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Abstract: More and more geotechnical structures are being designed on the basis of computer simulation of the soil behaviour. The most often used numerical tool for solving the equations is the finite-element method, which is the method of choice in this thesis. The classical material model for soils are the Mohr-Coulomb material model. For complex geometries a numerical solution is needed. It turns out that the apparently simple Mohr-Coulomb model is non-trivial to implement in the finite-element method. This is due to the fact that the Mohr-Coulomb yield criterion and the corresponding plastic potential possess corners and an apex, which causes numerical difficulties. A simple, elegant and efficient solution to these problems is presented in this thesis.

As with soils, rock masses also exhibit a pressure dependent constitutive behaviour. Therefore the Mohr-Coulomb and Modified Mohr-Coulomb material models are frequently used to model the behaviour of rock masses. In this thesis the principal stress update method is extended from the use with linear yield criteria to a Hoek-Brown material. The efficiency and validity are demonstrated by comparing the finite-element results with well-known solutions for simple geometries. A common geotechnical problem is the assessment of slope stability. The calculation of the slope safety factor using a linear Mohr envelope is straightforward, but with a curved Mohr envelope this is not trivial. A method of calculating the safety factor of a slope using the finite-element method and a curved Mohr envelope is presented. The results are compared with the safety factors obtained with a linear Mohr envelope, with which they are directly comparable, when the presented method is used. The classical problem of yield surfaces with corners and apexes is elaborated upon. A small modification to the formulation of the constitutive matrices on corners and apexes is presented. This formulation greatly improves the numerical stability of plasticity calculations. This is illustrated with a bearing capacity calculation on a highly frictional soil.

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