EXPERIMENTAL RESEARCH ON PLASTIC BRICKS MADE FROM WASTE PLASTIC

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ABSTRACT - This study describes the use of municipal plastic waste (MPW) in the construction industry. Plastic is a non-biodegradable material that takes thousands of years to decompose and causes soil and water pollution. The amount of plastic waste in municipal solid waste (MSW) is increasing rapidly. Usage is estimated to double every decade. Plastic consumption is high and one of the largest plastic wastes is polyethylene (PE). The use of earth-derived clay materials has caused resource depletion and one of these efforts is the efficient use of plastic waste and laterite quarry waste, along with small amounts of asphalt, to meet the growing demand for traditional building materials, which are less absorbent than laterite bricks. The challenge is to develop alternative building materials, such as brick, that have little but sufficient strength.

The use of MPW as a building material, especially in brick production, is one of the promising steps towards sustainable resource and waste management. Plastic waste can partially or completely replace one or more raw materials in brick production. Further research based on recent research and a better understanding of the use of waste plastics in bricks is needed to produce high-quality and durable bricks and to achieve an optimal balance in all aspects, especially in terms of cost and functionality.

KEYWORDS- plastic waste, brick, building material, MPW, construction industry, polymers.

INTRODUCTION- Plastics are made up of synthetic organic polymers which are widely used in different applications ranging from water bottles, clothing, food packaging, medical supplies, electronic goods, construction materials, etc. In the last six decades, plastics became an indispensable and versatile product with a wide range of properties, chemical composition and applications. Although, plastic was initially assumed to be harmless and inert, however, many years of plastic disposal into the environment has led to diverse associated problems. Environmental pollution by plastic wastes is now recognized widely to be a major environmental burden, especially in the aquatic environment where there is prolong biophysical breakdown of plastics,detrimental negative effects on wildlife, and limited plastic removal options.

PRESENT SCENARIO OF WASTE GENERATION IN INDIA- Globally, plastic production was estimated to be 380 million tonnes in 2018. Since 1950 to 2018, plastics of about 6.3 billion tonnes have been produced worldwide, 9% and 12% of which have been recycled and incinerated, respectively. Plastics of about 5 million tonnes are yearly consumed in UK alone, with only about one-quarter recycled, and the rest landfilled. It has been suggested by researchers that by 2050, oceans might contain more plastics than fish in terms of weight. Yearly, approximately 500 billion plastic bags are used out of which an estimated 13 million tonnes ends up in the ocean, killing approximately 100,000 marine lives.

OBJECTIVE-

- To compare strength of plastic bricks with normal clay bricks.
- To vary the percentage of plastic in bricks to determine the strength performance.
- Cost comparison in between plastic bricks and normal clay bricks.

LITERATURE REVIEW-

Alaa.A.Shakir, et.al (2013) – In the review of utilization of those waste, this paper reviewed recycling various waste material in bricks production. The effects of those wastes on the bricks properties as physical, mechanical properties will be reviewed and recommendations for future research as out comings of this review will be given. This reviewed approach on bricks making from waste is useful to provide potential and sustainable solution.

Maneeth P D, et.al, (2014), In this paper, bricks of different mix proportions were prepared with varying plastic (PET, PP), laterite soil (passing 2.36mm IS Sieve) and bitumen content, and the bricks were tested for compressive strength and water absorption. This study showed that strength of these bricks was dependent on plastic percentage and minimum 60% of plastic by weight is required for plastic soil bricks by trial and error method. 70% of plastic by weight was considered as the optimum dosage of plastic in the view of workability criteria and 2% of bitumen was taken as optimum binder content which resulted in compressive strength of 8.16N/mm2 which is higher than laterite stone (3.18N/mm2)and has less water absorption of 0.9536% than laterite stone.

Dinesh.S, et.al, (2016), This paper is the attempt made to study regard the properties of the bricks and paver blocks which are manufactured using plastic wastes, river sand and some colouring agents like red oxide. Various mix proportion of plastic and river sand (1:2, 1:3, 1:4, 1:5, and 1:6) were made and tested for compressive strength using compressive testing machine and water absorption test. From this study it was concluded that plastic soil bricks possess more advantages like cost effective because the natural resources consumed for the manufacturing of these bricks and paver blocks are very much less when compared to conventional one.

Arvind Singhal, Dr. Om Prakash Netula(2018) They used the mixture of plastic and stone dust in the molten form in the ratio of 3:7 in standard brick mould for which stone dust was sieved through 4.75 mm using sieve analysis and conducted test on water absorption to be found as 0%. Compressive strength of plastic sand bricks is 5.6 N/mm2 at the compressive load of 96 KN.

S S Chauhan, Bhusan Kumar(2019) They mixed the river sand and the PET plastic (molten form) in the ratio of 1:2, 1:3, 1:4 for mould size of (230*100*75) mm for which they found maximum compressive strength on the ratio of 1:2 mixture for the same size of the bricks. The water absorption of these bricks was observed less than 5% that is less than conventional clay bricks i.e. 15-20%. However, they failed in maintaining fire resistance property of these bricks.

Aman Kumar, Mainak Biswas,(2020) Plastic waste which is increasing day by day becomes eyesore and in turn pollutes the environment, especially in high mountain villages where no garbage collection system exists. A large amount of plastic is being brought into the tourist trekking regions are discarded or burned which leads to the contamination of environment and air.

Tarekegn Belay Wendimu(2021) Construction industry is gradually increasing through the whole of the world and it is consuming natural resource raw materials for construction materials. Traditional way of producing clay brick without giving care for natural resource brought deficiency of natural resource. Now the days, plastics waste is the big challenge of the world on Environmental impacts and Alternative using High-Density Polyethylene (HDPE) plastic waste Brick for construction material is preventing environmental impact of plastic and in other hand saving natural resources clay soil. High-Density Polyethylene (HDPE) plastic waste was collected from different sites it was thrown and before producing waste plastic Brick High-Density Polyethylene (HDPE) is cleaned, and the size is minimized as it was suitable for plastic waste Brick. After that Plastic waste Bricks were produced for different test.

Plastic -There are various types of plastics. As per the “society of plastics Industry’s” classification of plastics, the following detail is provided to allow customers and recyclers to identify.

Two different types of plastics.

Fig. 1 thermoplastics

Fig.2 thermosetting

(a).Thermo plastics (b).Thermo setting.

Thermo plastics	Thermo setting.
Thermoplastic can be synthesized by the process called addition polymerization.	Thermosetting plastics are synthesized by condensation polymerization.
Thermoplastic is processed by injection moulding, extrusion process, blow moulding, thermoforming process, and rotational moulding.	Thermosetting Plastic is processed by compression moulding, reaction injection moulding.
Thermoplastics have secondary bonds between molecular chains.	Thermosetting plastics have primary bonds between molecular chains and held together by strong cross-links.
Thermoplastics have low melting points and low tensile strength.	Thermosetting plastics have high melting points and tensile strength.
Examples Polystyrene, Teflon Acrylic ,Nylon	Examples Vulcanized rubber, Bakelite, Polyurethane, Epoxy resin, Vinyl ester resin

Cement- cement is a binder, a chemical substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource.Cements used in construction are usually inorganic, often lime or calcium silicate based, which can be characterized as hydraulic or the less common non-hydraulic, depending on the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).

Ordinary Portland Cement- the normal used in thesis work has Portland cement. Portland cement is the most common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco, and non-specialty grout.

Fig. 3 OPC Cement

It was developed from other types of hydraulic lime in England in the early 19th century by Joseph Aspdin, and is usually made from limestone. It is a fine powder, produced by heating limestone and clay minerals in a kiln to form clinker, grinding the clinker, and adding 2 to 3 percent of gypsum. Several types of Portland cement are available.

Sand- Sand is a granular material composed of finely divided mineral particles. Sand has various compositions but is defined by its grain size. Sand grains are smaller than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass.

Fig.4 Sand

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz

Water -Water used for mixing and curing of concrete shall be clean and free from oils, acids, alkalies, salts and organic materials or other substances they may be deleterious to concrete or steel. Portable water shall be used for mixing of concrete. Suspended solid matter in the water shall not exceed more than 200mg/l. The pH value of the water shall not be less than 6.

METHODOLOGY

- Collection of Materials.
- Batching.
- Melting.
- Mixing.
- Moulding.
- Curing

Collection of Materials- Plastic materials should be collected not only from food packaging and plastic bottles, but also from factory waste , hospital waste, and industrial waste. This applies to the plastic type LDPE.

Batching - 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.

Melting - 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 -Pieces of plastic are added into drum for melting until the proportion required by us is achieved. River sand is used for addition in plastic sand mixture. When the temperature of the melted plastic in the drum is around 180o C-200o C then the sand is added into the drum. The river sand and the melted plastic is stirred continuously so that both gets bonded perfectly. As the plastic pieces melt it start getting bonding with the sand particles and hence the mixture required for brick is created.

Moulding - In moulding process, the prepared mixture is then filled into wooden mould and then compressed by tamping rod. The pressure is applied by the tampering rod so as the mixture gets filled properly in the mould. Then it is left for cooling in air but before filling the Mould apply oil on the walls of mould so that at last brick can be removed easily.

Fig. 5 moulding brick

PROCESS OF CASTING PLASTIC SAND BRICK- 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 stone dust which we use is 3:7.
- The stone dust which we use in manufacturing of bricks/tiles is sieved for a size less than 4.75mm using sieve analysis.
- Then, we heated the stone dust on a furnace (Bhatti).
- The fine particles of plastic waste also heated on a furnace (Bhatti) till it is in a liquid form.
- Then, we add the stone dust 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 2.5Kg.

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]. The mix proportions were in the ratio of (1:3, 1:4, and 1:5). These are the ratio which represents the plastic, M-sand respectively.

Mix Design Calculations-

(a)Ratio (1:2) Size of brick = 19 X 9 X 9 cm

= 0.19 X 0.09 X 0.09 m

Volume of brick = 0.00153 m3

Sum of proportion= 1+2 = 3

Amount of plastic = (0.00153/2) x 1 = (5.1 x 10-4) x 1390 …… (1390 PET density)

Amount of plastic = 0.7089 kg of plastic.

Amount of sand = 0.00153 /2 X2

=(1.02 x 10-3) x 1620 …. (1620 Sand density)

Amount of sand=1.65kg of sand.

b) Ratio (1:3)

Size of brick = 19 X 9 X 9 cm = 0.19 X 0.09 X 0.09 m

Volume of brick = 0.00153 m3

Sum of proportion= 1+3=4

Amount of plastic =0.00153/2 X1

= (3.825 x 10-4) x 1390… (1390 PET density)

Amount of plastic = 0.53 kg of plastic.

Amount of sand= 0.00153/4 X3

= (1.14 x 10-3) x 1620 …. (1620 Sand density)

Amount of sand = 1.85 kg of sand

TESTS CONDUCTED ON PLASTIC BRICKS-

Compression Strength test- 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.

Result of compressive strength test

Table No. 1Compressive strength for 1:2 plastic to sand ratio, Plastic Sand Brick

Plastic Sand Brick (1:2Ratio)	Maximum Load (KN)	Compressive Strength (kg/cm2)
Specimen 1	500	193.87
Specimen 2	525	203.56
Specimen 3	490	189.99

Table No. 2 Compressive strength for 1:3 plastic to sand ratio, Plastic Sand

Plastic Sand Brick(1:3Ratio)	Maximum Load (KN)	Compressive Strength (kg/cm2)
Specimen 1	350	135.71
Specimen 2	320	124.07
Specimen 3	335	129.89

Table No. 3: Compressive strength for 1:4 plastic to sand ratio, Plastic Sand Brick

Plastic Sand Brick(1:4Ratio)	Maximum Load (KN)	Compressive Strength (kg/cm2)
Specimen 1	165	63.97
Specimen 2	150	58.16
Specimen 3	155	60.10

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. For the calculation of water absorption, the difference between wet brick and dry brick is done. The difference is the amount of water absorbed by the brick. After that the percentage of water absorption is calculated using the data.

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

***100**

Table No. 4 : Results of Water Absorption test

Table: For 1:2 ratios plastic to sand bricks, the water absorption is given below

1:2 Ratio Brick	W1(kg)	W2(kg)	Water Absorption(in %)
Specimen 1	3.053	3.082	0.949
Specimen 2	2.958	2.997	1.318
Specimen 3	3.014	3.051	1.227

Table No. 5: For 1:3 ratios plastic to sand bricks, the water absorption is given below.

1:3 Ratio Brick	W1(kg)	W2(kg)	Water Absorption(in %)
Specimen 1	2.532	2.601	2.723
Specimen 2	2.498	2.564	2.642
Specimen 3	2.594	2.678	3.238

Table No. 6: For 1:4 ratios plastic to sand bricks, the water absorption is given below.

1:2 Ratio Brick	W1(kg)	W2(kg)	Water Absorption (in %)
Specimen 1	2.411	2.516	4.351
Specimen 2	2.397	2.492	3.963
Specimen 3	2.456	2.568	4.560

CONCLUSION

- The everywhere , plastic waste can be put to good use in bricks.
- Plastic bricks can help reduce environmental pollution, thereby making the environment clean and fresh.
- Plastic sand bricks reduce the usage of clay in making of bricks.
- Water absorption of plastic sand brick is zero percent.
- Plastic sand bricks give an alternative option of bricks to the customers on affordable rates

The water absorption capacity is higher in comparison to conventional brick with a lower weight. Its uses are not restricted as only brick; it can even be utilized as a building block by increasing the dimension of the mould. Also, it reduces the use of wire used for fencing.

Floor tiles, sleepers, etc. can also be produced from it. This brick also turns out to be economical than conventional brick, by reducing the cost of incinerators for burning purpose and landfills.

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