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Prediction of size effects in open-hole laminates using only the Young's modulus, the strength, and the $\mathcal{R}$-curve of the 0° ply

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Abstract

Advanced non-linear Finite Element models for the strength prediction of composite laminates normally result in long computing times that are not suitable for preliminary sizing and optimisation of structural details. Macro-mechanical analytical models, in spite of providing quick predictions, are based on properties determined from tests performed at the laminate level, making preliminary design and optimisation of composite structures still too costly in terms of testing requirements. To overcome these disadvantages, an analytical framework is proposed to predict the notched response of balanced carbon fibre-reinforced polymer laminates using only three ply properties as inputs: the longitudinal Young's modulus, the longitudinal strength, and the $\mathcal{R}$-curve of the 0° plies. This framework is based on invariant-based approaches to predict the stiffness and the strength of general laminates, and an analytical model to estimate the $\mathcal{R}$-curve of balanced laminates. These laminate properties are then used in a Finite Fracture Mechanics model to predict size effects. The predictions for open-hole tension and compression tests are compared with experimental results

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