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Analytical, numerical and experimental analysis of unbalanced adhesive single-lap joints between aluminium adherends

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The single-lap joint is the most commonly used and studied due to its simplicity, although it endures significant bending due to the non-collinear load path, which negatively affects its load bearing capabilities. The use of material or geometric changes in single-lap joints is widely documented in the literature to reduce this handicap, acting by reduction of peel and shear peak stresses at the damage initiation sites in structures [1] or alterations of the failure mechanism emerging from local modifications [2]. In this work, the effect of using different thickness adherends on the tensile strength of single lap joints, bonded with a brittle adhesive, was analytically, numerically and experimentally evaluated. The joints were tested under tension for different combinations of adherend thickness. The effect of the adherends thickness mismatch on the stress distributions was also investigated by finite elements and by analytical method, which explained the experimental results and the strength prediction of the joints. The analytical analysis was based on the formulation presented by Zhao et al. [3]. In the end, a detailed comparative evaluation of unbalanced joints, commonly used in engineering applications, is presented to give an understanding on how modifications in the bonded structures thickness can influence the joint performance.

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