Asociación Argentina
de Mecánica Computacional

Resúmenes de Mecánica Computacional Vol I, pp. 117-117
C.I. Pairetti, M.A. Pucheta, M.A. Storti, C.M. Venier (Eds.)
S. Giusti, P. Sánchez, J. Mroginski (Issue eds.)
Rosario, November 5-8, 2024

THE ELASTIC PROPERTIES OF REINFORCED COMPOSITES WITH COMPLIANT INTERFACIAL BONDING: ASYMPTOTIC EXPANSIONS, ANALYTICAL APPROXIMATIONS, FULL-FIELD SIMULATIONS

Martín I. Idiart[a,b], Valentin Gallican[c], Miroslav Zecevic[d] and Ricardo A. Lebensohn[d]

[a]*Centro Tecnológico Aeroespacial / Departamento de Aeronáutica, Facultad de Ingeniería, Universidad Nacional de La Plata, Avda. 1 esq. 47, La Plata B1900TAG, Argentina.*

[b]*Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), CCT La Plata, Calle 8 N° 1467, La Plata B1904CMC, Argentina.*

[c]*Aix Marseille Univ, CNRS, Centrale Marseille, LMA UMR 7031, Marseille, France.*

[d]*Theoretical Division, Los Alamos National Laboratory, MS B216, Los Alamos, NM 87545, U.S.A.*

Keywords: Elasticity, interfaces, homogenization, Fast-Fourier Transform algorithms

Abstract. Analytical approximations are proposed for the linear elastic properties of fiber-reinforced materials with imperfect interfacial bondings across which displacements jump in proportion to the tractions. The fibers are all parallel, of circular cross section, and isotropically distributed on the transverse plane at finite volume fractions. Elastic properties of both matrix and reinforcement can be arbitrary, but those of their interfacial bonding are restricted to a particular form of common use. Proposals rely on the combined use of the Hashin-Shtrikman approximation for perfectly bonded systems and the equivalent inclusion concept. A variational framework is employed to generate pairs of elementary bounds, asymptotically exact results, and approximations for the effective elasticity tensor. Each member of the pair differs in the way the bonding compliance is averaged over the interfacial surface: an 'arithmetic' mean in one case and a 'harmonic' mean in the other case. Asymptotic expansions are used to infer the most convenient approximation for a given range of material parameters. In turn, their accuracy is assessed by confronting them to full-field simulations generated with a Fast Fourier Transform-based algorithm suitably implemented to handle interfacial imperfections. Comparisons for transversely isotropic materials with monodisperse reinforcements confirm the superiority of the harmonic and mixed approximations over the more common arithmetic approximation. Overall, the mixed approximation is found to provide the most accurate estimates for a wide range of interfacial bondings and reinforcement contents. The approximations should therefore constitute a valuable ingredient in mean-field descriptions for fiber-reinforced materials incorporating interfacial deformation processes.

ISSN: 2591-3522