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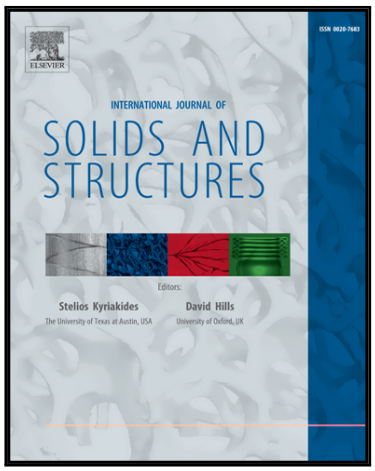

Local fields and overall transverse properties of unidirectional composite materials with multiple nanofibers and Steigmann-Ogden interfaces

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PII: S0020-7683(18)30214-2
DOI: 10.1016/j.ijsolstr.2018.05.019
Reference: SAS 9999

To appear in: *International Journal of Solids and Structures*

Received date: 22 February 2018
Revised date: 17 April 2018
Accepted date: 27 May 2018

Please cite this article as: Zhilin Han, Sofia G. Mogilevskaya, Dominik Schillinger, Local fields and overall transverse properties of unidirectional composite materials with multiple nanofibers and Steigmann-Ogden interfaces, *International Journal of Solids and Structures* (2018), doi: 10.1016/j.ijsolstr.2018.05.019

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Local fields and overall transverse properties of unidirectional composite materials with multiple nanofibers and Steigmann-Ogden interfaces

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June 6, 2018

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Abstract

This paper presents the semi-analytical solution for the transverse local fields and overall transverse properties of composite materials with aligned multiple cylindrical nanofibers. The interface between each fiber and the matrix is treated as a material surface described by the Steigmann-Ogden model, which accounts for the effects of surface tension as well as for membrane and bending stiffness of the surface. Assuming a plane strain setting, the problem is formulated in the transverse plane as an infinite elastic matrix with multiple circular inhomogeneities subjected to a uniform far-field load. The expressions for all elastic fields in the composite system are obtained analytically in the form of infinite series expressions. The Maxwell methodology is used to obtain the overall transverse elastic properties. The goal of this work is twofold: (a) to study the influence of the interactions between the inhomogeneities on the local fields and overall transverse properties of the composite system, and (b) to reveal the connection of the Steigmann-Ogden model (with zero surface tension) to a specific uniform interphase layer model. The results presented in this paper demonstrate that for fiber composite materials with medium to high volume fractions, the influence of the interactions can be significant.

Keywords: Circular inhomogeneities, Surface effects, Steigmann-Ogden model, Effective transverse properties

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