Three-dimensional stability of slopes subjected to seismic excitation

Design of slopes and analysis of existing slopes are carried out routinely using approximations of plane strain and substitution of quasi-static load for the seismic influence. These routine assumptions may be overly conservative for slopes with a well-defined extent of the failure mechanism. This is clearly the case, for instance, in excavation slopes. Recent developments in limit analysis with 3D failure mechanisms (Michalowski and Drescher 2009) make a tractable 3D analysis with seismic effect possible.

A rotational 3D mechanism is schematically illustrated in Fig. 1. The failure surface has a shape of a curvilinear cone, and the portion intersecting the slope soil has a spoon-like shape. Alternative mechanism can be generated by a circle of varying diameter rotating about its cord. This case is illustrated in Fig. 2. To assure a smooth transition to a plane mechanism in case of the absence of any constraints on mechanism width, a plane insert is used, as in Fig. 3.

The research is carried out to evaluate safety of slopes subjected to seismic excitation, predict the yield acceleration of slopes failing in a three-dimensional manner, and forecast displacements of slopes subjected to arbitrary acceleration records (3D analysis). This research is carried out by Graduate Student Tabetha Martell and Prof. Michalowski.