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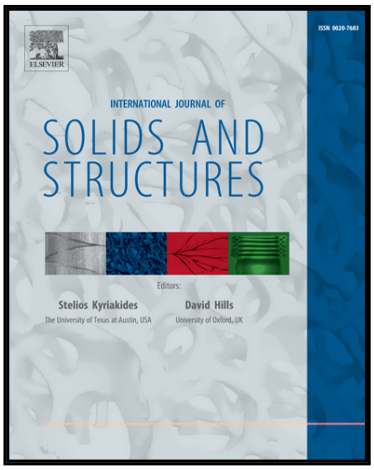

Indentation of adhesive beams

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Indentation of adhesive beams

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Abstract

We investigate the contact of a rigid cylindrical punch with an adhesive beam mounted on flexible end supports. Adhesion is modeled through an adhesive zone model. The resulting Fredholm integral equation of the first kind is solved by a Galerkin projection method in terms of Chebyshev polynomials. Results are reported for several combinations of adhesive strengths, beam thickness, and support flexibilities characterized through torsional and vertical translational spring stiffnesses. Special attention is paid to the important extreme cases of clamped and simply supported beams. The popular Johnson-Kendall-Roberts (JKR) model for adhesion is obtained as a limit of the adhesive zone model. Finally, we compare our predictions with preliminary experiments and also demonstrate the utility of our approach in modeling complex structural adhesives.

Keywords: Adhesion, Beam, Contact, Euler Bernoulli beam, Indentation, Linear elasticity.

1. Introduction

Research in patterned adhesives is often motivated by the structures of natural adhesives, such as those present in the feet of gekkos; see e.g. Hiller (1976), and Arul and Ghatak (2008). In conventional adhesives, such as thin, sticky tapes, only the top and bottom surfaces are active. However, multiple surfaces may be activated with appropriate patterning. With more surfaces participating in the adhesion process the adhesives show increased hysteresis and, so, better performance. One example of a patterned adhesive is the structural adhesive shown in Fig. 1(a), which was developed by Arul and Ghatak (2008). Figure 1(b) shows a possible mechanical model of the structural adhesive of Fig. 1(a) that utilizes several interacting adhesive beams. This motivates the goal of this paper, which is to investigate the adhesive contact of a beam; see Fig. 2(a).

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