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Sánchez-Arce, I. J.; **Ramalho, L. D. C.**; **Campilho, R. D. S. G.**; **Belinha, J.**

Meshless analysis of substrate stiffness and its effect on metallic double-L joint strength and stress distributions. (English) Zbl 1464.74410

Eng. Anal. Bound. Elem. 125, 190-200 (2021).

Summary: Aircraft, automotive, and wind turbine blade construction often require bonding of non-parallel substrates. T-joints are used for such purpose. However, reduced information about their mechanical behaviour is available in the literature, mostly reported with similar substrate thickness. When bonding a thin substrate on a thicker one, the thinner substrate could largely deform before the adhesive layer fails. Therefore, numerical techniques as the meshless methods (MM) are suitable to analyse this joint configuration. In this work, a MM was used to analyse T-joints with metallic substrates. The analyses were elastic-plastic and considered the Exponent Drucker-Prager (EDP), which is appropriate for ductile adhesives. Four substrate thicknesses (1–4 mm), and three different adhesive systems were considered, aiming to investigate the EDP suitability for the analysis of adhesive joints with non-parallel substrates and how substrate thickness and adhesive ductility influence joint strength ($P_{\max}$). Thus, $P_{\max}$, stress and strains along the bond-line, and plastic hinges in the substrates were evaluated. Regardless of the adhesive system, the increase of substrate thickness (t_{P2}) also increased $P_{\max}$. For adhesives with failure strain (ϵ_f) below 10%, experimental and numerical results have a good agreement, showing that the proposed methodology is suitable to analyse this joint type.

MSC:

74S99 Numerical and other methods in solid mechanics
65N35 Spectral, collocation and related methods for boundary value problems involving PDEs
65D12 Numerical radial basis function approximation
74A10 Stress
74C05 Small-strain, rate-independent theories of plasticity (including rigid-plastic and elasto-plastic materials)

Keywords:

adhesive t-joints; adhesive double-L joints; pull-out loading; meshless method; elastic-plastic analysis; exponent Drucker-Prager; ductile adhesives; NNRPIM; natural neighbours radial point interpolation method

Full Text: DOI

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