Solids SPP 256
Variational Methods

Computational polyconvexifcation of isotropic functions

Daniel Balzani, Maximilian Köhler, Timo Neumeier, Malte A. Peter, Daniel Peterseim, David Wiedemann

September 27–29, 2023

Abstract

Polyconvex relaxation is a reasonable option when faced with the minimization of energy functionals with non-convex energy densities. For this purpose, we present a method for the determination of the polyconvex envelope of isotropic energy densities, which can be characterized by means of their signed singular value representations. This leads to a simple algorithm for the numerical approximation of the polyconvex envelope. Instead of operating on the d^2-dimensional space of matrices (the deformation gradient in typical applications), the algorithm requires only the computation of the lower convex envelope of a d-dimensional manifold. This task is realized by standard algorithms from computational geometry or an optimization approach. The significant computational speedup, originating from the dimension reduction by moving from full matrix space to the space of signed singular values, is demonstrated in a series of numerical experiments.