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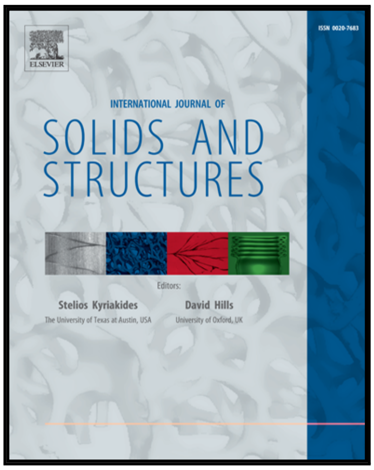

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Performance of Additively Manufactured Cylindrical Bonded Systems with Stiffness-Tailored Interface

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Abstract

The structural performance of multi-material bonded systems can be significantly improved by tailoring interfaces. Here, we report the performance of cylindrical bonded systems with stiffness-tailored interface both experimentally enabled by 3D printing, as well as by modeling. Stiffness-tailored systems are additively manufactured by engineering edge-compliance into the bondlayer. The deformation and failure behaviour of 3D printed shaft-tube joints with such stiffness-tailored bondlayer was evaluated experimentally under axial tensile loads and was found to have about 40% and 25% more load carrying capacity and toughness respectively compared to joints with homogeneous bondlayer. A linear-elastic finite element (FE) model benchmarked with experimental results was employed to examine how the stress redistribution in the bondlayer due to stiffness-tailoring led to improved performance of graded joints. Motivated by the superior performance of stiffness-tailored joints, an analytical model for such joints is proposed within the purview of axisymmetric linear elastostatics. The effect of smoothly grading the interface properties of 3D printed shaft-tube joints on stress distribution is investigated and the influence of grading on shear-transfer length is identified using the developed model considering power-law variation of bondlayer's modulus profile. A reduction in peak shear stress of about 45% was observed for systems with bondlength (l) greater than the shear-transfer length (l_{cri})

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