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PII: S0022-5096(16)30803-1
DOI: 10.1016/j.jmps.2017.02.006
Reference: MPS 3063

To appear in: *Journal of the Mechanics and Physics of Solids*

Received date: 3 November 2016
Revised date: 31 January 2017
Accepted date: 10 February 2017

Please cite this article as: Andrea Bacigalupo , Luigi Gambarotta , Dispersive wave propagation in two-dimensional rigid periodic blocky materials with elastic interfaces, *Journal of the Mechanics and Physics of Solids* (2017), doi: 10.1016/j.jmps.2017.02.006

Dispersive wave propagation in two-dimensional rigid periodic blocky materials with elastic interfaces

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Abstract

Dispersive waves in two-dimensional blocky materials with periodic microstructure made up of equal rigid units, having polygonal centro-symmetric shape with mass and gyroscopic inertia, connected with each other through homogeneous linear interfaces, have been analysed. The acoustic behavior of the resulting discrete Lagrangian model has been obtained through a Floquet-Bloch approach. From the resulting eigenproblem derived by the Euler-Lagrange equations for harmonic wave propagation, two acoustic branches and an optical branch are obtained in the frequency spectrum. A micropolar continuum model to approximate the Lagrangian model has been derived based on a second-order Taylor expansion of the generalized macro-displacement field. The constitutive equations of the equivalent micropolar continuum have been obtained, with the peculiarity that the positive definiteness of the second-order symmetric tensor associated to the curvature vector is not guaranteed and depends both on the ratio between the local tangent and normal stiffness and on the block shape. The same results have been obtained through an extended Hamiltonian derivation of the equations of motion for the equivalent continuum that is related to the Hill-Mandel macro homogeneity condition. Moreover, it is shown that the hermitian matrix governing the eigenproblem of harmonic wave propagation in the micropolar model is exact up to the second order in the norm of the wave vector with respect to the same matrix from the discrete model. To appreciate the acoustic behavior of some relevant blocky materials and to understand the reliability and the validity limits of the micropolar continuum model, some blocky patterns have been analysed: rhombic and hexagonal assemblages and running bond masonry. From the results obtained in the examples, the obtained micropolar model turns out to be particularly accurate to describe dispersive functions for wavelengths greater than 3-4 times the characteristic dimension of the block. Finally, in consideration that the positive definiteness of the

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