2022 Mid-Continent Transportation Research Symposium
Ames, Iowa
September 14–15, 2022
intrans.iastate.edu/events/midcon2022/

Strength of Multi-Material Stepped Bridge Columns

Brent Phares, Iowa State University
Zhengyu Liu, Iowa State University

Abstract

The Iowa Department of Transportation (DOT) rating engineer is sometimes asked by field personnel to make quick decisions regarding pile capacity and stability when scour is identified around bridge pile bents. A numerical evaluation program was developed and implemented to offer a user-friendly assessment tool that can be used to quickly evaluate pile strength.

The numerical program consists of finite element (FE) models established for steel H-piles with or without concrete encasement with consideration of linear and non-linear buckling and behavior. The research team validated the FE models against capacities calculated based on the provisions outlined in the American Institute of Steel Construction (AISC) Steel Construction Manual.

After validating the FE modeling techniques, the researchers performed parametric studies to understand the influence of concrete encasement on the pile buckling strength. The individually encased pile bents in the P10L standard with five H-pile sections (HP10—42, HP10—57, HP12—53, HP14—73, and HP14—89) were utilized for the parametric studies. These studies took into account different combinations of the unbraced pile lengths and concrete encasement lengths. The relationships between buckling strength of the steel H-piles with concrete encasements under concentric and eccentric loading conditions were derived from the results of the parametric studies.

The stiffness contributions of concrete encasements are not taken into account using the AISC Steel Construction Manual and American Association of State Highway and Transportation Officials (AASHTO) load and resistance factor design (LRFD) specifications for estimating the buckling strength of steel H-piles. The pile assessment tool that the researchers developed to quickly calculate the buckling strength of steel H-piles with concrete encasements includes the relationships between the buckling strength of steel H-piles with concrete encasement lengths for five cross-sections and two loading conditions. For the user's convenience, the researchers developed a graphical user interface for the tool, which requires the input of four parameters: loading eccentricity, H-pile section type, unbraced pile length, and concrete encasement length. This pile assessment tool can be utilized to quickly calculate the pile capacity and to assist state rating engineers in making rapid decisions regarding pile capacity.

The contents of this abstract reflect the views of the author(s), who are responsible for the facts and accuracy of the information presented herein. © 2022 by Iowa State University.