

MANUFACTURING OF BRICKS FROM HDPE AND PP PLASTIC

¹R. KRISHNA MOHAN, ²N. SRIKANTH, ³SK. SHAHENSHA, ⁴M. SAI TEJA, ⁵M. AKHIL BHARAT

¹Associate professor, ^{2,3,4,5}U.G. Students

Mechanical engineering department,

Godavari Institute of Engineering and Technology, Rajahmundry, India.

Abstract: Our surroundings got a lot of waste generated especially from plastic and that too one time used plastic which resulted in polluting our own habitat. As mechanical engineering students we were jolted by watching the huge amount of impact this waste plastic is creating and then we decided to give this problem a solution in our style by giving it a mechanical touch. That is when we decided to manufacture bricks from this waste plastic which can be used in those particular applications depending upon the need of hour. This project experiments on composition of plastic in creating those bricks from waste plastic. This project mainly uses plastic waste of HDPE (high density polyethylene) and PP (poly propylene) for recycling. Heated up to their plasticity zone and then transferred into a mould and compression force is applied to attain the final product of high quality brick. By using different moulds we can obtain different sizes of the plastic bricks depending upon the size of it, which are then tested for Compressive strength, Impact load and Absorption of water.

INDEX TERMS - PLASTIC WASTE (HDPE AND PP), COLLECTING, SHREDDING, HEATING CHAMBER, MOULD, HYDRAULIC COMPRESSION, PLASTIC BRICKS.

I. INTRODUCTION

The first commercial plastic was developed over one hundred years ago, but the plastic became major consumer material only after the growth of the petrochemical industry in the 1920s. Now plastic have not only replaced many wood, leather, paper, metal, glass, and natural fibre products in many applications, but also have facilitated the development of entirely new types of products that are so versatile in use that their impact on the environment are extremely wide ranging.. Careless disposal of plastic bags chokes drains, blocks and porosity of the soil and cause problems for ground water recharge. If treated correctly, this resource can become the beginning of something new for you, society and the planet at large. This resource lying around everywhere can be useful for source of income to our community. There is good opportunity of plastic waste to eliminate plastic pollution, reducing the demand for new plastic products and closing its materials loop while creating better livelihoods for people around the world.

1.1 Plastic

Plastics are typically organic polymers of high molecular mass and often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, however, an array of variants are made from renewable materials such as polylactic acid from corn or cellulose from cotton linters.

1.2 Types of Plastic

1. PET (polyethylene terephthalate)

This is a strong plastic and it is easily seen by its transparent look. They are used as bottles, jars and spray bottles. The items made from this plastic are commonly recycled.

2. HDPE (high density polyethylene)

This plastic is very strong in nature and used for food or drink containers. Some of the items made from this plastic include shampoo bottles, oil bottles, soap bottles and bleaches. This plastic has good moulding properties.

3. PVC (polyvinyl chloride)

These plastics are most commonly used for plumbing pipes and it is very toxic when heated up.

4. LDPE (low density polyethylene)

Plastic bags, Trays, squeezable bottles, and snap-on lids are made from LDPE. Usually this plastic works well with recycling.

5. PP (polypropylene)

These plastics are easily available in the markets. This plastic is strong and can usually resist higher temperatures. These are widely used for products like Plastic chairs, syrup bottles etc. It also works well with recycling.

6. PS (polystyrene)

PS is also known as Styrofoam and it is recyclable, but not efficiently and recycling takes a lot of energy. Disposable cups, plastic food boxes and packing foam are made from this plastic.

7. Other (Mix)

This code is used to identify other types of plastic that are not defined by other six codes which are mentioned above. ABS, Acrylic is included in this category and it is more difficult to recycle.

1.3 Mixing of Plastic

Different plastic types should never be mixed together when working with Plastic as this will make it impossible to recycle them again. Mixing plastics would end their cycle and resulting in structural weakness and low quality products.

1.4 Plastic pollution

As per the study conducted by Central Pollution Control Board (CPCB) in 60 major cities of India, it has been observed that around 4059 T/day of plastic waste is generated from these cities. The fraction of plastic waste in total Municipal Solid Waste (MSW) varies from 3.10% (Chandigarh) to 12.47% (Surat). Average plastic waste generation is around 6.92% of MSW. The plastic waste generation data for 60 major cities in India is annexed. With extrapolation of the plastic waste generation data from 60 major cities, it is estimated that around 25,940 T/day of plastic waste is generated in India. As plastic is composed of major toxic pollutants, it has the potential to cause great harm to the environment in the form of air, water and land pollution.

But simply, plastic pollution is when plastic has gathered in an area and has begun to negatively impact the natural environment and create problems for plants, wild life and even human population. Often this includes killing plant life and causes danger to local animals. Plastic is an incredible useful material, but it is also made from toxic compound known to cause illness.

- To reduce the plastic pollution, Recycling is the only way in this view.

II. LITERATURE REVIEW

2.1 Introduction

Quantities of waste plastic have been rising rapidly during the recent decades due to the high increase in industrialization and the considerable improvement in the standards of living, but unfortunately, the majority of these waste quantities are not being recycled but rather abandoned causing certain serious problems such as the waste of natural resources and environmental pollution. Around 8.3 billion tonnes of plastic have been produced by the humans since the early 1950s. And there is rapid growth in global plastic production and increased to 381 million tonnes in 2015. Plastics have become an integral part of our lives. The amount of plastics consumed annually has been growing steadily. Its low density, strength, user-friendly designs, fabrication capabilities, long life, lightweight, and low cost are the factors behind such phenomenal growth. And is the best invention in the human kind but it is also a worst thing in mankind where we did not put serious thought into the used plastic products and it became huge trash like mountains around the world, there by polluting the water and land.

There are some ways to recycle and reduce the plastic but often they are costly, so finding a good method to recycle the plastic in least cost is main thing in this point.

2.2 Incineration

By considering the environmental and safety-conscious behaviour in the 21th century, it is necessary to reduce activities that cause environmental damage. More care should be taken for recycling, waste-handling and environmental-friendly solutions, due to the increased amount of waste caused by the penetration of plastics. In view of the limited resources and availability of land for disposal, especially in the metropolitan cities, there is a need for a concerted effort to develop cost-effective and feasible policy options for tackling the waste management problems. It could cause serious problems to the humankind and natural environment if the process is not properly controlled and monitored. This is the situation that seemingly a growing amount of plastic waste is used in residential combustion appliances, of which adverse environmental and health effects most of people are not aware.

III. MATERIALS & METHODOLOGY

The materials which we used to produce the plastic bricks are High Density Polyethylene (HDPE) and Polypropylene (PP) plastic. They have good moulding properties and works well even while recycled. The HDPE and PP plastics have the following properties: Stiffness, resistance to chemicals and moisture, ease of processing, and ease of forming.

3.1 Melting points of plastics

Material	Temperature	Time(minutes)	Weight(Kgs)
HDPE	130	18	5
PP	170	20	5

Table-3.1: Melting temperatures of different plastics according to CIPET, Chennai

3.2 Plastic preparation process:

3.2.1 Collecting of different plastics

The first thing to do before production of plastic bricks, it is necessary to collect the required plastic materials which are available at plastic waste storage facilities. Plastics at this stage are mixed and dirty and they need to be shredded, sorted and cleaned.

3.2.2 Sorting

The next stage after collecting different plastics is sorting. The sorting of plastic is a crucial role for all recycling activities. It provides smoother processes and easier maintenance. An efficient sorting system allows the team to know which type of plastic is being used and it is done manually by checking the SPI code.

3.2.3 Shredding

In this stage the plastic objects which are big in size are chopped into small pieces to reduce its size, enable cleaning and storing in the effective manner. Always ensure only particular type of plastic should be placed inside the machine for chopping purpose.

3.2.4 Cleaning

Plastic which are collected from the scrap facilities is very dirty and it requires cleaning before recycling it. The shredded plastic pieces are cleaned by water and properly filtered. After it is washed it is required to dry before being melted.



Fig-3.2: cleaning the shredded plastic

3.2.5 Storing

After the plastic is properly cleaned and dried it need to be stored in order to use at particular hour of need. It is better to store the plastic pieces in large boxes or in containers with code stickers attached to it for better identification.

3.3 Fabrication of Mould

In order to produce the Plastic brick at required dimensions it is necessary to fabricate the mould at required dimensions. We designed the mould by considering the general clay brick dimensions and keeping the equipment available for our need. The mould we fabricated consists of two basic parts namely: Mould cabin and Compression plate.

The metal we used to fabricate the mould is Mild steel which has good strength and low cost. Scrap Mild steel plates of thickness 5mm and length of 23 cm used as base plate and width of 10cm side walls were used for the preparation of the mould cabin. By aligning the plates in rectangular shape and then followed by Arc welding. Interlock rods are also welded to the Base plate.

Type	Length(mm)	Width(mm)	Thickness(mm)	No. Of Plates
Base plate	240	110	5	1
Side plates	240	100	5	2
Side plates	105	95	5	2

Table-3.3.1 Metal Plate Dimensions of Mould



Fig-3.3.1 Fabrication of Mould

3.4 Fabrication of Equipment

The shredded plastic pieces are fed into the stainless steel pipe which is surrounded by heating coils and known as Heating Chamber. The equipment is prepared with few components which are listed below.

Components used for the Design and fabrication of Equipment

- Frame
- Stainless steel pipe
- Heating coils
- Plunger

3.4.1 Frame

It is necessary to make the frame for the heating chamber for supporting purpose. The frame provides the better stability and holds the heating chamber rigidly. The material used for the frame is mild steel and has hollow square shape rods which are welded together at required positions to hold the heating chamber. A hopper is also provided on the frame for feeding of plastic pieces into the heating chamber.

3.4.2 Stainless steel pipe

For melting the shredded plastic we have used the stainless steel pipe. One of the reasons to use this is, it provides good thermal properties and the adhesion of plastic is less compared to other metals. The specifications of stainless steel pipe are mentioned below:

Length = 4 feet
Diameter = 4 inches
Thickness = 4 mm



Fig-3.4.1 Frame and Stainless steel pipe

3.4.3 Heating coils

For melting the plastic pieces which are placed inside the steel pipe we need an external source of heating device. By considering the amount of plastic to be melted and length of the steel pipe, certain number of coils is required. And these coils are mounted around the steel pipe. The heating element which is used inside the coils is Nichrome wire.



Fig-3.4.2 Equipment and Heating coils

3.4.4 Plunger

Plunger is used to push the melted plastic from the heating chamber into the mould. This extraction of melted plastic is performed manually.

3.5 Production of Plastic Bricks

In this process the shredded plastic is weighed according to the plastic brick needed. Then these shredded plastics (proportions of HDPE and PP) are mixed together and fed into the heating chamber through hopper. The open sides of the heating chamber are closed with circular plates. When the power supply is enabled to the heating coils, it gets heated up and the plastic pieces start to melt at certain period of time. Once the plastic is sufficiently melted it can be loaded into the mould by giving the external force using the plunger at the rear side of the heating chamber.

The flow of melted plastic can be adjusted as the plunger is operated manually. Generally it takes about 15-20 minutes for the plastic to be melted in the heating chamber.



Fig-3.5.1 Loading Molten Plastic into the Mould and Applying Hydraulic load

After the molten plastic is poured into the mould Hydraulic load is applied on the compression plate which is placed on the top of the mould. By giving the hydraulic load it increases the strength of the Brick and removes the air gaps inside the mould. After 5-10 minutes the load is removed by unloading and the mould is left to cool in the atmospheric air. Once the mould gets cooled remove the Plastic Brick from the mould and check the object.

Note:

The mould should be cooled in the atmospheric air for better properties and structure of the Brick. If the mould is quenched directly in the liquid it may change the properties of Brick and makes it brittle.



Fig-3.5.2 Final Brick of size 22X9.5X6 cm

3.6 Safety Precautions:

- Proper ventilation should be provided to the room.
- Cover your eyes with clear and white spectacles.
- While melting the plastic pieces it produces harmful gases which are bad for health, so it is better to have face mask.
- The electric circuits should be properly insulated and there should be no loose connections.
- Use gloves and leather shoes which protect us from the burns.

IV. RESULTS

4.1 Compression Test

In compression test the Plastic Bricks (proportions of HDPE and PP) are tested along with the clay brick and cement brick. Then the values are evaluated using the equations. The obtained values of different Bricks are tabulated below.

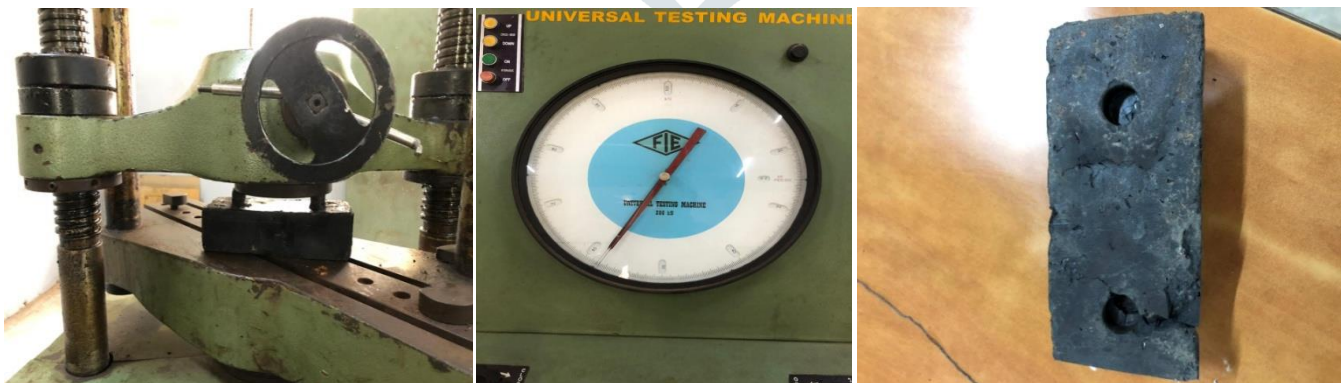


Fig-4.1 Plastic Brick Before and After Compression Testing

S.No	Type of Brick	Area in cm ²	Compressive load (KN)	Stress Kg/cm ²
1	Clay Brick	220	50	23.16
2	Cement Brick	220	115	53.28
3	HDPE-50% & PP-50%	209	157	76.57
4	HDPE-40% & PP-60%	209	97	47.31
5	HDPE-70% & PP-30%	209	128	62.43

Table-4.1 Compressive stress of various Bricks

Inference: From the above results we can conclude that the Brick made with proportions of 50% of HDPE and 50% of PP sustain high compressive strength and still exists bonding where as other Bricks are broken into pieces.

4.2 Izod Impact Test

Izod impact test is an ASTM standard method of determining the impact resistance of materials. In this test the notched specimen of size 64X9X9 mm is used to determine the impact energy.



Fig-4.2 Izod Impact Test showing before and after testing

S.No	Type of Plastic	Impact Energy Absorbed (J/m ²)
1	HDPE-50% & PP-50%	10.4
2	HDPE-40% & PP-60%	6.9
3	HDPE-70% & PP-30%	6.9

Table-4.2 Izod Impact Energy Readings

Inference: From the above experiment analysis we can say that 50:50 compositions of HDPE and PP have high impact energy.

4.3 Water Absorption Test

Water absorption test on bricks are conducted to determine durability property of bricks such as burning, quality and behaviour of bricks in weathering. A brick with water absorption of less than 7% provides better resistance to damage by freezing. The degree of compactness of bricks can be obtained by water absorption test, as the water is absorbed by pores in bricks. The water absorption increases with increase in pores. So, the bricks, which have water absorption less than 3% can be called as vitrified. In this test the brick which is in dry condition is weighted then same Brick is immersed in the water up to 24 hours and then it is weighted. The weight difference between these two condition brick gives the amount of water absorbed by the brick.



Fig-4.3.1 (a) Before Soaking



Fig-4.3.2 (b) After Soaking

Inference: From the above test comparisons we can say that these bricks are very bad for water absorption. So they can be used in cold weather countries or use as Paver blocks etc.

S.No	Type of Brick	Water Absorption Percentage
1	Clay Brick	34
2	Cement Brick	42
3	HDPE-50% & PP-50%	0.44
4	HDPE-40% & PP-60%	0.25
5	HDPE-70% & PP-30%	0.23

Table-4.3 Water Absorption Percentage

Inference: From this test we can infer that bricks which are made from plastic are very bad for absorption. So, they can be used in cold weather conditions or can be used as Plastic sleeper ties and Paver blocks.

V. DISCUSSION

5.1 Construction of Houses and Walls using Plastic Bricks

Some people have doubts whether it is ok to construct the houses or walls by using the Plastic Bricks, is it safe or can have long life. Here my answer, in one's life time one might produce the enough plastic waste which is sufficient to construct the compound walls and plastic blocks in the garden. If someone produces it beyond that amount, we can even construct small houses or can be used to construct walls for the home. It contributes to minimize the environmental pollution in cities, villages, seas, lake and rivers. They also serve as the good insulation from the chilling weather and especially in heavy rainy zones.



Fig- 5.1 Final Construction

Compared to normal clay bricks and cement bricks, Plastic Bricks are Lego construction type. Apart from that these bricks are interlocked to each other and then mesh is wounded around the walls which are made with iron or other materials then this mesh enables to hold the cement on the walls.

VI. CONCLUSION

This work effectively converts waste plastic into useful building material like interlocking bricks which can effectively reduce the environmental pollution and further decrease the problem of waste plastics in the society. Rather than the waste plastic going into the landfill or incineration it can be used as construction materials at a much lower cost after undergoing certain specific processing. It also reduces the construction cost by eliminating the use of mortar during construction by using recyclable plastic/composite bricks.

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