

HR-332 Design Methodology for Corrugated Metal Pipe Tiedowns

Key Words: CMP, Corrugated Metal Pipe, Tiedowns, uplift

ABSTRACT

Questionnaires were sent to transportation agencies in all 50 states in the U.S., to Puerto Rico, and all provinces in Canada asking about their experiences with uplift problems of corrugated metal pipe (CMP). Responses were received from 52 agencies who reported 9 failures within the last 5 years. Some agencies also provided design standards for tiedowns to resist uplift. There was a wide variety in restraining forces used; for example for a pipe 6 feet in diameter, the resisting force ranged from 10 kips to 66 kips. These responses verified the earlier conclusion based on responses from Iowa county engineers that a potential uplift danger exists when end restraint is not provided for CMP and that existing designs have an unclear theoretical or experimental basis.

In an effort to develop more rational design standards, the longitudinal stiffness of three CMP ranging from 4 to 8 feet in diameter were measured in the laboratory. Because only three tests were conducted, a theoretical model to evaluate the stiffness of pipes of a variety of gages and corrugation geometries was also developed. The experimental results indicated a "stiffness" EI in the range of 9.11×10^5 k/in² to 34.43×10^5 k/in² for the three pipes with the larger diameter pipes having greater stiffness. The theoretical model developed conservatively estimates these stiffnesses.

Recognizing that soil over and around 64PIs will contribute to their stiffness, one field test was conducted on a pipe 10 feet in diameter. The test was conducted with 2 feet of soil cover and a foreslope of 2:1. This test indicated that the soil cover significantly increased the stiffness of the pipe.

Future plans include development of a finite element analysis to better describe the soil structure interaction. With those relationships and the data from additional field tests, design standards based on a rational design procedure will be developed. The soil structure analysis and the development of design standards for CMP tiedowns will comprise the final phase of this study.