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# Mechanik-Seminar / Graduiertenkolleg 1483

Referent: **Dr.-Ing. Holger Aretz**
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Datum: Donnerstag, 28.01.2010
Uhrzeit: 15:45-17:15 Uhr
Ort: Hertz-Hörsaal, Geb. 10.11, Raum 126

Thema: **"A general symmetry-preserving formulation of the flow-rule in rate-independent plasticity"**

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## Abstract:

Classically, the flow-rule of rate-independent plasticity is derived on the basis of the hypothesis of maximum dissipation along with the constraint that the stress state must satisfy the yield condition. Using the Kuhn-Tucker optimality conditions, this constraint can be conveniently introduced into this maximization problem.
The derivation outlined above yields what is nowadays known as the “associated flow-rule”. Thus, one may state that the associated flow-rule and the maximum dissipation principle are equivalent. As a consequence of the associated flow-rule, the strain-rate is proportional to the yield surface normal leading to the terminus “normality rule”. For most metallic materials, the associated flow-rule/normality rule is satisfied within the precision of experimental measurement techniques and is, therefore, accepted as the standard in materials modeling. As an important byproduct, the material tangent stiffness is symmetric. This is not only beneficial with respect to uniqueness and stability theorems, but also because of the lower computational effort required in numerical procedures to solve boundary value problems.
The highly recognized experimental works of Spitzig and Richmond reveal that most of the tested metallic materials were to a fairly good approximation incompressible, but exhibited a notable dependence of the flow-stress on hydrostatic pressure. However, if the associated flow-rule is applied to such a material, dilatancy is predicted which is in contradiction to the experimentally observed incompressibility. Thus, inspired by the mechanics of rocks and soils such material behavior is commonly modeled by introducing a so-called “non-associated” flow-rule, whereby the plastic strain-rate is not proportional to the yield function gradient, but is rather parallel to the gradient of a so-called stress potential whose primary purpose is to control (or even eliminate) the dilatancy. However, since the potential function can be more or less arbitrarily chosen, an undesired ambiguity enters the plasticity theory. Furthermore, the tangent material stiffness becomes unsymmetrical which raises important questions regarding uniqueness and stability of equilibrium configurations. Furthermore, the computational effort increases considerably.
It is obvious that the essential problem is in fact that the derivation of the flow-rule rests on the maximum dissipation principle. Therefore, in order to arrive at an unambiguous theory, another route of derivation is employed which yields, as a convenient byproduct, a tangent material stiffness that is always symmetric while no new hypotheses enter the formulation.

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Alle Interessenten sind herzlich eingeladen.
Prof. Dr.-Ing. Thomas Böhlke