RELIABLE COMPUTATION IN GEOTECHNICAL STABILITY ANALYSIS

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ABSTRACT

Limit analysis is one of the main method in geotechnical stability analysis [3]. It enables to determine a limit parameter for a prescribed load (the so-called limit load) and related failure surface. The limit load represents an important safety factor and the body collapses beyond the limit value. Classical theory of limit analysis is based on associative perfect plasticity and is supported by mathematical theory [1]. We distinguish static and kinematic approaches to limit analysis. The static approach is obtained from stress fields that satisfy the equilibrium equation, the stress boundary conditions and the yield criterion. Such a treatment leads to lower bounds of the limit load. The kinematic approach is based on admissible velocity fields that satisfy the velocity boundary condition and other constraints arising from the dissipation potential. It leads to upper bounds of the limit load. The static and kinematic approaches are mutually dual and can be defined as convex optimization (variational) problems, the so-called limit analysis problems.

We focus on the Drucker-Prager yield criterion which is frequently used in geotechnical practice. The corresponding kinematic limit analysis leads to a conic optimization. We introduce a specific inf–sup condition between stress and velocity fields, discuss its validity and show its consequences for limit analysis. In particular, we prove the equivalence between the static and kinematic approaches and derive guaranteed and fully computable upper bounds of the limit load. Our numerical solution is based on a penalization of the problem, finite elements, Newton-like methods and local mesh adaptivity. We introduce numerical examples on strip-footing and slope stability benchmarks. The contribution is a joint work with J. Haslinger (Prague, Ostrava) and S. Repin (Jyväskylä, St. Petersburg), and extends results from [2] where the von Mises yield criterion were used.

REFERENCES

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