Kansas Department of Transportation

TECHNICAL SUMMARY

Establishing a Design Procedure for Buried Steel-Reinforced High Density Polyethylene (SRHDPE) Pipes

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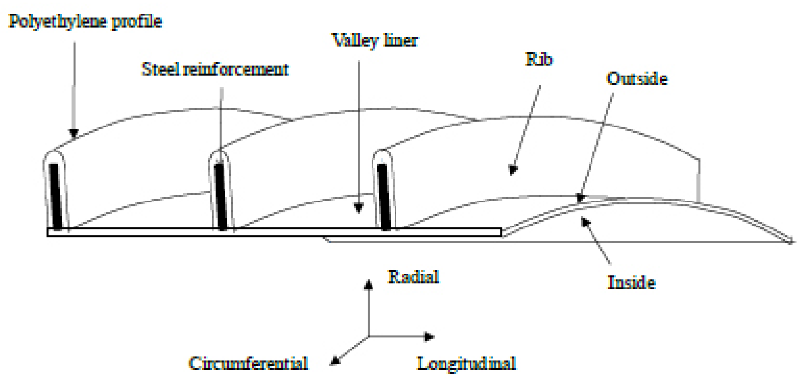
Deep Kumar Khatri, M.S.
Jie Han, Ph.D., P.E.
Ryan Corey, M.S.
Robert L. Parsons, Ph.D., P.E
The University of Kansas



3D View of an SRHDPE Pipe

Introduction

Metal and plastic pipes have been used extensively as storm sewers and buried drainage structures in transportation projects. Metal pipes have high strength and stiffness but are susceptible to corrosion from wastewaters containing acid, and from aggressive soils. Plastic pipes are resistant to corrosion, erosion, and biological attack but have certain disadvantages including lower long-term strength and stiffness (dimensional reliability), buckling, and tearing of pipe wall. To address the disadvantages of metal and plastic pipes, a new product, steel-reinforced high-density polyethylene (SRHDPE) pipe, has been developed and introduced to the market, which has high-strength steel reinforcing ribs wound helically and covered by corrosion-resistant high density polyethylene (HDPE) resin inside and outside. The steel reinforcement adds ring stiffness to the pipe to maintain the cross-section shape during installation and to support overburden stresses and traffic loading. The HDPE resin protects the steel against corrosion and provides a smooth inner wall. The combination of steel and plastic materials results in a strong and durable material with a smooth inner wall. Different methods are available for the design of metal and plastic pipes. The American Water Works Association (AWWA) Manual M11 (2004) provided the design procedure for metal pipes and the 2007 ASSHTO LRFD Bridge Design Specifications had separate design procedures for metal and plastic pipes. However, it is not clear whether any of these procedures for metal and plastic pipes can be used to design an SRHDPE pipe. Moreover, no approved installation or design specification is available specifically for the SRHDPE pipes.

Project Description

To establish a design procedure for SRHDPE pipes, various laboratory tests were conducted in this study to evaluate the stiffness, buckling resistance, and long-term creep behavior of SRHDPE pipes of

24 inches in diameter in air. In addition, large-scale plate loading tests were conducted on the pipe in a trench condition under 2 feet of shallow cover in a large geotechnical testing box (10 feet long x 6.6 feet wide x 6.6 feet high) to evaluate the performance of the SRHDPE pipe during installation and under static and cyclic loadings. In this study, Kansas River sand and crushed stone were used as bedding and backfill materials while AB-3 aggregate and Kansas River sand were used as base courses.

Parallel plate loading test results show that the SRHDPE pipes met both the minimum pipe stiffness and buckling limit criteria according to the ASTM F2562/F2562M. The creep test conducted in air for a month demonstrated that the SRHDPE pipe deformed under a sustained load. The vertical arching factors (VAF) obtained from the measured earth pressures on the pipe crown during the installation of the pipes were compared with the analytical solutions in McGrath (1998) were used. The measured deflections of the pipes during the installation were compared with those predicted by the modified Iowa formula (1958). The measured earth pressures on the top of the pipe were compared with those estimated by Giroud and Han (2004) and the simplified distribution method in the 2007 ASSHTO LRFD Bridge Design Specifications. The measured deflections of the pipes during loading were also compared with the modified Iowa formula (1958). The strains on steel and plastic were measured at various locations during both installation and loading.

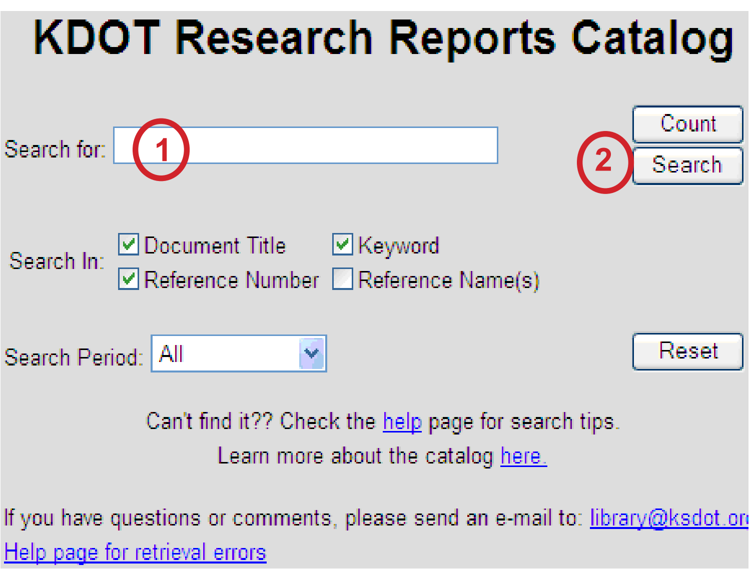
Project Results

Based on the testing and analysis, it can be concluded that:

1. The pipe wall-soil interface should be designed as a fully bonded interface to be conservative
2. The Giroud and Han (2004) method and the simplified distribution method in the 2007 AASHTO LRFD Bridge Design Specifications reasonably predicted the pressures on the top of the SRHDPE pipes induced by static and cyclic loadings
3. The modified Iowa formula (1958) reasonably predicted the deflections of the SRHDPE pipes during the installation and over-predicted the deflections during static and cyclic loadings
4. The pipe wall area was enough to resist the wall thrust during installation and loadings
5. The highest measured strains recorded in steel and plastic during the installation and loadings in all the tests were within the permissible values

Report Information

For technical information on this report, please contact: Dr. Robert Parsons, the University of Kansas Department of Civil, Environmental, and Archtectural Engineering, Learned Hall, 2153 W 15th Street, Lawrence, Kansas 66045-7618; 785.532.7612; rparsons@ku.edu.



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