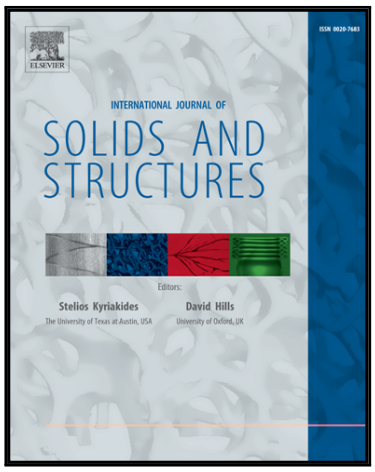

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Strength and toughness in shear of constrained layers

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Abstract

Confined layers may fracture in shear. This occurs, for example in adhesive joints and composite materials. A common mechanism for shear fracture is the formation of shear hackles associated with an expansion of the layer. This makes shear toughness and strength depend on the constraint of the expansion. By constraining the expansion using external loading in experiments, the expansion is reduced but not totally inhibited. The experiments are evaluated using the path independent properties of the *J*-integral. It is shown that the shear toughness increases for the more constrained case. Thus, from a strength analysis perspective, ignoring the expansion leads to a conservative estimate of the fracture properties. Extrapolation of the evaluated properties to totally inhibited expansions gives the traction separation relation and the fracture toughness for a layer in simple shear.

Key words: adhesive; cohesive law; cohesive layer; constrain; dilatation; mode II; shear fracture; shear hackles; simple shear

Nomenclature

a	Unbounded length of specimen
b	Width of layer
c	Position of the compressive load
h	Height of substrate
m	Length parameter
t	Thickness of layer
u	Strain energy per unit volume
v, v_0	Shear deformation; with subscript 0 indicating the value at the start of the layer
w, w_0	Normal deformation; with subscript 0 indicating the value at the start of the layer
B	Width of substrate
E	Young's modulus of the substrates
F	Applied force