

# **Long-term Design Properties of Corrugated HDPE Pipe**

August 10<sup>th</sup>, 2011

# Current Long-term Properties

- Tensile Strength
  - Short term value = 3000 psi
  - Long term value = 900 psi
- Modulus
  - Short term value = 110,000 psi
  - Long term value = 20,000 psi

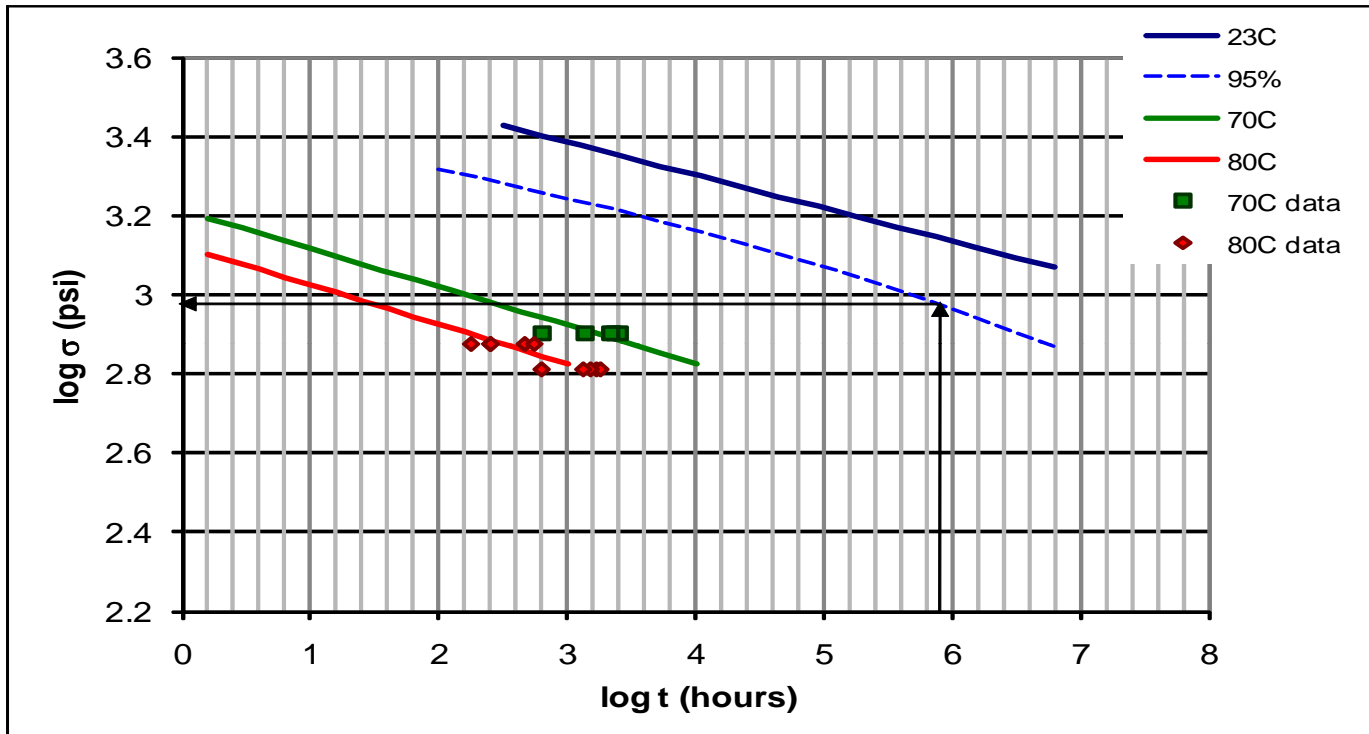
# Proposed Test Methods

- Long-term Tensile Strength will be determined by FM 5-572, Procedure B on pipe junction specimens.
- Long-term modulus will be determined by FM 5-577 on pipe liner.

# Long-term Tensile Strength

- Establish the SCR curves using FM 5-572, Procedure B.
- Perform tests at temperatures of 70 and 80°C and applied stresses of 650 and 450 psi, or others.
- Extrapolate test data to generate the SCR curve at 23°C with 95% confidence.
- Determine the applied stress corresponding to 100 year from the predicted 23°C curve.

### Predicted Life Time of at 23C



The 100-year tensile strength for corrugated HDPE pipe is predicted to be 800 psi.

## **Long-term Tensile Strength**

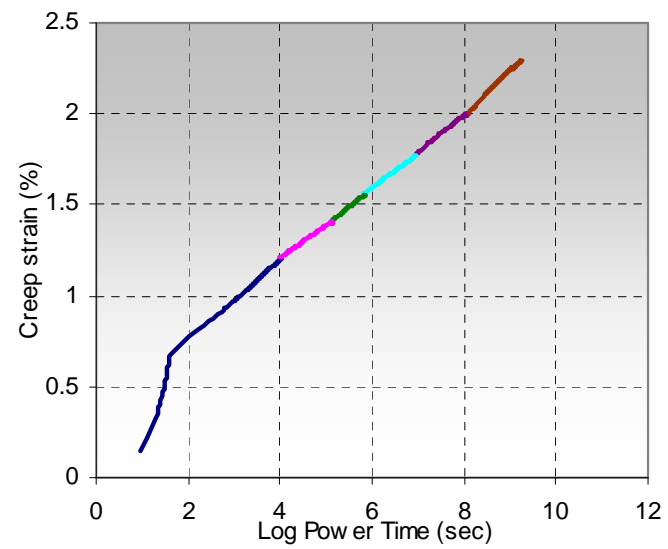
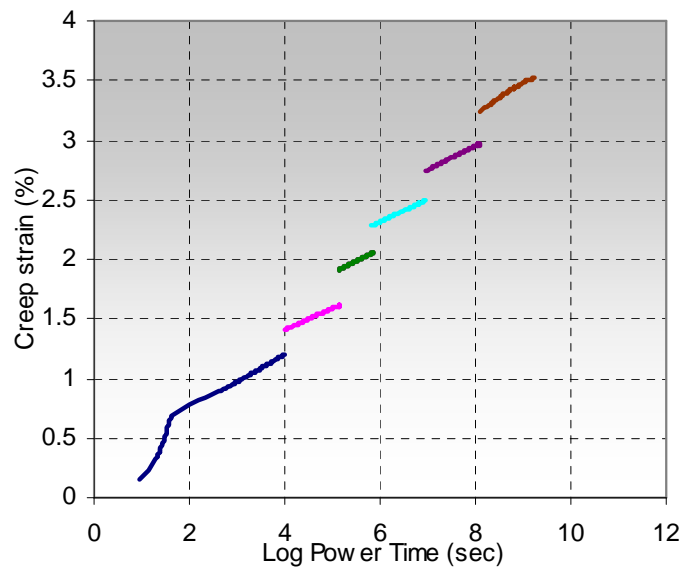
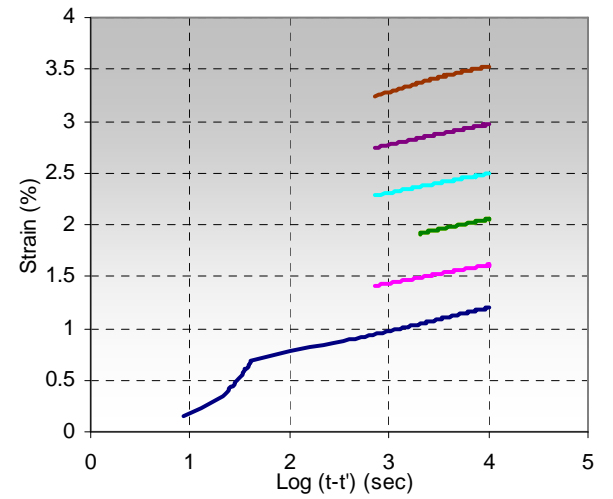
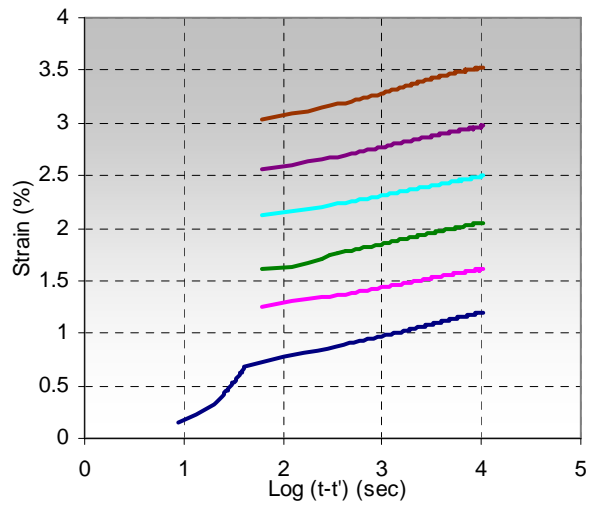
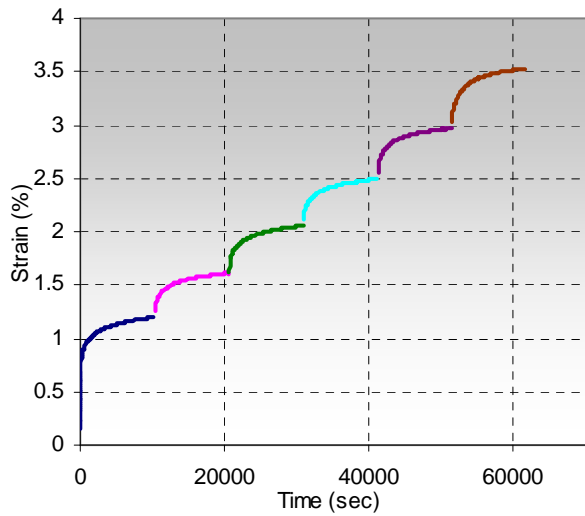
If industry would like to increase the recommended 100-year tensile strength, an interlaboratory test program should be carried out using slightly higher applied stresses defined in Section 948.

**Acceleration Creep Test to**  
**Determine the Long-term Modulus**

## **Stepped Isothermal Method (SIM)**

- It is a national standard test method, ASTM D6992
- The method has been successfully used to evaluate creep property of HDPE and PET geogrids.
- Single test specimen is subjected to a series of temperature steps under a constant stress.
- Master creep curve at 23°C can extend to 100 years.





# Round Robin Programs

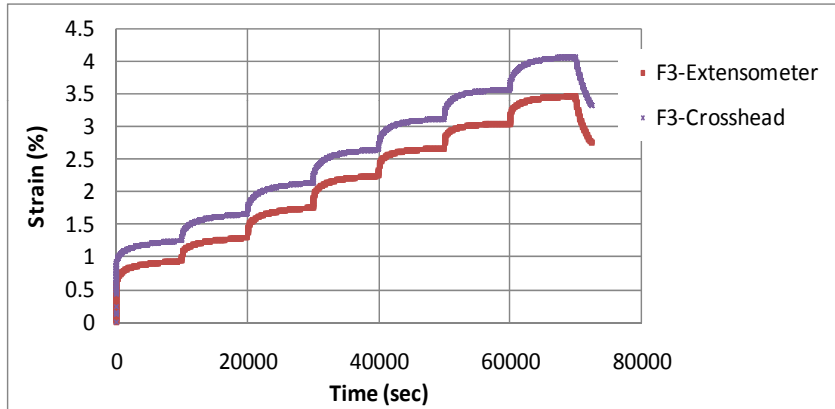
## RR-#1

- Identify the discrepancy of test procedure and apparatus among the four participating labs.
- Determine the appropriate method to measure the creep strain: cross-head movement of the tensile machine vs. strain gauge.

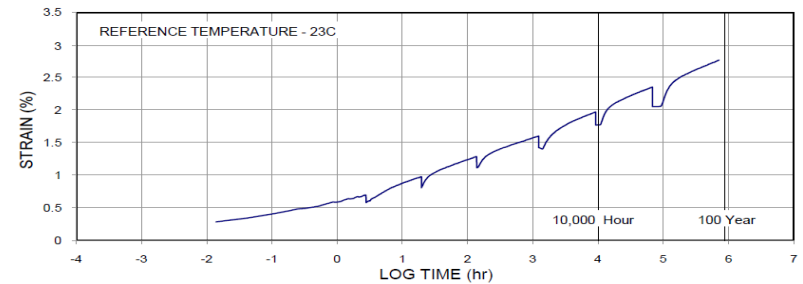
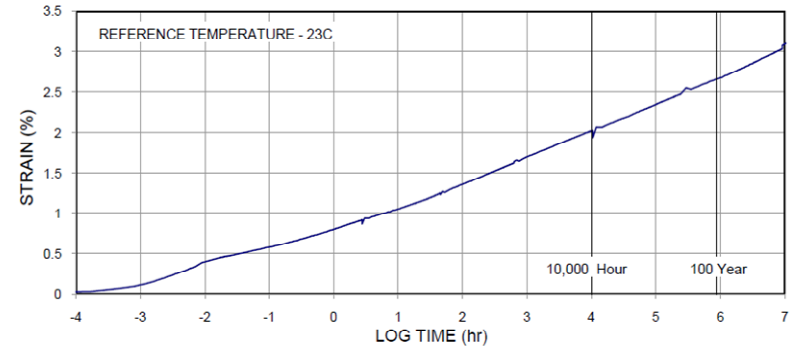
Strain Measurement Method	Strain Gauge	Cross-head Movement
Test Specimen	ASTM D 638, Type IV (Dumbbell specimen)	ASTM D 882 (1-inch strip specimen)
Gauge Length	1-inch	2-inch
Grip Distance	2.5-inch	2-inch

# Test Results

## SIM tests on 1-inch strip specimens



Strain gauge shall be used to measure creep strain



Time to equilibrium at each temperature step is essential.

## Findings

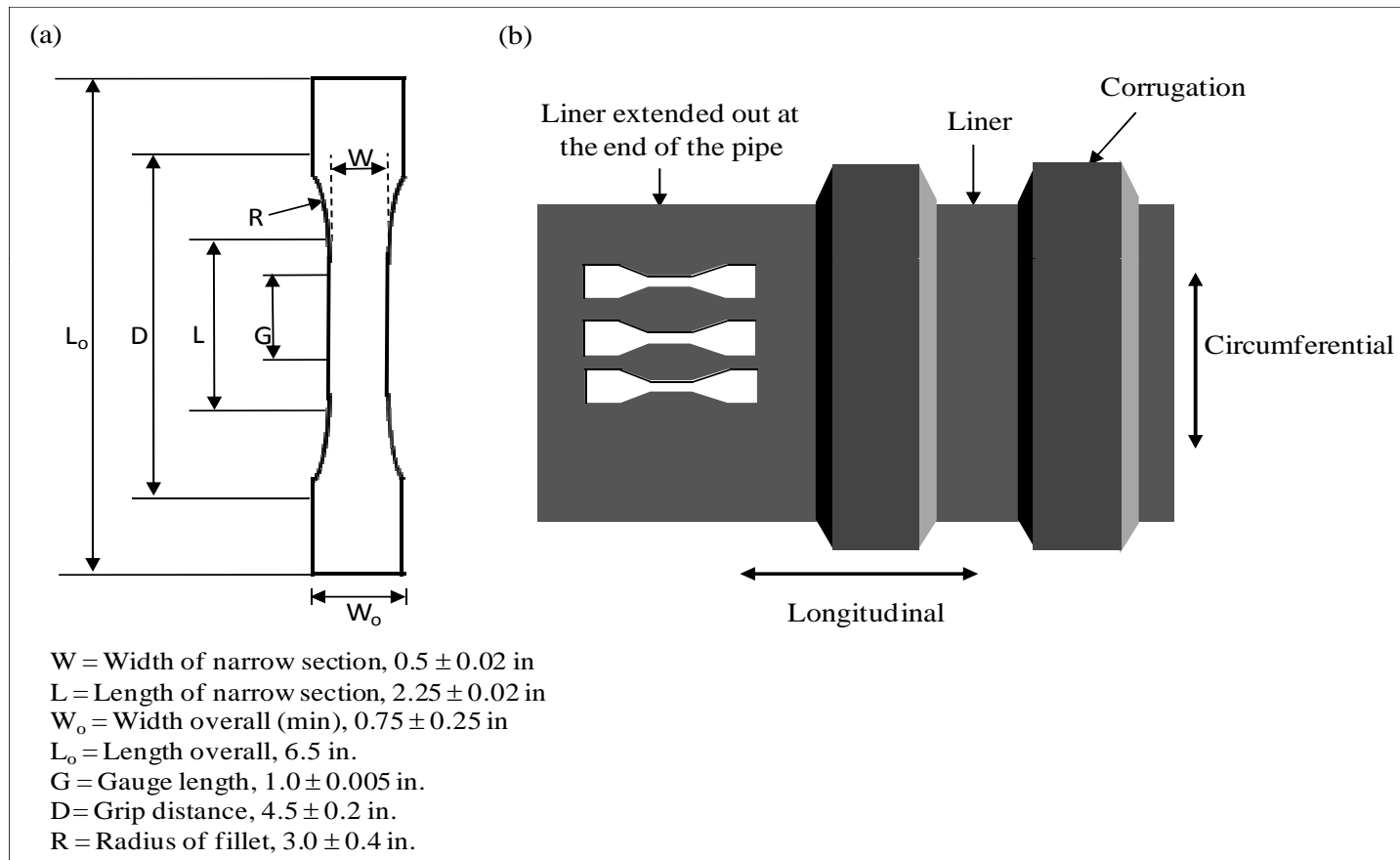
- Strain gauge must be used to measure the creep strain.
- The duration to reach equilibrium at each temperature step should be within 15 minutes.

# Round Robin Programs

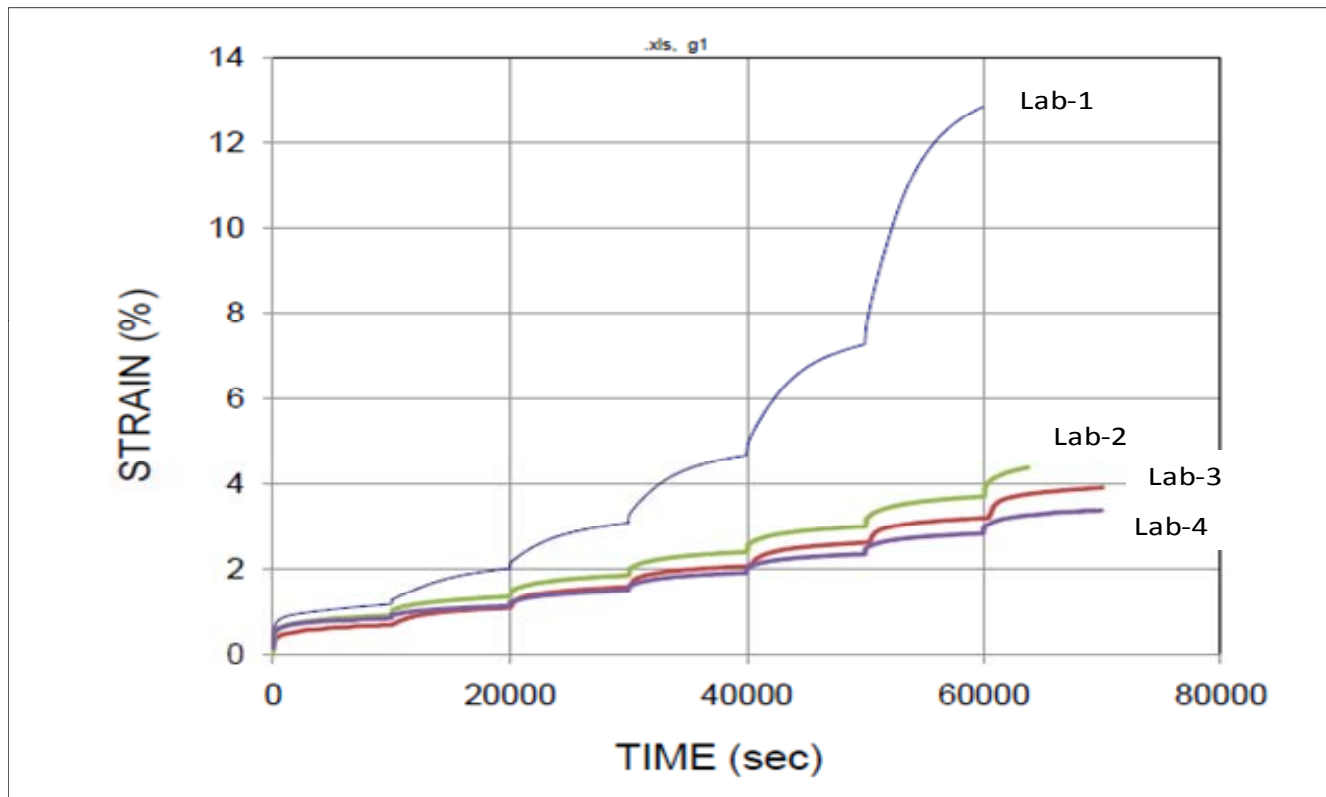
## RR-#2

- Investigate the variability of temperature control and strain gauge.
- Use the “top-hat” material of the pipe instead of the pipe liner portion of the pipe.

# Location of Test Specimen



# Test Results



Lab-1 used load cell to control the applied force.  
Others used dead load to apply the force to the specimen

## Findings

- The top-hat material is too thin to be used for the SIM test. A compressive stress may be introduced by attaching the strain gauge to such thin material subsequently affecting the creep strain.
- Dead-load must be used to apply force to the test specimen in the SIM test.

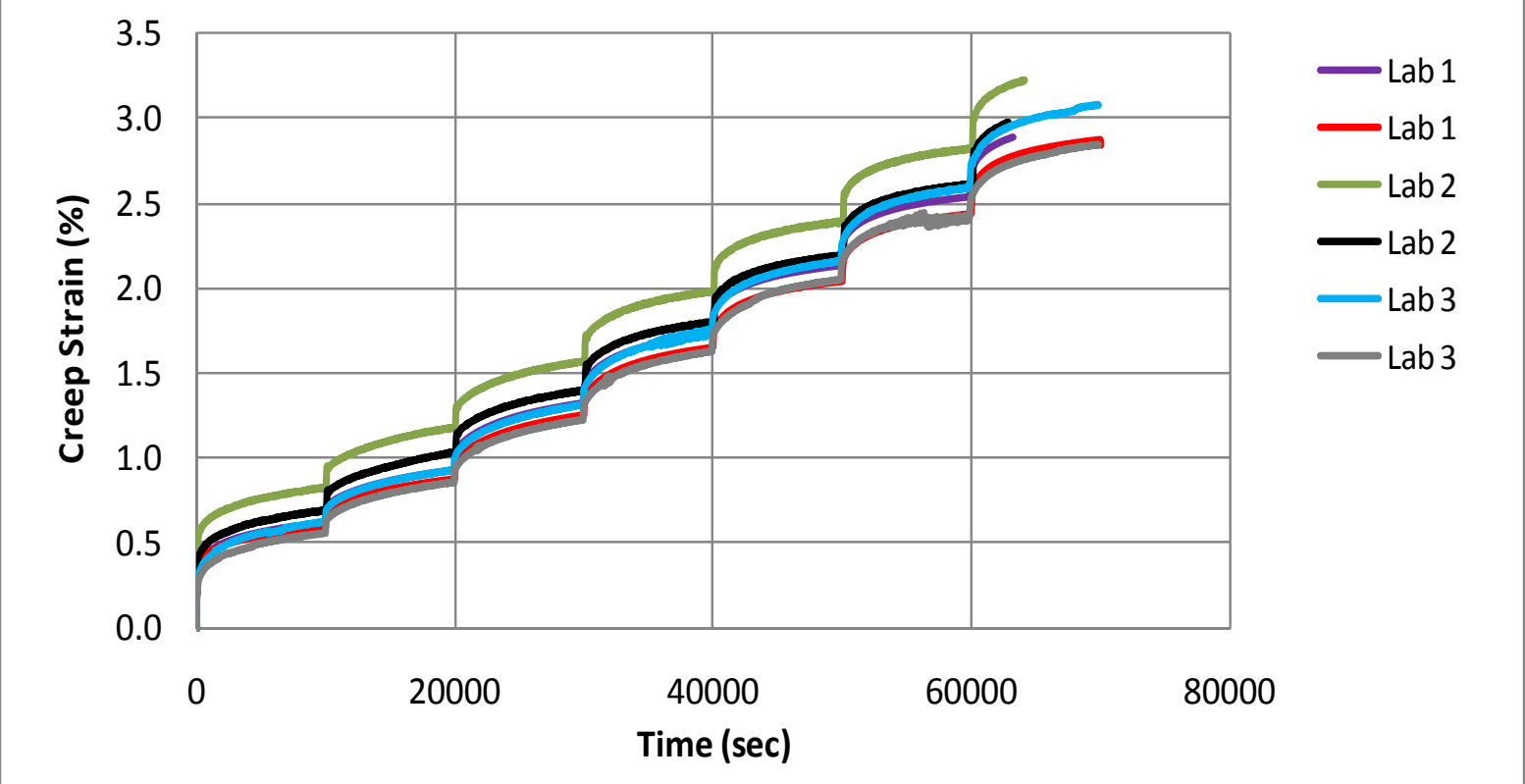


# Round Robin Programs

## RR-#3

- Isolate the variability contributed by the test equipments from that by the test specimens.
- Test specimens were taken from the compressive molded plaques instead of pipe liner.

# Test Results



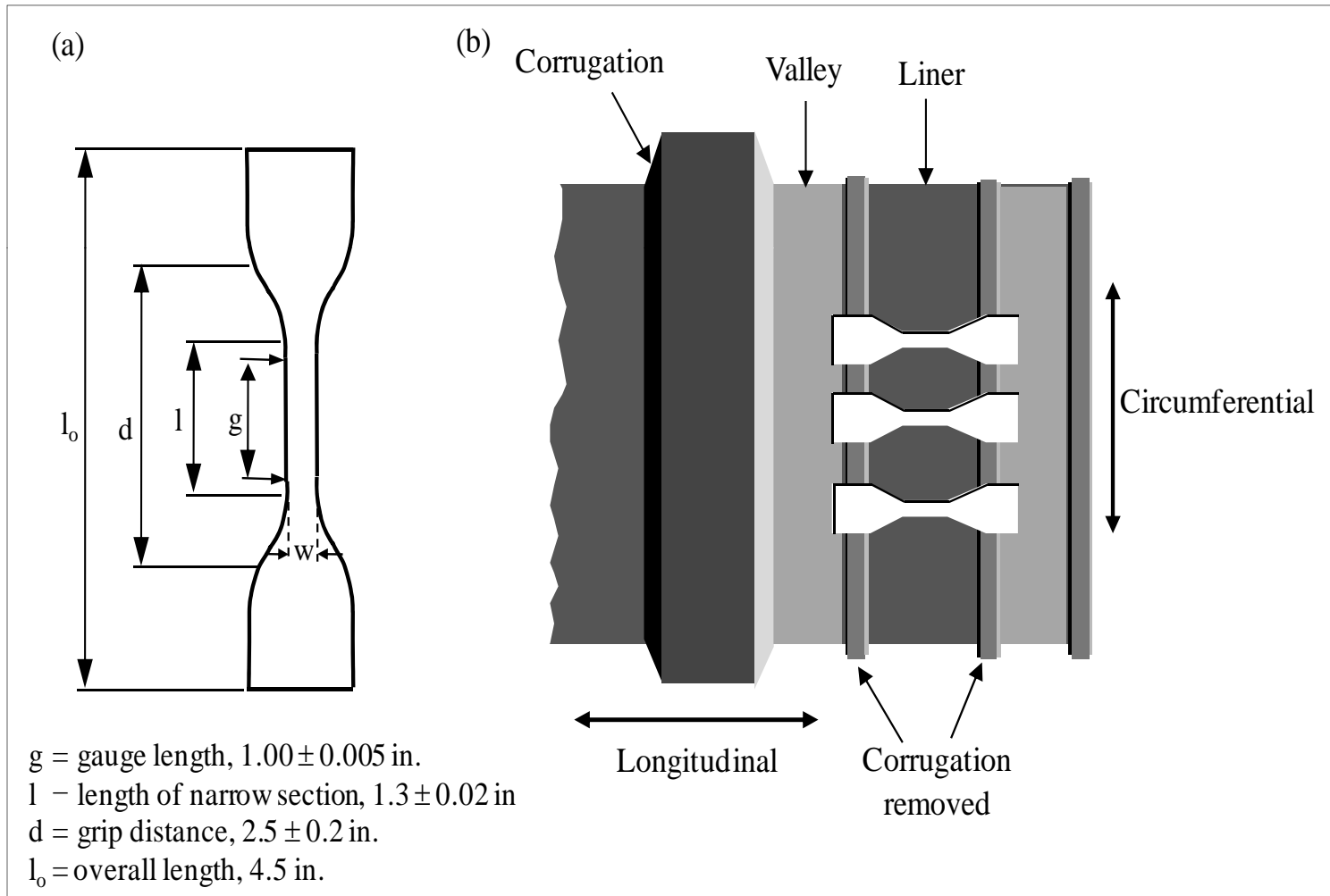
Waiting for the results from Lab. 4

# Round Robin Programs

## RR-#4

- Test specimens will be taken from the liner part of the pipe.
- Three types of resins and two manufacturing processes will be evaluated.
- Results will be used to determine the long-term modulus value with 95% confidence.

# Location of Test Specimen



# Summary

- The test methods to determine long-term tensile strength and modulus have been established.
- Long-term tensile strength value has been recommended.
- Long-term modulus value will be established in couple months (October, 2011).