A Review of

Depth of Cover Tables for Concrete and Corrugated Metal Pipe

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By

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Executive Summary

Since the advent of the circular closed conduit, and its use for conveying surface drainage through roadway embankments, methods have been required to determine the limiting magnitude of allowable vertical loads that could be applied to the buried pipes. These allowable load limits were sought to prevent damage to the conduit, or excessive deformation leading to unsatisfactory operation, that might result from these limits being exceeded. With minor modifications, these methods have largely remained unchanged since their inception; and the current 7th Edition of the AASHTO LRFD Bridge Specification continues to support their use.

In general, the problem of allowable pipe cover must be addressed separately for two general categories of section behavior and failure. Concrete, clay, and other rigid materials typically fail by rupture of the pipe wall in flexure, with a majority of the applied vertical load being resisted by the bedding material. Steel, plastic, and other flexible types of conduit will deform under load, and will typically fail by buckling of the pipe wall. The flexible nature of these pipe sections causes a significant portion of the applied vertical load to be resisted by induced lateral passive action of the backfill material, as the vertical loads lead to an ovalization of the pipe cross section.

This report documents the findings of a study conducted to review the history and current practice of establishing allowable pipe fill heights for circular and arched concrete pipe, as well as circular and arched corrugated steel pipe. Concluding this review, recommendations using the latest edition of the AASHTO LRFD Bridge Specification are provided as a basis for updating the tabular pipe cover data currently contained in Iowa DOT Standard Road Plan DR-104.

Concrete Pipe

The determination of allowable fill height over buried concrete pipe can be determined through the use of either the Indirect Design or Direct Design methods. The Indirect Design method is an empirical method developed about 100 years ago using the concept of the D-load to relate insitu pipe strength to the results of a standard laboratory test, while the more recently developed Direct Design method is a rational approach using a more customary limit states design procedure. While both methods are commonly used, and both have been shown to produce satisfactory results, it was found that the majority of agencies still rely on the Indirect Design Method to establish controls on maximum fill height.

Corrugated Steel Pipe

Allowable fill heights for corrugated steel pipe have changed considerably as research into flexible conduit behavior continues to advance. Initially using arbitrarily small deflections for control, more modern methods look at the behavior of the thin pipe wall under complex loading that involves fully engaging the passive soil resistance of the adjacent soil for support. These more recent methods make checks of the stiffness of the pipe wall under ring compression the primary control in determining maximum fill heights.

Current Practice

A review of the current methods and pipe cover values was conducted for the states neighboring Iowa, and the results of that investigation are contained later in this report. Most of the agencies use methods as prescribed by the AASHTO Bridge Specification, but many appear to have cover tables produced by fairly dated editions of the specification.

Recommendations

The recommendations for updating the minimum cover and maximum fill height tables depicted on Iowa DOT Standard Road Plan DR-104 involve employing the current 7th Edition of the AASHTO LRFD Bridge Specification. In many cases, limitations placed on fill height in past editions of the code have been removed, allowing larger values to be used than are currently shown on the standard. In the case of metal pipe, research is ongoing; and it is expected that more refinements to the specification will be forthcoming as the behavior of flexible buried pipe is further understood.