20th European Mechanics of Materials Conference - EMMC20
Florence, Italy | May 27th-29th, 2026
www.emmc20.unifi.it

A Bridging-Domain strategy for anisotropic damage simulation in large-scale heterogeneous structures

Zakaria Chafia[1], Julien Yvonnet[2], Jérémy Bleyer[3]

[1] MSME, Gustave Eiffel University, France. zakaria.chafia@univ-eiffel.fr
[2] MSME, Gustave Eiffel University, France. julien.yvonnet@univ-eiffel.fr
[3] Navier, Ecole des Ponts ParisTech, France. jeremy.bleyer@enpc.fr

Paper ID: 24
Symposium S16: Advanced modelling techniques: Time and space scale bridging

Abstract

A Bridging Domain Phase Field (BD-PF) framework for modeling anisotropic damage in large-scale heterogeneous structures is proposed. This efficient multiscale approach employs a bridging-domain strategy to couple an overlapping coarse-scale homogenized model and a localized high-fidelity model. Reducing computational costs relies on the use of coarse meshes for modeling damage at the macroscopic scale, and fine meshes in regions of interest to accurately capture the crack nucleation and early stages of damage evolution. The coupling is achieved using the Arlequin approach, where only the displacement problem is coupled through a variational formulation that weights the energies of each subdomain in the overlapping zone. Damage at each scale is evaluated independently using two different approaches. At the macroscopic scale, the recently developed M-DDHAD method is employed, in which six internal variables are used to characterize damage of the RVE, while the phase field approach is used for modeling damage in localized regions of interest. Numerical applications are provided, demonstrating the potential of this framework for large-scale industrial applications.

Keywords:

Anisotropic damage Multiscale modeling Computational homogenization Data-Driven Phase field method Crack nucleation Composite materials