8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

VIRTUAL TESTING OF COMPOSITE MATERIALS AND STRUCTURES

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Key words: Multiscale modeling, composite, structures, micromechanics. solid mechanics

ABSTRACT

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 achieved predictive accuracy in the presence of damage and fracture. This limitation is starting to be overcome by new modeling strategies, advances in simulation tools, and the increased power of digital computers, which are making possible "virtual" tests in which 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. Virtual testing is rapidly emerging as a key technology in the area of structural composites, which will help to reduce dramatically design time, facilitate optimization and cut down the cost of certification.

The most recent advances in the area of virtual testing for composite materials and structures will be presented in the mini-symposium through a number of keynote and invited talks. The focus topics will be:

- Realistic spatial representation of composite materials at the fiber, laminar and structural level.
- New computational models to simulate non-linear deformation and fracture processes in composite materials (extended finite elements, cohesive crack models, continuum damage mechanics, non-local approaches, etc.).
- Computational strategies to solve large, non-linear problems (parallel and distributed computing, domain decomposition techniques, etc.).
- Multiscale and hierarchical approaches to account for different time and length scales in the simulations.
- Experimental characterization of the dominant damage and fracture mechanisms in composite materials and structures at atomic, microscopic and structural levels.
- Experimental calibration and validation of virtual testing strategies at the material, coupon and structural levels.

It is envisaged that the papers presented in the mini-symposium will be published in a special issue of the International Journal of Fracture.