ABSTRACT

Expansion joints increase both the initial cost and the maintenance cost of bridges. Integral abutment bridges provide an attractive design alternative because expansion joints are eliminated from the bridge itself. However, the piles in these bridges are subjected to horizontal movement as the bridge expands and contracts during temperature changes. The objective of this research was to develop a method of designing piles for these conditions.

Separate field tests simulating a pile and a bridge girder were conducted for three loading cases: (1) vertical load only, (2) horizontal displacement of pile head only, and (3) combined horizontal displacement of pile head with subsequent vertical load. Both tests (1) and (3) reached the same ultimate vertical load, that is, the horizontal displacement had no effect on the vertical load capacity. Several model tests were conducted in sand with a scale factor of about 1:10. Experimental results from both the field and model tests were used to develop the vertical and horizontal load-displacement properties of the soil. These properties were input into the finite element computer program Integral Abutment Bridge Two-Dimensional (IAB2D), which was developed under a previous research contract. Experimental and analytical results compared well for the test cases.

Two alternative design methods, both based upon the American Association of State Transportation Officials (AASHTO) Specification, were developed. Alternative One is quite conservative relative to IAB2D results and does not permit plastic redistribution of forces. Alternative

Two is also conservative when compared to IAB2D, but plastic redistribution is permitted. To use Alternative Two, the pile cross section must have sufficient inelastic rotation capacity before local buckling occurs. A design example for a friction pile and an end-bearing pile illustrates both alternatives.