Development of Environmental Durability Test Methods for Bonded Composite Joints

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ABSTRACT

Although environmental durability of composite bonded joints is of importance, no standardized test methods currently exist for such durability assessment. Previous research performed in this investigation suggests that a variation of the standardized metal wedge test is well suited for assessing environmental durability. However, additional complications are produced by the varying flexural rigidity (E_f I) of composite adherends. An important advancement from this investigation was transitioning from the use of measured environmental crack growth to calculated fracture toughness as a measure of environmental durability. Recent research has focused on addressing remaining questions and establishing limits of applicability towards future ASTM standardization of the composite wedge test. The apparent fracture toughness of the bonded composite adherends may be calculated based on the measured crack length and flexural rigidity of the composite adherends. Multiple methods have been identified and evaluated for determining the in-situ flexural rigidity. The use of DCB-type loading of representative specimens following wedge testing appears to be well suited for flexural rigidity measurement. Further testing and analysis are underway to explore the accuracy of this methodology and a recommended procedure will be developed for use in a draft ASTM standard.

Additional research has led to the development and initial assessment of a hybrid traveling wedge test capable of measuring crack-opening force measurements across larger bond areas without the use of a universal testing machine. Efforts have focused on performing tests using a prototype roller wedge assembly with force transducers. Using the measured opening force and an initial measure of crack length, estimates of the bondline fracture toughness may be obtained as the instrumented roller wedge is advanced through the bondline. When desired, the roller wedge may be halted, a static wedge reinserted, and test specimen subjected to the desired environmental conditions for durability assessment using procedures being developed for conventional composite wedge testing.

Further improvements are underway to other existing ASTM adhesive test methods through the recently established ASTM D14.80.01 Task Group and the CMH-17 Testing Working Group. Based on research performed in earlier phases of this investigation, a comprehensive revision of the ASTM D3762 metal wedge test has been completed followed by initial ASTM subcommittee balloting. Current efforts are focusing on identifying suitable shear strain measurement methods and procedures for use in the ASTM D5656 thick adherend lap shear test.