
Standard Practice for Service Life Determination of Corrugated HDPE Pipes Manufactured with Recycled Content

AASHTO Designation: R 93-19¹

Technical Subcommittee: 4b, Flexible and Metallic Pipe

Release: Group 2 (June)



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1. SCOPE

- 1.1. This standard practice details the procedure for determining the service life of corrugated high-density polyethylene (HDPE) pipes containing recycled materials. Service life is relative to Stage II brittle failures via the slow crack growth mechanism.
 - 1.2. The service life determination in this standard practice is based on analysis of failure data from testing conducted in accordance with ASTM F3181, the Un-Notched Constant Ligament Stress (UCLS) test.
 - 1.3. This standard practice can be used to establish minimum UCLS performance criteria to ensure a desired service life at given service conditions for corrugated HDPE pipes containing recycled materials.
 - 1.4. This standard practice is applicable for pipes containing recycled materials and manufactured in accordance to M 294. It is applicable both for pipes manufactured with post-consumer recycled (PCR) materials and post-industrial recycled (PIR) materials. It is not intended for pipes manufactured with only virgin materials.
 - 1.5. The values stated in SI units are to be regarded as standard. Within the text, the U.S. Customary units are shown in parentheses, and may not be exact equivalents.
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2. REFERENCED STANDARDS

- 2.1. *AASHTO Standard:*
 - M 294, Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
- 2.2. *ASTM Standards:*
 - D4703, Standard Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
 - F3181, Standard Test Method for the Un-notched, Constant Ligament Stress Crack Test (UCLS) for HDPE Materials Containing Post-Consumer Recycled HDPE

- 2.3. *NCHRP Report:*
- Pluimer, M. L., J. Sprague, R. Thomas, L. McCarthy, A. Welker, S. Sargand, E. Shaheen, and K. White. *National Cooperative Highway Research Program Report 870: Field Performance of Corrugated Pipe Manufactured with Recycled Polyethylene Content*. NCHRP, Transportation Research Board, Washington, DC, 2018.
- 2.4. *Other Document:*
- Pluimer, M. L. *Evaluation of Corrugated HDPE Pipes Manufactured with Recycled Materials in Commuter Railroad Applications*. Villanova University, Doctoral Dissertation. Proquest Publishing, 2016.

3. TERMINOLOGY

- 3.1. *Definitions:*
- 3.1.1. *contaminant*—inorganic particulate matter or other non-HDPE material that creates inclusions or stress risers in the crystalline structure of HDPE.
- 3.1.2. *crack initiation*—portion of the slow crack growth mechanism associated with the initial development of a craze zone and micro-cracks around a contaminant, void, or discontinuity (see Figure 1).
- 3.1.3. *crack propagation*—portion of the slow crack growth mechanism associated with successive yielding of HDPE material ahead of a crack tip (see Figure 1).
- 3.1.4. *Popelar shift method (PSM)*—method of bidirectionally shifting brittle crack failure data from HDPE specimens tested at elevated temperatures and stresses to other service conditions for lifetime prediction.
- 3.1.5. *post-consumer recycled (PCR) HDPE materials*—HDPE materials from products that have served a previous consumer purpose (for example, laundry detergent bottles, milk bottles and other consumer goods).
- 3.1.6. *post-industrial recycled (PIR) HDPE materials*—HDPE materials diverted from the waste stream during a manufacturing process that have never reached the end user.
- 3.1.7. *slow crack growth (SCG)*—a failure mechanism for HDPE defined by brittle cracks that propagate through the material under conditions of tensile stresses lower than its short-term mechanical strength, also known as Stage II failures (see Figure 1); comprised of two phases: crack initiation and crack propagation.