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Alexandre Jouan, Andrei Constantinescu

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a critical comparison of shear tests for adhesive joints

Alexandre Jouan*, Andrei Constantinescu

Laboratoire de Mécanique des Solides, CNRS, Ecole Polytechnique, Université Paris-Saclay, 91120 Palaiseau, France, alexandre.jouan@polytechnique.edu, andrei.constantinescu@polytechnique.edu

*Corresponding author

Abstract:

Adhesive joints get a growing part of assembly solutions in various industrial applications and are considered as an alternative to soldering and welding. Their small thickness to length or aspect ratio and the importance of the interface with the assembled parts increase the difficulties for measuring their characteristic mechanical properties such as constitutive law, endurance limit, etc… Several testing configurations and methods have been proposed in the literature without a clear emergence of an optimal configuration. This paper proposes a critical review of four different methods taken from the literature and industrial standards: the single lap joint shear test, the thick adherent shear test, the ARCAN test and napkin ring test. In order to contribute to the emergence and to help the experimentalist find an optimal specimen design, the heterogeneities of stress and strain field distributions are here discussed. The test specimens and configurations under scrutiny are compared using both closed-form expressions and Finite-Element computations and considering two different criteria: the spatial distribution of shear stress and the triaxiality ratio between normal and shear stresses in the joint. This study highlights both advantages and limits of each method for mechanical behavior and fatigue characterization. As a final consequence of the remarks an optimal specimen configuration is proposed.

Keywords: adhesive joint; experimental setup; stress homogeneity; triaxiality ratio

1. Introduction

In the last decades, adhesive joints (also denoted as “adhesive layer”) obtained a growing share of the bonding and assembly solutions in various industries. This is illustrated by technical studies across various fields like aeronautics and automotive , seawater , offshore and electronics. The replacement of soldering and welding by adhesive bonding has brought several advantages up: an easier assembly process, lower temperatures during the manufacturing process, an alternative to lead soldering, the possibility to bind diverse materials together. The extending area of utilization requires novel mechanical tests to assess the behavior and the reliability of the joints.