APPLICATION OF THE MATERIAL FORCE METHOD TO DISSIPATIVE MATERIALS

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The objective of this contribution is the exploitation of the notion of material forces in the computational mechanics of dissipative materials. To this end we consider the framework of isotropic geometrically non–linear continuum damage and thermo–hyperelasticity and investigate the spatial and material settings that lead to either spatial or material forces, respectively. Thereby material forces essentially represent the tendency of material defects to move relative to the ambient material. In this contribution we combine the material force method with an internal variable approach towards damage mechanics and a dissipative coupled thermo-hyperelasticity.

Thus the appearance of distributed material volume forces that are conjugated to state variables (damage variable, temperature) necessitates the discretization of these as an independent field in addition to the deformation field. Consequently we propose a monolithic solution strategy for the corresponding coupled problem. The underlying kinematics, strong and weak forms of the coupled problem will be presented and implemented within a standard Galerkin finite element procedure. As a result in particular global discrete nodal quantities, the so–called material node point (surface) forces, are obtained. Moreover, the identification of spurious material forces acts as a sensitive indicator of insufficient mesh discretization.

Several examples emphasize the influence of the damage zone/temperature field in front of a crack tip. In consequence of the distributed material volume forces a 'shielding' effect in the vicinity of the crack tip can be observed. This will be quantified by using a 'Modified Boundary Layer'-formulation (MBL-formulation) of a straight, traction free crack.