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Statistical model for initiation governed intralaminar cracking in composite laminates during tensile quasi-static and cyclic tests

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Abstract

A simple model for predicting intralaminar cracking in laminates under cyclic loads is proposed and validated. The model is limited to low stresses and low crack density and is based on the assumption that the non-uniformity of the fiber distribution is the main reason for the observed large variation of cracking resistance along the transverse direction of the layer. Hence, the resistance variation in quasi-static and in cyclic loading can be described by the same parameter. At low crack density the failure resistance variation is more significant than the variation of the stress state in the specimen, the latter becoming dominant at high crack density. At low crack density the Weibull distribution for probability of intralaminar cracking is used for crack density growth simulation during cyclic loading. Assuming the non-uniformity of the fiber distribution as the cause for variation of cracking resistance, the Weibull shape parameter in cyclic loading is the same as in quasi-static loading case while the scale parameter is assumed to degrade with the applied number of cycles and this dependence is described by a power function. Thus, the determination of parameters is partially done using quasi-static tests and partially using cyclic tests, significantly reducing the necessary testing time. The predictions of dependency of the cracking on the stress and number of cycles are validated against experimental observations of cracking in the 90-plies of quasi-isotropic non-crimp fabric (NCF) laminates as well as in tape based cross-ply laminates.