Long-term Design Properties of Corrugated HDPE Pipe

August 10th, 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.
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.

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

W = Width of narrow section, 0.5 ± 0.02 in
L = Length of narrow section, 2.25 ± 0.02 in
W_o = Width overall (min), 0.75 ± 0.25 in
L_o = Length overall, 6.5 in.
G = Gauge length, 1.0 ± 0.005 in.
D = Grip distance, 4.5 ± 0.2 in.
R = Radius of fillet, 3.0 ± 0.4 in.
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**

- **Corrugation**
- **Valley**
- **Liner**

**Dimensions:**
- $g = \text{gauge length, } 1.00 \pm 0.005 \text{ in.}$
- $l = \text{length of narrow section, } 1.3 \pm 0.02 \text{ in}$
- $d = \text{grip distance, } 2.5 \pm 0.2 \text{ in.}$
- $l_o = \text{overall length, } 4.5 \text{ in.}$
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).