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PERFORMANCE EVALUATION OF PLASTIC BRICK COMPOSITES

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ABSTRACT: *Plastics are one of the most leading and using material in our day to day life only because of its low cost, easily availability and its properties. Even though the plastics are shown tremendous results but usage is limited only because of the material is hazardous environmentally. Plastic pollution is the accumulation of plastic objects and particles (e.g. plastic bottles, bags and microbeads) in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans. Plastics that act as pollutants are categorized into micro-, meso-, or macro debris, based on size. Plastics are inexpensive and durable, and as a result levels of plastic production by humans are high. However, the chemical structure of most plastics renders them resistant to many natural processes of degradation and as a result they are slow to degrade. Together, these two factors have led to a high prominence of plastic pollution in the environment.*

The main idea of the project is to convert this waste plastic scrap into useful plastic Bricks for constructive purpose under proper environmental conditions. In this the waste plastic is mixed with sand, clay and cement to form the composite bricks to achieve the sufficient strength. The plastic waste was obtained from the bags, cans and bottles which are chopped into the small pieces for mixing with sand and cement to form the composites by using casting and molding process. To analyze the performance of the molded composite brick the 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 also subjected to compressive and water absorption test to know the proper applicability in construction usage. These results showed that, the Plastic Composite Brick was more efficient than the clay brick and cement brick.

Keywords: Compressive test, sand, Plastic, Water absorption test, hazardous material, molten plastics paste.

1. INTRODUCTION

Plastic is a very common material that is now widely used by everybody in the world. Plastic plays a predominant role in reusable in this era, as it is compact and light in weight. Common plastic items that are used are covers, bottles, and food packages. The great problem with plastic is its decomposition. Plastic is made of polymer chemicals and they are non-biodegradable. This means that plastic will not decompose when it is placed in earth.

So reusing or recycling of it can be effectual in mitigation of environmental impacts relating to it. It has been proven that the use of plastic bottles as innovative materials for building can be a proper solution for replacement of conventional materials.

The use of this material has been considered not only for exterior walls but also for the ceiling of the building. The objective of this project is to investigate the key and positive characteristics of this product and the benefits obtained by using it in building. It also intends to compare the characteristics of some construction materials such as brick, ceramic and concrete block with bottle.

1.1 RECYCLING PROCESS:

The simplest of plastic recycling processes involves collecting, sorting, shredding, washing, melting, and pelletizing. The actual particular processes vary based on plastic resin or type of plastic product.

- Most plastic recycling facilities use the following two-step process:
- Sorting plastics automatically or with a manual sort to make sure all the contaminants are removed from the plastic waste stream.
- Melting down plastics directly into a new shape or shredding into flakes then melting down before being finally processed into granulates.

1.2 OBJECTIVES

1. To develop an efficient way and to effectively utilize the waste plastics.
2. To reduce the consumption of natural resources such as clay for the manufacturing of bricks.

3. To minimize and reuse generation of waste plastic on the land and water to avoid land and water degradation and consequent pollution hazard.

2. LITERATURE REVIEW

1. The paper is based on experimental results of sand sample casted with use of plastic bags pieces to study the compressive and split tensile strength **[Raghatate Atul M, 2015]**. **2.** This study investigate the application of pulverized fine crushed plastic (produce from melting and crushing of high density polyethylene) as replacement of fine aggregate in sand with varying known percentages.[**P. Suganthyet al., 2013**] 3. This study presents the results of addition of waste plastics along with steel fibers with an objective to seek maximum use of waste plastic in concrete. **[KhileshSarwe., 2014**]. 4. The strength of geo polymer paver block is increased by increasing the foundry sand as replacement of fine sand **[BendapudiSarath Chandra Kumar, 2014]**. **5.** They have studied the environment friendly disposal of shredded plastic bags in concrete mix to be use in construction industry which have dire need for alternative material to be use in lieu of conventional materials. **[A Bhogayata., 2012].**

3. METHODOLOGY

3.1 Flow Chart about Project

First, we need to collect the plastic waste and separate it from other wastes. Second, we should dry the plastic waste if it is wet and has a content of moisture. We have to use dry plastic waste. Then, we crush the plastic waste in small particles. The small particles crush into fine size particles. Fine particles of plastic waste also heated on a vessel till it is in a liquid form. We add the stone dust into melt plastic. We can mix it properly and make a mix. We poured the mix into moulds. Keep it the mould for dry.

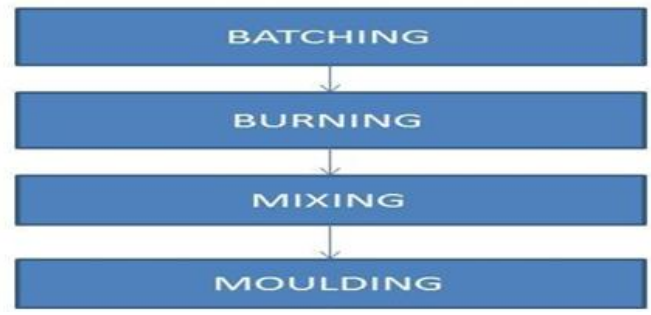


Fig 3.1 flow chart

Batching

Fig3.2 batching

Batching of plastic Measurement of materials for making brick is called batching. After collection of materials we separate the types of plastic and remove any other waste presented in the collected material and check that any water content in in sample collected ten proceed for burning.

Burning

Burning of waste plastic After completion batching the plastic waste were taken for burning in which the plastic bags are drop one by one into the container and allowed to melt. These would be done in closed vessel because to prevent the toxic gases released into atmosphere. These will be at the temperature of 90-110 degrees centigrade.

Mixing

Mixing of materials is essential for the production of uniform and strength for brick. The mixing has to be ensure that the mass becomes homogeneous, uniform in color and consistency. Generally, there are two types of mixing, Hand mixing and mechanical mixing.

In this project, we adopted hand mixing. Until the entire plastic content required for making plastic brick of one mix proportion is added into it. Then these plastic liquids thoroughly mixed by using trowel before it hardens. The mixture has very short setting bags are turned to molten state; the river sand is added to it. The sand added is mixed time. Hence mixing process should not consume more time.

Mixing proportion for project are as follows:

- Sand and wasteplastic1:3and 2:1
- Sand, waste plastic and cement::1:1:3

Moulding

After completion of proper mixing we place mix into required mould. In these projects we use the normal brick sizes (10x10x10 cm). After 1 days remove the brick from the mould and then done curing.

Curing

The test specimens after moulding were allowed to dry for a period of 24 hours. The specimens were kept in curing tank and allowed to cure for a period of 5days.

3.2 MATERIAL USED

- Sand
- Cement
- Plastic waste

SAND

The silica material was utilized as a fine aggregate in concrete and mortars. Natural river sand is the most preferred choice as a fine aggregate material. River silica sand is a product of natural weathering of rocks over a period of millions of years. It is mined from the river beds.

S. No	Tests	Result
1	Specific gravity	2.62
2	Bulk density	1690 kg/m^3
3	Fine modulus	2.92

Table 3.1 General value of sand

PLASTIC

Plastics are commonly used substances which play an important role in almost every aspect of our lives. The widespread generation of plastics waste needs proper end of-life management. The highest amount of plastics is found in containers and packaging's (i.e. bottles, packaging, cups etc.).

Waste plastic	Available as
Poly-ethylene terephthalate (PET)	Drinking water bottles etc
High Density Polyethylene (HDPE)	Carry bags, bottle caps, house hold articles etc.
Low Density Polyethylene (LDPE)	Milk pouches, sacks, carry bags, bin linings, cosmetics and detergent bottles.
Poly propylene (PP)	Bottle caps and closures, wrappers of detergents, biscuit etc.
Urea formaldehyde	Electrical fittings, handles and Knobs.
Polyester resin	Casting, bonding fibers (glass, Kevlar, carbon fiber)

Table 3.2 TYPES OF PLASTIC AND ITS USES

S.No	Properties Results
Density At 23˚C	0.958
Elastic Modulus	9 3
Tensile Creep Strength	8 4
Bending Creep Modulus	1
Tensile Strength At 23˚C	2
Elongation At Break (%)	> 600
Thermal Conductivity	0.8
Ignition Temperature	3

Table3.3 GENERAL VALUE OF PLASTIC

CEMENT:

The manufacturing of Cement was conducted by heating limestone (calcium carbonate) with small quantities of other materials (such as clay. Tests were carried out on various physical properties of cement and the results are shown in test data of materials. Cement will act as a binding material.

S.No	TEST	STANDARDS
1	Initial setting time	30 minutes
2	Final setting time	600 minutes
3	Fineness	Not less than 90%
4	Specific gravity	3.10 to 3.15
5	Standard consistency	30% to 35%

Table 3.4 STANDARD VALUE OF CEMENT

PROCEDURE FOR PLASTIC BRICKS

- First, we need to collect the plastic waste and separate it from other wastes.
- Second, we should dry the plastic waste if it is wet and has a content of moisture. We have to use dry plastic waste.
- Then, we crush the plastic waste in small particles by crushing machine.
- Then, the small particles crush into fine size particles.
- The ratio of plastic and sand which we use is 1.3;2:1 also sand; cement and plastic which we use is3:1:1
- The sand which we use in manufacturing of bricks/tiles is sieved for a size less than 2.92mm using sieve analysis.
- Then, we heated the stone dust on a.
- The fine particles of plastic waste also heated on a vessel till it is in a liquid form(200^0c-300^0c).
- Then, we add the sand and cement into melt plastic.
- Then, we can mix it properly and make a mix.
- Then, we poured the mix into moulds.
- Then keep it the mould for dry and demould it on a next day.
- The weight of the brick is between1.0Kg to 1.5Kg.

MIX DESIGN

In order to find the plastic soil bricks that they possess high compressive strength with various mix proportions are made and they are tested using compressive testing machine [CTM].

Table 3.5 MIXTURE OF PLASTIC, SAND AND CEMENT

S. No	Material	For 1 Brick in Kgs
1	SAND	0.900gm
2	PLASTIC	0.300gm
3	CEMENT	0.300gm

(1:1:3)

S. No	Material	For 1 Brick (Ratio-1:3) in Kg	For 1 Brick (Ratio-2:1) in Kg
1	PLASTIC	0.300gm	0.700gm
2	SAND	1.200gm	0.350gm

Table 3.6 Mixture of Plastic and Sand

WATER ABSORPTION TEST

In this test at first the bricks are weighed in total dry conditions. Then they will be allowed to be dipped in fresh water for about 24 hours in a container. The bricks are taken out of the water after 24 hours and are wiped with a cloth. The wet brick is weighed using a weighing machine.

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.

FORMULA

Water absorption = {[Weight of wet brick–Weight of dry brick]/Weight of dry brick}*100

CALCULATION

- WATER ABSORPTION RATION (PLASTIC AND SAND-1:3)

$$= \frac{(1473-1448)}{1448} \times 100 = 1.76$$

- WATER ABSORPTION RATION (PLASTIC AND SAND-2:1)

$$=\frac{1027-1010}{1010}\times 100 = 1.68$$

- WATER ABSORPTION RATION (PLASTIC,CEMENT AND SAND-1:1:3)

$$=\frac{1526-1507}{1507}\times 100 = 1.26$$

COMPRESSION TEST

Fig 3.3 Compression test

Compression testing is used to determine how a product or material reacts when it is compressed, squashed, crushed or flattened by measuring fundamental parameters that determine the specimen behavior under a compressive load.

In this test, the cubical brick specimen is placed in the compression strength testing machine. After placing it we will apply the load on the brick without any shock. The load will be increased at a rate of 140kg/cm2 min continuously till the specimen's resistance to increasing load breaks down and it cannot withstand any greater load further. Recording the maximum load applied to the brick specimen and the appearance and type of failure is also noted along with any unusual features.

FORMULA:

COMPRESIVE STRENGTH= MAXIMUM LOAD APPLIED SPECIMEN AREA (1) =F/A

Where,

F -Maximum load applied (KN)
A – Specimen Area (mm2) = 100*100 =10000mm^2

CALCULATION

- COMPRESSIVE STRENGTH (DRY BRICKK-1:3) = $\frac{35000}{10000} = 3.5MPA$
- COMPRESSIVE STRENGTH (WET BRICKK-2:1) = $\frac{30000}{10000} = 3MPA$
- COMPRESSIVE STRENGTH (WET BRICKK-1:3) =$\frac{25000}{10000}$= 2.5MPA
- COMPRESSIVE STRENGTH (DRY BRICKK-2:1) = $\frac{38000}{10000}$= 3.8MPA
- COMPRESSIVE STRENGTH (WET BRICKK-1:1:3) =$\frac{50000}{10000} = 5MPA$
- COMPRESSIVE STRENGTH (DRY BRICKK-1:1:3) =$\frac{38000}{10000} = 3.8MPA$

IMPACT TESTING

Fig 3.4 Impact test

An impact test is used to observe the mechanics that a material will exhibit when it experiences a shock loading that causes the specimen to immediately deform, fracture or rupture completely. To perform this test the sample is placed into a holding fixture with the geometry and orientation determined by the type of test that is used and then a known weight generally but not always in the shape of a pendulum is released from a known height so that it collides with the specimen with a sudden force. This collision between the weight and specimen generally results in the destruction of the specimen but the transfer of energy between the two is used to determine the fracture mechanics of the material.

EFFLORESCENCE TEST:

The standard used for the test is ISS 1077-1970. It is done to detect the presence of alkalis in PET bricks which is harmful. The alkalis form a grey or white patch on the surface of the brick. A flat bottom container is used in which sufficient distilled water is poured. The

depth of immersion is 25mm.The brick is immersed into the distilled water and left for 24 hours.

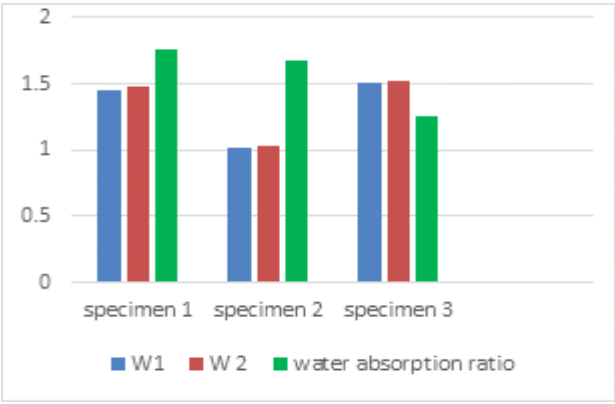
- Distilled water to be filled in a dish of suitable size. The dish should be made of glass, porcelain or glazed stone ware.
- Place the end of the bricks in the dish, the depth of immersion in water being 25mm. Place the whole arrangements in a warm (for example,200 C to 300 C) well ventilated room until all the water in the dish is absorbed by the specimen and the surface water evaporate
- Cover the dish with suitable cover, so that excessive evaporation from the dish may not occur.
- 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
- Examine the bricks for efflorescence.

4. RESULT AND CONCULSION

RESULT

Table 4.1 Results for Water Absorption Ratio For Different Plastic Brick

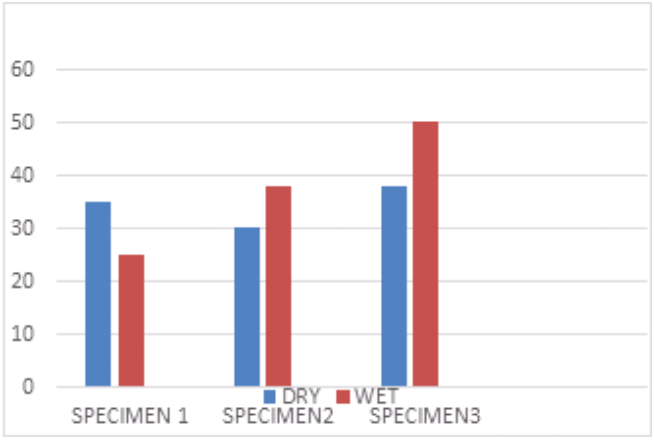
S. NO	RATIO OF BRICK	BEFORE W_1 (IN Kg)	AFTER 5 DAYS W_2 (IN Kg)	WATER ABSORPTION RATIO (%)
1	PLASTIC AND SAND(1:3)	1.448	1.473	1.76
2	PLASTIC AND SAND(2:1)	1.010	1.027	1.68
3	PLASTIC;CEMENT AND SAND(1:1:3)	1.507	1.526	1.26



Graph 4.1 water absorption test

Table 4.2 RESULTS FOR COMPRESSION TEST ON DIFFERENTPLASTIS BRICK

SNO	SPECIMEN	LOAD (DRY)	STRESS (DRY)	LOAD (WET)	STRESS (WET)
1	PLASTIC AND SAND(1:3)	35KN	3.5MPA	25KN	2.5MPA
2	PLASTIC AND SAND(2:1)	30KN	3MPA	38KN	3.8MPA
3	SAND;PLASTIC AND CEMENT (1:1:3)	38KN	3.8MPA	50KN	5MPA



Graph 4.2 COMPRESSION TEST GRAPH

Table 4.3 RESULT ON IMPACT TEST FOR DIFFERENT PLASTIC BRICK

S.NO	SPECIMEN	RESULT IN JOULES
1	SAND AND PLASTIC(1:3)	52 J
2	SAND AND PLASTIC(2:1)	40 J
3	PLASTIC:SAND AND CEMENT(1:1:3)	60 J

CONCULSIONS

1. Plastic Sand Bricks made of plastic waste which otherwise would have created pollution, possess advantages of cost efficiency, resource efficiency, etc.
2. It leads us towards our sustainable development goal. The bricks made have less porosity and light weight with more compressive strength.
3. Further research might improve the quality and durability of Plastic Sand Bricks. The results we have got shows us that the compressive strength of this brick is high when compared to the conventional clay bricks for the same size and also the weight of these bricks are less which in turn will decrease the dead weight of the structure.
4. The water absorption of these bricks are very less 0.9 % - 4.5% and whereas in normal clay bricks it is around 15% - 20% of the weight of brick.
5. Although, the fire resistance of plastic bricks is something that requires further research, in its current composition these bricks can serve excellently for water conservation purposes, Underground tanks or to form an underlining for sanitary landfills.

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