



*The Ohio Department of Transportation  
Office of Research & Development  
Executive Summary Report*

**Phase 1: Proof of Concept Validation of Methodology to  
Examine the Responsible Use of Recycle in Corrugated  
Polyethylene (PE) Drainage Pipe**

*Start Date:* August 1, 2005

*Duration:* One year

*Completion Date:* July 28, 2006

*Report Date:* October 31, 2006

*State Job Number:* 134255

*Report Number:* FHWA/OH-2006/20

*Funding:* \$35,000.00

*Principal Investigator:* Dr. Ken Oliphant,  
Ph.D., P.Eng.

*ODOT Contacts:* Ms. Karen Pannell

*Technical:* Mr. Lloyd Welker

*Administrative:*  
*Monique R. Evans, P.E.*  
*Administrator, R&D*  
*614-728-6048*

*For copies of this final report go to*  
<http://www.dot.state.oh.us/divplan/research>  
*or call 614-644-8173.*

*Ohio Department of Transportation  
Office of Research & Development  
1980 West Broad Street  
Columbus, OH 43223*

**Problem**

Corrugated High Density Polyethylene (HDPE) pipe has been successfully used in a variety of applications for many years. Recently, there has been interest in the responsible use of recycled materials in corrugated HDPE pipe. Prior to full use of these materials, the potential impact of recycle materials on pipe performance needs to be characterized. This Research Program is to demonstrate Proof of Concept of a methodology for examining the viability of utilizing recycle in corrugated polyethylene (PE) drainage pipe.

**Objectives**

The objective of this Research Program was to demonstrate Proof of Concept of a methodology for examining the viability of utilizing recycle in corrugated HDPE drainage pipe. As stress crack resistance is the critical property for determining pipe durability, the proposal focuses on the proof of concept and preliminary development of a methodology to generate accelerated stress crack resistance data enabling projection and validation of in-service performance.

## Description

As slow crack growth (SCG) has been identified as a potential key criterion in long-term field performance for HDPE corrugated pipe, research was undertaken to develop a test method for corrugated HDPE pipe samples that results in laboratory SCG failures that test the highest stress risers in a pipe wall geometry. The test method developed utilizes pipe ring segments that are internally pressurized and tested at elevated temperature that results in a SCG failure in the liner wall. By applying the mathematical modeling techniques of the Rate Process Method (RPM) on laboratory SCG data obtained on pipe ring samples at multiple temperatures and multiple pressures and developing correlations between the stresses in laboratory testing for virgin and recycled materials, it is possible to project the difference in SCG resistance between virgin and recycled materials under service conditions. Once the RPM performance of control HDPE corrugated pipe made with virgin resins is determined, it is then possible to determine the effect of recycled materials by conducting a similar RPM experiment on the same pipe produced with recycled materials. This report will explain the pipe ring test method, compare SCG failure modes of laboratory data with field experience, describe use of RPM methodology on the laboratory SCG data, and detail the proposed next phase in the development of the methodology.

## Conclusions & Recommendations

The pipe ring test method appears to be a viable method to access the effect of recycled materials on the slow crack growth resistance of corrugated HDPE pipe, with respect to virgin resins. The SCG mechanism observed in the laboratory pipe ring test method is the same SCG mechanism observed in corrugated HDPE pipe under field service conditions. Finite Element Analysis (FEA) indicates the high stress area is at the notch formed between the crown and the liner, and this is the failure location for the pipe ring specimen. FEA also provides a correlation between the internal pressure in the pipe ring specimen

and the stress at the notch tip. The advantages of the pipe ring test method are:

- Testing is conducted on the final extruded product
- The sample is more representative of the end-use product as the circumference of the pipe is tested rather than just a small test bar
- This method is applicable to any size corrugated pipe
- The failure modes are similar to testing solid wall pipe – ductile failures at high pressure and brittle (SCG) failures at low pressure
- The test results capture both the period of time for the crack initiation and crack propagation normally seen in SCG failures in finished product
- Extensive modeling techniques for pressure piping, such as the Rate Process Method, appear to be applicable to estimating service life of corrugated HDPE pipe once correlations with stresses in field applications are developed
- The test method can determine the effect of recycled materials on the slow crack growth resistance of HDPE corrugated pipe by comparing to similar pipe made from virgin resin
- The test method may be useful as a post-production quality control test as failures are attainable within a short time frame
- The test method could also be used to determine the effects of secondary loads such as bending and deflection

## Implementation Potential

The test method is at a developmental stage, however, it may potentially be used as a post-production quality control test as failures are attainable within a short time frame.

It may have applicability in defining the installation design parameter for different materials and pipe designs. However, further work is required to validate the methodology and develop the relationship between applied test conditions and field installation conditions.