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Experimental determination of mixed-mode fracture toughness for rigid polyurethane foams
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Abstract
Cellular materials represent a new class of materials and main parameters that characterize the cellular structure are relative density, cells shapes (open or closed cells), wall thickness and cell diameter/length. Polyurethane foams crush in compression and have a brittle fracture in tension, so their failure could be evaluated based on Linear Elastic Fracture Mechanics. Fracture toughness in mixed mode loading is of particular interest because foam cracking weakens the structure's capacity for carrying loads. The mixed mode fracture of three closed-cell rigid PUR foams with densities: 100, 145 and 300 kg/m3 were experimentally investigated. Fracture tests were performed with a loading speed of 2 mm/min at room temperature, using both Asymmetric Semi-Circular Bend (ASCB) specimens and Single Edge Cracked (SEC) specimen and a mixed mode loading device. In this respect a numerical determination of Stress Intensity Factor (SIF) solutions for ASCB specimen were performed using Abaqus software. The advantages of these specimens are the simple geometry and the ability to produce full range of mixed modes, from pure mode I to pure mode II, only by changing the support span or loading direction. Fracture criteria based on the cellular topology and tensile strength of the solid material is assessed. It was found that the density of foams is the most important parameter influencing the fracture toughness. The crack propagation angles and the crack path were also determined experimentally and numerically. The foams cells morphology and pore distribution were studied before testing through scanning electron microscopy. © Springer International Publishing Switzerland 2017.

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