Physical Characterization of Waste-Plastic Brick and Development of material for pothole filling

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Abstract: **In our daily life we come across with many different types of Plastics. According to Central Pollution Control Board (CPCB), total plastic waste which is collected and recycled in India is estimated to be 9,205 tons per day (approx. 60% of total plastic waste) and 6,137 tons (40%) remain uncollected and littered. This 40% mainly includes thin plastic bags. In the present work we have attempted to make bricks from waste plastic and sand. This brick is resistant to oil, water, salts and acids. It is more durable as compared to other bricks and can withstand temperature up to 180 degree Celsius. We feel this can be an effective way of recycling waste plastic bags in the near future. Further the same material can be used effectively filling potholes on Indian roads. The bricks were subjected to various tests like temperature variation, resistance to acids, fire and saline water, compressive strength and hardness strength and showed superior performance to the material presently used on roads. It is found that these methods can be an effective way to recycle plastic bags which otherwise remain out of the recycling process. These bricks can thus help in reducing pollution caused due to plastic bags. It can replace pavement blocks for better road as it is made from plastic. It doesn't allow water to seep hence it is expected to have better lifespan compared to that of concrete blocks.**

***Keywords*: Plastic Brick, Plastic bags, Ecological Problem, Potholes, CPCB.**

I. INTRODUCTION

All Many plastic bags are used only once, this usage is very less in comparison to their long lifespan. Thin plastic bags in particular represent a serious ecological problem. They are easily tossed by the wind and we can see many stretches of land turned into landscapes of plastic. Also, they land in rivers and streams and ultimately in the sea. According to a study, it is estimated that it takes 500 years for a plastic bag to decompose when exposed to sunlight. If it is not exposed to sunlight, say it remains at the bottom of the landfill, the plastic may remain intact indefinitely. Although standard polyethylene bags don't biodegrade, they do photodegrade. When exposed to ultraviolet radiation from sunlight, polyethylene's polymer chains become brittle and start to crack. This suggests that plastic bags will eventually fragment into microscopic granules. However, scientists aren't sure how many centuries it takes for the sun to work its magic. That's why certain news sources cite a 500-year estimate while others prefer a more conservative 1,000-year lifespan.

Fig.1. Brick made from waste plastic bags.

II. RAW MATERIALS

1) **Low-density polyethylene** (LDPE) is a thermoplastic made from the monomer ethylene. LDPE is defined by a density range of 0.910–0.940 g/cm3. It is not reactive at room temperatures, except by strong oxidizing agents, and some solvents cause swelling.

2) **Sand**: Coarse and fine river sand and construction sand were used as raw material in manufacturing of brick.

III. METHODOLOGIES

1) Unclean and unsorted plastic bags were heated in empty oil tin of 15litre.

2) The plastic melts and we get a semi-fluid form of it.

3) While the mixture is still hot and semi-fluid, sand was added to the mixture and it was stirred continuously. It was further heated for 5-10minutes, while the mixing continues.

4) Then the hot mixture was poured into a rectangular mold and allowed to cool for 10 min in cold water.

5) After cooling in cold water, mold was removed and brick was kept for cooling in open air for 3-4 hours. When the brick is totally cooled down, we get a rigid structure.

IV. Physical Characterization of Brick

1.*Test for sustainment of day-night temperature*:

The brick was kept on terrace to expose it to surrounding normal day-night temperature for 15 days.

Table 1 Dimensions of Brick for 15 days

Date	First Brick (length x breadth x height) (in cm)	Second Brick (length x breadth x height) (in cm)	Day/Night temperature (degree celcius)
3 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 12°
4 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 18°
5 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 17°
6 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 14°
7 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 11°
8 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 10°
9 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 9°
10 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 8°
11 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 8°
12 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	31°/ 9°
13 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	31°/ 10°
14 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	28°/ 15°
15 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	28°/ 19°
16 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	30°/ 17°
17 Dec 2016	19.7 x 11 x 3	17.5 x 9.2 x 5	31°/ 16°

Result: No change in dimensions of brick.

2. *Compressive strength Test :*

In compressive strength test pressure was applied on the brick to find its compressive strength. Tests are done at "HITECH Construction Material Testing Laboratory". In this test pressure was applied gradually on the brick by a Semi-automatic compression testing machine. The tests are performed as per methods described in IS 15658(2006). Refer figure no.2

Table 2 Compressive strength of brick

Sr.No.	Length (mm)	Width (mm)	Net Area(mm^2)	Load (kN)	Compressive strength (N/mm^2)	Avg (N/mm^2)
1	185.9	88.8	16497.8	262	15.88	
2	189.4	86.6	16410.5	144	8.77	
3	187.8	91.4	17158.4	120	6.99	11.82
4	186.7	90.5	16890.8	201	11.90	
5	188.4	92.2	17374.2	270	15.54	

Result of compression test = 11.82 newton /mm^2.

3. *Water Absorption*:

The tests are performed as per methods described in IS 15658(2006).

Table 3 Water Absorption in Brick

Sr.No.	Dry Weight (g)	Wet Weight (g)	Water Absorption (%)	Average (%)	Efflorescence observation
1	2588	2592	0.15		
2	1620	1625	0.31	0.18	Nil
3	2997	2999	0.07		

Result: Negligible water absorption observed. No efflorescence observed.

4. *Salty Water Test:*

This test is done to check how much resistant is the brick to saline water so as to use it in coastal regions. Salty water was prepared by adding granular salt to hot water till the water solution becomes saturated i.e. anymore salt added to solution remains as it is and can't be dissolved.

Result: There was no change in structure of brick or effect of salt observed on brick.

Fig.2 Brick Testing

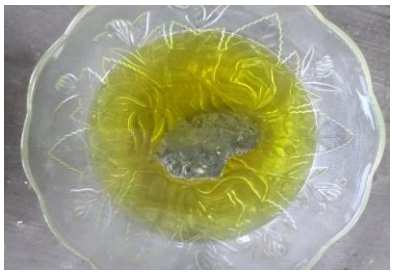

Fig.3 Acid Test

5. *Acid Test:*

Acid used: Concentrated Hydrochloric Acid (HCl). Refer figure no.3.

Table 4 Brick in Acid for one week

DAY	ACID QUANTITY	CHANGE OBSERVED
19 feb 2017	50ml	No change
20 feb 2017	100ml	No change
21 feb 2017	150ml	No change
22 feb 2017	200ml	No change
23 feb 2017	250ml	No change
24 feb 2017	300ml	No change

Result: No change in colour, dimensions of brick were observed. No emission of gases or change in structure of brick observed when acid is poured on brick.

6. *Effect of Changing Proportion of Sand: Plastic on Compressive Strength:*

Bricks were made with different proportions of sand and plastic. Later Compressive strength test was conducted on them.

Table 5 Compressive strength with changing Proportion of Sand and Plastic

Sr. No.	Proportion of SAND (%)	Proportion of PLASTIC (%)	Compressive Strength(N/mm^2)
1	85	15	16.9
2	80	20	15.88
3	75	25	15.54
4	70	30	15.2
5	65	35	11.9
6	60	40	10

Result: Optimum proportion for having maximum compressive strength is found to be 85:15 as sand: plastic.

7. *Effect of Changing Sand Type:*

The bricks were made from varied types of sand depending on size of sand particles.

Table 6 Changing Sand Type

Sr. No	Sand Type	Compressive Strength(N/mm^2)
1	River Sand (Coarse)	5.84
2	Construction Sand (small size)	15.88
3	Construction Sand (Coarse)	11.82

Result: Smaller the size of sand particles, higher compressive strength of brick was observed.

Fig.4 Coarse sand (River gravel)

Fig.5 Construction sand

8. *Hardness Test:*

In this test a scratch is made on brick surface using a steel rod. We can also use any other hard material as well. The scratch had no significant effect on any property of brick. This shows that the brick is of good quality.

9. *Fire Resistance:*

Individually plastic can be easily burnt. But Sand is an insulating material. Thus addition of sand to plastic gives insulation properties to plastic brick. No change is seen on brick upto 200degree Celsius, above this crack are developed on brick with increasing temperature.

10. *Potholes Filling:*

According to the report of TOI(Sept 21,2017,11:42 IST) Pothole-ridden roads have claimed 11,386 lives across the country over the past four years, which translates into roughly seven deaths a day. The material from which Plastic Bricks are made can be poured into potholes on road. This material immediately settles with any road texture and sticks to the base.

Fig.6 Mixture for filling Pothole

Fig.7 Pothole filled with mix

V. Results and Analysis

This Brick is made from plastic therefore no effect of oil, salts and acids is observed. It is less porous to water. Also, it can withstand compressive strength of 11.82 N/mm2. It does not expand on heating. On increasing plastic content, the compressive strength of brick decreased. On changing the type of sand, the compressive strength varies. Finer the sand more is the compressive strength of brick.

VI. Conclusions

This method can be an effective way to recycle plastic bags which otherwise remain out of the recycling process. This Brick can thus help in reducing pollution caused due to plastic bags. It can replace pavement blocks. As it is made from plastic it doesn't allow water to seep in. Hence, it is expected to have better life live twice than that of concrete blocks.

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