Fabrication of Plastic Brick Manufacturing Machine and Brick Analysis

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Abstract

Plastic is one of the daily increasing useful as well as a hazardous material. At the time of need plastic is found to be very useful, but after its use, its simply thrown away, creating all kinds of hazards. Plastic is not bio degradable, so it will continue to be hazardous for more than centuries.The idea of this paper is to find a use for this waste plastic scrap into something beautiful. The mixing of plastic with sand to create a new type of brick was put into thought. Since it is uneconomical to approach a local brick manufacturer for lending the machine, we designed and fabricated a brick manufacturing machine in the nearby engineering workshop. The machine was designed so as to fulfil our need for manufacturing brick in small quantity. The plastic scrap used was leftover pieces of bottles, cans etc. So, as a trial the plastic was chopped into small pieces and heat was supplied from below. Into the molten plastic paste, M- sand was added in suitable proportions. The paste contained noting more than M-sand, plastic and thermocol. After thorough mixing, the paste was poured into a rectangular mould with standard brick dimensions.The paste took only 20 minutes to settle and harden. Cooling of the set was done by water cooling and after 5 more minutes the brick was extracted from the mould. It had a dark grey texture and increased weight by the initial analysis. Local brick testing methods were conducted such as free fall of the brick and scratch test. In both of those tests, our brick showed increased strength.The brick was subjected to compressive test, water absorption test and efflorescence test. The results showed promise, that the Plastic Composite Brick was efficient than the clay brick and cement brick.

Keywords: Compressive test, Efflorescence test, M-sand, Plastic, Water absorption test

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I. Introduction

A plastic compactor is a machine used to compress plastic materials into a large bale for storage or shipping purposes. This machine can vary in design, but generally, it will feature some sort of hopper or container into which plastic can be loaded, as well as one or more hydraulic arms that will compress that plastic into one large bale. Once the bale is created, another arm or system will be used to remove the bale from the container, as the bale is likely to be quite heavy.

Some machines do not create bales; instead, they may create bricks of plastic that can be cut, either by hand or by the machine, into pre-set lengths. This allows for easy stacking or storage, as well as easier handling. The plastic compactor may also heat the plastic while it is in the chamber to essentially melt the plastic into the desired shape. This can reduce or eliminate the need for a hydraulic arm for pressing materials, though some plastic compactor models will use a combination of the hydraulic arms and heating elements to create the plastic bricks. Some machines will feature a conveyor on which materials can be loaded; the machine can then load the plastics at a steady rate into the container or hopper.

Recycling processing plants commonly use plastic compactor machines to compress various plastic materials into bricks or bales for shipping, storing, or for moving to the next phase of the recycling process. In some cases, the plastic is loaded into the compactor and forced into brick form, which essentially ends the recycling process. The raw material can then be sold to manufacturers or otherwise used for fueling purposes or other manufacturing purposes. The size of the machine will usually dictate how much material can be processed at one time, and a recycling plant is likely to feature more than one plastic compactor to improve productivity.

Our machine is different from other compactor machines as it does not produce bales but a brick of high strength. It has many parts which include parts for heating, mixing, compacting etc. It mixes M-sand, thermocol and all types of plastics to form brick.

II. DESCRIPTION OF EQUIPMENTS

Plastic brick manufacturing machine (PBMM) is different from other compactor machines as it does not produce bales but a brick of high strength. It has many parts which include parts for heating, mixing, compacting etc. It mixes M-sand, thermocol and all types of plastics to form brick. Thermocol acts as the binder and so it has very high strength. Other compactor machines just compress it to a reduced volume for easy transportation to recycling unit. But our machine itself recycles the plastics into a useable form. The machine was designed to approach the limit of possible volume reduction via compaction methods.

A. Mixing Unit:

The type we used is the drum mixer, which can be classified as non-tilting, split drum, or titling drum mixers, as well as truck mixers or reversing drum mixers.

Fig. 1: Mixing unit

Table – 1
Characteristics of each type of mixer

Type of Mixer	*Characteristics*
Non-tilting mixer	*Single drum rotating about a horizontal axis. Fixed blades work the concrete towards the discharge end of the mixer, in order to provide a rapid rate of discharge. The typical capacity is 1 CY.*
Split drum mixer	*The drum, rotating on a horizontal axis, separates into two halves, allowing the concrete to be discharged cleanly and rapidly. No blades are required since cohesion to the top and bottom of the drum and cleats provide adequate charging and mixing. Typical capacity is 2.5 CY and provides a short mixing cycle and rapid discharge.*
Tilting drum mixer	*Are common in various sizes. They are most suitable for concrete with large sized aggregate and, since they have a rapid discharge rate, are suitable for low workability concrete. Internal blades lift and tumble the ingredients onto itself. Two primary types exist: horizontal (one end has and opening for charging and a different end for discharging) and single drum (materials are charged and discharged through a single opening). The main difference between all mixers is the tilting mechanism. "Each manufacturer attempts to reduce installation height and maintain a relatively simple mechanism"*
Reversing drum mixer	*Rotate in one direction for mixing and in the reverse direction for discharge. One set of blades exists for each operation. Provide efficient mixing with very little build up within the mixer. Are suitable with dry concrete mixes.*
Drum Truck Mixers	*Two types: rear discharge and front discharge. Both utilize fins to mix and discharge the concrete and are powered by engine driven-variable speed hydraulic systems.*

B. Motor:

Here the motor is used as the rotary equipment. The specifications of the motor used were 0.5 Hp and 150 rpm.

Fig. 2: Motor

C. *Burner:*

The fuel used was kerosene. It provided the necessary heat of the flame for the plastic to melt.

Fig. 3: Burner

III. WORKING OF PBMM

The operational principle of this machine is as follows:

1) Switch on the burner and allow maximum air flow through the burner
2) Provide the plastic waste into the drum for a quantity for single brick
3) Switch on the motor and the starts rotating at 150 rpm.
4) The waste plastics starts to get melted in about 5 to 10 minutes
5) Suitable proportion of M sand and thermocol is added into the molten plastic.
6) As the drum rotates the plastic gets mixed to the M sand and forms a paste.
7) After complete mixing the motor and burner is switched off.
8) The handle is tilted and the paste is poured into the mould and is allowed to settle.
9) The final product is removed from the mould box and is sent for compression testing using Hydraulic Brick testing machine.

IV. ANALYSIS OF BRICK FROM PLASTIC SCRAP

The fabrication process was completed and 8 bricks were made, 5 of those in dimensions of the normal clay red brick and the other 3 in shapes of triangle, rectangle and a pavement tile. The composition of the first four standard bricks are shown in the table below.

Table – 2
Percentage composition of various bricks

SAMPLE	*M Sand (%)*	*Plastic (%)*	*Thermocol (%)*
1	*90*	*5*	*5*
2	*80*	*15*	*5*

3	*70*	*25*	*5*
4	*60*	*35*	*5*

The rectangle shaped bricks (sample 1-4) were at first provided for water absorption test and efflorescence test. Then those bricks were send to undergo compression test in the testing facility.

A. Compression Test:

This test is done to know the compressive strength of brick. It is also called crushing strength of brick. Four specimens of bricks were taken to laboratory for testing and tested one by one. In this test, a brick specimen is put on crushing machine and applied pressure till it breaks. The ultimate pressure at which brick is crushed is taken into account. All four brick specimens are tested one by one and the load at crushing was noted.

Fig. 4: Hydraulic Brick Testing Machine

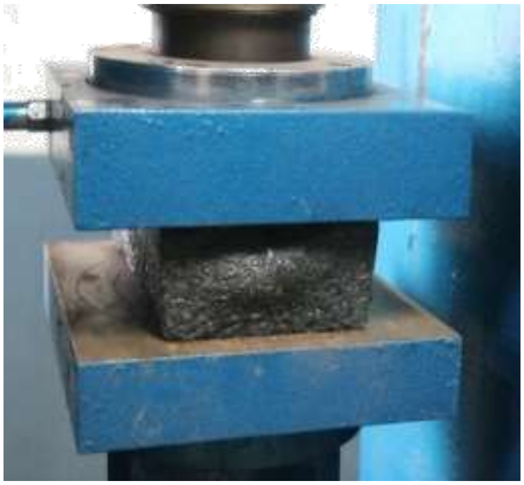

Fig. 5: Brick Testing

Procedure:

1) Four bricks with different proportions were manufactured.
2) Each brick was placed in the test area in the ascending order of plastic content.
3) Load was applied until the brick broke.
4) The maximum load at crushing in KN was noted

B. Water Absorption Test:

In this test, bricks are weighed in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion, those are taken out from water and wipe out with cloth. Then, brick is weighed in wet condition. The difference between weights is the water absorbed by brick. The percentage of water absorption is then calculated. The less water absorbed by brick the greater its quality. Good quality brick doesn't absorb more than 20% water of its own weight.

Fig. 6: Water Absorption test

Procedure:

1) Dry the specimen in a ventilated oven at a temperature of 105°C to 115°C till it attains substantially constant mass
2) Cool the specimen to room temperature and obtain its weight (M1) specimen too warm to touch shall not be used for this purpose
3) Immerse completely dried specimen in clean water at a temperature of 27+2°C for 24 hours
4) Remove the specimen and wipe out any traces of water with damp cloth and weigh the specimen after it has been removed from water (M2).
5) Water absorption, % by mass, after 24 hours immersion in cold water as shown in equation

$$W = \frac{M_2 - M_1}{M_1} \times 100$$

C. *Efflorescence Test:*

The presence of alkalis in bricks is harmful where it forms a gray or white layer on brick surface by absorbing moisture. To find out the presence of alkalis in bricks, this test is performed. In this test, a brick is immersed in fresh water for 24 hours. Then, it is taken out from water and allowed to dry in shade. If the whitish layer is not visible on surface, it proofs that absence of alkalis in brick. If the whitish layer visible about 10% of brick surface, then the presence of alkalis is in acceptable range. If that is about 50% of surface, then it is moderate. If the alkali's presence is over 50%, then the brick is severely affected by alkalis

Procedure:

1) Distilled water to be filled in a dish of suitable size. The dish should be made of glass, porcelain or glazed stone ware.
2) Place the end of the bricks in the dish, the depth of immersion in water being 25mm. Place the whole arrangements in a warm (for example,20^0 C to 30^0 C) well ventilated room until all the water in the dish is absorbed by the specimen and the surface water evaporate
3) Cover the dish with suitable cover, so that excessive evaporation from the dish may not occur.
4) When the water has been absorbed and bricks appear to be dry, place a similar quantity of water in the dish and allow it to evaporate as before
5) Examine the bricks for efflorescence.

V. RESULTS AND DISCUSSION

A. *Effect of Different Ratio of Plastic Waste on Compression Test:*

Table – 3
Effect of Different Ratio of Plastic Waste on Compression Test

Brick number	*SAMPLE 1 (90:05:05)*	*SAMPLE 2 (80:15:05)*	*SAMPLE 3 (70:25:05)*	*SAMPLE 4 (60:35:05)*
Length(mm)	*175*	*175*	*175*	*175*
Breadth(mm)	*100*	*100*	*100*	*100*
Area(mm2)	*17500*	*17500*	*17500*	*17500*
Max. load on crushing(KN)	*172.63*	*183.06*	*192.55*	*186.14*
Compressive strength(N/mm2)	*9.86*	*10.46*	*11*	*10.63*

Fig. 7: Effect of different ratio of plastic waste on compression test

From the compression test result, it clearly shows that the value of compressive strength decrease as the ratio of plastic waste increase. Even though the compressive strength increases upto a proportion of 70:25:05, from the next composition, the compressive strength is found to be decreasing. It can be summarised that the increase in plastic content have caused the brick to be much flexible, which in turn reduces the compressive strength.

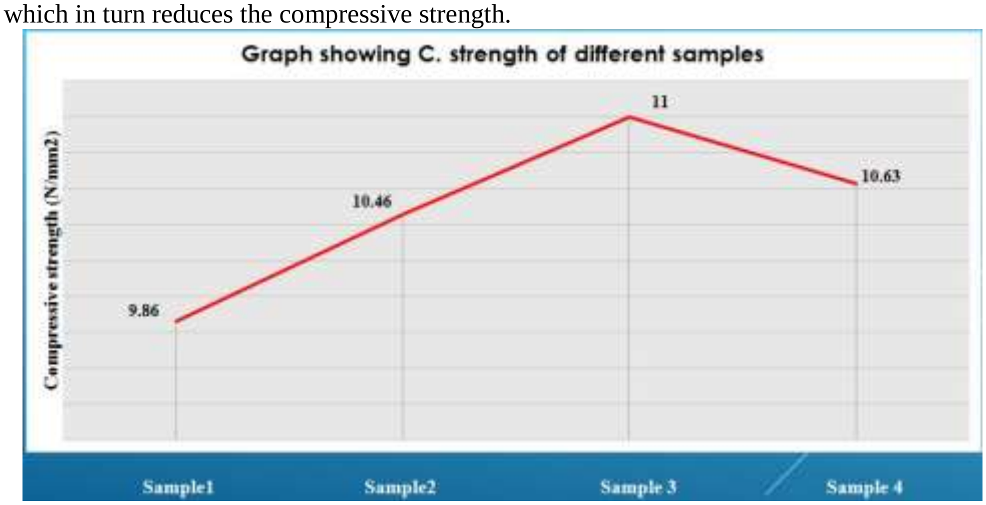

Fig. 8: Graph showing compressive strength of different samples

B. Effect of Different Ratio of Plastic Waste on Water Absorption Test:

Table – 4
Effect of different ratio of plastic waste on water absorption test

Sample	*Weight before*	*Weight after*
1	*1.3*	*1.3*
2	*1.4*	*1.4*
3	*1.3*	*1.3*
4	*1.4*	*1.4*

The bricks those were of different shapes were undergone water absorption test. The samples were immersed in a bucket of water for 24 hours, and then cleaned with a dry cloth. The weight after were measured and it didn't show any variation. The lower the % of water absorbed, the greater the quality of the brick. The results showed zero percent water absorption.

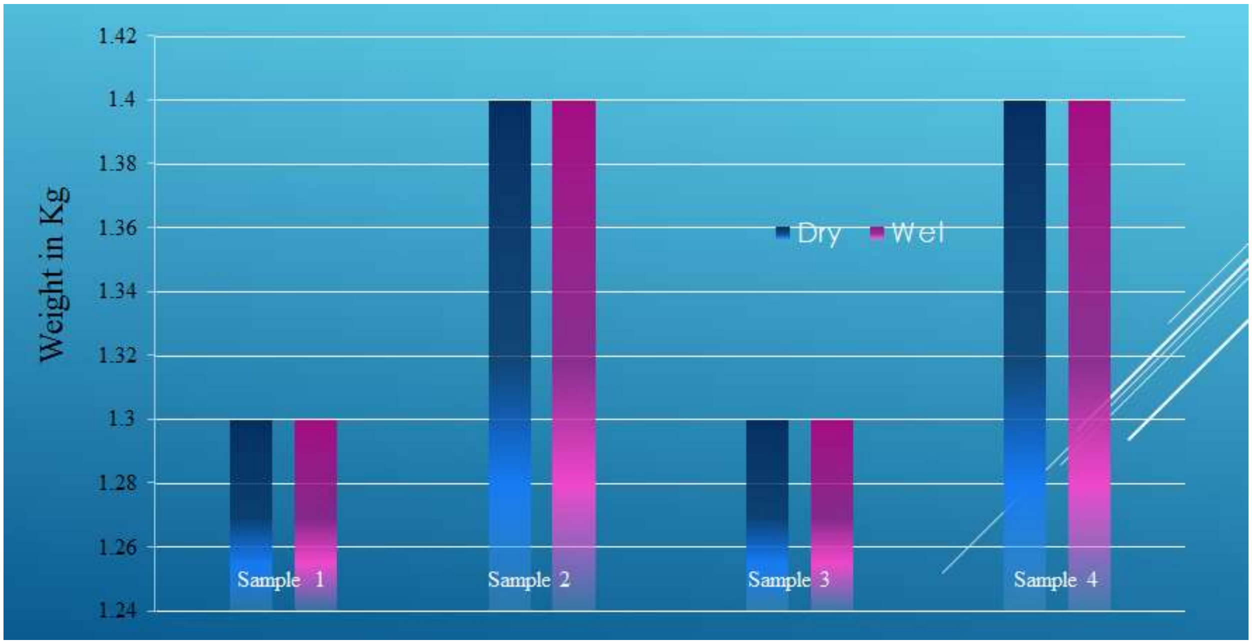

Fig. 9: Results of water absorption test

C. *Effect of Different Ratio of Plastic Waste in Efflorescence Test :*

Table – 5
Effect of different ratio of plastic waste in efflorescence test

Brick Number	*Nil*	*Low*	*Medium*	*High*
Sample 1	✓			
Sample 2	✓			
Sample 3	✓			
Sample 4	✓			

In the test for efflorescence, the bricks were immersed in water for 24 hours and then dried in shade. Each brick was carefully examined, for fungus or mold. No such kind of problems were noticed.

VI. CONCLUSION

The machine was completed to the corrected specifications. It was tested in the workplace to find the errors. It can be concluded that the machine effectively converts plastic into useable shapes such as bricks and pavement tiles, and also reduces the amount of plastic waste resulting due to throw away culture.

The compressive strength decreases with increasing waste plastic ratios. The various proportions of 5%, 10% and 15% plastic waste had maximum load at crushing as 172.63 KN, 183.06 KN, 192.55 KN, and 186.14 KN respectively. Also the compressive strength of the bricks were 9.86, 10.46, 11, 10.63 N/mm^2. This may be attributed to the decrease in the adhesive strength between the waste plastic and the M-sand. It seems that the bonding between the plastic particles and the M-sand is weak after a certain limit. However, the mixes of sand bricks and plastics waste seems possible because water absorption was null. Furthermore, there aren't any salt/alkalis presence in the manufactured brick.

The reduced compressive strength values of waste plastic bricks mixes show that it can be used only in situations that required low-degree workability. But, at the specific proportion, the brick showed higher compressive strength and durability. The applications are numerous in civil engineering, namely, precast bricks, partition wall panels, canal linings, and so forth. Recommendation for further study, it will emphasize on grind the waste into fine powder and mix into such proportion to achieve maximum packing density. It may result to increase in compressive strength and binder, or plasticizer should be added to the mixture to increase the bind between plastic surface and M-sand particle.

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