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Predicting environmental degradation of adhesive joints using a cohesive zone finite element model based on accelerated fracture tests

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Abstract

A framework was developed to predict the fracture toughness of degraded adhesive joints by incorporating a cohesive zone finite element (FE) model with fracture data of accelerated aging tests. The developed framework addresses two major issues in the fracture toughness prediction of degraded joints by significant reduction of exposure time using open-faced technique and by the ability to incorporate the spatial variation of degradation with the aid of a 3D FE model. A cohesive zone model with triangular traction-separation law was adapted to model the adhesive layer. The degraded cohesive parameters were determined using the relationship between the fracture toughness, from open-faced DCB (ODCB) specimens, and an exposure index (*EI*), the time integration of the water concentration. Degraded fracture toughness predictions were done by calculating the *EI* values and thereby the degraded cohesive parameters across the width of the closed joints. The framework was validated by comparing the FE predictions against the fracture experiment results of degraded closed DCB (CDCB) joints. Good agreement was observed between the FE predictions and the experimental fracture toughness values, when both ODCB and CDBC were aged in the same temperature and humidity conditions. It was also shown that at a given temperature,