

ABSTRACT

Basu, Dipanjan. Ph.D., Purdue University, December, 2006. Analysis of Laterally Loaded Piles in Layered Soil. Major Professor: Rodrigo Salgado.

A new method for static analysis of laterally loaded piles embedded in multi-layered soil is developed in this thesis. The differential equations governing pile deflections in different soil layers, due to a concentrated static force and/or moment acting at the pile head, are obtained using energy principles and calculus of variations with the assumption that soil behaves as a linear elastic material. The differential equations are solved analytically using the method of initial parameters. Pile deflection, slope of the deflected curve, bending moment, shear force and soil resistance (pressure) can for the entire pile length be obtained by this method. The analysis takes explicit account of the three-dimensional interaction between a pile and the surrounding soil and produces results that have the same level of accuracy as that of a three-dimensional finite element analysis. However, because pile response is obtained analytically, the time required for running this analysis is only a small fraction of an equivalent three-dimensional finite element analysis.

Further extension of the analysis is made to account for soil nonlinearity by incorporating a nonlinear elastic algorithm (using a secant modulus approach) that takes into account the degradation of soil modulus with increase in strain (or stress). The initial portion of the (nonlinear) load-deflection response of piles can be predicted using this method. However, more sophisticated soil constitutive relationships need to be incorporated in the analysis to predict pile response beyond the initial stages of loading.

A preliminary study of the possibility of extending the method to analyze pile groups is made. The single-pile analysis can be modified to obtain pile group response because the analysis not only produces pile deflection but also gives the displacement, strain and stress fields of the soil mass surrounding the pile. Further research for successful implementation of pile group analysis is required so that real field problems can be solved.