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# Utilization of Plastic Waste in Foundry Sand 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 foundry waste Sand 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 Foundry Waste sand and 60/70 grade bitumen was added in range of 2 to 5% by weight of sand in molten form and this bitumen- plastic resin was mixed with Foundry waste sand 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 Foundry waste sand to satisfy the increasing demand of conventional building materials.***
***Keywords—Waste Foundry Sand, Fly Ash, PET Waste, Bitumen, Compressive Strength Test, Efflorescence Test, Water Absorption Test.***

## I. INTRODUCTION

The waste generated from the industries cause environmental problems. Hence the reuse of this Waste material can be emphasized. Foundry sand is high quality silica sand that is a byproduct from the production of both ferrous and nonferrous metal casting Industries. Foundry sand used for the centuries as a molding casting material because it's high thermal conductivity. The physical and chemical characteristics of foundry sand will depend in great part on the type of casting process and the industry sector from which it originates. In the casting process, molding sands are recycled and reused multiple times. Eventually, however, the recycled sand degrades to the point that it can no longer be reused in the casting process. At that point, the old sand is displaced from the cycle as byproduct, new sand is introduced, and the cycle begins again. Two general types of binder systems are used in metal casting depending upon which the foundry sands are classified as: clay bonded systems (Green sand) and chemically- bonded systems. Both types of sands are suitable for beneficial use but they have different physical and environmental characteristics. Over the last decades, much research has been conducted on the mechanical, chemical and durability aspects of foundry sand. But inadequate research focus is given to the study of the strength and durability aspects of foundry sand. A foundry is a manufacturing facility that produces metal castings by pouring molten metal into a preformed mold to yield the resulting hardened cast. The primary metals cast include iron and steel from the ferrous family and aluminium, copper, brass and bronze from the nonferrous family. Foundry sand is high quality silica sand that is a by-product from the production of both ferrous and nonferrous metal castings. The physical and chemical characteristics of foundry sand will depend in great part on the type of casting process and the industry sector from which it originates. In this paper we have manufactured sand brick and give suitability of sand brick to construction

## II. EXPERIMENTAL MATERIALS

### *A. Pet Waste*

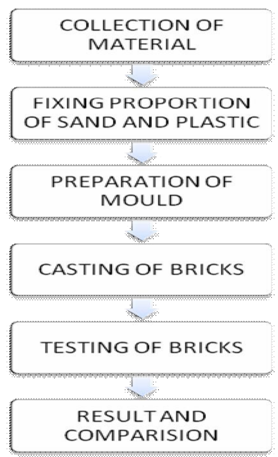
Collection of plastic wastes can be done by 'bring-schemes' or through kerbside collection. Bring-schemes tend to result in low collection rates in the absence of either highly committed public behavior or deposit-refund schemes that impose a direct economic incentive to participate. Hence, the general trend is for collection of recyclable materials through kerbside collection alongside MSW. To maximize the cost efficiency of these programmes, most kerbside collections are of co-mingled recyclables (paper/board, glass, aluminium, steel and plastic containers). While kerbside collection schemes have been very successful at recovering plastic bottle packaging from homes, in terms of the overall consumption typically only 30–40% of post-consumer plastic bottles are recovered.

### *B. Foundry Waste Sand*

The most common casting process used in the foundry industry is the sand cast system. Virtually all sand cast molds for ferrous castings are of the green sand type. Green sand consists of high-quality silica sand, about 10 percent bentonite clay (as the binder), 2 to 5 percent water and about 5 percent sea coal (a carbonaceous mold additive to improve casting finish). The type of metal being cast determines which additives and what gradation of sand is used. The green sand used in the process constitutes upwards of 90 percent of the molding materials used.

In addition to green sand molds, chemically bonded sand cast systems are also used. These systems involve the use of one or more organic binders (usually proprietary) in conjunction with catalysts and different hardening/setting procedures. Foundry sand makes up about 97 percent of this mixture. Chemically bonded systems are most often used for "cores" (used to produce cavities that are not practical to produce by normal molding operations) and for molds for nonferrous castings.

## III. METHODOLOGY




First, the material is selected for preparation of bricks, afterwards all the properties of material are get studied.Next, material is collected from different sources of their generation. And detailed study of material and its properties is carried out.Third, proportion of plastic and sand is defined by analyzing its properties. Fourth, Mould were prepared for casting of bricks :Further, Material is prepared for casting of bricks as per defined proportion and as per defined method of mixing. Next, Different tests were identified for testing of bricks and bricks are tested for different kind of tests. And results get compared with test results of conventional bricks. Finally, results get analyzed.

## IV. ACTUAL MIX DESIGN OF PLASTIC SAND BRICKS

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, With the foundry waste sand 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 foundry waste sand was collected from iron casting foundries.After casting of iron parts sand produced from mold is 100% waste sand. This waste was crushed using rammers and sieved in a 2.36mm IS sieve. This foundry waste sand was brought to laboratory for preparation of bricks. This soil was sun-dried to reduce the water content. A mould of size 24.5x11x9cm was prepared. Bricks of different mix proportions were prepared, for each brick 3kg of the laterite soil was added with varying bitumen content of 2, 5 and 10% along with variation in percentage of plastic. Bricks were prepared by compacting through vibration. 9kg of clean sieved foundry waste sand is collected. 70% of plastic (PET, PP) by weight of soil is cleaned and heated to a molten state. Then sieved soil is added at intervals with proper mixing. At the final stage 2% of bitumen by weight of soil is added and mixed for uniform distribution to prepare 3 bricks. The hot mix is poured into the moulds and then compacted by vibration. The bricks are de-moulded after 30 min and air dried for a period of 24hr for proper heat dissipation. Of each mix proportion bricks were prepared and tested for compressive strength in the compressive testing machine (CTM)

A. *Bricks were prepared for following different proportion's*

*1)* Brick No 1
Sand = 60 %

*2)* Brick No 2
Sand = 40 %

PET Waste = 37 %
Bitumen = 03 %
Fly ash = 0 %

PET Waste = 37 %
Bitumen = 03 %
Fly ash = 20 %

*3)* Brick No 3
Sand = 30 %
PET Waste = 37 %
Bitumen = 03%
Fly ash = 30 %

## V. RESULTS & DISCUSSION

### *A. Compression Test*

Table 1: Maximum load and compressive strength of different ratio of plastic waste

| Sample | Weight(kg) | Density(kg/m3) | Max load at crushing(KN) | Compressive strength(N/mm2) |
|---|---|---|---|---|
| Brick 1 | 3.888 | 1560 | 192.6 | 8.73 |
| Brick 2 | 3.311 | 1334 | 210.2 | 9.53 |
| Brick 3 | 3.067 | 1229 | 157.2 | 7.12 |

From the compression test result, it is clearly showed that the value of compressive strength decrease as the ratio of plastic waste increase. The brick sample 2 with 40% sand and 40% PET wasteand 20% fly ash shows the compressive strength of 9.53 N/mm2. Which is almost double than that of convention brick strength.

### *B. water absorption test*

| Sample | Weight before(kg) | Weight after(kg) | % water absorbed |
|---|---|---|---|
| Brick1 | 3.888 | 3.891 | 0.10 |
| Brick2 | 3.311 | 3.315 | 0.13 |
| Brick3 | 3.067 | 3.073 | 0.21 |

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Water absorption test showed excellent performance of the plastic waste brick. Good quality of bricks shall not absorb more than 20% of water. This concludes that the presence of plastic waste in the bricks helps on the performance of the bricks.

*C. Efflorescence test*

Efflorescence test also showed the excellence performance of the sand bricks. There is no absence of grey or a white deposit wasshown on its sand bricks surfaces for all ratios.. From this test, we can conclude that no alkalis was presence in this sand brick

*D. Hardness Test*

In this test, a scratch was made on brick surfaces. This test was carried out for all the proportions of brick. While the scratch was made with the help of finger nail on the bricks, very light impression was left on the sand brick surface. So this test results that fibrous concrete bricks are sufficiently hard.

*E. Soundness Test*

In this test two bricks from same proportion were taken and they were struck with each other. The bricks were not broken and a clear ringing sound was produced. So the bricks are good.

*F. Structure Test*

In this test, the bricks were broken and the structures of that bricks were examined, whether they were free from any defects such as holes, lumps, etc.In this test, sand bricks were cut into equal parts. The sand brick piece structure was homogenous, compact, and free from defects and this brick pieces look like a cake piece.

## VI. COST COMPARISION

*A. Labour cost*

Labours required-

1) Head mason – 1/10 No´s
2) Mazdoor – 3 No´s
3) Bristi – ½ No´s

Head Mason rate – 800 Rs/day

Labour rate- 400 Rs/day

One labour can manufacture 300 bricks

So,Labour cost per unit brick = 1480/900 = 1.6 Rs/brick

*B. Material cost*

1) Plastic - Nil
2) Foundry sand - Nil
3) Fly ash - Nil
4) Bitumen-

Rate of bitumen – 20 Rs/kg

Bitumen required for 1 brick – 0.084kg

Cost of bitumen – 20*0.084 = 1.68 Rs/brick

*C. Transportation cost*

*1) Foundry sand*

Density of foundry sand = 2590 kg/m3

Volume of truck = 14.5 m3

Rate for 1 trip of truck = 4000 Rs.

Cost of transport of foundry sand = 4000/37555 = 0.1 Rs/kg

= 0.1*1.68 = 0.16 Rs/brick

*2) Plastic*

Quantity of plastic filled in a truck = 3000 kg

Cost of transport of plastic = 4000/3000 = 1.3 Rs/kg

= 1.3*1.68 = 2.1 Rs/kg

*3) Fly ash*

Density of fly ash = 600 kg/m3

Cost of transport of fly ash = 4000/8700 = 0.45 Rs/kg

= 0.84*0.45 = 0.37 Rs/brick

*D. Coal cost*

Rate of coal = 3000 Rs/tonne

Coal required = 0.2 tonne per 1000 bricks

Cost of coal for 1000 bricks = 3000*0.2 = 600 Rs

Cost of coal = 600/1000 = 0.6 Rs/brick

*E. Total cost of brick*

Cost of brick = 1.6+1.68+0.16+2.1+0.37+0.6 = 6.51 Rs/brick

*F. Profit*

Profit = 10% of 6.51 = 0.651 Rs/brick

*G. Total manufacturing cost of brick*

= 6.51+0.651

= 7.1 Rs/brick.

*H. Discussion*

As we know that the cost of conventional brick is 8 Rs/brick. Cost of manufactured brick is less than the cost of conventional brick of same size. So this brick is economical than conventional brick.

## VII. CONCLUSION

According to the discussion of results the following conclusions are derived by this study:

*A.* The foundry sand brick consist of waste materials and therefore cost is very low compared to conventional bricks.
*B.* Since, the waste materials are used, it reduces landfills and pollution problems.
*C.* The compressive strength of brick is more than that of conventional brick.
*D.* The compressive strength of brick is 9.53 N/mm$^2$ which is nearly equal to twice than that of conventional bricks with weight of brick 3.311 Kg but brick 3 is also economical due to its maximum compressive strength as7.12 N/mm$^2$ which is much more than convention brick strength and its weight is less as3.067 Kg.
*E.* The bricks were not broken after falling from height of 1 m.
*F.* The brick has a lesser water absorption than conventional brick. So it can be a better alternative building material.
*G.* Using the foundry sand brick in a building, total cost will be reduced from 20% to 25%.
*H.* In site lot of bricks are wasted while cutting only. The labors could not able to cut the bricks exactly what they need. But, foundry sand bricks can be cut into exactly two pieces. By using conventional saw blades. So, we can get any shape and size of foundry sand brick.
*I.* As we know that the cost of conventional brick is 8 Rs/brick. Cost of manufactured brick is less than the cost of conventional brick of same size. So this brick is economical than conventional brick.

## VIII. ACKNOWLEDGEMENT

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