KANSAS DEPARTMENT OF TRANSPORTATION

RESEARCH

HYDRAULIC RESISTANCE OF SMALL-DIAMETER HELICALLY CORRUGATED METAL PIPE

Report Number: K-TRAN: KU-07-5

By: Bruce M. McEnroe, Ph.D., P.E. and Travis R. Malone
The University of Kansas

Introduction

The hydraulic resistance of helical corrugated metal pipe (CMP) is strongly dependent on helix angle – the angle of the corrugations relative to the longitudinal axis of the pipe. Smaller-diameter pipes have smaller helix angles. Helical corrugations with a significant downstream orientation (small helix angle) offer less resistance to flow than annular corrugations.

Project Objective

Through this study we hope to ascertain the currently unknown Manning n values to use in the design of helical CMP.

Project Description

This report documents an experimental investigation of Manning n values for small-diameter helical CMP with 2.67" x 0.50" corrugations. Sixty-foot lengths of 18-inch, 15-inch and 12-inch pipe were tested in the University of Kansas hydraulics laboratory. Each test pipe was assembled from three 20-foot pipe sections. The helical CMP sections were manufactured with 12 inches of annular corrugations at each end to accommodate the connector bands. The 18-inch pipe was tested on a 0.39% slope, the 15-inch pipe on a 0.85% slope, and the 12-inch pipe on a 0.68% slope. The pipes were tested flowing full and partly full at depths ranging from 30% to 90% percent of the pipe diameter.

Project Results

The full-flow tests yielded Manning n values of 0.0178 for the 18-inch pipe, 0.0154 for the 15-inch pipe, and 0.0142 for the 12-inch pipe. These n values are considerably lower than the accepted values for annular CMP but higher than the values recommended by the American Iron and Steel Institute for helical CMP. The Manning n values obtained for partly full flow varied with the depth of flow. These tests yielded n values in the following ranges: 0.0184-0.0206 for the 18-inch pipe, 0.0170-0.0180 for the 15-inch pipe, and 0.0160-0.0194 for the 12-inch pipe. Manning n values for partly full flow tend to be higher for shallower flow. Manning n values for nearly fully flow (80-90% full) are about 10% higher, on average, than n values for full flow. The annular corrugations at the section joints cause significant local energy losses. The Manning n values computed from the experimental data account for these local losses across the joints as well as the losses through the helical sections.

Report Information

For technical information on this report, please contact: Bruce M. McEnroe, The University of Kansas, 2150 Learned Hall, 1530 W. 15th Street, Lawrence, Kansas, 66045; Phone: 785-864-2925; fax: 785-864-5631 e-mail: mcenroe@ku.edu.

For a copy of the full report, please contact: KDOT Library; 700 SW Harrison Street, Topeka, Kansas 66603-3754; Phone: 785-291-3854; Fax: 785-291-3717; e-mail: library@ksdot.org.