SMART
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The Behavior of Recycled HDPE Under Vertical Loads Using Stepped Isothermal Methods via TCI

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ABSTRACT

This research is concerned with the compressive creep behavior of the viscoelastic material, High Density Polyethylene (HDPE) commonly used to manufacture polymeric piling, decking, and fender elements. In this research, we developed a Mechanics Apparatus to control the temperature of a specimen as it is tested for creep. A load is applied to the specimen while the temperature changes. This apparatus facilitates experimental examination of the effect of combined temperature cycles and different loading rates on the durability of recycled (HDPE) specimen bars. Through a series of cyclic temperature variation, we collected experimental data and analyzed it from several aspects: ultimate strength under different loading rates at varied temperatures of 25 C, 38 C, 49 C AND 60 C. The Stepped Isothermal Method (SIM) have been adapted to study the time and temperature dependent compressive creep of HDPE.

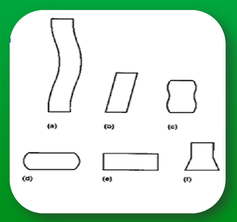
BACKGROUND

❑What is HDPE?

"High-density polyethylene (HDPE) (0.941 < density < 0.965) is a thermoplastic material composed of carbon and hydrogen atoms joined together forming high molecular weight products"(Gabriel, L).

❑Why use HDPE as piling/foundation for structures?

Traditional piling such as wood, metals or concrete are very susceptible to termites, the elements and erosion. It also alleviates the increasingly high cost to replace traditional piling. HDPE is also Environmentally friendly because it is possible solution to the large amount of plastic discarded into landfills each year in America.



Different modes of deformation in compression testing

Deteriorated traditional piling

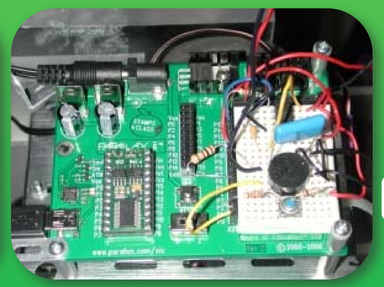
HDPE PILING

PROJECT GOALS

- Build a temperature control instrument (TCI) using basic stamp.
- Run compression tests on recycled (HDPE) specimen bars for eight hours at 400psi and 800psi.
- Control and increase the temperature every two hours the of the specimen using TCI.
- Record and analyze the data collected.

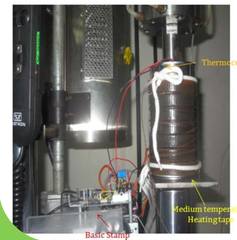
Instron Fasttrack™ 8800 Compression machine

Recycled HDPE specimen



Temperature control instrument (TCI) using basic stamp

HOW DOES THE TEMPERATURE CONTROLLER WORK?



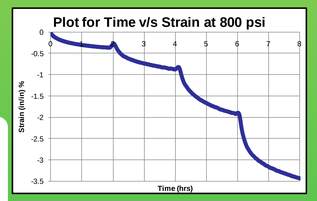
- The thermocouple, which is connected to the Basic Stamp, reads the temperature of the liquid surrounding specimen.
- The Basic Stamp then tells the heating tape through the DMP6402 relay to lower or raise temperature to produce the desired temperature we want.

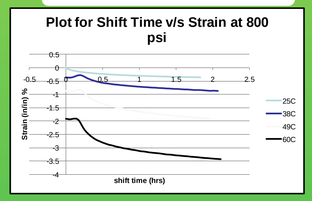
LABORATORY SET-UP

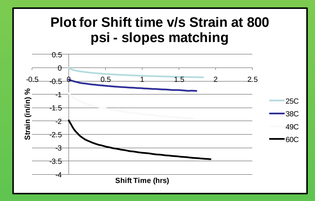
- The thermocouple is attached to the specimen.
- The heating coil is wrapped around a metal can where the specimen is placed and submerged in water.
- The specimen is sandwiched between two vertical rods of the compression machine, the top comes in direct contact with our specimen.
- Pressure is then applied on the specimen based on our pre-set parameters of 400psi and 800psi.
- Readings are recorded and expressed in a graph on the computer

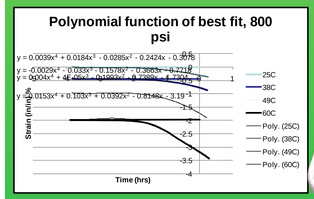
MATERIALS

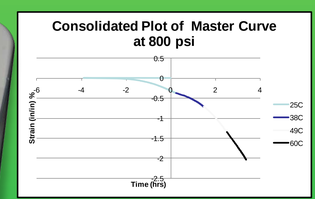
ANALYSIS OF DATA











Stress (psi): $\sigma = \frac{Load..(P)}{Area..(A)}$ Area: $A = \frac{\pi}{4} d^2$

$Strain = \frac{\Delta L}{L} = \frac{Change\,in\,length}{Initial\,length}$

PROCEDURES

➢We began by building a new and improved temperature controller instrument (TCI) using the basic stamp.

➢We ran several trails to insure that our TCI was performing properly and could also reach the maximum temperature require for our experiment (60 C).

➢We then wrote a basic stamp program that allowed us to have a stabilized temperature we desire.

We set the compression machine to produce pressure of 400psi and 800psi. The entire test per specimen, at each pressure was ran for 8hrs.

➢We let the thermocouple calibrate to 25 Celsius at least 15-20 minutes before we began our tests to stabilize the reading.

➢We then increased the temperature in 2 hour increments. Our first temperature change was from 25 C to 38 C, then 38 C to 49 C, and finally 49 C to 60 C.

➢At the end we removed the thermocouple and specimen from the liquid, after we turned off all the devices.

➢We examined the sample for any visible changes.

DISCUSSION

❑The temperature control instrument we built in the meets our requirements. It successfully controlled and stabilized the temperature of our specimen for a desire length of time.

❑The results are comparable to the outcome the obtained by the use of other testing methods for creep in prior research.

❑ The TCI had no limitation to reach a desired temperature level (it is able to reach temperatures up to 125˚C) within a reasonable time period of 5~ 10 min.

❑The test results indicate:

- Stepped Isothermal Method (SIM) are appropriate methods for accelerating creep in compression at stresses below 5.5 MPa (800 psi).
- Recycled HDPE experience plastic deformation at temperature at 60˚C test limit: A steeper strain (%) vs. time (hrs) curve is generated as the specimen enters its fourth temperature level of 60˚C.

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