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

Toufik Ayoub and Marcia Moore

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.

PROJECT GOALS
- Build a temperature control instrument (TCI) using basic stamp.
- Run compression tests on recycled (HDPE) specimens 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.

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, metal 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.

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 allows 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.

Acknowledgements: This material is based upon work supported by the National Science Foundation under an RET Site Project with Grant #: EEC-0807286: Science and Mechatronics Aided Research for Teachers (SMART). Special thanks to Dr. Magued Iskander, Saumil Parikh, Dr. Vikram Kapila and Jared Alan Frank for their help and suggestions.