Asymptotic homogenization of rough elastic surface

Vivek Singh*†[1], Arthur Geromel Fischer[2], Kim Pham[3], and Kostas Danas[4]

[1]Laboratoire de Mécanique des Solides – École polytechnique, Route de Saclay, 91128 Palaiseau Cedex, France – France

[2]Manufacture Française des Pneumatiques Michelin – Manufacture Française des Pneumatiques Michelin – France

[3]Laboratoire de Mécanique et ses Interfaces – ENSTA Paris, Institut Polytechnique de Paris – France

[4]Laboratoire de mécanique des solides – Ecole Polytechnique, Centre National de la Recherche Scientifique – France

Abstract

Consider an elastic medium, which consists of a periodic arrangement of heterogenities on a surface. Such geometry has been explored for applications in acoustics and electromagnetics using the interface homogenization method. The elastic application of such configuration needs to be studied in detail. The bottleneck with the study of such complex configuration is the requirement of large computational resource for capturing the rapid variation of the displacement field in the complex microstructural region using an extremely fine mesh. The present study deals with the homogenization of a thin elastic rough surface, thereby resolving the related computational issue. The study considers a linear elastic material and the homogenization model is based on the matched asymptotic expansion technique. The actual problem consists of a material block with rough surface consisting of periodic arrangement of voids/defects (having periodicity p) and the surface is subjected to mixed boundary condition. When the void/defect periodicity at the surface is much smaller than the macroscopic length L ($p << L$), we get an effective problem with an effective boundary condition at the bottom. The homogenization model is validated by comparison with results from the full-field finite element simulations.

*Speaker

†Corresponding author: vivek.singh@polytechnique.edu