Florida Department of Transportation Research

Pile/Shaft Designs Using Artificial Neural Networks (i.e., Genetic Programming) with Spatial Variability Considerations
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In this project, University of Florida researchers sought to improve the unit skin friction and tip resistance correlations embedded in the FB-Deep software algorithm for estimating driven pile and drilled shaft resistance. They utilized an artificial neural networks (ANN) approach, shown to reduce uncertainty in design. Recently, ANN has been coupled with genetic programming (GP), making use of so-called genetic evolution concepts to develop equations that result in the minimum mean square error between the predicted and measured values.

Researchers collected data from driven pile sites in Florida and Louisiana, as well as drilled shaft sites in Florida, obtaining 458 SPT borings on pile sites and 815 borings on drilled shaft sites from geotechnical reports and plans. Sixty-four static load tests for piles and 66 for drilled shafts were acquired; for the piles, 48 tests reached Davisson capacity (i.e., nominal resistance), and for 28 of these, skin and tip resistance were separable. The drilled shaft data consisted of elements that were instrumented with strain gauges from which unit skin transfer (T-Z) was assessed for Florida limestone.

To analyze the data, the GP algorithm was capable of predicting a pile's unit skin friction and tip resistance based on soil type, SPT blow count, pile/shaft diameter, pile/shaft type, and load. The GP was instructed to begin with the same procedures used in FB-Deep and then to elaborate, as necessary, to minimize mean square error between the predicted and measured values of unit skin friction and tip resistance. In development of the correlation curves, different forms of averaging — arithmetic, harmonic, and geometric — were considered. For soil/rock delineation, the Unified Soil Classification System was used to separate the material into four general types: clays; silty sands or sandy silts; clean sands; and limestone rock.

The researchers' detailed analysis of the results of the genetic programming and comparison with FB-Deep provided insight into the benefits of the new approach and the possibility of updating existing software to include GP estimates of capacity.

Many transportation structures are supported on deep foundations such as driven piles or drilled shafts.

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