Flexural Testing of CIPP

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Routine Quality Assurance of CIPP Installations

- Each CIPP installation is unique
- To ensure the quality of an installation, contractors and their clients:
  - Control input variables
  - Verify outcomes
Routine Quality Assurance of CIPP Installations

Verify outcomes

- Video inspection
- Dimensional inspection
- Initial Structural Properties
Testing Process

- Contractor prepares field sample
- Test laboratory:
  - measures wall thickness
  - prepares 5 flexural test specimens
  - tests the samples and prepares report
What is the Data Used For?

- Confirmation that initial properties are achieved after curing
  - 1st – ASTM F1216 minimums

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Minimum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural strength</td>
<td>D 790</td>
<td>4 500 (31)</td>
</tr>
<tr>
<td>Flexural modulus</td>
<td>D 790</td>
<td>250 000 (1 724)</td>
</tr>
<tr>
<td>Tensile strength (for pressure pipes only)</td>
<td>D 638</td>
<td>3 000 (21)</td>
</tr>
</tbody>
</table>

*The values in Table 1 are for field inspection. The purchaser should consult the manufacturer for the long-term structural properties.*
What is the Data Used For?

- Confirmation that design objectives were achieved after curing
  - 2nd – Design thickness and modulus
Initial Structural Properties

ASTM F1216-09 specifies:

- Flexural Strength and Flexural Modulus are determined with ASTM D790
Initial Structural Properties

Test Results
- Width: 0.5015 in
- Depth: 0.1960 in
- Support Span: 3.1360 in
- Flexural Tangent Modulus: 2920.1570 MPa

Test Summary
- Counter: 1309
- Elapsed Time: 00:04:59
- Operator: CHRIS
- Specimen Identification: H0E50070-2
ASTM D790 was not designed for CIPP

Method defines a test specimen with a rectangular cross section.
ASTM D790

- PVC Pipe Form
- CIPP Field Sample
- Test specimen blank
ASTM D790

3 types of test specimen permissible

A  B  C
ASTM D790

2 test orientations permissible

ID in Tension  ID in Compression
ASTM D790

Through thickness location can vary

Outside Diameter

Inside Diameter
2010 Study of 9 CIPP Materials

Tested:
Specimen type, orientation, test location

Results:
All three factors predictably & significantly influence flexural test results
Study Results
Specimen Type

**Flexural Strength**
Type B as much as 39% higher than Type A

**Flexural Modulus**
Type B as much as 54% higher than Type A
Study Results
Test Orientation

Flexural Strength
ID in tension as much as 44% higher

Flexural Modulus
ID in tension as much as 57% higher
Study Results
Test Location

Flexural Strength
ID location as much as 51% higher

Flexural Modulus
ID location as much as 58% higher
Possible Causes

- Difficult to measure non-machined original surfaces accurately.
- During curing, inside diameter of CIPP achieves higher temperature for longer time than outside diameter.
Issues That Arise

- Large variation in test data between labs
- Difficult to confidently use data to confirm contract compliance
  - 1st – ASTM F1216 minimums
  - 2nd – Design modulus
Higher Flexural Properties
+ Lower Variation
Questions?

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