# ABSTRACT

Bandini, Paola. Ph.D., Purdue University, December 2003. Numerical Limit Analysis for Slope Stability and Bearing Capacity Calculations. Major Professor: Rodrigo Salgado.

Limit analysis uses the lower and upper bound theorems of plasticity theory to find the rigorous lower and upper bound solutions of stability problems. The limit analysis theorems are formulated as linear problems to be solved using linear programming techniques. Based on finite element discretization of the soil mass, the stress field is optimized to determine the highest lower bound solution, and the velocity field is optimized to determine the lowest upper bound solution. The soil is assumed to follow the Mohr-Coulomb yield criterion. In this research, the numerical limit analysis is applied to (*i*) the assessment of the stability of soil slopes subjected to seismic loading and (*ii*) the bearing capacity of footings, both under plane-strain conditions. In the seismic slope stability analysis, the (pseudo-static) $k_c = \frac{a_c}{g}$ seismic coefficient required to cause collapse of the slope is the optimized variable in the analysis. Plots of $k_c$ as a function of the slope inclination and shear strength parameters were constructed for simple homogeneous slopes using the results from the analyses. Limit equilibrium and logspiral upper bound calculations were also performed for comparison purposes. Two examples, one including porewater pressure and another with complex slope geometry and soil profile, were investigated using the three approaches. Results from the

limit equilibrium methods are in excellent agreement with the rigorous lower and upper bounds for all cases studied. In the second part of the research, the numerical limit analysis is used to determine the bearing capacity of rigid, strip footings. Curves of the depth factor $d_q$ as function of the embedment ratio $D/B$ were developed from the rigorous lower and upper bound bearing capacity solutions for footings in cohesive and cohesionless soils. Estimates of the depth factor $d_q$ for cohesionless soils were obtained by comparing the bearing capacity of an embedded footing with that of a surface footing with a surcharge equivalent to $\gamma D$ of the embedded foundation, for various soil friction angles. Lower and upper bound values of the load inclination factor $i_\gamma$ for footings in cohesionless soils were also determined as part of this research. Semi-empirical solutions commonly used in engineering practice are compared with those obtained applying numerical limit analysis.