Industry updates regarding AASHTO M 294 revision incorporating Recycled Materials

COMP - Technical Subcommittee 4b
August 7, 2018
Research Overview

- **NCHRP Project 4-32 – Performance of Corrugated Pipe Manufactured with Recycled Content**
  - $350,000 project, TRI was prime contractor
  - Completed in 2011 and published in *NCHRP Report 696*

- **NCHRP Project 4-39 – Field Performance of Corrugated HDPE Pipes Manufactured with Recycled Materials**
  - $600,000 3-year project built on Project 4-32; TRI and Crossroads Engineering Services were Principal Investigators
  - Completed in 2016 and will be published in *NCHRP Report 870*

- **Evaluation of Corrugated HDPE Pipes Manufactured with Recycled Materials in Commuter Railroad Applications**
  - PhD Dissertation, published by Michael Pluimer, PhD in 2016
Research Background

- Evaluated **28 different recycled resins** (25 PCR, 3 PIR), **75 different blends** of virgin and recycled materials, and **24 full-scale pipes** (4 different manufacturers) manufactured with various blends of recycled materials

- Service life model validated on 9 full-scale pipes containing a range of recycled material blends

- Over 1000 different tests conducted

- 11 years of research (contract started in Feb. 2006), project budget of $950,000 ($350K for NCHRP 4-32, $600K for NCHRP 4-39)
Background - Past Research

• Both post-consumer (PCR) and post-industrial (PIR) recycled materials evaluated, but focus on post-consumer

• Included both field and lab testing, as well as the development and validation of a service life prediction model
Overview of Recycled Materials for Corrugated HDPE Pipe

- Post-consumer recycled (PCR) PE materials
  - PE materials from products that have served a previous consumer purpose
  - Flake or reprocessed pellets
  - More readily available than PIR materials and more consistent in performance, though may have lower stress crack resistance
  - Approx. 5.5 billion pounds of these materials in agricultural and land drainage pipes over past 20 years!
NCHRP Report 870 Validated Service Life Prediction Method

• Every pipe that was predicted to crack developed cracks within the predicted timeframe, both for the parallel plate test and the simulated field test

• None of the pipes that were not predicted to crack developed cracks

• The UCLS test provides the basis for a true performance-based specification for pipes manufactured with recycled materials

• The percent recycled content isn’t as important as the final blend properties
  • NCLS, UCLS & OIT test properties that govern service life
All material properties and performance expectations specified in M294 are identical for pipe made with virgin or recycled resins

- pipe stiffness
- impact strength
- flattening
- stub compression
- dimensions
- workmanship
- same cell classification 435400C
- same NCLS criteria
Additional requirements for M294 Pipe made with Recycled Resins

- **Pipes manufactured with recycled materials must also meet the following criteria:**
  - Average UCLS failure time must exceed a minimum calculated value to ensure that service life exceeds 100 years
  - Minimum OIT of 20 minutes (ensures resistance to Stage III chemical failure)
  - Elongation at break must exceed 150% (redundant contaminant test)

- **None of the test pipes made with recycled materials and evaluated in NCHRP 4-39 met the final requirements specified in the standard**
M294 Revision Implementation

- Published by AASHTO June 13, 2018
- No guidance for implementation or “grandfathering”
  - No pipe marked M294R prior to 6/13/18
  - Pipe marked M294 (only) is made with virgin only if manufactured prior to 6/13/18
  - State-by-state implementation is assumed
- NTPEP – setting implementation of August 1, 2018
  - Pipe produced after 8/1 must either be marked M294V or M294R
  - Pipe produced between 6/13/18 and 8/1/18:
    - Either M294 or M294V (for virgin only).
    - Pipe produced with recycled resin content must be marked M294R and “contains recycled resins”
## NTPEP Audits for M294 Pipe Production

### Section 3: Standard Specifications

<table>
<thead>
<tr>
<th>Auditor Note - Indicate if current versions of the following AASHTO &amp; ASTM standards are available at the plant.</th>
<th>AASHTO</th>
<th>ASTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification for Corrugated Polyethylene Drainage Pipe</td>
<td>M 252-09</td>
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<tr>
<td>Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter</td>
<td>M 294-10</td>
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<tr>
<td>Test Method for Tensile Properties of Plastics</td>
<td>D 638-10</td>
<td></td>
</tr>
<tr>
<td>Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulation Materials</td>
<td>D 790-10</td>
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<tr>
<td>Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer</td>
<td>D 1238-10</td>
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<tr>
<td>Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement OR Test Method for Density of Plastics by the Density-Gradient Technique</td>
<td>D 792-08</td>
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<tr>
<td>D 1505-10</td>
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<tr>
<td>Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle Furnace Technique</td>
<td>D 4218-96 (08)</td>
<td></td>
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<tr>
<td>Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings</td>
<td>D 2122-98 (10)</td>
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<tr>
<td>Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading</td>
<td>D 2412-11</td>
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<tr>
<td>Test Method for Determination of Impact Resistance of Thermoplastic Pipe and Fittings by Means of a TUP (Falling Weight)</td>
<td>D 2444-99 (10)</td>
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<tr>
<td>Specification for Polyethylene Plastics Pipe and Fittings Materials</td>
<td>D 3350-10a</td>
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</tr>
<tr>
<td>Test Method for Notched, Constant Ligament-Stress (NCLS) Test to Determine Slow-Crack-Growth Resistance of HDPE Resins or HDPE Corrugated Pipe</td>
<td>F 2136-08</td>
<td></td>
</tr>
</tbody>
</table>

**Comments:** The plant had current versions of all applicable AASHTO and ASTM standards. These standards were located and accessed through the corporate Share Point System.
**Key proposed changes to HDPE Work Plan**

*Finished Product Material Testing* - One finished product sample shall be collected for every 45,000lb [20,412 kg] of product produced or every 24 hours, or whenever the material blend ratios are changed by more than 5% or the blend constituents are changed, whichever comes first. Material samples from the finished product shall be tested for the properties in Table 4.

**Table 4: Test Requirements for Finished Product Containing Recycled HDPE**

<table>
<thead>
<tr>
<th>Test Property</th>
<th>Test Designation</th>
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<tbody>
<tr>
<td>Density</td>
<td>ASTM D4883</td>
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<tr>
<td>Melt Index</td>
<td>ASTM D1238</td>
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<tr>
<td>Un-notched Constant Ligament Stress (UCLS)</td>
<td>ASTM F3181</td>
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<tr>
<td>Oxidation Induction Time (OIT)</td>
<td>ASTM D3895</td>
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<tr>
<td>*Notched Constant Ligament-Stress (NCLS)</td>
<td>ASTM F2136</td>
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<tr>
<td>Break Strain</td>
<td>ASTM D638</td>
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Proposed Revisions to the Work Plan for HDPE Pipe Audits is under review

• Task Group completed proposed revisions

• Revised Work Plan issued for ballot August 3, 2018

• Expect opportunity for first audits of plants producing HDPE pipe made with recycled resins in September
Industry Implementation of NTPEP HDPE Work Plan Revisions

If plant audit scheduled to occur in late 2018:
• Manufacturer can request to add audit of HDPE made with recycled resins

If plant audit has already occurred for 2018:
• Manufacturer can request for an additional audit to be scheduled later in 2018, for an additional fee

Some manufacturers may wait choosing to schedule audits for HDPE with recycled resins in 2019

Some manufacturers may wait to see if enough DOT interest in their area to justify NTPEP audit and inventorying 2 M294 products
Earth Day Network, the organization that leads Earth Day worldwide, has chosen as the theme for 2018 to End Plastic Pollution.

EDN has built a multi-year campaign to End Plastic Pollution. Our goals include ending single-use plastics, promoting alternatives to fossil fuel-based materials, promoting 100 percent recycling of plastics, corporate and government accountability and changing human behavior concerning plastics.
China has stopped importing nearly half of the world’s plastic waste as of January 2018 (mainly from wealthiest nations)

Approximately 72% of the world’s plastic waste went to China & Hong Kong since 1992 w/HK passing on 63% to China.

Waste management facilities are struggling to process the excess waste. Some states are now allowing recyclable materials into landfills

2016: California exported 500K tons of low grade plastic to China

An estimated 111 million metric tons could pile up by 2030
Our Sustainability Efforts

DOT will incorporate sustainability principles into our policies, operations, investments and research through innovative initiatives and actions such as:

- Infrastructure investments and other grant programs,
- Innovative financial tools and credit programs,
- Rule- and policy- making,
- Research, technology development and application,
- Public information, and
- Enforcement and monitoring

DOT has incorporated sustainable practices into the Department’s mission and operations. DOT will continue to pursue opportunities for the national transportation system which:

- Promote energy and natural resource conservation,
- Decrease emissions of greenhouse gases (GHGs) and other pollutants,
- Enhance our operations by minimizing use of hazardous materials and chemicals,
- Advance our national interest in increasing energy efficiency,
- Reduce our dependence on fossil fuels,
- Ensure transportation infrastructure resiliency and
- Build livable communities.
Buy Clean California Act

Executive Order B-30-15 issued by Governor Brown stipulates that “State agencies shall take climate change into account in their planning and investment decisions and employ full life-cycle cost accounting to evaluate and compare infrastructure investments and alternatives.”

BCCA 3504. In carrying out its duties under this article, an awarding authority shall strive to achieve a continuous reduction of emissions over time.
Preliminary LCA Data
(to be presented at Plastic Pipe XIX – September 2018)

Indexed comparison of key LCA Categories by Pipe Type
Indexed comparison of LCA Emissions Categories by Pipe Type

- Global Warming
- Acidification
- Eutrophication
- Ozone Depletion
- Smog

Pipe Types:
- PE
- PE with 50% RC
- PVC
- RCP
- Steel, 24 in alum
Questions?