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# STUDY OF PLASTIC DUST BRICK MADE FROM WASTE PLASTIC

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**Abstract -** The main objective of this research work is to develop an efficient way to effectively utilize the waste plastic which is a great threat for the sustainment of ecological balance and to reduce the plastic waste which is increasing day by day. Bad effects of plastic waste are felt throughout the world. So, in order to solve this issue, an attempt is done to reduce the disposal problem of plastic waste by using plastic extruder machine. Extruder machine utilizes plastic waste and changes the waste plastic into useful construction materials. This study also aims at reducing the soil getting wasted during manufacturing of burnt bricks, by producing a brick which is environmentally friendly and also economical. A comparative study of burnt brick and plastic dust brick is done to showcase the advantage of plastic dust brick in areas of strength, economy, etc. Compression strength test was performed on the plastic dust brick and its strength was found to be 6.66 $N/mm^2$ which is higher than red clay bricks which have a compressive strength of 3-5 $N/mm^2$.

**Index Terms -** Plastic extruder machine, Plastic dust, Burnt brick.

## I. INTRODUCTION

Plastic waste is a global phenomenon and its side effects are felt throughout the universe. The amount of damage it does is irreplaceable. Waste in its various forms is increasing in landfills. Due to disastrous effects plastic has on human life, environmentalists are persistently working to get a solution to the problem of plastic disposal. They are focusing on day to day human practices which can help to reduce the disposal problem. One of thetechniques employed is the 5 R's(**R**educe, **R**ecycle, **R**euse, **R**ecover, and **R**esidual Management) which is considered to be a base of waste management and should be strictly followed in order to promote ecological balance through conscious human behavior and choices. There is a mixture of biodegradable as well as non-biodegradable matter. Wastes which can't be broken down by other living organisms are referred to as non-biodegradable wastes, they generally consist of plastic bottles, rubber, glass, cans, vinyl, Styrofoam, and metals like aluminum, iron & tin. Apart from other non-biodegradable wastes, the management of plastic waste is mostly the matter of concern today because it is not rotten easily. Owing to their non-biodegradable and bulky nature plastic waste generates formidable problems in the management. It can even resist incineration.

Incineration, in fact, may not be possible due to the production of noxious or toxic fumes. Plastic can remain under the ground for 500 years, which leads to the contamination of soil and thus pollutes the environment. PVC is also a kind of aplastic waste for which requires immediate attention for its safe disposal. According to the report of Central Pollution Control Board (CPCB), it is seen that the packaging and polyvinyl chloride (PVC) pipe industry grows at 16-18% per year. In the day today practices we use different kind of plastics goods and this demand for plastics goods is increasing rapidly from domestic use to industrial applications also. It is growing at an annual rate of 22% annually. The polymers production has reached to 8.5 million tons in 2007. Table 1 provides the total plastics waste consumption in India during last decade.

| Sr. No. | Year | Consumption (Tones) |
|---|---|---|
| 1. | 1996 | 61,000 |
| 2. | 2000 | 3,00,000 |
| 3. | 2001 | 4,00,000 |
| 4. | 2007 | 8,500,000 |

**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.

| Sr. No | 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 |

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

| Sr.No. | Thermoplastic | Sr.No. | Thermoset Plastic |
|---|---|---|---|
| 1. | Polyethylene Tetra phthalate (PET) | 1. | Bakelite |
| 2. | Polypropylene (PP) | 2. | Epoxy |
| 3. | Poly Vinyl Acetate (PVA) | 3. | Melamine |
| 4. | Poly Vinyl Chloride (PVC) | 4. | Polyester |
| 5. | Polystyrene (PS) | 5. | Polyurethane |
| 6. | Low-Density Polyethylene (LDPE) | 6. | Urea Formaldehyde |
| 7. | High-Density Polyethylene (HDPE) | | |

**Table 3 Typical thermoplastic and thermosetting resins**
**Source: Central Pollution Control Board**

It increased greatly over few decades. People's reliability on plastic is increasing rather than decreasing. Various disasters have occurred due to increasing plastic waste and one example of the same is Apex regional landfill situated in Las Vegas, USA. It is regarded as worlds one of the most harmful and disastrous landfills which as its spread area is 2200 acres. It daily receives about 9,000 tons of municipal solid waste and was opened in the year 1993. Based on this detail it can be easily estimated the amount of harm it's doing to the environment. New York Department of Health reports methane and carbon dioxide as the major gases produced and makeup to 90 to 98% of landfill gas. Nitrogen, oxygen, ammonia, sulphides, hydrogen and various other gases are also produced in small volumes. These gases have an odour similar to rotten eggs and hence it gets difficult to live in an area which is near to landfills. Besides odor, landfill gases can also impact health causing problems that can be acute or chronic which is a major concern. Landfill causing fire is also a recurring problem. The University of Iowa reports that there are more than 8000 landfill fires occurring every year in U.S. Smoke from these fires can cause respiratory diseases if they are contaminated by chemicals, and water in fire suppression efforts can spread leachate pollution of soil and water sources. Not only air quality is affected by landfills, but also is a major source of groundwater contamination. It is reported that leachates from landfills do have heavy metals like barium, chromium, cobalt, nickel, and lead which enters the soil and into the groundwater contaminating it. They destroy the soil properties which are required for growth, nourishing, etc for a plant. Leachates from landfills pollute rivers and other water sources. Ammonia which is one of the common gases found in landfills converts itself into nitrogen and causes eutrophication, where algal growth increases and uses up all the oxygen present in the water killing marine life. Moreover, toxins in leachates can kill wild and domestic animals that drink thesewaters. In humans also, its side effects are felt, they cause nausea, stomach pain, rashes, fevers,and headaches. This generally happens because surface water and groundwater are connected and hence pollutants can move back and forth.

Hence, it is evident that dumping into landfills has to be avoided and an alternate solution to it is the requirement of time. To humans, plastic is available in avariety of forms such as HDPE, PET, Bakelite, LDPE. Plastic is usually made from long chains of hydrocarbons along with additives and can be easily moulded into any desired shape. Plastic is categorized as Thermoset plastics and Thermoplastics. Plastics once melted can be easily moulded and then once if its again heated it again softens and can take any desired shape. Thermoset plastics, however once melted and takes any shape, it cannot be reheated. Thermoplastics includevariety products such as PPS, LDPE, PVC, HDPE, PET, etc. while Thermoset plastics include Nylon, Bakelite, etc. In the MSW, the contribution of Thermoplastics is about 80% and Thermoset constitutes approximately 20% of the total plastics waste generated. Table 4 shows the types of typical thermoplastic and thermosetting resins. Owing to the number of side effects use of plastic have instead of decrease in the consumption, its utilization is increasing rapidly. This is proved by the estimated difference in plastic consumption in 1950's and its current consumption. Estimates have shown that plastic consumption increase from 5 million tons in 1950's to nearly 100 million tons at present.

So, reducing the plastic waste is aneed for the time and here plastic extrusion can be regarded as one of the most effective methods for reducing the plastic waste. Extruder machine can intake the waste plastic which might go into landfill otherwise and converts it into various sustainable construction material. The advantage of extruder machine is that it not only helps in making construction material but also helps in plastic disposal problem. The method which extruder machine employs is, raw plastic is this raw plastic is melted and forms a continuous profile allowing production for various construction materials. This process causes no harm to any form of life or environment and is very useful.

Recently increasing awareness has led companies to manufacture products made from recycled plastics such as recycle rubber, road rail tile resins, P/C tiles etc and also there is an immediate need to solve these problems, which extrusion helps for.

## II. MACHINERY DETAILS

Plastic Extruder Machine owing to its complexity is one of the most intricatemachines available. Complicated design of the machines makes it difficult to use it. Processes such as drilling, boring, cutting, etc are involved in the construction of the machine. Due to this confusion are created and hence to reduce it different methods used were categorized under

theheading, Cutting operation, Machine operation, Welding operation & Assembly operation and Finishing operation.

### A. MATERIAL SELECTION

Material selection depends on the properties of the materials to be used during its construction. If the material does not fulfill the requisite condition required for the use then it is not allowed to be used. Few conditions such as with what ease can it be welded, its hardness, ability to resist abrasion, etc play an important role in material selection. Whether a material is economical or not also plays a role in selection. Materials used for the purpose of construction of machine are Barrel, Nozzle and Screw conveyor while the material used for the hopper is sheet metal.

### B.COMPONENTS OF MACHINE

Cutting of metals into different shapes and sizes as per the requirement of the machine is done using frame cutting and to join different parts of machinery drilling and welding operations are carried out.

Parts used for the construction of machinery are strong enough to sustain high temperatures as well as abrasion. 38 Cr MOAL/A featuring nitrogen treatment is used for the construction of screw conveyor and barrel and the surface is treated with alloy as the possess high hardness. Uniform mixing and melting are done due to the new designs of thescrew conveyor. Equipment's which are required for the regulation of machine includes temperature control box, ceramic band heaters, hear box, etc. also, the functioning of feeding is highly improved due to thespiral barrel with alongitudinal groove.

## III. WORKING

The operational principle for the working of the machine is given below:

1. The heater is switched on and the temperature required for heating f plastic is set. Temperature is generally beyond 220 degree Celsius.
2. A hopper with a wide mouth is used for the feeding of waste plastic into the extruder machine. Different kind of waste plastics is fed into the hopper and reaches the rotating screw conveyor via gravity.
3. As the screw is rotating, this rotation conveys the waste plastic forward through the barrel which is set at a high temperature.
4. The depth of the channel along which the waste plastic is traveling also keeps on decreasing, which forces plastic to reduce in size with the additional help of barrels high temperature.
5. This combination of compression and screw rotation causes friction which generates heat and is called as shear heating.
6. Barrels heating and shear heat together melts the plastic and the final product is collected at the end of the machine where a nozzle is situated. The nozzle is called as anoutlet.
7. The end product coming through the outlet is collected inside a mould and once the mould is completely filled it is properly cooled.
8. After proper cooling of the brick inside the mould it is removed and compressive strength of the brick is found.

## IV. ANALYSIS OF THE PRODUCT

Plastic dust bricks contain 100% waste plastic in the dust form. Other products such as fly ash, bitumen, etc. could have been added along with the waste plastic to see a change in the strength of the resulting product, but with a point of view to achieve highest economy addition of any other product was avoided. This plastic dust was fed into the hopper which acted as aninlet of extruder machine and went through the various process to get end product at nozzle inside a mould.

After the removal of brick from the extruder machine, it was cooled down in a controlled environment. To accelerate the cooling process, the mould was even dipped inside a bucket of water with its upper face open to the atmosphere.

| Sample No | Composition in Weight % | Density ($g/cm^3$) |
|---|---|---|
| Sample No 1 | 100% Plastic dust brick | 0.8888 |
| Sample No 2 | Burnt brick | 1.890 |

**Table 4 Density of samples**

As density impacts the strength of the product, density of the samples used are found and presented above in table 4. Next, to find the compressive strength of the brick thus produced, Universal Testing Machine was employed. In this, the plastic dust brick is placed between 2 cushion pads of the machine and then the load is applied vertically. Failure load is noted and accordingly, the compressive strength is found out.

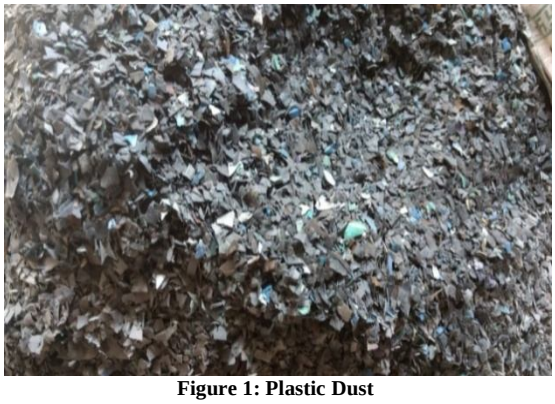

**Figure 1: Plastic Dust**

## V. RESULTS AND DISCUSSIONS

The waste product used as the main component is plastic dust. Plastic dust is the waste product generated as the by-product of many industrial products such as PVC pipes, etc. Plastic dust is available in abundance and goes into landfills if not treated. This waste product then releases harmful gases like methane polluting the air and also is a source of groundwater contamination. Also, burnt bricks which utilize natural resources leads to depletion of natural resources. To manufacture these bricks, they are burnt in akiln which creates a large amount of pollution and again harms the environment.

| Sample | Plastic brick | Burnt brick |
|---|---|---|
| Length of Brick 'L' (mm) | 150 | 190 |
| Breadth of Brick 'B' (mm) | 150 | 90 |
| Area of Brick 'A' ($mm^2$) | 22500 | 17100 |
| Load at failure 'P' (N) | 149790 | 68400 |
| Compressive strength ($N/mm^2$) | 6.66 | 4 |

**Table 5 Details of samples**

Hence, this study helps in reducing the problems related to plastic waste and also helps in reducing the problems related to manufacturing of burnt bricks. The final product from plastic dust was tested for the compressive strength and it was found that the compressive strength of plastic dust brick is 6.66 $N/mm^2$ which is higher than conventional bricks which have strength between 3-5 $N/mm^2$.

Table 5 gives details about the samples used which includes, size and the area of the brick prepared along with its load at failure. It is found that the compressive strength of the sample is high enough to sustain heavy loads and can be successfully used as a construction material.

**Figure 2: Plastic Dust Brick**

## CONCLUSION

Thestudy presented above helps 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 abuilding 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.

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