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# Plastic-Soil Bricks Substituting Traditional Bricks

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***Abstract: One of the major issue discussed in UN Council meetings from last decade is high utilization of plastics and its degradation techniques, as no such effective techniques is yet discussed. So, the utilization of these waste plastic is done by manufacturing the plastic soil bricks which will indeed pause the time phase for the scientists to discover the effective degradation techniques for near about 30-40 years. As repeated recycling of PET bottles poses a potential danger of being transformed to a carcinogenic material 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. The bricks manufactured possess the properties such as neat and even finishing, and satisfactory compressive strength in comparison with laterite stone to satisfy the increasing demand of conventional building materials.***
***Keywords: Poly ethylene terephthalate (PET), Laterite quarry waste, plastic-soil brick***

## I. INTRODUCTION

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. [1] This rock can be easily cut into brick shaped blocks for building construction. The laterite stone is rich in iron and aluminum and it is formed in hot and wet tropical areas. A good reservoir of laterite stone is present in the coastal Karnataka and some northern parts of Karnataka and in the northern parts of Kerala, due to which lot of quarrying of laterite bricks takes place. The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. This is due to rapid growth of population, urbanization, developmental activities and changes in life style which leading widespread littering on the landscape. [2]

### *A. Chemical structure of waste plastic*

*Polyethylene terephthalate* (sometimes written poly(ethylene terephthalate)), commonly abbreviated *PET*, *PETE*, or the obsolete PETP or PET-P, is the most common thermoplastic polymer resin of thepolyester family and is used in fibers for clothing, containers for liquids and foods, thermoforming for manufacturing, and in combination with glass fiber for engineering resins.

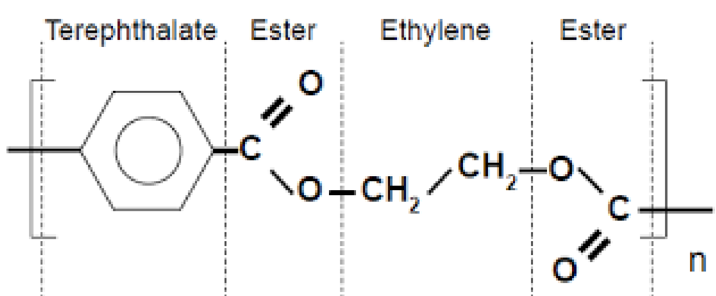



**Figure 1:** The chemical structure of the PET monomer.

### *B. Properties of plastic*

Following are the general properties of plastics.

1) *Strength:* The plastics are sufficiently strong and can be used for load bea1ring structural members. The strength of plastics can further be increased by reinforcing them with various fibrous materials. [3]
2) *Weather Resistance:* The plastics, prepared from phenolic resins, are only good in resisting weather effects. Certain plastics are seriously affected by ultraviolet light. [3]

3) *Fire Resistance:* Plastics, being organic in nature, are combustible. But the resistance to fire temperature depends upon the plastic structure. Cellulose acetate plastics burn slowly. Polyvinyl chloride (PVC) plastics are non-inflammable. Phenol formaldehyde and urea formaldehyde plastics are used as fire proofing materials. [3]
4) *Durability:* Plastics generally possess sufficient durability, provided they offer sufficient surface hardness. Thermoplastic varieties are found to be attacked by termites and rodents. [3]
5) *Dimensional stability:* Plastics easily maintain its shape and do not go under plastic deformations. [3]
6) *Chemical resistance:* Plastics offer great resistance to moisture, chemicals and solvents. Many plastics are found to possess excellent corrosion resistance. Plastics are used to convey chemicals. [3]
7) *Thermal resistance:* The plastics have low thermal conductivity and therefore foamed or expanded varieties of plastics are used as thermal insulators. [3]
8) *Working conditions:* All operations like drilling, sawing, punching, clamping etc. are carried out easily on plastics, just like wood. [3]
9) *Moisture resistance:* This property depends upon variety of plastics used, for example, cellulose plastics are considerably affected :by the presence of moisture, whereas polyvinyl chloride plastics offer high resistance to moisture. [3]
10) *Ductility* Plastics, generally, have low ductility and hence plastic structural members may fail without warning. [3]
11) *Miscellaneous properties:* In addition to above properties, plastics have following qualities.
a) Plastics are available in variety of colors, both opaque and transparen
b) Plastics possess excellent insulating property, so used as electric insulators
c) Plastics are clean, light and shining, so they need not be given any finish such as painting, polishing etc
d) Normally thermo-plastics have low melting point and cannot be used where temperature or heat condition persists
e) They possess good optical and sound absorption qualities. [3]

## II. LITERATURE

The increased use of plastics products as packaging application in the recent years have increased the quantity of plastics in the solid waste stream to a great extent. The quantum of solid waste is ever increasing due to increase in population, development activities, changes in life style, and socio-economic conditions. It is estimated that approximately 15722 tons per day (TPD) of plastic waste is generated on the basis of per capita consumption based on population of India. In a study produced in 1998, Asian cities produced 0.76 million tons of MSW per day. By 2025, these numbers will more than double to 1.8 million tons per day if something is not done to stem the increase in waste. (World Bank, 1999) [6]. India generate, 5.6 million metric tons of plastic waste annually, with Delhi generating the most of at municipality at 689.5 metric tons every day, as per the report from the Central Pollution Control Board (CPCB) [3].Per 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 of 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.[4]

Table 1 [Plastic consumption in India]

| Sr. no. | Years | Consumptions |
|---|---|---|
| 1 | 1996 | 61,000 |
| 2 | 2000 | 3,00,000 |
| 3 | 2001 | 4,00,000 |
| 4 | 2007 | 85,00,000 |

Table 2 documents the demand of different polymers in India during years 2001-02 and 2006-07. The comparison of demand and consumption from Table 1 and Table 2 indicates that projections are correct.

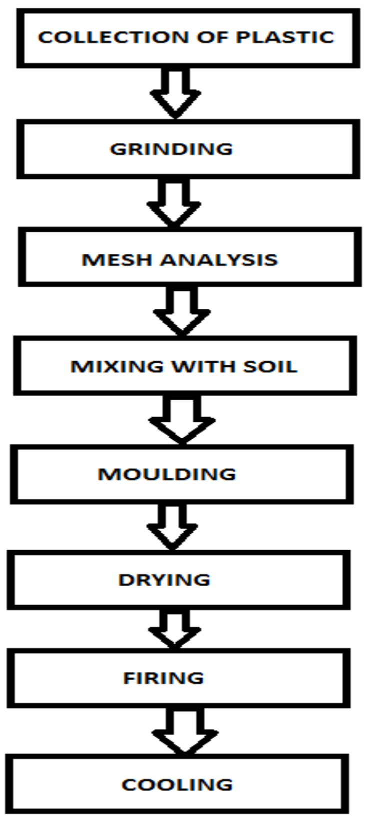
| Sr. No. | Type of Polymer | 1995-96 | 2001-02 | 2006-07 |
|---|---|---|---|---|
| 1. | Polyethylene | 0.83 | 1.83 | 3.27 |
| 2. | Polypropylene | 0.34 | 0.88 | 1.79 |
| 3. | Polyvinyl chloride | 0.49 | 0.87 | 1.29 |
| 4. | Polyethylene Terephthalate | 0.03 | 0.14 | 0.29 |

Table 2 [Polymer demand in India (Million Tons)]

## III. METHODOLOGY

The main objective of this research is to effectively utilize the waste plastic material for the span of 30-45 years. The similar techniques utilized earlier had the major environmental problem of $CO_x$ removal which was directly evolved in the atmosphere and which indirectly offend the major concern. With the laterite quarry waste to manufacture an alternative building material by which both the questions of a scientific disposal of waste plastic as well as scarcity of traditional building materials can be answered. The laterite quarry waste was collected from Alette. [5]

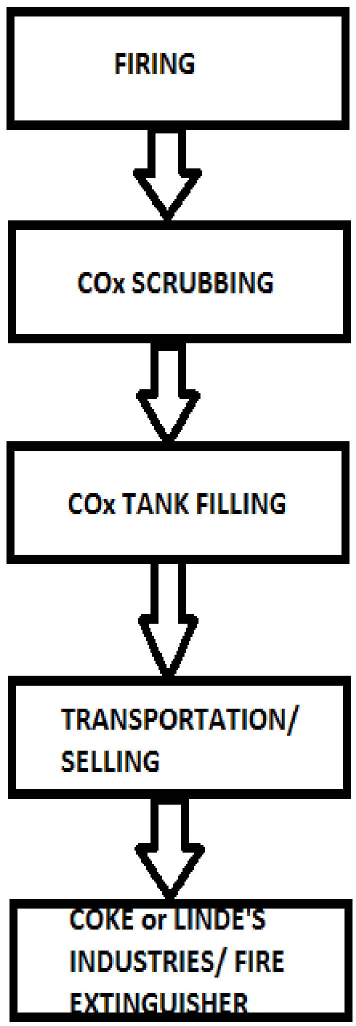
### *A. Fig. 2 (Flow diagram of Manufacture of bricks)*




1) *Collection of waste plastic:* The mixed MSW received from municipal corporation by means of day to day garbage collection vans.And when the laterite stone is cut from the quarrynearly 15-20% of laterite waste is obtained.
2) *Grinding and mesh analysis*: This waste was crushed using rammers and sieved in a 2.36mm IS sieve. This sieved laterite soil was brought to laboratory for preparation of bricks.

3) *Mixing:* 65-70% of plastic content by weight and 30-35% laterite soil content were mixed properlywith proper proportion of water.
4) *Moulding:* A mould of size 20x10x10cm was prepared. Bricks of different mix proportions were prepared, for each brick 3kg of the variable plastic and laterite soil content. Bricks were prepared by compacting through vibration.
5) *Drying and Firing:* Mould formed are dried in the drying oven for 24-48 hrs. The dried bricks are transferred to the kiln. Then temperature in the kiln is around 200ºC-980ºC. The plastic waste start melting at 250ºC and the waste plastic starts behaving as a binding agent. The $CO_x$ liberated is then passed through the $CO_x$ scrubber through the single opening available for flue gases from the kiln.
6) *Cooling:* Then the bricks were allowed to cool in cooling chamber or in free open atmosphere for 48-72 hrs. Cooling is done

Fig. 3 (Flow diagram of $CO_x$ Collection)




### B. *$Co_x$ Scrubbing Unit*

The advantages of such a low-$CO_2$ scrubbing unit are obvious: the plastic-soil bricks kiln can be retrofitted with such a CO2-capture system, because it does not interfere with a manufacture of bricks. Even in a possible failure of the CO2-scrubbing system, there is no effect in production of bricks, i.e. the availability of bricksis guaranteed. There are 5 major carbon group capture technology with 14 substituting sub- categories. Each of these different categories has different benefits and drawbacks, as well as applicability in different situations. So, the installation of COx can be done by reviewing the following sections. Other separation techniques include chemical looping which effectively removes oxygen from air prior to combustion.

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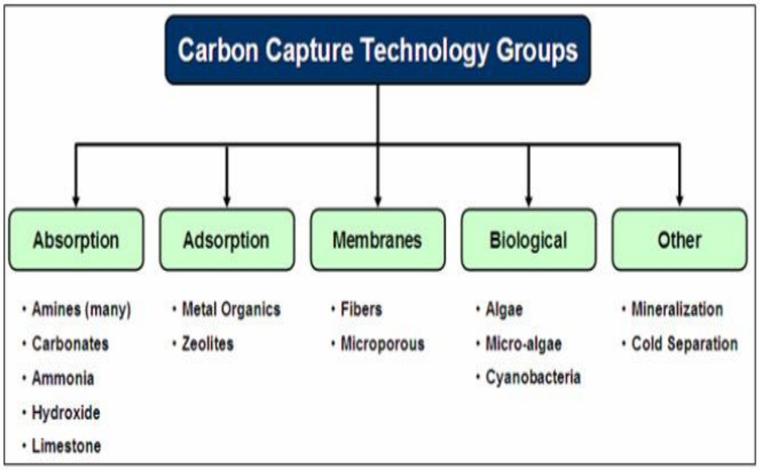
Fig. 3 (Carbon Capture Technology Groups)




## IV. EXPERIMENTAL RESULT

### *A. General*

The results of experiments conducted for various percentages of plastic mixed with laterite quarry waste.

### *B. Effect of water cooling on strength of plastic-soil bricks*

For manufacturing of plastic-soil bricks a minimum of 60% of plastic by weight of soil was required as determined by trial and error method, so 65% of plastic by weight of soil is considered as a starting proportion. Compression strength was conducted on bricks of size 20x10x10cm.The compression strength test results are given in Table 3[6]

Table 3 [Compressive strength of water cooled plastic-soil bricks]

| Sr No. | Types of heat dissipant ions | Percentage of plastic | Days | Average compressive strength |
|---|---|---|---|---|
| 1 | Water Cooled | 65-70 | 3 | 7.3 |
| 2 | | | 7 | 7.24 |
| 3 | | | 28 | 7.21 |

There is no much effect on compressive strength of plastic-soil bricks on water cooling since for 3,7 and 28 days of water cooling the compressive strength is almost same. Therefore, only air cooling is adopted.

### *C. Effect of variation in plastic content on compressive strength and water absorption of plastic-soil bricks*

The effect of variation in percentage of plastic on compression strength of plastic soil bricks and the water absorption is tabulated in the Table 6 respectively. From the test results, it was found that as the percentage of plastic increased, the compressive strength of the brick also increased. So, it shows that the strength of plastic-soil bricks is dependent on the percentage of plastic.

Table 4 [Compressive strength of water cooled plastic-soil bricks]

| Sr.No. | Types of dissipation | Percentage of plastic by weight of soil | Water absorption (%) |
|---|---|---|---|
| 1 | Air cooled | 0 | NA |
| 2 | | 65 | 1.8242 |
| 3 | | 70 | 0.9536 |
| 4 | | 75 | 0.7962 |
| 5 | | 80 | 0.5954 |

The compressive strength test results of plastic-soil bricks for 65 and 70% of plastic contain by weight of soil with constant binder content of 2% by weight of soil, gives same compressive strength (8.16 N/mm$^2$), but 70% plastic contain is considered as optimum in the view of work ability criteria during manufacture. From the test results, it was observed that the water absorption also decreases with increase in percentage of plastic. The plastic-soil brick containing 70% plastic & 2% bitumen gives negligible water absorption of 0.9536%.

### *D. Effect of binder content variation on compressive strength of plastic-soil bricks*

From the test results, it is evident that for 5% bitumen by weight of soil gives maximum compressive strength of 10 N/mm$^2$ but from economic considerations 2% of bitumen content is taken as optimum binder content, which has a compressive strength of 8.16 N/mm2 which would be satisfactory. On increasing the percentage of binder (bitumen) the compressive strength of brick also increases up to 5%, but further increase in bitumen decreases the strength. Also, serves the purpose of transforming a thermoplastic into thermosetting plastic

Table 5 [Effect of binder content variation on compressive strength]

| Bitumen Content (%) | Optimum Plastic Content (%) | Compressive Strength (N/mm$^2$ ) |
|---|---|---|
| 0 | 70 | 2.39 |
| 2 | 70 | 7.42 |
| 5 | 70 | 10.34 |
| 10 | 70 | 2.12 |

### *E. Compression strength test and water absorption on laterite stone*

The Compressive strength and water absorption test on laterite stone of size 30x20x15cm was conducted and the test result is as shown Table 5.

Table 5 [Compressive strength and water absorption of laterite stone (30x20x15 cm)]

| Material | Average load (kN) | Compressive strength (N/mm$^2$) | Water absorption % |
|---|---|---|---|
| Laterite stone | 191 | 3.18 | 14.58 |

Properties of plastic-soil bricks are uniform but in the case laterite stone whose properties are varied widely depending on the quarry from which it was obtained.

## IV. CONCLUSION

The plastic soil bricks made by the waste plastic materials which intern might get harmful for all living beings. The compressive strength test results for plastic-soil bricks with 65-70% plastic content by weight of soil will gives a compressive strength of 8.16N/mm$^2$ which is higher than laterite stone (3.18N/mm$^2$).

And has a lesser water absorption(0.9536%) than laterite stone (14.58%). So, it can be a better alternative building material from the compressive strength test results of plastic-soil bricks for various percentages of binder(bitumen) content by weight of soil with constant plastic content of 70% by weight of soil, it is observed that on increasing the percentage of binder(bitumen) the compressive strength of brick also increases up to 5% (10 N/mm$^2$), but further increase in bitumen decreases the strength (2.04N/mm$^2$).

But from economic considerations 2% of bitumen content is taken as optimum binder content which results in compressive strength 8.16 N/mm$^2$ that is greater than laterite stone (3.18 N/mm$^2$). The efficient usage of waste plastic in plastic-soil bricks has resulted in effective usage of plastic waste and thereby can solve the problem of safe disposal of plastics, also avoids its wide spread littering. And the utilization of quarry waste has reduced to some extent the problem of its disposal.

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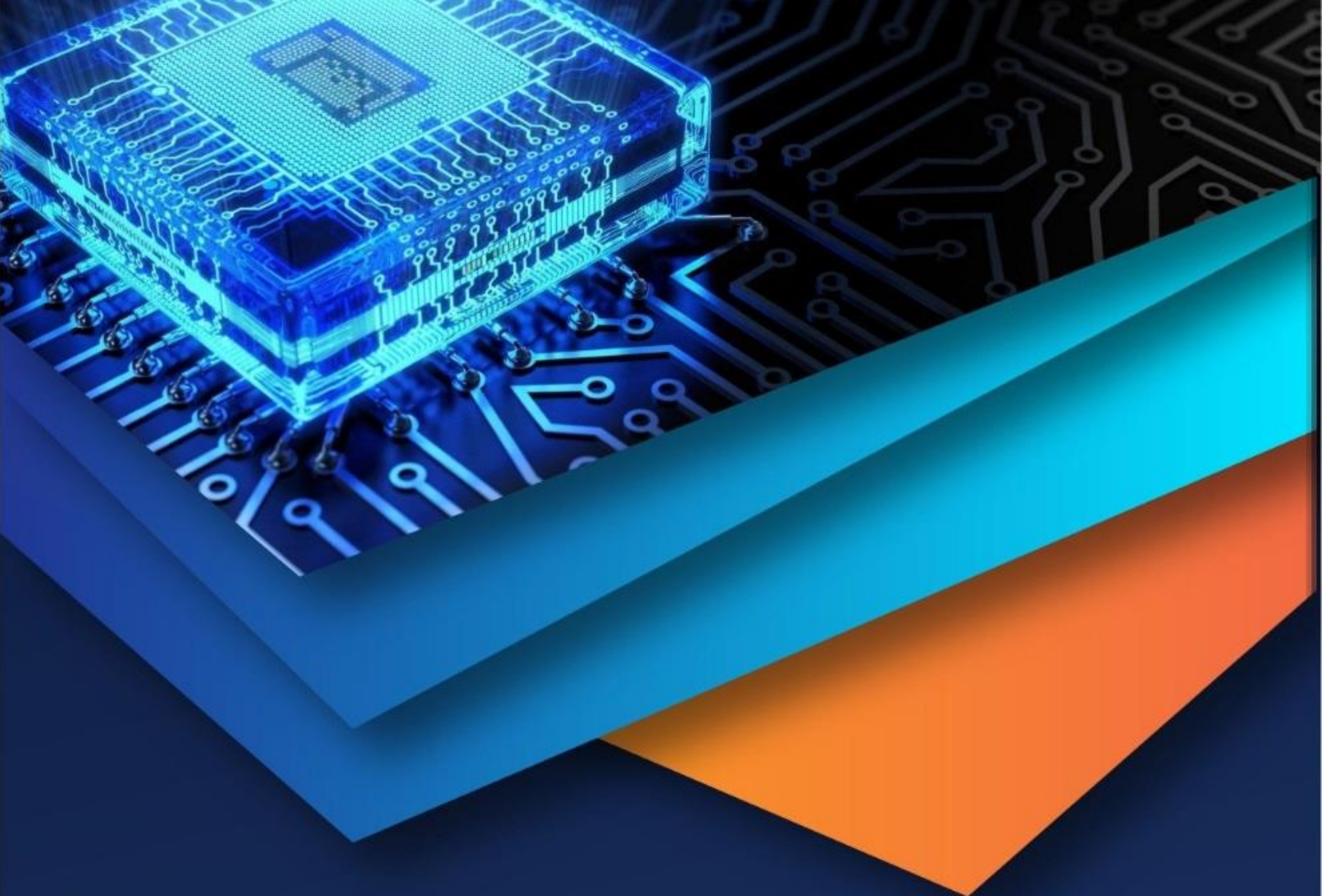


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