UTILIZATION OF WASTE PLASTIC IN MANUFACTURE OF PLASTIC SOIL BRICKS

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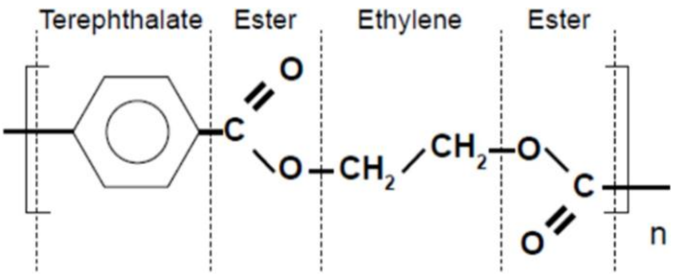
Abstract - There has been a considerable imbalance between the availability of conventional building materials and their demand in the recent past. On the other hand the laterite quarry waste is abundantly available and the disposal of waste plastics (PET, PP,etc.) is a biggest challenge, as repeated recycling of PET bottles pose 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 in range of 60 to 80% by weight of laterite quarry waste and 60/70 grade bitumen was added in range of 2 to 5% 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 laterite stone to satisfy the increasing demand of conventional building materials.

1. INTRODUCTION

Soil is a loose, unconsolidated material on the earth's crust and it is formed by the weathering of solid rocks. The laterite formation was named in southern India1807, and it was described by Francis Buchanan-Hamilton. He named it from the Latin word "later" which means brick. This rock can be easily cut into brick shaped blocks for building construction. The lat-erite 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 norhten parts of Karnataka and also in the northern parts of Kerala, due to which lot of quarrying of laterite bricks takes place. In quarries while cutting out the laterite stones with the help of cutting ma-chines which produces 15-20% of soil wastes which pose a problem of disposal. The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. It is estimated that the rate of expansion is double for every 10 years, this is due to rapid growth of population, urbanization, developmental activities and changes in life style which leading widespread littering on the landscape. Thus disposal of waste plastic is a serious problem globally, since they are non biodegradable and also researchers have found that the plastic materials can remain on earth for 4500 years without degradation [1]. Plastic have many good characteristics which include versatility, light-ness, hardness, and resistant to chemicals, water and impact.

1.1 Chemical structure of a waste plastic (polyethylene terephthalate)

The monomer for the production of Poly ethylene terephthalate (PET) is ethylene teryphthalate and this consists of the ethylene molecule (-CH2 - CH2-), two ester molecules (-COO-), and the teryphthalate ring molecule. The only atomic species present in PET are therefore hydrogen, oxygen, and carbon. Burning PET generates only carbon dioxide (CO_2) and water (H_2O). So there is no potential danger of harmful gas emission even when PET is burnt but in the present work only melting of PET was required. The structure of the PET monomer is shown below



The Chemical Structure Of The PET Monomer

1.2 Properties of plastics [1]

Physical properties of PET were as given in Table 1

TABLE 1

PHYSICAL PROPERTIES OF POLY ETHYLENE TEREPHTHALATE

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

The test samples are collected from the laterite stone quarry nearer to village Aletti, which is located in the Dakshina kannada district, Sullia taluka, Karnataka, India.

Fig. 2. Laterite Quary.

In this context work was under taken with following objectives To arrive at the optimum quantity of waste plastic (PET bottles) and also the bitumen that could result in a building material (brick) with good strength and less water absorption. To de-velop a scientific way of reusing the waste plastic (PET bot-tles) along with the utilization of laterite quarry waste that could result in an alternative building material with the satisfac-tion of all the requirements of good building material.

2. OBJECTIVES

A. To determine the optimum percentage of plastic and soil in brick.
B. To compare the strength of brick casted with mixer of liquid form of waste plastic and laterite soil burnt brick.
C. To compare the water absorption value of brick casted with mixer of liquid form of waste plastic and laterite soil to burnt brick,
D. To vary the percentage of plastic in brick to determine the strength of performance.
E. To obtain eco-friendly bricks from waste materials, that is, plastic and laterite quarry dust.
F. To reduce pollution which is caused by plastic and laterite quarry dust.
G. To arrive at the optimum dosage of plastic that could result in building material with good strength and less water absorption.
H. To develop an alternative building material.
I. To compare conventional and fusion brick

3. METHEDOLOGY

The main objective of this project work is to develop an efficient way to effectively utilize the waste plastic which is a great threat for the sustainment of ecological balance, 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. When the laterite stone is cut from the quarry nearly15-20% of laterite waste is obtained. This waste was crushed using rammers and sieved in a2.36mm IS sieve. This sieved laterite soil was brought to laboratory for preparation of bricks. This soil was sun-dried to reduce the water content. A mould of size 20x10x10cm was prepared. Bricks of different mix proportions were prepared, for each brick approximate 3kgof the laterite soil was added with varying bitumen content of 2%, of plastic. Bricks were prepared by compacting through vibration. Clean sieved laterite quarry waste was collected and 50% of plastic (PET) by weight of soil is cleaned and heated to a molten state. Then the sieved soil is added at intervals with proper mixing. At the final stage 2% of bitumen by weight of soil is added because bitumen gives good result at 2% and mixed for uniform distribution to prepare bricks. The hot mix is poured into the moulds and then compacted by vibration. The bricks are remolded after 30 min and air dried for a period of 24hr for proper heat dissipation. Bricks were prepared and tested for compressive strength in the compressive testing machine (CTM).

(PET) Plastic bottles

Melten the plastic

Mixing of Plastic-soil

Casting of brick

Sample of brick

4. MATERIAL PROPERTIES

4.1 Preliminary test results

Sieve analysis test: Sieve analysis test was conducted for the laterite quarry waste; the gradation curve obtained from the test is shown in fig

From graph:

D10=0.37 D30=0.68 D60=1

Coefficient of uniformity Cu = D60/D10

Cu = 1/ 0.37

Cu = 2.7

Coefficient of curvature Cc = D30/ (D60*D10)

Cc = 0.68/ (1* 0.37)

Cc = 1.83

Result: From the grain size distribution curve we obtained the values of Cu = 2.7 and

Cc = 1.83, hence we can conclude the soil sample is appears to be well graded.

Permissible Limit: According to [IS: 2720-part 4, 1975] Cc should be between 1 and 3.

Specific gravity of soil: Specific gravity of soil was conducted for the laterite quarry waste.

Calculation: $Gs = \frac{W4 - W1}{(W2 - W1) - (W3 - W4)}$

Where,

Gs =Specific gravity of Soil.

W1=Weight of Density Bottle with Lid, G.

W2=Weight of Density Bottle + 1/3 of Soil, G.

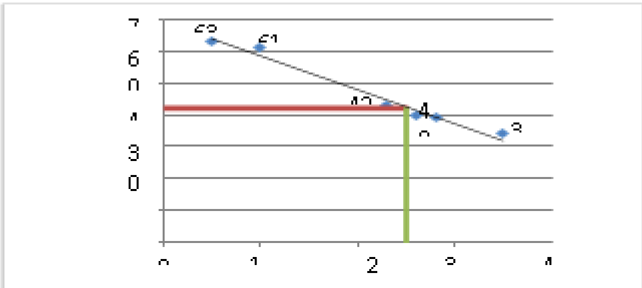
W3 =Weight of Density Bottle + 1/3 of Soil + Water, G.

W4=Weight of Density Bottle + Water, G.

Result: Specific gravity of soil is 2.672.

Permissible Limit: According to [IS: 2720-part 3, 198] = 2.65 to 2.85

Liquid Limit by Casagrande: Liquid Limit by Casagrande was conducted for the laterite quarry waste. Water content is obtained as shown in fig.



Result: Liquid limit is 42.5%.

Permissible Limit: According to [IS: 2720(Part-4), 1975] Range should between 40-60%

Properties of Bitumen

Bitumen is primarily used to improve the binding property of molten plastic and also it serves the purpose of transforming a thermoplastic into thermo setting plastic. The various tests are conducted on the bitumen.

Tests on Bitumen

1. Penetration test

2. Softening point test

3. Specific gravity

INDEX PROPERTIES OF BITUMEN

SL.NO	EXPERIMENTS	RESULTS
1	Penetration (mm)	63.33mm
2	Softening point (◦c)	56.3°c
3	Specific Gravity	1.01

Experimental Results

According to IS 3495(Parts 1 to 4): 1992 Tests to be conducted for Bricks are

1. Determination of Compressive Strength.
2. Determination of Water Absorption.

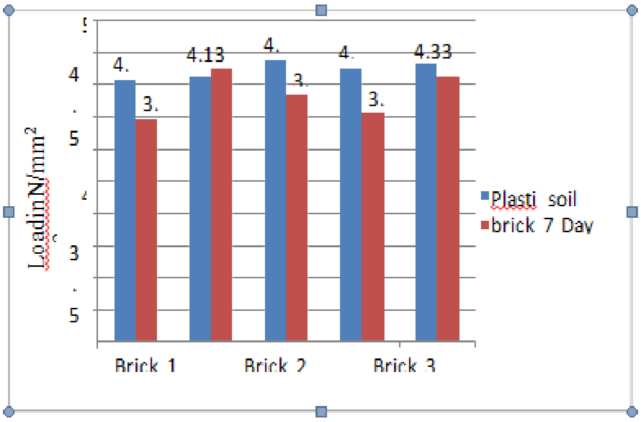
Determination of Compressive Strength

Compressive Strength machine

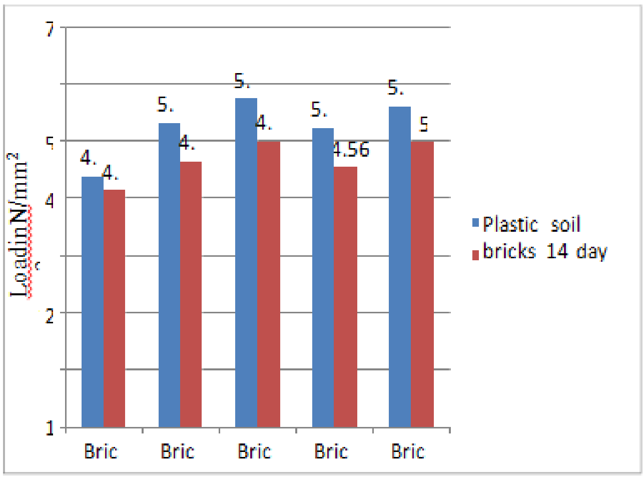
Determination of Water Absorption

Water Absorption

Comparison of compressive strength of 7 days plastic soil bricks and burnt bricks



Comparison of compressive strength of 14 days plastic soil bricks and burnt bricks



5. CONCLUSIONS

- To overcome disposal of waste plastics and make a good use of it in a building material, PET bottles were mixed with laterite soil waste and bitumen. By referring to the journals we understood that plastic brick will cool soon and doesn't absorb moisture.
- The compressive strength test results for plastic-soil bricks with 50% plastic content by weight of soil with the binder(bitumen) content of 2% by weight of soil will give a compressive strength of 5.25N/mm2 which is higher than burnt brick(3.5N/mm2) and has lesser water absorption(5%) than burnt brick(18%). So it can be a better alternative building material.
- The efficient usage of waste plastic in plastic-soil bricks has resulted in solving the problem of safe disposal of plastics and it also avoids wide spread of quarry waste to some extent.

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