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Comparative study of different finite element formulations for the relaxed micromorphic model

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Modeling metamaterials is a challenging topic due to the underlying size-effect phenomena. Generalized continuum theories are promising computational tools for the description of such materials. The relaxed micromorphic model [1] has been used successfully to model the main microscopic and macroscopic mechanical properties of the assumed metamaterials for many applications, see for example [2]. It reduces the complexity of the general micromorphic theory and requires fewer material parameters while showing superior behavior compared to other micromorphic models as it exhibits a bounded stiffness for the small specimen. The energy functional of the relaxed micromorphic model employs the Curl of a micro-distortion field, similar to the Cosserat model, but employs the full kinematics of the micromorphic theory. Therefore, the solution exists in $H(\mathrm{curl}, \mathcal{B})$ for the micro-distortion field while the displacement is in $H^1(\mathcal{B})$.

In our presentation, we introduce different finite element formulations for the relaxed micromorphic model, see [3]. The advantages of the tangential-conforming formulation in $H^1(\mathcal{B}) \times H(\mathrm{curl}, \mathcal{B})$ compared to a standard formulation in $H^1(\mathcal{B}) \times H(\mathcal{B})$ are revealed via numerical examples. Furthermore, we investigate the physical interpretation of the different components of the relaxed micromorphic model.

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