HR-362 Design Methodology for Corrugated Metal Pipe Tiedowns

Key Words: Corrugated Metal Pipes, CMP,

ABSTRACT

This investigation is the final phase of a three-part study whose overall objectives were to determine if a restraining force is required to prevent inlet uplift failures in corrugated metal pipe (CMP) installations, and to develop a procedure for calculating the required force when restraint is required.

In the initial phase of the study (HR-306), the extent of the uplift problem in Iowa was determined and the forces acting on a CMP were quantified. In the second phase of the study (HR332), laboratory and field tests were conducted. Laboratory tests measured the longitudinal stiffness of CMP and a full scale field test on a 3.05m (10 ft) diameter CMP with 0.612m (2 ft) of cover determined the soil-structure interaction in response to uplift forces.

Reported herein are the tasks that were completed in the final phase of the study. In this phase, a buried 2.44 in (8 ft) CMP was tested with and without end-restraint and with various configurations of soil at the inlet end of the pipe. A total of four different soil configurations were tested; in all tests the soil cover was constant at 0.61 in (2 ft). Data from these tests were used to verify the finite element analysis model (FEA) that was developed in this phase of the research. Both experiments and analyses indicate that the primary soil contribution to uplift resistance occurs in the foreslope and that depth of soil cover does not affect the required tiedown force.

Using the FEA, design charts were developed with which engineers can determine for a given situation if restraint force is required to prevent an uplift failure. If an engineer determines restraint is needed, the design charts provide the magnitude of the required force. The design charts are applicable to six gages of CMP for four flow conditions and two types of soil.