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www.elsevier.com/locate/ijadhadh

PII: S0143-7496(17)30082-9
DOI: http://dx.doi.org/10.1016/j.ijadhadh.2017.04.002
Reference: JAAD2001

To appear in: *International Journal of Adhesion and Adhesives*

Received date: 19 April 2016
Accepted date: 28 March 2017

Cite this article as: U.T.F. Carvalho and R.D.S.G. Campilho, Validation of pure tensile and shear cohesive laws obtained by the direct method with single-la j o i n t s , *International Journal of Adhesion and Adhesives* http://dx.doi.org/10.1016/j.ijadhadh.2017.04.002

Validation of pure tensile and shear cohesive laws obtained by the direct method with single-lap joints

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Abstract

Joining with structural adhesives in the aeronautical industry dates back to some decades, although only more recently this technique has been implemented to load bearing parts in other industries. This technique enables joining steel with aluminium or fibre-reinforced composites, with a major weight advantage. Cohesive Zone Models (CZM) are an accurate design method for bonded structures but, depending on the adhesive type and specimen's geometry, the accuracy of the strength predictions may be highly compromised by the choice of the cohesive laws. This work presents a validation of tensile and shear CZM laws of three adhesives obtained by the direct method applied to Double-Cantilever Beam (DCB) and End-Notched Flexure (ENF) tests, respectively. The validation is carried out by considering a mixed-mode bonded geometry (the single-lap joint) with different overlap lengths (L_O) and adhesives of distinct ductility. Initially, the precise shape of the cohesive law in tension and shear of the adhesives is estimated, followed by their simplification to parameterized triangular, trapezoidal and linear-exponential CZM laws. Validation of the CZM laws was accomplished by direct comparison of the load-displacement (P-δ) curves and maximum load (P_m) of the single-lap joints as a function of the tested L_O values. The strength predictions were accurate for a CZM law shape consistent with the adhesive type, although the differences between CZM shapes were not too significant.

Keywords

A. Epoxides, A. Polyurethanes, B. Aluminium and alloys, D. Cohesive zone model, *J*-integral