COMPUTATIONAL MATERIAL FORCES IN SINGLE-SLIP CRYSTAL-PLASTICITY

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The main goal of this contribution is the application of the material force method to dissipative materials within a finite element setting whereby special emphasis is placed on single—crystal plasticity. The balance equations on the material manifold, i.e. the material motion balance of momentum necessitates the computation of the spatial gradient of the plastic distortion. Thus, for the sake of clarity we restrict ourselves to the particular case of solely one active slip system. The main concern is then to elaborate two different numerical approaches:

On the one hand, the active sliding parameter is treated as an internal variable. With this field available on the 'Gauss-point-level,' standard interpolation techniques can be applied such that the slip parameter is L_2—projected onto the node points of the finite element mesh. It is then straightforward to compute the corresponding, spatial gradient which is a key ingredient to the material force method. Apparently, loading and unloading conditions, i.e. the Kuhn-Tucker conditions, are incorporated at the 'Gauss-point-level.'

On the other hand, the sliding parameter is introduced as an additional degree of freedom. Once more, the corresponding spatial gradient represents one of the essential fields for the application of the material force method. In contrast to the previous formulation the computation of this gradient field can be performed by convenient application of standard finite element techniques. However, loading an unloading conditions, i.e. the Kuhn-Tucker conditions, are now introduced at the 'finite-element-level' which results in an active set search borrowed from convex nonlinear programming.

Finally, several numerical examples comparing the accuracy of both approaches close the lecture.