A micromorphic continuum formulation for finite strain elasticity

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Abstract

This work proposes a generalized theory of deformation which can capture scale effects also in a homogenously deforming body. Scale effects are relevant for small structures but also when it comes to heterogeneous material or high strain concentrations as in the case of localised shear bands or at crack tips, etc. In this context, so-called generalized continuum formulations have been proven to provide remedy as they allow for the incorporation of internal length-scale parameters which reflect the micro-structural influence on the macroscopic material response.

Here, we want to adopt a generalized continuum framework which is based on the mathematical description of a combined macro- and micro-space [Sansour and Skatulla, 2010]. The approach introduces additional degrees of freedom which constitute a so-called micromorphic deformation. First the treatment presented is general in nature but will be specified for the sake of an example and the number of extra degrees of freedom will be reduced to four. Based on the generalized deformation description new strain and stress measures are defined which lead to the formulation of a corresponding generalized variational principle. Of great advantage is the fact that the constitutive law is defined in the generalized space but can be classical otherwise. This limits the number of the extra material parameters necessary to those needed for the specification of the micro-space, in the example presented to only one.

References

Sansour, C., Skatulla, S., 2010. A micromorphic continuum-based formulation for inelastic deformations at finite strains. application to shear band formation. International Journal of Solids and Structures 47, 1546–1554.