Review Paper on Bricks Made From Waste Plastic And Its Application- Case Studies

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Abstract- *This paper has discussed effect of using plastic as material in making of bricks. Different mix are discussed from research work published in international journals such as IRJET (International Research Journal of Engineering and Technology) and News articles. Test results of Compression test and water absorption test on the bricks made from plastic are discussed. These results were found to be better than that of conventional Bricks. Also cost comparison is done with conventional Bricks. Further a mix design is done that excludes melting procedure of plastic to reduce environmental impact.*

Keywords- Plastic bricks, Comparison, Reduce environmental impact.

I. 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 bags, 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. Though plastic is a very useful material that is flexible, robust, and rigid they become waste after their use, and they pollute the air and land. Recycling is processing use waste materials into new products to prevent waste of potentially useful materials. The increase in the popularity of using eco-friendly, low cost and lightweight construction materials in building industry has brought about the need to investigate how this can be achieved by benefiting to the environment as well as maintaining the material requirements and their standards. From the advantages of plastic recycling procedure is used. To produce plastic bricks is an optimal method for controlling the problem by decomposition of plastic waste and it costs economical to produce building materials. In this study, plastic waste from factories will be used to incorporate with cement and sand to produce sand bricks. The bricks will then be tested to study the compressive strength, efflorescence, and water absorption. In the recent past research, the replacement and addition have been done with the direct inclusion of polyethylene, low density polyethylene (LDPE) bags in shredded form, chemically treated polyethylene-fibre, LDPE in small particles form by replacing natural coarse aggregate. Most of replacements have been done by volume calculation and showed the decreased in compressive strength as the increased plastic waste. In this study, recycled plastic waste have been introduced in the form of small particles of the shredded plastic. The replacement of plastic waste material has been done by weight.

PRESENT SCENARIO OF WASTE GENERATION IN INDIA

Growth of population has increased our urbanization as a result rising standard of living due to technological innovations have contributed to an increase both in the quantity and variety of solid wastes generated by industrial, agricultural activities, mining and domestic. Globally the estimated quantity of wastes generation was 12 billion tonnes in the year 2002 of which 11 billion tonnes were industrial wastes and 1.6 billion tonnes were municipal solid wastes (MSW). About 23 billion tons of solid wastes are expected to be generated annually by the year 2022. Annually, Asia alone generates 4.4 billion tons of solid wastes and MSW comprise 795 million tons of which about 48 (6%) MT are generated in India. MSW generation in India, is expected to reach 300 million tones and land requirement for disposal of this waste would be 169.6 km2 as against which only 20.2 km2 were occupied in 1997 for management of 48 Million tonnes. As it is studied that apart from municipal wastes, the organic wastes from agricultural sources alone contribute more than 350 million tons per year. However, it is reported that about 600 million tons of wastes have been generated in India from agricultural sources alone. The Quantity of wastes generated from agricultural sources are sugarcane baggage, paddy and wheat straw and husk, wastes of vegetables, food products, tea, oil production, wooden mill waste, coconut husk, jute fibre, groundnut shell, cotton stalk etc. In the industrial sector inorganic solid waste could are coal combustion residues, bauxite red mud, tailings from aluminium, iron, copper, and zinc primary extraction processes. Generation of all these inorganic industrial wastes in India is estimated to be 290 million Tons per annum. In India, 4.5 million tons of

hazardous wastes are being generated annually during different industrial process like electroplating, various metal extraction processes, galvanizing, refinery, petrochemical industries, pharmaceutical and pesticide industries.

II. MIX DESIGN OF PLASTIC BRICK

Research work published in IRJET (International research journal of engineering and technology) Vol 6. Issue4 where thoroughly studied. In order to make better improvement a mix design is made to reduce the negative impact on the environment that takes place due to melting procedure of plastic so accordingly some changes were made in the original mix design.

To find the plastic bricks that they possess high compressive strength with various mix proportions are made and they are tested using compressive testing machine (CTM). Here W/C ratio is to be kept between 0.35 to 0.5 based on type of mixing. (IS 2185)

Sl. No	PLASTIC %	CEMENT (KG'S)	FLYASH (KG'S)	SAND (KG'S)	Plastic (KG'S)
1	5	0.992	4.04	3.078	0.162
2	10	0.992	4.04	2.916	0.324
3	15	0.992	4.04	2.754	0.486
4	20	0.992	4.04	2.59	0.648

III. METHODOLOGY

1. Collection of materials.
2. Batching.
3. Shredding.
4. Mixing.
5. Moulding.
6. Curing.

1. Collection Of Plastic Materials

The plastic material should be collected from the factories waste and hospital waste and industries waste and food packages and plastic bottles this will come under the LDPE plastic type.

2. 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 is in sample collected then proceed for shredding.

3. Shredding

The Plastic Shredders Are Used to Shred the waste plastic into Small Pieces Which can be used in mixing plastic with fly ash, cement, and sand.

4. Mixing

Mixing of materials is essential to produce uniform and strength for brick. The mixing must be ensured that the mass becomes homogeneous, uniform in colour 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

5. Moulding

After completion of proper mixing, we place mix into required mould. In these projects we use the normal brick sizes (19x9x9 cm). after 2 days remove the brick from the mould and then done curing.

6. 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 28 days.

IV. EXPERIMENTAL INVESTIGATION

1. Properties Of Plastic (LDPE<4.75mm)

When exposed to ambient solar radiation the plastic procedure two greenhouse gases, methane, and ethylene. Due to its low-density properties (branching) it breaks down more easily over time, leading to higher surface areas. The supply of glasses shall be of diagonal gases from virgin LDPE increase with surface area or time, with rates at the end of a 212day incubation of 5.8 nmol g-1 d-1 of methane, 14.5 nmol g-1 d-1 of ethylene, 3.9 nmol g-1 d1 of ethane and 9.7 nmol g-1 d-1 of propylene. In case of air it was incubated, LDPE releases gases in air by ~2 times and ~76 times higher in comparison to water for methane and ethylene, respectively.

Sl. No.	Experiments	Values
1	Density @26^{0}C	0.958
2	Elastic modulus	9
3	Tensile cube strength	8
4	Bending creep modulus	1
5	Tensile strength @23^{0}C	2
6	Elongation at break (%)	>600
7	Thermal conductivity	0
8	Ignition Temperature	3

2. Sand [Size < 4.75mm IS 2185(2000)]

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 riverbeds. River sand is becoming a scarce commodity now. River was the clean water of superior sand is far superior for construction purposes than any other sand used in construction. Quarrying of river sand is an important economic activity in India with river sand forming a crucial raw material to the construction industry.

3. 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.

4. Fly Ash

Fly ash is a residue resulting from combustion of pulverized coal or lignite in thermal power plants. About 80% of the total fly ash is in finely divided form which is carried away with flue gases and is collected by electrostatic precipitator or other suitable technology. The balance 20% of ash gets collected at the bottom of the boiler and is referred to as bottom ash. Fly ash got into a fine powder in the comparable to cement, however some particles have size less than 1 micron in equivalent diameter.

Sl. No	COMPONENTS	PERCENTAGE (%)
1	Sio_2	35 to 39
2	Fe_2O_3	0.5 to 2
3	Al_2O_3	20 to 33
4	CaO	5 to 16
5	MgO	1 to 5.5
6	So_3	0.5 to 1.5

V. TEST METHODS

1. Compression Strength

The tests on Compressive strength of the specimen brick shall be calculated for 3 aspects after 7, 14 & 28 days of curing using the formula as follows,

$$\text{Compressive strength} = \frac{\text{Applied Max load x 1000 (N)}}{\text{Gross sectional Area } (mm^2)}$$

The compressive strength test are done as per the procedure laid down in IS 3495(part1): 1992.After the curing period gets over bricks are kept for testing. To test the specimens, the bricks are placed in the calibrated compression testing machine of capacity 3000 KN (Kilo Newton) and applied a load uniform at the rate of 2.9 kN/min. By obtaining the maximum load shall be taken as failure of load with specimen fails to produce any further increase in indicator reading on testing machine.

2. Water Absorption

As per IS 3495(part2) :1992 Bricks should not absorb water more than 12% by its weight. The bricks to be tested should be dried in an oven at a temperature of 105°C to 115°C till attains constant weight cool the bricks to room temperature and weight (W1). Immerse completely dried and weighed (W1) brick in clean water for 24 hours at temperature of 27°C remove the brick and weigh (W2).

Water absorption % = (W2- W1)/ W1 x 100

3. Test Results

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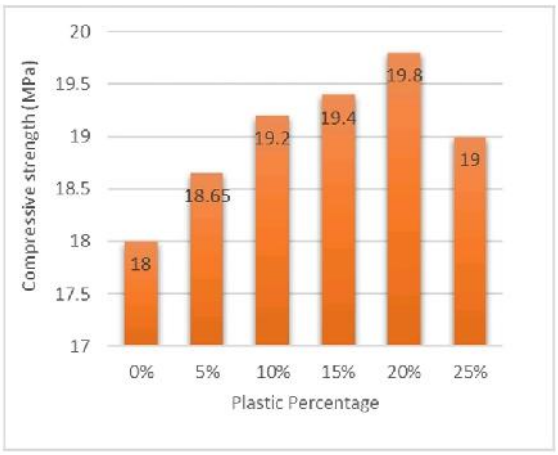
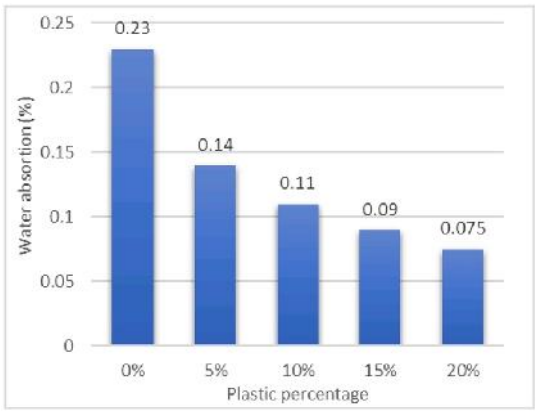
I. Compression Test



II. Water Absorption



VI. CASE STUDY

1. Introduction

Students of SCMS school of engineering and technology, karukutty, India published a paper titled "Manufacturing and experimental investigation of bricks with plastic and m sand" the paper was studied as a part of our research work. The student has utilized waste plastic such as Waste plastic bottles and mixed with m sand to make plastic bricks. Compression test and water absorption test were conducted on the manufactured bricks the results shown that when the amount of plastic is increased till the ratio of 1:4(plastic: sand) the average compressive strength increased up to 18.3 N/mm2 and water absorption was the found to decrease with increase in plastic percent in bricks.

2. Methodology

Materials used are PET bottles and M-sand. Plastic wastes are collected, and PET bottles are sorted out. The collected PET bottles are to be cleaned with water and dried. Then it is added to the pan and heated. M-sand is added in required proportion when plastic turns into hot liquid and mixed thoroughly. Mould (19x9x9cm) is oiled for easy removal of bricks and the mixture is poured into the mould and it is compacted in 3 layers with 25 blows each with a tamping rod. Surface finished with trowel. The brick can be easily demoulded by just lifting the wooden mould after 30 minutes. Various experiments are carried out to determine the properties such as compressive strength, durability, thermal resistance, water absorption etc. of the prepared plastic soil bricks.

3. Experimental Investigation

I. Compression Test

Average compressive strength for different ratios of plastic soil bricks were determined.

Plastic soil brick(Ratio)	Average Compressive strength(N/mm^2)
1:2	11.70
1:3	13.06
1:4	18.13
1:5	15.88
1:6	11.50
Burnt clay bricks	8.92

From the results, the ratio of plastic soil brick 1:4 has maximum compressive strength, so it is chosen for doing all the other tests on bricks. It shows that as the plastic content increases, the compressive strength increases up to a certain limit and then decreases. This may be due to the decrease in adhesive strength between plastic and M-sand. It seems that bonding between plastic particles and M-sand is weak after certain limit as the increase in plastic content might have caused the brick to be much flexible, which in turn reduces its compressive strength.

II. Water Absorption Test

Water absorption for different ratios of plastic soil bricks were determined and is shown in table below.

Plastic soil brick(Ratio)	Water absorption(%)
1:2	1.10
1:3	0.31
1:4	0.27
1:5	1.47
1:6	1.66
Burnt Clay bricks	15.28

Water absorption test showed excellent performance of plastic soil bricks. Water absorption value is least for plastic soil brick of ratio 1:4 and the percentage reduction of water absorption compared to burnt clay bricks is 98.2%.

III. Prism Test

Prism test was done for different mortar ratios for plastic soil bricks (1:4) and it was compared with that of the burnt clay bricks.

Cement Mortar Ratio	Compressive strength of masonry prism (N/mm^2)	
	Plastic soil bricks	Burnt clay bricks
1:3	12.7	7.5
1:4	11.3	6.6
1:5	10.2	4.1

It is observed that the compressive strength of masonry prism increases with increase in mortar strength and is greater than that of burnt clay bricks.

Advantages

1. Allow recycling of waste plastic.
2. If made with hollow cells, they can be filled with compacted dirt, increasing their potential utility for projects lasting several years.
3. They can be used for insulation
4. They should be sufficiently economical, with potential for easy recycling. Under submerged conditions they should last much longer.
5. Overall cost of brick will be reduced

Disadvantages

1. Mortar would not stick, unless they are designed with specialized rough surface. Even then, mortar is not expected to stick reliably.
2. Plastic may appear strong, but it would deform under pressure.
3. As such they would have a limited lifespan due to degradation by UV. Extreme arctic weather would make them brittle. Or else, they would crack in several years due to thermal cycling. Skilled labours are required.

Conclusion Of Case Study

Plastic soil bricks possess more advantages than burnt clay bricks and it is cost effective. Brick made with 1:4 ratio of Plastic to M-sand gives a compressive strength of 18.13N/mm2, which is greater than the requirement for a first class brick. It can be used as a permanent structure in the construction of walls. The water absorption for the brick is almost negligible. It is 98.2% less compared to burnt clay bricks. The compressive strength of Masonry Prism made of plastic soil bricks, were found to be more than that of conventional brick Masonry Prism. The compressive strength of masonry prism increases with increase in mortar strength.

Thus, the efficient usage of waste plastics in plastic soil bricks has resulted in effective usage of plastic wastes.

VII. ACKNOWLEDGEMENT AT INTERNATIONAL LEVEL

Nairobi-based start-up company Gjenge Makers, founded by Nzambi Matee, has created a lightweight and low-cost building material that is made of recycled plastic with sand to make bricks that are stronger than concrete materials.

With her initiative, Matee has recently been named a Young Champion of the Earth 2020 Africa winner at the United Nations Environment Programme (UNEP). The award "provides seed funding and mentorship to promising environmentalists as they tackle the world's most pressing challenges."

Their product is almost five to seven times stronger than concrete.

The factory is only in its beginning stages, but it has already recycled 20 tons of plastic since 2017 and created 120 jobs in Nairobi.

Gjenge bricks are also one of the more affordable options on the market. They cost approximately $7.70 per square meter, as opposed to $98 per square yard for concrete produced in the U.S.

VIII. COST COMPARISON

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Cost of burnt clay brick of same size is 8 Rs. / Brick. Cost of plastic soil bricks is calculated to be 4.01Rs/brick which is about half of burnt clay bricks of same size and hence is economical.

IX. CONCLUSION

1. Waste plastic, which is available everywhere, may be put to an effective use in brick.
2. Plastic bricks can help reduce the environmental pollution, thereby making the environment clean and healthy.
3. Plastic sand bricks reduce the usage of clay in making of bricks.
4. Plastic sand bricks give an alternative option of bricks to the customers on affordable rates.
5. Water absorption of plastic sand brick is zero percent.
6. Compressive strength of plastic sand brick is 19.8 MPa for 20% plastic.

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