A SUSTAINABLE BRICK FOR A BETTER TOMORROW

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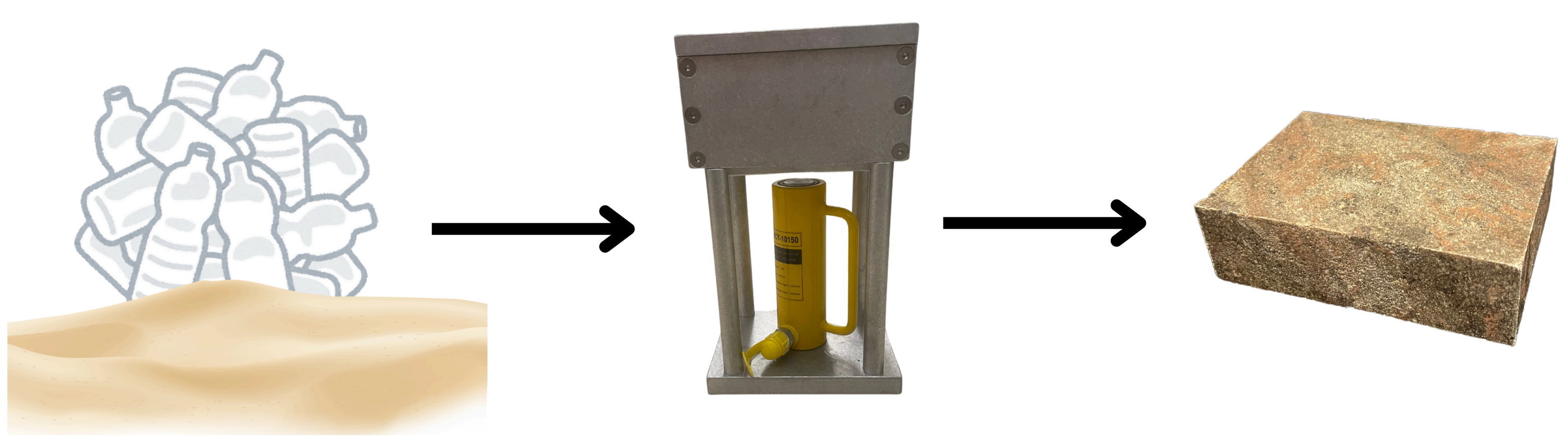
Introduction

The growing environmental concern surrounding plastic waste has prompted the exploration of innovative recycling and reusing methods. This research investigates the potential of utilizing high-density polyethylene (HDPE) and low-density polyethylene (LDPE) plastic waste to create sustainable bricks. Building on the work of Gjenge Makers, who have developed pavers from recycled plastic and sand, this study aims to evaluate the strength, durability, and environmental impact of plastic-sand composites and assess their viability as a substitute for conventional construction materials.



Procedure

Material Composition: 70% Sand, 30% High-Density Polyethylene (HDPE)
Raw Material Input per Brick: 3.10 lbs of sand mixed with 1.33 lbs HDPE plastic
Thermal Processing: The sand and HDPE plastic mixture is heated to 650ºF. At this temperature, the HDPE plastic melts, encapsulating the sand particles and forming a homogenous, dough-like composite material.
Compression Molding: 2 lbs of heated dough is transferred to a mold and subjected to 100 psi in a hydraulic press to form the brick.
Cooling through Water Quenching: The brick is rapidly cooled to solidify and stabilize the final dimensions and weight.
Average Dimensions of Bricks Created:

- 4.902" x 2.091" x 6.562"

Weight After Pressing and Cooling:

- 4.097lbs

Ongoing Research

Aggregate Addition:
Concrete is made of cement a binder, sand, and an aggregate like gravel. In the plastic brick, HDPE is the binder, so the addition of gravel could significantly increase the compressive strength of the brick. Tests would need to be run to find the optimal ratio of sand, plastic, and aggregate.

Recycling Waste:
The main goal of the research is to recycle plastic and create sustainable bricks. HDPE and LDPE plastic can be obtained from milk jugs, plastic bottles, piping, plastic bags, and food packaging. Ongoing research aims learn how to shred and repurpose the materials into strong building materials.

Colorful Bricks:
In an attempt to create a more appealing building brick, dyes can be added to the mixture allowing for customizable and colorful bricks.

Reducing Dimension Tolerance:
Bricks used in construction must adhere to strict dimension tolerances ranging from +/- 1/16 of an inch. The variation in thickness and mass indicates the need for improved dimensional accuracy.

Methodology

3-Pt. Bend Test

- Displacement of 0.05 in/min

$$S = \frac{3F}{wt^2}$$

- S = modulus of rupture of the specimen [psi]
- F = maximum load [lbf]
- w = specimen width [in]
- t = thickness
- S = 500.04 psi

Compressive Test

$$\sigma_{max} = \frac{F_{max}}{A}$$

- Force applied at a rate of 4000 lbf/min through the cross-section of the brick
- Max Force = 20000 lb
- Max Stress = 593.24 psi

Buckling Test

- Force applied at a rate of 2000 lbf/min
- Force applied through the length of the brick
- Max force = 19883 lb
- Max Stress= 1896.37 psi

Plastic Deformation

- The amount of irreversible change in the material thickness due to the applied forces.
- The sample had 0.0594 inches of plastic deformation

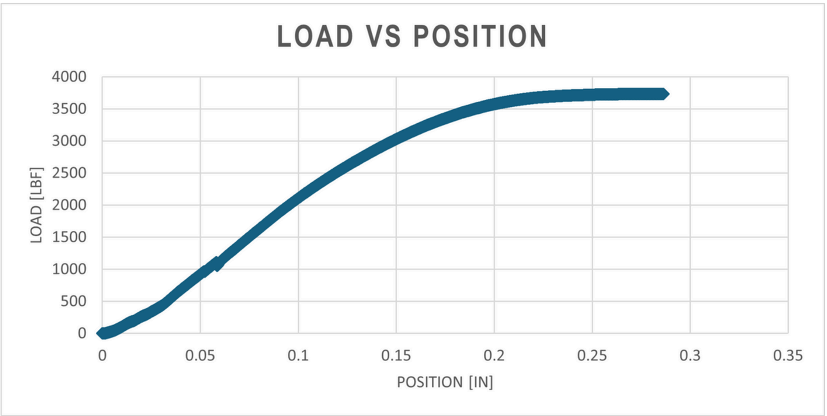
Specific Heat

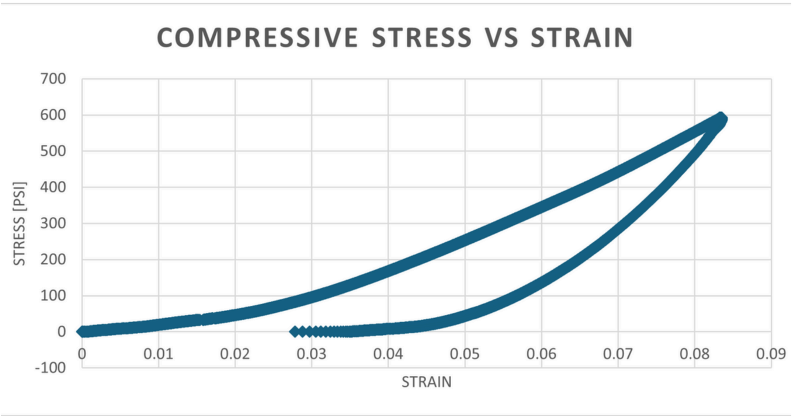
- Heating the specimen and a refractory brick and letting it air cool, recording temperature every 5 minutes

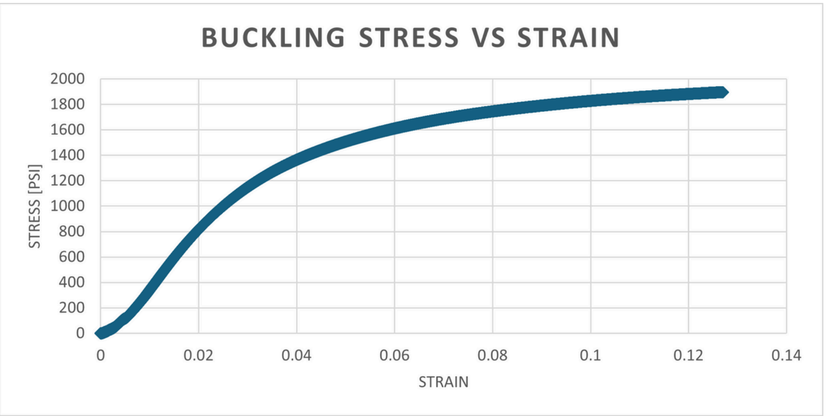
$$Q=mcT$$

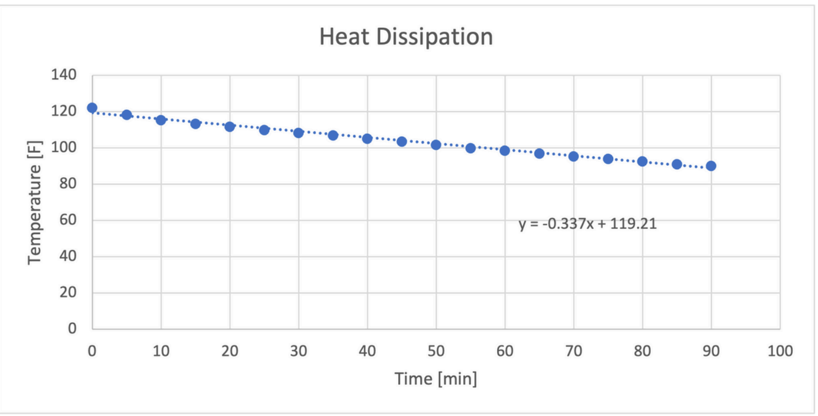
- Calculating specific het of the brick compared to the refractory brick it increased 3.5x.

Results









Conclusion

- The results of this experiment show that plastic waste can be recycled and used in building materials. 1 brick is manufactured using plastic equivalent to approximately 100 HDPE milk jugs. To determine its strength, the material was tested with flexural, compressive, and buckling loads. Standard clay bricks used today have minimum compressive strengths of 2200 psi. Our compressive strength was not reached however in the buckling test a stress of 1896.27 psi was reached. More testing will need to be conducted to determine the brick's limits.
- Testing determined the material properties of the brick, it is strong and durable while still experiencing plastic deformation and stress relaxation. After the loads increased the material had a period of relaxation reducing the stresses with the brick. The extent of the relaxation needs to be tested to learn how it could affect a structure.
- Preliminary tests show a significant increase in specific heat of the brick structure. Based off of the composition of the brick we expected results 1.3x the refractory brick. With the data showing a much larger increase, 3.5x, more tests need to be ran to confirm the results.

Acknowledgments

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