# How to Simplify Return-Mapping Algorithms in Computational Plasticity: PART 1 – Main Idea

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## ABSTRACT

The plastic flow rule is an essential part of small-strain elastoplastic constitutive models. The rule is usually prescribed by the derivative of the plastic potential. However, it is well-known that the potential need not be differentiable everywhere. If the potential is non-differentiable for the investigated stress state then it is necessary to correct formulation of the plastic flow rule, e.g., use more than one plastic multiplier. It is well-known that the definition of the flow can be unified using the subdifferential of the potential. But it is not too known that the subdifferential formulation can be useful even for numerical realization of many elastoplastic models.

To demonstrate it, the non-associated model containing the Drucker-Prager yield criterion and a nonlinear isotropic hardening law is chosen. The corresponding constitutive initial-value problem is discretized in time by the implicit Euler method. The standard elastic predictor – plastic corrector algorithm is very nicely and in detail described in [1]. The corresponding plastic correction has one drawback – one must guess whether the unknown stress lies in the smooth portion or in the apex of the yield surface and solve different systems of non-linear equations for these two cases.

Using the subdifferential form of the plastic flow rule, we obtain just one system of nonlinear equations including both cases of the return. Elimination of some unknown leads to solving of one equation with the unknown plastic multiplier. Moreover, it can be shown that the equation has a unique solution and one can a priori decide whether the return will be realized into the smooth portion or the apex. This approach simplifies the implementation and can be generalized for other plastic criteria, e.g., for the Mohr-Coulomb criterion.

The improved implementation of the problem will be described in detail and illustrate on numerical examples within the contribution [2] presented by M. Cermak.

## REFERENCES

[1] E. A. de Souza Neto, D. Peric, D. R. J. Owen, “Computational Methods for Plasticity: Theory and Application”. Wiley, 2008.

[2] M. Cermak, S. Sysala, “How to Simplify Return-Mapping Algorithm in Computational Plasticity: PART 2 – Implementation Details and Experiments”. Abstract submitted to COMPLAS 2015.