Computing the effective crack energy of heterogeneous materials by a fast Fourier transform based method on a combinatorially consistent grid

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This contribution is concerned with computing the effective crack energy of periodic and random media which arises in mathematical homogenization results for the Francfort-Marigo model of brittle fracture. The problem at hand may be recast as a continuous maximum flow problem. A previous solver based on the fast Fourier transform (FFT) using a finite element discretization led to solution fields with ringing or checkerboard artifacts and was limited in terms of the achievable accuracy. We therefore suggest using the combinatorial continuous maximum flow discretization (CCMF) introduced by Couprie et al. The latter is devoid of artifacts, but lacks an efficient large-scale solution method. We fill this gap and introduce a novel solver which relies upon the FFT and a doubling of the local degrees of freedom which is resolved by the alternating direction method of multipliers (ADMM). We provide an adaptive strategy for choosing the ADMM penalty parameter which further speeds up the solution procedure. The salient features of the proposed approach are demonstrated on problems of industrial scale.

References:

[1] https://doi.org/10.1002/nme.6792

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