VIRTUAL ALLOWABLE COMPUTATION TO SPEED-UP NEW CFRP MATERIAL INSERTION

Anthony Cheruet, e-Xstream engineer

Pierre-Yves Lavertu , e-Xstream engineer

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ABSTRACT

In the research of lightweighting solutions, the use of CFRP has dramatically increased during the last two decades both in aerospace and automotive industries. However designers are still facing the challenge to accelerate the insertion of new materials for applications. One of the main challenge concerns the reduction of the material screening and selection time which relies only on experimental procedure. Globally speaking, there is a need for a material definition and certification in a numerical form to meet platform requirement and that allows to reduce cost and development time of new material by replacing manual tests with advanced simulation.

A comprehensive simulation process is then proposed and will be described. This process allows to define a complete test matrix in order to generate B-basis allowable for a material system given, unidirectional or woven reinforced. Several aspects have to be considered. The first concerns the material modeling and the strength and failure behavior. This modeling combines micromechanics that derives through mean-field homogenization the non-linear composite properties from constituent properties and microstructure description and progressive failure. The second aspect considers the test matrix that needs to be defined and this one can cover the layup definition, the type of tests to be simulated, and the environmental conditions. Finite Element models will be generated accordingly. Finally the last aspect considers the material sensitivity to parameters variability with full Uncertainty Quantification Method. The mean-field homogenization provides a

mean to investigate the origin of variability from material properties (stiffness and strength constituent properties), the manufacturing process (fiber fraction, voids) and the variability from testing conditions such as the fiber orientation.

Specific examples of coupon will illustrate this process that allows the generation of B-values allowable after a complete virtual test campaign of UD or woven reinforced polymer. These examples concern the standard unnotched and open hole tests but also will describe how the challenge of a filled-holed and assembled coupon can be solved. The process is completely integrated in the DIGIMAT software package.