Accepted Manuscript

Flexural elasticity of woodpile lattice beams

Enrique Cuan-Urquizo, Atul Bhaskar

PII: S0997-7538(17)30126-2

DOI: 10.1016/j.euromechsol.2017.09.008

Reference: EJMSOL 3493

To appear in: *European Journal of Mechanics / A Solids*

Received Date: 13 February 2017

Revised Date: 18 September 2017

Accepted Date: 20 September 2017

Please cite this article as: Cuan-Urquizo, E., Bhaskar, A., Flexural elasticity of woodpile lattice beams, *European Journal of Mechanics / A Solids* (2017), doi: 10.1016/j.euromechsol.2017.09.008.

Flexural elasticity of woodpile lattice beams

Enrique Cuan-Urquizo[a,*], Atul Bhaskar[a]

[a]*Computational Engineering and Design Group, Faculty of Engineering and the Environment, Boldrewood Innotavion Campus, University of Southampton, Burgess Road, Southampton SO16 7QF, United Kingdom*

Abstract

Flexure of slender structures, composed of filaments in a woodpile arrangement, is theoretically studied. Expressions for the apparent bending stiffness are derived. The model is validated experimentally using three-point bending. Computer simulations show that bending is accompanied by lattice shear for increased porosity. A shear-inclusive micromechanical model for two different stacking arrangements is developed. This is further refined by including shear deformation within the filaments, which is supported by numerical simulations for relatively short filament overhang. The apparent flexure and shear of lattice beams are attributed primarily to *stretch* and *flexure* of the filaments, respectively. Asymptotic formulas for the effective bending stiffness in terms of the relative density are presented. The apparent bending stiffness scales linearly with the volume fraction, whereas the apparent shear stiffness scales with the cube of the volume fraction. Exclusion of lattice shear leads to errors for by over an order of magnitude in the extreme, unlike void-free solid beams where shear is a higher order effect. Excellent quantitative agreement with numerical results is obtained for a wide range of porosity and external aspect ratio, when lattice shear is included in the model.

Keywords: structure-property relationship, flexural properties, apparent shear modulus, woodpile lattice

2010 MSC: 00-01, 99-00

*Corresponding author

Email address: ecuanurqui@itesm.mx (Enrique Cuan-Urquizo)