ABSTRACT

Agudelo, Luz M. MS, Purdue University, August 2019. **FINITE ELEMENT MODELING OF BURIED ARCHED PIPES FOR THE ESTIMATION OF MAXIMUM FILL COVERS** . Major Professor: Ghadir Haikal Professor.

The Indiana Department of Transportation implements maximum soil fill covers to ensure the safe installation and operation of buried pipes. Historically, fill cover tables are provided by INDOT, but the methodology for calculating these covers is not well documented. The finite element method enables a comprehensive analysis of the soil-pipe system taking into account soil conditions, pipe type and geometry, and conditions on the pipe-soil interface.

This thesis discusses the calculation of maximum fill covers for corrugated and structural plate pipe-arches using the finite element software CANDE and compares the results with previous results obtained by INDOT. CANDE software uses the Finite Element method, and the Load and Resistance Factored design based on a two-dimensional culvert installation in a soil-pipe model. The model is set up under plain strain conditions and is subjected to factored dead and live load, and provides an analysis of the structure based on safety measures against all factored failure modes associated with the structural material.

Significant issues were encountered when calculating the maximum fill covers for pipe-arches in CANDE, including the inability of standard CANDE (Level 2 mesh) to model pipe-arches, lack of convergence for nonlinear analysis, and fill cover results higher than expected. To solve these issues, the pipe-arches were modeled using Level 3 solution in CANDE. The CANDE analyses were run using small-deformation analysis after buckling was eliminated as a governing failure mode using parallel simu-

lations in Abaqus. Numerical results were compared to analytical solutions following ASTM standards.

The results showed that CANDE and INDOT calculations differ significantly, with the CANDE results yielding higher fill covers than those provided in INDOT specifications. These differences are attributed to the assumed loading pattern at failure. While the CANDE results assume that the maximum fill cover height is defined by the failure of the pipe considering the radial pressure (Pv), the INDOT results are limited by the bearing capacity of the soil around the corner radius (Pc).