Creep Test on HDPE and RFG Using the Stepped Isothermal Method. Temperature Control Instrument

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Abstract

Temperature-induced stresses can be a major concern for reinforced concrete structures in regions of drastic temperature changes. The use of fiber-reinforced polymers (FRP) and High Density Polyethylene (HDPE) has increased due to their excellent corrosion resistance, high strength-to-weight-ratio, and stiffness-to-weight ratio. However, different coefficients of thermal expansion of the constituent materials result in high residual stresses which can accentuate micro cracking and void generation in hot climates. This article presents the effects on durability of High Density Polyethylene and reinforced fiberglass reinforcing specimen bars due to combined temperature cycles and different loading rates. Specifically, the degradation of HDPE and FRP bars due to load cycling, compression, and compression fatigue loading are experimentally investigated. After a series of cyclic temperature variation, the properties of polymer and fiberglass rods are evaluated from several aspects: ultimate strength under different loading rates, elastic modulus, fatigue strength, and failure mode analysis.

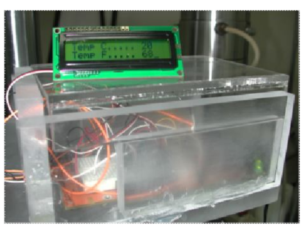
The goal of this Mechatronic/Soil Mechanic research is to present students with visual demonstration of material tested for creep when it is subjected to different temperature levels. The temperature control instrument (TCI) can be used in different areas where temperature is controlled/measured/recorded throughout the experiment.

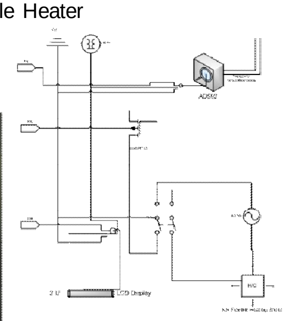
In our summer research at NYU-Poly, we have opted for an apparatus that will control the temperature of a specimen as it is being tested for creep. A load is applied to the specimen while the temperature changes. Data are collected and analyzed to determine the effect of temperature change on the specimen strength, strain, and elasticity. An extrapolation method is applied to predict the behavior of the specimen when time is prolonged.

High Density Polyethylene (HDPE) and reinforced fiberglass (RFG) samples are tested in compression to determine the creep effect for a temperature range from 24C to 60C under sustained loading, for 8 hours. A procedure for extrapolating creep strains to longer time intervals was then utilized. The procedure is based on applying time-shift factors to creep strain curves conducted at elevated temperatures to establish a master strain curve for longer intervals. The procedure was applied to test creep on virgin high density polyethylene (HDPE) rods and reinforced fiberglass at creep stress of 800 psi and at a temperature starting from 24C (room temperature), then increased to 38C after 2 hours and then increased to 49C after another 2 hours and to 60C at the end of 6 hours. Two type of specimen were tested. One sample named as "HDPE" is .75 in. in diameter and 1.5 in. in length, and the other sample "RFG" is .5 in. in diameter and 1 in. in length. Temperatures creep curves of 8-hours were shifted to create a 67-hour master strain curves at each loading level.

Materials used in creating the TCI;

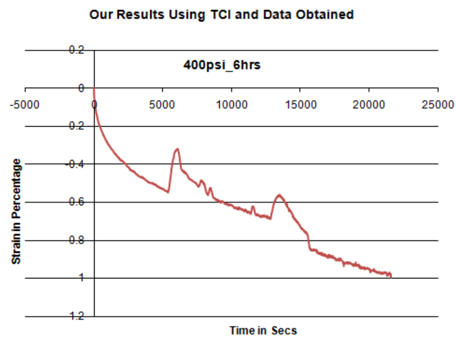
- ·Demo board from Parallax
- ·BasicStamp2p
- ·DS 2760
- ·Omega Kapton Insulated Flexible Heater
- ·2N3904 NPN Transistor
- ·16 x 2 non backlight LCD
- ·Plexiglas (for casing)





Temperature Control Instrument

Data



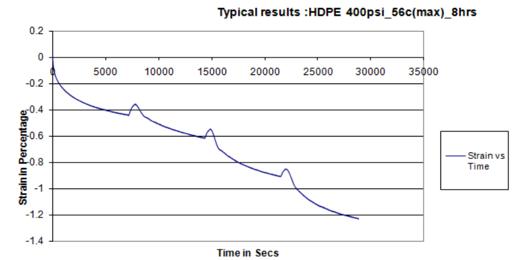
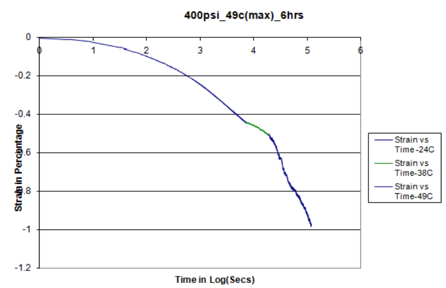
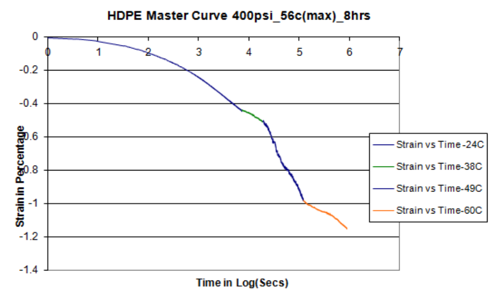
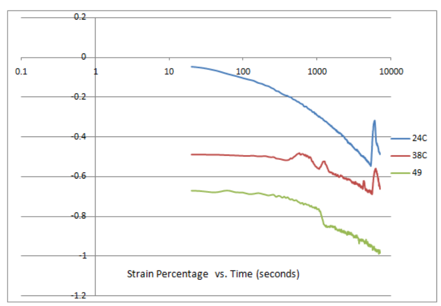


Figure 2 Plot for Time versus Strain at 400 psi







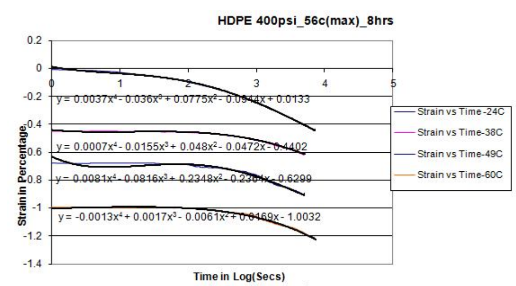


Figure 4 Strain versus time

Materials used;

- ·TCI
- ·Instron MTS 8000
- ·HDPE rods

Conclusions

Due to some limitation in temperature control, the TCI would not reach temperatures exceeding 56C. This is due to the low power supply that could not supply enough energy to the insulated heater to raise the temperature to our desired level of 60C. However, an attempt to preheat the specimen from a different source was done; the heater still could not hold that temperature to the desired level of 60C. We had to cut off the last 2 hour phase and only test at 24C, 38C, 49C, and 56C. A solution to the problem we encountered is to supply more power through the AC adapter for a larger active area of the insulated heater. A second solid state relay should added to the bread board, and an independent power source need to be connected to the insulated heater will solve the temperature problem. We coupled a second insulated heater, in parallel circuit configuration with the first insulated heater using the same external power source and the temperature of the water closely reached the desired level much faster.

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