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PREFACE

Virtual fracture testing of composite materials and structures

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The burden of testing to prove the safety of structures upon whose integrity human lives depend is immense: a typical large airframe, for example, currently requires $\approx 10^4$ tests of material specimens, along with tests of components and structures up to entire tails, wing boxes, and fuselages, to achieve safety certification. This cost has to date been unavoidable: while computational stress analyses provide good predictions in the elastic regime, they have not previously achieved predictive accuracy in the presence of damage and fracture.

This limitation is starting to be overcome by new modeling strategies, which combine advances in the generality and physical realism of damage formulations with new experimental techniques for probing the physics of failure at the micron and nanometer scales. Along with the ever-increasing power of digital computers, these research advances are making possible virtual tests of such high fidelity that they can be substituted for many of the experiments currently necessary for materials design and certification. Instead of an actual test, the mechanical behavior of a structure up to ultimate failure is computed through simulations of the physical processes involved at the atomic, microscopic and structural scales. While some actual experiments remain an essential component of the virtual test strategy, providing model calibration and validation, a reasonable goal of virtual test developers is to reduce the total number of tests required in a design and certification cycle by an order of magnitude.

Virtual testing is rapidly emerging as a key technology for structural composites, with the promise of dramatically reducing design time, facilitating optimization and cutting the cost of certification.

Recent advances in this area were presented in the Symposium "*Virtual Fracture Testing of Composite Materials and Structures*" held at the 8th World Congress of Computational Mechanics, June 30–July 4, 2008 in Venice, Italy. The symposium was sponsored by the International Association for Computational Mechanics and the International Union of Theoretical and Applied Mechanics and comprised 22 invited talks by researchers from academia and industry. A selection of these talks is included in this special issue of the International Journal Fracture.

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