Kansas Department of Transportation

TECHNICAL SUMMARY

Establishing a Design Procedure for Buried Steel-Reinforced High-Density Polyethylene Pipes: A Field Study

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Jie Han, Ph.D., P.E.
Fei Wang
Deep Kumar Khatri, Ph.D.
Robert L. Parsons, Ph.D., P.E.

The University of Kansas

Introduction

Several national standards and specification have been developed for design, installation, and materials for precast concrete pipe, corrugated metal pipe, and HDPE pipes. However, no national accepted installation standard or design method is available for SRHDPE pipes, which limits their usage. Even though ASTM F2562 (2008) provides the requirements for the SRHDPE pipe product, it does not provide engineers and guidance or instructions on how to design SRHDPE pipes during installation and under traffic loading.

Project Objective

The objective of this research was to use the test data obtained from the field study to verify/improve the design procedure for the SRHDPE pipes during installation and traffic loading.

Project Description

Two field tests were conducted to investigate the field performance of steel-reinforced high-density polyethylene (SRHDPE) pipes during installation and under traffic loading. One test site was located on E 1000 road in Lawrence, KS, which is close to Clinton Lake. Three SRHDPE pipes with a diameter of 3 ft and a length of 24 ft were buried in a 6 ft wide trench with 2 ft thick soil cover. This test site had two test sections: one section was filled with Aggregate Base Class 3 aggregate (AB3) and the second section was filled with crushed stone. The second field study was conducted at a Kansas Department of Transportation (KDOT) storage yard in Kansas City, KS. Four 6 ft long SRHDPE pipes with a diameter of 2 ft were connected and buried in a trench with a dimension of 4.6 ft wide × 27.5 ft long × 4.2 ft deep. Two types of backfill material were also used in the trench, namely, AB3 aggregate and crushed stone. Earth pressures, pipe deflections, and pipe strains on plastic valley, plastic cover, and steel ribs were monitored during pipe installation and under static loading on both test sites.

Project Results

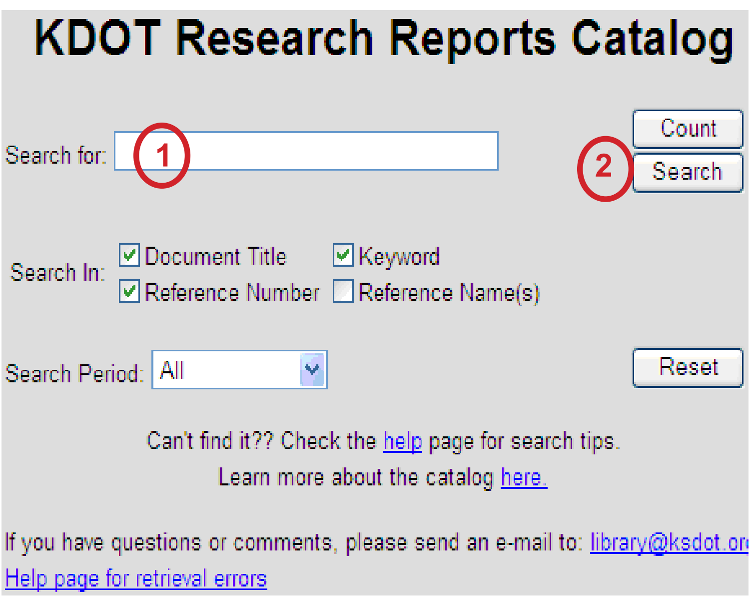
The test results from the pipe installation and static loading showed that (1) the vertical arching factor (VAF) on the top of the pipe was approximately 1.1 and the lateral earth pressure coefficient was approximately 0.65; (2) the peaking deflection was observed in both field tests in a range of 0.25 to 1.80% (the peaking deflection in the AB3 section was greater than that in the crushed stone section); (3) the maximum strain of the pipe occurred on the plastic valley in the longitudinal direction at the pipe crown, which was in a range of 0.4-0.6% and much lower than the strain limit of 5% suggested by the American Association of State Highway and Transportation Officials (AASHTO, 2012); and (4) the Giroud and Han (2004) method and the AASHTO (2012) method could reasonably estimate the earth pressure on the pipe under static loading, while the Iowa Formula could estimate the pipe deflection during installation and caused by static loading.

The earth pressures, the pipe deflections, and the strains of the pipes in the Lawrence site were monitored for 680 days and all increased with time. Two empirical correlations were proposed to calculate the VAF and the pipe stiffness factor at a given time.

The AASHTO (2012) design methods for metal pipes and high-density polyethylene (HDPE) pipes were modified for SRHDPE pipes based on the laboratory and field test results. A design procedure for SRHDPE pipes is proposed and illustrated by a design example.

Project Information

For information on this report, please contact Jie Han, Ph.D., P.E.; University of Kansas, 1530 W. 15th St, Lawrence, KS 66045; (785) 864-3714 phone; jiehan@ku.edu.



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