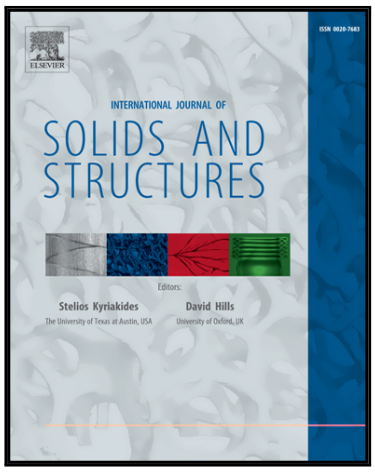

Size-dependent modelling of elastic sandwich beams with prismatic cores

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Size-dependent modelling of elastic sandwich beams with prismatic cores

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ABSTRACT

Sandwich panel strips with prismatic cores are modelled using the modified couple stress theory and their elastic size-dependent bending behavior investigated. Compatibility between the discrete sandwich and continuum beam kinematics is first discussed. A micromechanics-based framework to estimate effective mechanical properties is provided and unit cell models constructed with elementary beam elements to determine the stiffness parameters of various prismatic cores. Numerical studies show that the modified couple stress Timoshenko beam enhances the static deflection predictions of the classical Timoshenko model. A sensitivity measure based on structural ratios is proposed to estimate the influence of size effects in the global beam-level response. The parameters governing size effects in elastic sandwich beams are identified: face-to-core thickness ratio, core density and topology, vertical corrugation order and set of load and boundary conditions. Size effects are shown more pronounced in low-density cores that rely on corrugation bending as shear-carrying mechanism. Based on the external load, boundary conditions and sensitivity factor, one can assess whether size effects are non-negligible in a given engineering structure.

Keywords: Size effect, sandwich panels, couple stress theory, prismatic cores

1. Introduction

All-metal prismatic sandwich panels are a lightweight alternative to conventional plates used in civil, mechanical, vehicle engineering and other applications. The structure is composed of two skins separated by a low-density, visibly discrete core, which governs the mechanical properties and can be tailored based on the application requirements. In the marine industry, sandwich panels with various cores have been studied to substitute the conventional plate with ribs arrangement (Kujala and Klanac, 2005). Prismatics such as the X- and Y-cores have been used for the double hull design due to their relative simple production and impact performance (Naar et al., 2002; Ehlers et al., 2012). Advances in manufacturing encouraged the development of micro-architectured prismatics, whose multifunctional capacity includes