand sieving process on the sand sieving plastic(right) for the batching process

5.6 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, M-sand respectively.

- **Mix Design Calculations**

a) Ratio (1:2)

Size of brick = 19 X 9 X 9 cm

= 0.19 X 0.09 X 0.09 m

Volume of brick = 0.00153 m3

Sum of proportion= 1+2 = 3

Amount of plastic = (0.00153/2) x 1 = (5.1 x 10-4) x 1390 …… (1390 PET density)

Amount of plastic = 0.7089 kg of plastic.

Amount of sand= $\frac{0.00153}{2}$ x 2

= (1.02 x 10-3) x 1620 …. (1620 Sand density)

Amount of sand=1.65kg of sand.

b) Ratio (1:3)

Size of brick = 19 X 9 X 9 cm = 0.19 X 0.09 X 0.09 m

Volume of brick = 0.00153 m3

Sum of proportion= 1+3=4

Amount of plastic = $\frac{0.00153}{2}$ x 1

= (3.825 x 10-4) x 1390… (1390 PET density)

Amount of plastic = 0.53 kg of plastic.

Amount of sand= $\frac{0.00153}{4}$ x 3 = (1.14 x 10-3) x 1620 …. (1620 Sand density)

Amount of sand = 1.85 kg of sand

5.7 Burning:

In this burning of plastic bottles is done. Plastic bottles are cut into pieces and then these pieces are put in drum for melting. In the first step stones, drum and firewood are arranged. The stones hold the drum and the firewood is ignited. Drum is heated to remove moisture from the drum. The plastic is then put into the drum and allowed to melt.

5.8 Mixing:

Pieces of plastic are added into drum for melting until the proportion required by us is achieved. River sand is used for addition in plastic sand mixture. When the temperature of the melted plastic in the drum is around 180o C-200o C then the sand is added into the drum. The river sand and the melted plastic is stirred continuously so that both gets bonded perfectly. As the plastic pieces melt it start getting bonding with the sand particles and hence the mixture required for brick is created.

5.9 Moulding

In moulding process, the prepared mixture is then filled into wooden mould and then compressed by tamping rod. The pressure is applied by the tampering rod so as the mixture gets filled properly in the mould. Then it is left for cooling in air but before filling the mould apply oil on the walls of mould so that at last brick can be removed easily. The application of oil on the inner surfaces of the mould is must as after solidification the brick will not come out easily and to remove the mould some pressure must be applied that would wear the edges of the brick. So proper oiling is needed before filling the mixture in the mould. The brick then can be removed from mould after 24 hours.

Fig: Plastic Sand Brick after removing it from the mould

CHAPTER-6

RESULTS

TESTS ON BRICKS

6.1 Compression Strength test (BS 5628: Part 1: 1992)

In this test, the cubical brick specimen is placed in the compression strength testing machine. After placing it we will apply the load on the brick without any shock. The load will be increased at a rate of 140kg/cm2 min continuously till the specimen's resistance to increasing load breaks down and it cannot withstand any greater load further. Recording the maximum load applied to the brick specimen and the appearance and type of failure is also noted along with any unusual features.

COMPRESIVE STRENGTH= MAXIMUM LOAD APPLIED

SPECIMEN AREA

COMPRESSIVE STRENGTH = F/A

Where,

F - Maximum load applied (KN)

A – Specimen Area (mm2)

Table: Result of compressive strength test

Table: Compressive strength for 1:2 plastic to sand ratio, Plastic Sand Brick

Plastic Sand Brick (1:2Ratio)	Maximum Load (KN)	Compressive Strength (kg/cm2)
Specimen 1	500	193.87
Specimen 2	525	203.56
Specimen 3	490	189.99

Table: Compressive strength for 1:3 plastic to sand ratio, Plastic Sand Brick

Plastic Sand Brick (1:3Ratio)	Maximum Load (KN)	Compressive Strength (kg/cm2)
Specimen 1	350	135.71
Specimen 2	320	124.07
Specimen 3	335	129.89

Table: Compressive strength for 1:4 plastic to sand ratio, Plastic Sand Brick

Plastic Sand Brick (1:4Ratio)	Maximum Load (KN)	Compressive Strength (kg/cm2)
Specimen 1	165	63.97
Specimen 2	150	58.16
Specimen 3	155	60.10

Fig: Compression strength test on brick to determine the load carrying capacity of bricks under compression

Fig: Brick after the compressive strength test, failure due to compressive load

6.2 Water Absorption Test (IS 1077-1970):

In this test at first the bricks are weighed in total dry conditions. Then they will be allowed to be dipped in fresh water for about 24 hours in a container. The bricks are taken out of the water after 24 hours and are wiped with a cloth. The wet brick is weighed using a weighing machine. For the calculation of water absorption, the difference between wet brick and dry brick is done. The difference is the amount of water absorbed by the brick. After that the percentage of water absorption is calculated using the data. Water absorption of bricks tells about the bonding of bricks with mortar. Although other factors such as grooves and design on bricks also improve the bonding. For sand bricks which have less water absorptivity leaner mortar layer is used for bonding bricks and mortar. Greater quality bricks absorb less amount of water. For a good quality brick, the water absorption should be less than 20% of its own weight.

Water absorption = {[Weight of wet brick–Weight of dry brick]/Weight of dry brick} *100

Table: Results of Water Absorption test

Table: For 1:2 ratios plastic to sand bricks, the water absorption is given below

1:2 Ratio Brick	W1(kg)	W2(kg)	Water Absorption (in %)
Specimen 1	3.053	3.082	0.949
Specimen 2	2.958	2.997	1.318
Specimen 3	3.014	3.051	1.227

Table: For 1:3 ratios plastic to sand bricks, the water absorption is given below.

1:3 Ratio Brick	W1(kg)	W2(kg)	Water Absorption (in %)
Specimen 1	2.532	2.601	2.723
Specimen 2	2.498	2.564	2.642
Specimen 3	2.594	2.678	3.238

Table: For 1:4 ratios plastic to sand bricks, the water absorption is given below.

1:2 Ratio Brick	W1(kg)	W2(kg)	Water Absorption (in %)
Specimen 1	2.411	2.516	4.351
Specimen 2	2.397	2.492	3.963
Specimen 3	2.456	2.568	4.560

6.3 Efflorescence Test

The standard used for the test is ISS 1077-1970. It is done to detect the presence of alkalis in PET bricks which is harmful. The alkalis form a grey or white patch on the surface of the brick. A flat bottom container is used in which sufficient distilled water is poured. The depth of immersion is 25mm.The brick is immersed into the distilled water and left for 24 hours. The container is covered with a glass sheet to prevent excessive evaporation. After that the brick is removed from the container and left to dry for the same amount of time wherein the same amount of water must have evaporated from the open container without the brick or the sheet.

Table 4: Alkali presence in the bricks as appeared on the surface

Nil	0%
Slight	Up to 10%
Moderate	10% - 50%
Heavy	More than 50% without Powdered flakes
Serious	More than 50% with Powdered flakes

The efflorescence in the brick can be categorised into the above categories on the basis of area covered by salt/alkalis.

6.4 Fire Resistance Test:

The standard used for the test is BIS 3809 1979. The plastic alone is readily susceptible if not flammable to elevated temperatures and in case of fire, the sand and plastic mixture may withstand temperatures that plastics alone usually cannot.

It has been observed that the structural integrity of the bricks holds very well up to 180oC. In this test we will first heat and maintain the brick at the standard testing temperature in the furnace and then we will do the compressive strength test to check whether the properties change or not.

CHAPTER-7

CONCLUSION

The proposed project presented above intends to resolve in reducing the plastic waste disposal problem as it utilizes the waste even in its finest form and converts that useless material into a useful construction material. Extruder machine plays a prominent role in the conversion of waste plastic into its melted form. Also, extruder does not possess any threats to the environment and hence can be used without any restriction. It also helps in reducing the usage of natural resources which are utilized during the manufacturing of burnt bricks, also it reduces the pollution which is generated from kiln during brick manufacturing. The final end product can be used as brick, which is having a higher strength than conventional brick. Also, the water absorption capacity is higher in comparison to conventional brick with a lower weight. Its uses are not restricted as only brick; it can even be utilized as a building block by increasing the dimension of the mould. Also, it reduces the use of wire used for fencing. Floor tiles, sleepers, etc. can also be produced from it. This brick also turns out to be economical than conventional brick, by reducing the cost of incinerators for burning purpose and landfills.

CHAPTER-8

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CERTIFICATE

This is to certify that the Project work entitled "Experimental Study of Plastic Bricks Made From Waste Plastics" carried out by Mr. SACHIN JAISWAL (1SJ17CV064), Mr. IRFAN BASHIR (1SJ18CV434), Mr. VIRESH (1SJ17CV079), Ms. VINAYA KUMARI (1SJ18CV433) students of SJC Institute of Technology in partial fulfilment for the award of Bachelor of Engineering in Civil Engineering of the Visvesvaraya Technological University, Belagavi during the year 2020-21. It is certificated that all correction/ suggestions indicated for internal assessment have been incorporated in the report deposited in departmental library.

The Project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said Degree.

2/8/21	2/8/2021	
Mrs. SHARADA S A	**Dr. G Narayana**	**Dr. G. T. RAJU**
Signature of the Guide	Signature of the HOD	Signature of Principal
Dept. of Civil Engg.	Dept. of Civil Engg.	SJCIT
SJCIT	SJCIT	

External Viva

Name of the Examiners Signature with date

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