HR-292 Validation of Design Recommendations for Integral Bridge Abutment Piles

Key Words: Integral abutment bridges, Design recommendations

ABSTRACT

Since integral abutment bridges decrease the initial and maintenance costs of bridges, they provide an attractive alternative for bridge designers. The objective of this project is to develop rational and experimentally verified design recommendations for these bridges.

Field testing consisted of instrumenting two bridges in Iowa to monitor air and bridge temperatures, bridge displacements, and pile strains. Core samples were also collected to determine coefficients of thermal expansion for the two bridges. Design values for the coefficient of thermal expansion of concrete are recommended, as well as revised temperature ranges for the deck and girders of steel and concrete bridges.

A girder extension model is developed to predict the longitudinal bridge displacements caused by changing bridge temperatures. Abutment rotations and passive soil pressures behind the abutment were neglected. The model is subdivided into segments that have uniform temperatures, coefficients of expansion, and moduli of elasticity. Weak axis pile strains were predicted using a fixed-head model. The pile is idealized as an equivalent cantilever with a length determined by the surrounding soil conditions and pile properties. Both the girder extension model and the fixed head model are conservative for design purposes.

A longitudinal frame model is developed to account for abutment rotations. The frame model better predicts both the longitudinal displacement and weak axis pile strains than do the simpler models. A lateral frame model is presented to predict the lateral motion of skewed bridges and the associated strong axis pile strains. Full passive soil pressure is assumed on the abutment face.

Two alternatives for the pile design are presented. Alternative One is the more conservative and includes thermally induced stresses. Alternative Two neglects thermally induced stresses but allows for the partial formation of plastic hinges (inelastic redistribution of forces). Ductility criteria are presented for this alternative. Both alternatives are illustrated in a design example.