Trenchless Technology Center
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Results of ASTM D2990 - Flexure Creep Test for Aqua-Pipe®

PREPARED FOR

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1 Introduction

This report summarizes the flexural creep test results for AquaPipe®, manufactured by Sanexen Services Environnementaux Inc. as per ASTM D 2990-09 – "Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics". The test commenced on August 2nd 2012 and terminated on September 20th 2013, spanning a total of 10,104 hours.

2 Flexural Creep Test (ASTM D2990)

The flexure test setups were fabricated using steel channels and bars. The experimental setups were placed inside the TTC's environmental chamber. A programmable air condition unit and a humidifier were utilized to ensure temperature of 23 ± 2°C and humidity 50 ± 5% over the duration of the test. For the bending creep samples, the dial gauge was positioned between the specimen and the applied load, at the center of the specimen. Images of the experimental setups housed inside the environmental chamber are shown in Figure 1.

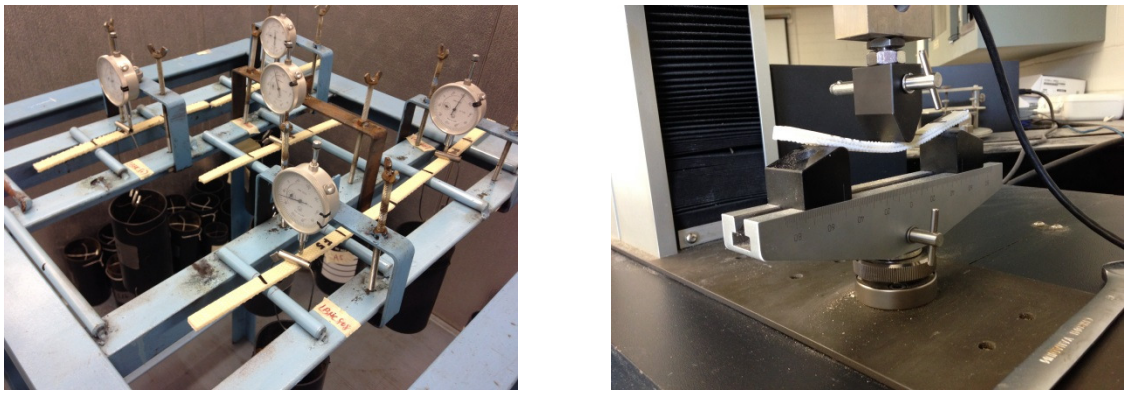

Figure 1: Specimens inside the Environmental Chamber (left) and Short Term Bending Test (right)

The loads were applied rapidly and smoothly within a period of 1 to 5 seconds. The first set of data was recorded in accordance with the following time schedule: 1, 2, 6, 12, 18 and 30 minutes; 1, 2, 5 and 20 hours; every 24 hours until reaching 504 hours; every 48 hours between 504 hrs to 1,032 hrs; every 96 hours between 1,032 to 3,528 hrs; and finally weekly from 3,528 hrs to 10,104 hrs.

3 Flexure Creep Test Results

Five samples were subjected to flexure creep test, but one of the experimental setup was disturbed and therefore, discarded in the final report. Flexure strain results are shown in Table 1 for the four (4) specimens.

Table 1: ASTM D2990 Bending Creep Specimens' Information and Test Results

Sample ID	Load (lb)	Sample Length (in)	Sample Width (in)	Sample Thickness (in)	Maximum Stress (psi)	Maximum Strain (%)
F-1	0.5	4	0.526	0.205	135.563	0.048
F-2	1.0	4	0.472	0.208	294.147	0.094
F-3	2.0	4	0.516	0.199	588.161	0.231
F-4	2.5	4	0.517	0.200	725.437	0.270

The flexure strain versus duration (normal-log scale) at various stress levels is given in Figure 2. Increase in strain levels was observed due to the externally applied load, suggesting that the specimens were in the secondary phase of their stress-strain history curve at the end of the 10,000 hours test period.

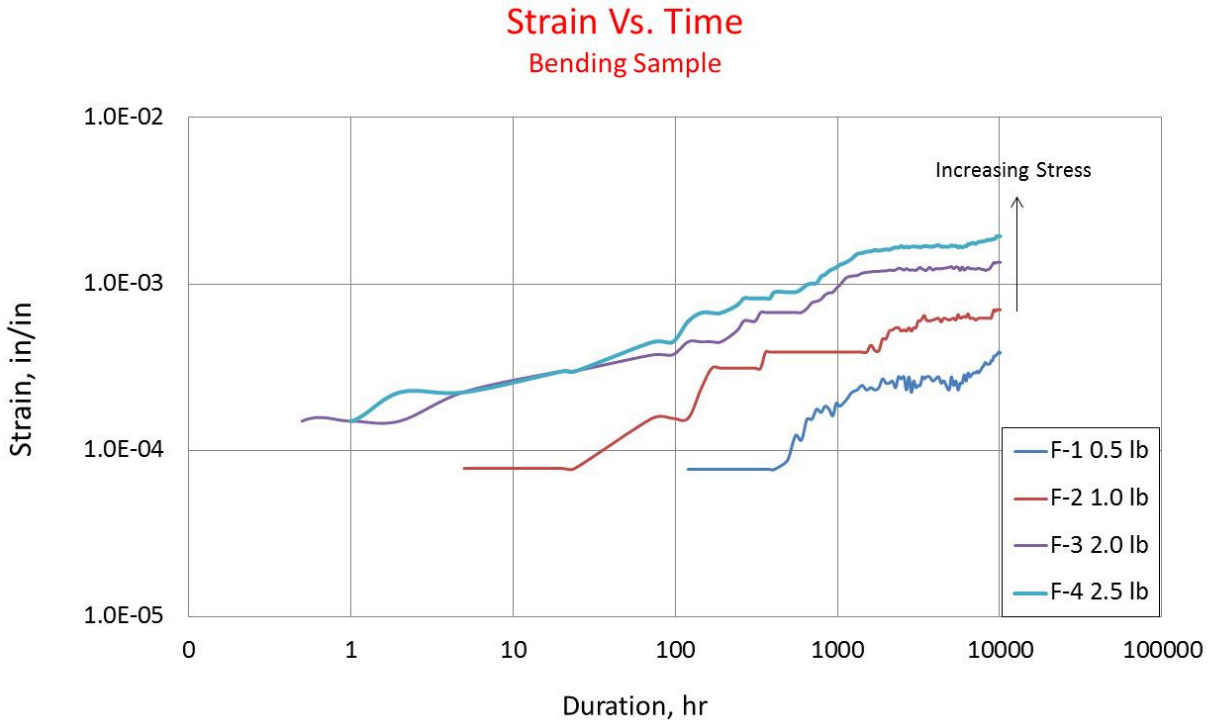

Figure 2: Logarithmic Creep Strain vs. Time at Various Stress Levels

Flexure creep modulus versus time curve is shown in Figure 3. The Figure 3 displays the trend lines based on power equation that are plotted for the measured strain data. The 50 years creep

value of flexure modulus (E_{LT}) was estimated by extending the experimentally measured trend line.

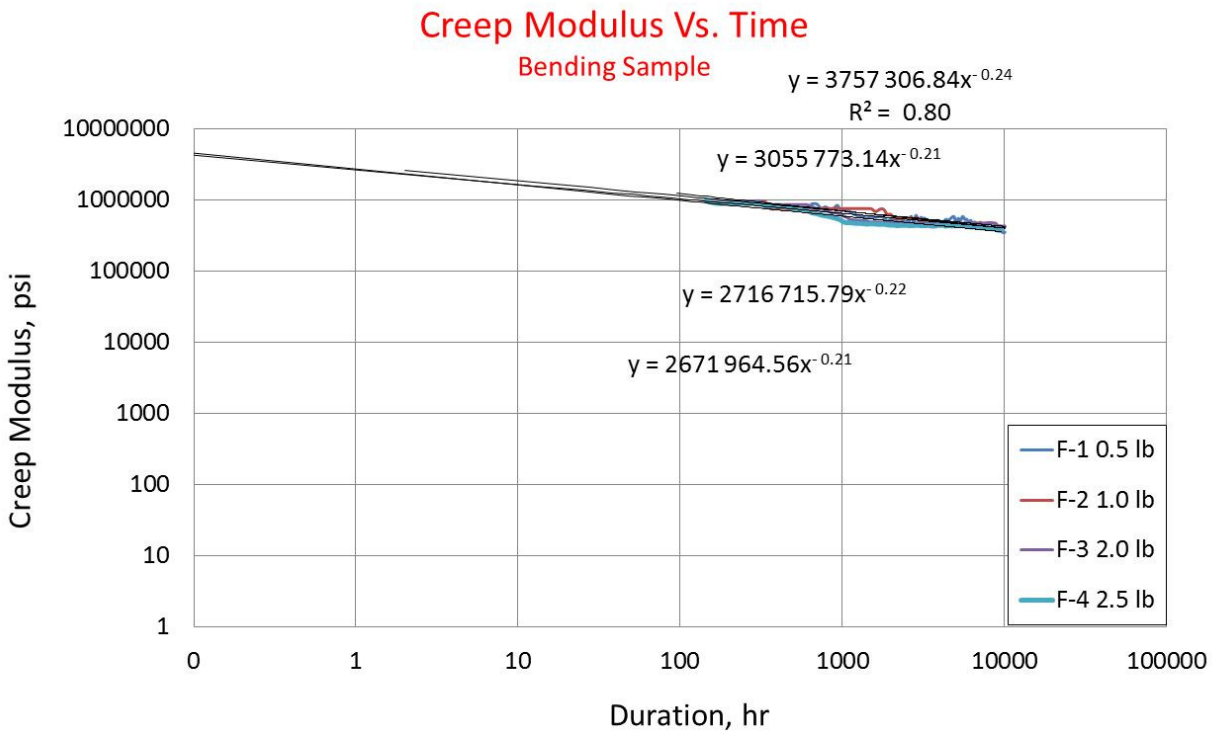

Figure 3: Logarithmic Creep Modulus vs. Time Curve

4 Short Term Flexural Test Results

Short term flexure tests were performed on five (5) specimens prepared from the same CIP flat panel. Peak bending stress and bending modulus (E_{ST}) values are summarized in Table 2.

Table 2: Short Term Bending Test Results

Sample ID	Sample Length (in)	Sample Width (in)	Sample Thickness (in)	Bending Stress (psi)	Bending Modulus psi
1	4	0.501	0.201	9,597	283,975
2	4	0.502	0.203	9,303	297,795
3	4	0.504	0.203	8,797	282,722
4	4	0.496	0.201	9,409	286,625
5	4	0.496	0.199	8,927	297,660
			Average	9,207	289,755

5 Conclusion - Projected Flexure Creep Modulus

Percentage of flexure creep modulus for 50 yrs (438,000 hrs) calculated using the power equations obtained from the trend line drawn in Figure 3 are shown in Table 3. The flexural creep retention factor was found around 60%.

Table 3: Comparison of Short Term and Long Term Flexure Modulus

Applied Load, lb	A	50 yr Duration, hr	B	Creep Modulus, psi	Average Short Term Flexure Modulus, psi	$\frac{E_{LT}}{E_{ST}} \times 100$
0.50	3,757,307	438,000	-0.24	166,312	289,755	57.4%
1.00	3,055,773		-0.21	199,715		68.9%
2.00	2,671,965		-0.21	174,631		60.3%
2.50	2,716,716		-0.22	155,927		53.8%
			Average	174,146		60.1%

6 Reference

ASTM D2990-09 - "Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics".