Abstract

A simplified model is proposed to investigate the stress fields and the strain energy release rate (SERR) associated with cracks in bonded joints in wind turbine blades. The proposed two-dimensional model consists of nonparallel upper and lower shells with adhesive between the shells at the tapered end. Nonlinear finite element analysis (FEA) is performed in a systematic parametric study of material and geometric properties. Two failure modes and their locations are predicted at different combinations of parameters: yielding at the outside end of the adhesive and interface cracking at the inside end of the bondline. Effect of the shell curvature on the stress fields is also considered. Based on the classic beam theory and the beam-on-elastic-foundation (BOEF) assumption, stress and displacement fields of the adhesively-bonded joint were determined by a new theoretical model to support the results from the numerical computation. The failure analysis is continued by studying the effects of manufacturing defects in the adhesive bond. Single and multiple voids are embedded to simulate air bubble trapped in the interface. The numerical and analytical studies are conducted to investigate SERR associated with the voids and results are provided to illustrate the effects of void position and void size.

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