The GeoEngineering Centre

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RESEARCH SUMMARY

FIRST STUDY OF THE EFFECTS OF WALL LOSS DUE TO CORROSION

FIRST STUDY OF THE EFFECTS OF SOIL EROSION ON STABILITY

INVESTIGATION OF HOW CORROSION CHANGES THRUST AND MOMENT IN THE PIPE WALLS

STUDY INVESTIGATES CHANGES IN YIELD AND BUCKLING STRENGTH

THREE DIMENSIONAL ANALYSIS PERMITS DETAILED MODELING OF CORROSION GEOMETRY

SIMPLIFIED TECHNIQUES DEVELOPED TO ESTIMATE STRENGTH LOSS

HIGHLIGHTS

- **Publications include the manuscript "Finite element study of corroded metal culvert stability" in the Transportation Research Record, and articles in two international conferences**
- **Also conducted an industrial project modeling a composite steel-HDPE pipe product**

STABILITY OF DETERIORATED METAL CULVERTS

Corrugated metal culverts are common in many areas of North America, and internationally. Many of those constructed in the 1960s and 1970s are now reaching the end of their design lives. In areas, like Eastern Ontario, corrosion across the invert of the culvert is common. After wall perforation, ingress of external groundwater can lead to erosion.

Deteriorated steel culvert in Eastern Ontario

Both 2D and 3D finite element analyses were performed using ABAQUS, to examine how the magnitude of compressive thrust changes in the wall of the culvert (especially at the springlines), and how the culvert's resistance to yield and buckling is affected. The project demonstrated that there is little change in thrust as corrosion develops, and that the stability against yield decreases in proportion to wall loss. Changes in stability against buckling were more complex, with dramatic decreases in resistance to buckling if erosion voids are allowed to develop adjacent to the structure. Three dimensional modeling of the corrugated geometry permitted explicit representation of the geometry of corrosion, and study of failure modes like local buckling. Local buckling at the springlines (sides of the culvert) becomes a possibility when wall loss brings steel thickness below 3 mm.

Since Ministries and Departments of Transportation have insufficient funds to replace all corroded structures, it is essential to determine which structures need repair and replacement, and which have significant remaining service life. In addition to providing guidance on the consequences of steel corrosion, the study emphasized the critical nature of any erosion of the backfill, which can dramatically reduce structural resistance to buckling, in addition to the risk that a soil void under the overlying pavement can collapse and cause significant accidents (and loss of life).

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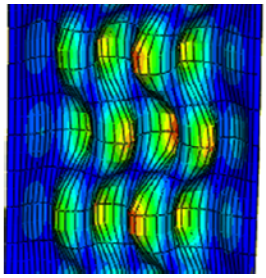

Local buckling in corrugated pipe after wall thinning

STRENGTH OF A NEW COMPOSITE PIPE PRODUCT

Work for Contech Construction Products in 2008 involved calculations to study the performance of a novel high density polyethylene pipe stiffened with steel ribs. Using strain data collected using strain gages (as shown *to the left*) during buried pipe testing, the analysis of the steel-HDPE composite was calibrated and used to evaluate pipe performance. This included the patterns of strain distributions in the HDPE (*shown at right*).