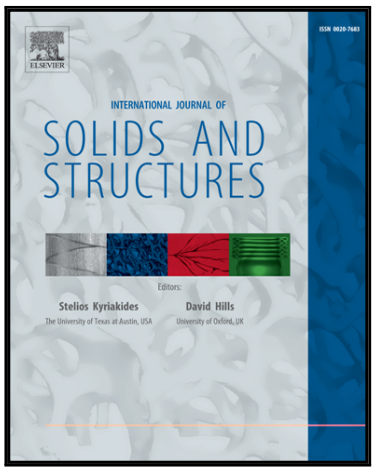

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A non-linear hyperelastic foundation beam theory model for double cantilever beam tests with thick flexible adhesive

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Abstract

Flexible adhesive joints, with adhesives of very low elastic modulus and very large failure deformation, are of special interest in industrial applications. Nevertheless, there is a lack of effective models for predicting their behaviour for structural applications. Existing methods developed for stiff compressible adhesives are not able to accurately capture the nonlinearities present on a thick flexible bondline. This paper presents a new analytical model for the simulation of a flexible adhesive bonded joint in a double cantilever beam (DCB) setup. Using the concepts of elastic foundation beam theory and developing them for a more general non-linear hyperelastic foundation case, a semi-analytical model is proposed. The effectiveness of the model, with respect to other approaches shown in the literature, is compared against experimental results for Krafft's flexible adhesive SILKRON POLYMER H-100. The hyperelastic foundation model accurately predicts the load-displacement response of the adhesive.

Keywords: DCB, flexible adhesives, beam on elastic foundation, hyperelasticity, analytical model

1. Introduction

Flexible adhesives are being increasingly used thanks to the advantages they offer regarding to stiff adhesives, in terms of damping, improved impact behaviour, increased fatigue life, among others [1]. Applications using these kinds of adhesives can be found in many industries, such as in the automotive, aeronautic or building sectors [2].

Appropriate methodologies to experimentally characterize the hyperelastic behaviour of flexible adhesives have been recently proposed [2, 3, 4]. Nevertheless, very few studies have been devoted to the analytical modelling of flexible adhesive joints. In fact, almost all the existing models have been developed for rigid adhesives [5, 6, 7, 8] and their suitability for flexible adhesives has not yet been analysed in depth.

In the modelling of the adhesive bonded joints according to the Elastic Foundation Beam Theory, the adhesive layer is considered as a linear elastic foundation whose the stiffness of the foundation is associated to the properties of

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