Recycling of used Milk Pouches to Tiles: An Innovative Green Initiative

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Abstract

In last century, the use, production and demand for plastic has increased dramatically due to urbanization and population growth. Plastic waste is one of the major contributors to the municipal solid waste. Being non-degradable, the plastic waste is a serious problem for environmental issues. Recycling of the plastic is one of the best solution to reduce the plastic pollution. Most of the plastics can be readily recycled. According to National Geographic Survey, a whopping 91% of plastic has never even been recycled till date.

Literature survey reflects that research studies on recycling of plastic waste to tiles is very less. Despite of the fact that tiles made from plastic will have less weight and more flexural strength compared to cement tiles. In our R & D work, we attempted to convert used milk pouches to tiles. In this paper, an attempt has been made to discuss the manufacturing of tiles by recycling of used milk pouches. The tiles manufactured from this method compared with other tiles for their properties and cost.

Keywords: - Green Initiative, Recycle, Plastic Waste, Milk Pouches, Reuse, Tiles

1. Introduction

Plastic production has expanded significantly over the past century as a result of the population's fast growth and rising demand for plastic. garbage from the food, paper, and plastic industries accounts for 9–12% of the weight of municipal solid garbage. Due to their slow rate of deterioration, plastic trash needs billions of years to degrade. Plastic trash buildup is a very important environmental issue. One of the best ways to lessen plastic pollution is to recycle plastic. The demand for virgin materials to make brand-new plastic products will decline as a result. Many plastics are easily recyclable, but 91% of plastic has never even been recycled, according to National Geographic.

The all of the "branded plastic" that comes from "dairy products packaging," such as milk, buttermilk pouches, yoghurt, and ice cream cups, is thrown away every day by homes. It's interesting to note that a "garbage audit" conducted by the NGO Chintan, which focuses on solid waste management, showed that the only "low-recyclable value cups and tetra packs" of Mother Dairy, Amul, etc. brands made up 36% of the total branded plastics gathered in a sample of mixed garbage in Delhi. Mother Dairy and Amul milk packets, which otherwise have "high-recycle value," accounted for 57% of the "single-layer plastic" after the garbage study. However, the companies lack any formalised collecting or recycling mechanisms. Due to their extremely poor resale value, Rag Pickers hardly ever select these milk packets. As a result, only a small percentage of milk pouches get recycled, while the majority clog sewers, float in rivers, or decay in landfills. At recycling facilities, these packages can be fully cleaned before being dried, chopped, and shred into small bits. These tiny grains are suitable for recycling.

Waste plastic can be recycled in a variety of industries, including those that produce fuel, home items, fabric and clothes, shoe bottoms, and more. Waste plastic is greatly needed to create construction materials. Another report proposed replacing cement in the production of construction bricks and concrete blocks with melted waste plastic bags. As the percentage of plastic in the bricks increased from 33.33 to 66.67%, their thermal conductivity decreased from 1.70 103 W/m K to 1.43 103 W/m K. The thermal conductivity decreased from 1.61 103 W/m K to 1.50 103 W/m K as Environmental Science and Pollution Research increased the plastic content in concrete blocks from 20 to 50%. As the plastic component of both the bricks and the concrete grew, so did the bending moment and bending stress. The brick's bending moment increased from 540.00 to 1711.25 N m and the bending stress from 3.24 to 10.26 N m2 as the plastic content increased from 33.33 to 66.67%. owing to its small size, excellent adaptability, and capacity to be modified to meet particular technological requirements. Waste plastic can be used to create building materials like concrete blocks and bricks (Abdel Tawab et al. 2020). In addition to other uses, a few research discussed the recycling of plastic trash to create other tiles. According to a report, we are able to produce roof tiles using sand and recycled high-density polyethylene (HDPE). Between 30 and 80% of the total weight of the combination was HDPE. The tiles were put through density, impermeability, and flexural breaking load tests. According to the findings, the density of tiles reduced from 1.8 to 1.379 kg/m3, impermeability decreased, but flexible strength increased as the percentage of plastic waste increased (Seghiri et al. 2017). For floor tiles, hollow blocks, and roof tiles, it was also alleged that waste plastic and shattered glass were used. In these, glass fragments can partially substitute river sand and plastic trash can replace cement. The percentages of plastic trash, fine glass, and fine sand in hollow blocks were 33%, 11.2%, and 44.6%, respectively. Floor tiles were made of 32% plastic waste and 68% glass, while roof tiles were made of 30% plastic waste and 70% glass. The 27 MPa comprehensive strength was discovered to be ideal. The typical breaking strength of roof tiles was found to be 2356 N.

Based on a review of the literature, it was found that very few research have examined the recycling of waste plastic into tiles. Despite having less weight and greater flexural strength than cement tiles, tiles manufactured of plastic will be lighter. Thus, our goal was to create tiles from recycled milk packets. Bathroom cement tiles were examined, and the mechanical qualities and cost of manufactured tiles were compared.

2. Materials and Methods:

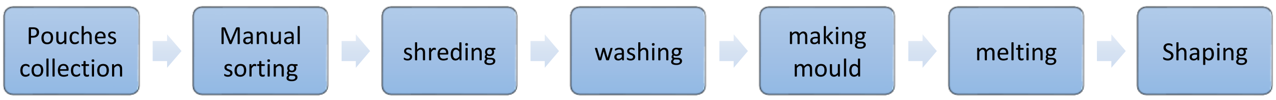
2.1 Materials used are as following;

Sawdust, discarded milk pouches with LDPE label were collected from houses, shops and from society.

2.2 Methodology of conversion from Plastic to tiles:

Unwanted elements were taken out of the waste and the various forms of plastic waste were sorted from one another. Then, for a lab-scale experiment, plastic bags were divided into smaller pieces using scissors and cutters.Using the right equipment under size reduction, plastic can be shredded on a greater scale. After that, the parts washed to get rid of adhesive, paper labels, dirt, and other leftovers. To give the molten plastic its final shape of the tile, we employ an appropriate mould. This was created by joining MS plates with welding. Along with it, a hammer created to exert vertical forces on the liquid plastic and condense it. Shredded plastic pieces were gradually added to the mould to melt, then the mould was heated. A fuel or an electric heater might be the heat source. Once the plastic reached the glass transition temperature, more plastic was added. After producing a sizable volume of molten plastic, we gradually put sawdust as a binder in the mould. In order to compress the plastic into a denser body and provide space for more shredded plastic and sawdust, vertical force was applied using a clamp or hammer as soon as the material softened enough to undergo deformation. We carried out the aforementioned process repeatedly until we had a tile of a specific thickness.

Compression testing, vertical flammability testing, and static friction testing were done to determine the mechanical strength of the tile. According to ASTM D 695-2015 Standard, a compression test performed. To calculate modulus, an extensometer attached to the fixture's front is employed. According to IS 15061:2002 Standard, a vertical flammability test was conducted. Tests for static friction conducted in accordance with ASTM D1894.



3. Results and Discussion:

For checking the properties of LDPE made tiles following test were done on the component:

3.1 Compression test:

According to ASTM D 695-2015 Standard, a compression test was performed. The typical specimen size for this is 12.7 x 12.7 x 25.4mm. The specimen is positioned between parallel Compressive plates. The material is thereafter crushed steadily. Stress-strain information is recorded simultaneously with the maximum load. To calculate modulus, an extensometer attached to the fixture's front is employed. Calculations for compressive strength and modulus are both helpful in this test. These equations are used to calculate them.

Compressive Load= Maximum Compressive Load / Minimum cross sectional area

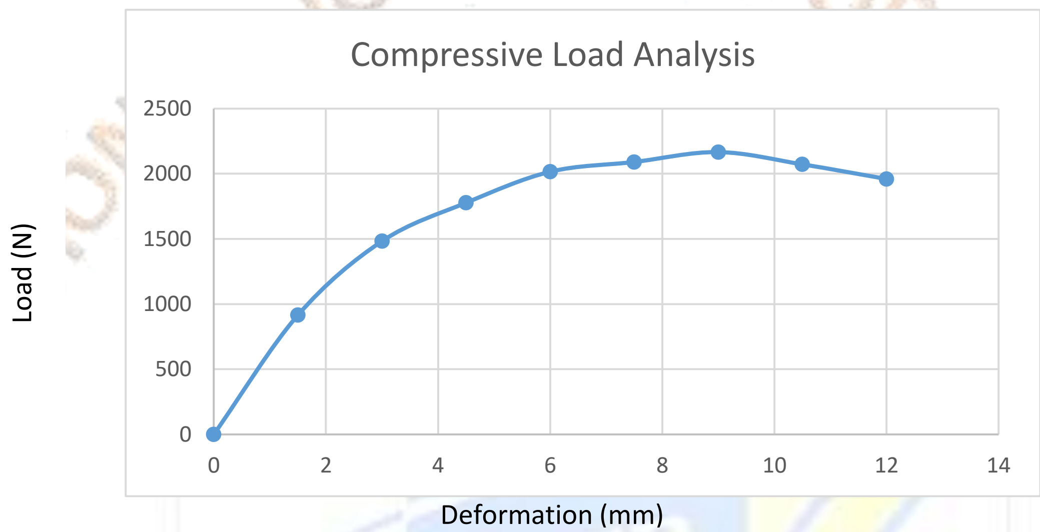


Figure 1: Effect of Load on deformation

Equipment used in this test are:

i. Instron universal tester

ii. Extensometer

3.2 Vertical flammability test

It was tested in accordance with IS 15061:2002 Standard. The test sample's dimensions were 10 x 13 x 95 mm. The burning rate should not be greater than 100 mm/min in order to pass this test.

Figure 2: Flammability test

3.3 Static friction test:

A block is placed on the component to be examined for this test. The block is attached to a horizontal string that is made vertical by being passed over a pulley. One end of the string is attached to a weight box, which is filled with more weights. It was noted the weight at which the block had just begun to move. Static friction coefficient was calculated using the followingformula:

Static friction coefficient = Total weight of the weight box / Weight of block

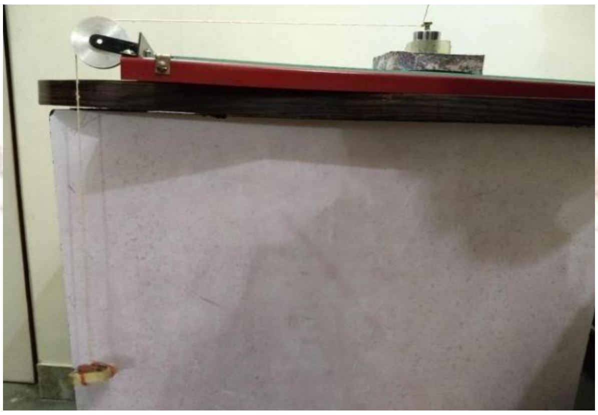


Figure 3: Friction Test

4. Cost Estimation:

The sample tiles we made have a dimension of 9cm×6cm.

We know that 1cm=0 feet 0.394 inch.

Hence dimension for 9cm×6cm in feet are; 0.2952×0.1959.

Area= 0.2953×0.1969 = 0.0578 Sq. ft

For this dimension the material cost for LDPE plastic of milk pouches require quantity is 20 bags of 500ml.

1 Kg of plastic cost 10-12 rupees in which there is approximately 90 to 100 plastic bags.For 20 pouches approximately 0.5 rupees cost estimated. Market wholesale price of sawdust is 2500 rupees per ton. 10gm require for sample dimension, thus 0.25 rupee is estimated.

The heating source we used is LPG for 30 min which cost 0.405 rupee to reach the temperature of 115 to120 0C for melting of LDPE plastic.

The total estimated price for 0.0578 Sq. ft is;

0.5+0.025+0.405=0.93 rupees

For 1 Sq. ft cost of tiles is approx. 16.08 rupees

Table 1: Compressive Strength Analysis

Sr. No	Sample Identification	Compressivestrength (MPa)	Peak Strength
1.	LDPE	16.97	2095.6

Table 2: Vertical Flammability Test

Sr. No	Specified	Observed	Remark
1.	The burning rate should not bemore than 100mm/min	Burning rate52 mm/min	Pass

Table 3: Comparative Analysis with Bathroom Tile

Material	μ			Average μ	Average Price
	1	2	3		
LDPE Composite	0.5	0.5	0.5	0.5	Rs.16.08 per sq. ft
Bathroom Tile	0.5185	0.5	0.5185	0.5123	Rs. 28 Per sq. ft

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Fig 4: Final LDPE tile

5. Conclusion

A completely recycled product manufactured at a very cheap price. The strength of the LDPE tile (2176 N) was found to be equally comparable to the strength of ceramic tile (2200 N). The material is unbreakable as against ceramic tile. The static friction factor is better than the available product making it suitable foranti-friction tile fittings. Manufactured tiles have good machinability in cutting and finishing. Manufactured tile floats on water, making it suitable for marine applications like rafts,floats,etc.

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