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EXPERIMENTAL BUILDING BLOCK APPROACH AND NUMERICAL MODELLING OF THERMOPLASTIC COMPOSITE USED FOR FUSELAGE PANELS

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ABSTRACT

The present work focuses on the experimental and numerical investigation of thermoplastic composite aircraft structures through a building block approach [1-3]. Numerical simulations take part as to derive a preliminary behavior of the thermoplastic composite material and extract the optimum geometry and stacking sequence and then validation comes from the experimental campaign. The tests are extended from material characterization coupons to the demonstrator multistiffener panel.

The aim of this survey is to verify the numerical modeling of a multistiffener panel through a simplify experimental campaign at lower-level components. At first, at the material level, several coupons were tested at the main loading scheme, tension, compression (Fig 1), and shear so to derive the in-plane elastic properties and strength of material and establish a material database. Failure of these coupons was predicted also by feasible FEM models. Then, at the non-specific level, the material database is applied at fracture and impact simulations, and the results were verified with the corresponding experimental tests. Specifically, the tests are Mode I, II and Compression after Impact, where the fracture toughness, the residual compression strength and an overview of failure were extracted. Moreover, bearing and fastener pull through tests were conducted for quantifying failure of thermoplastic composite joints and obtaining an estimation for the corresponding joints in the fuselage panel. This constitutes the element level. Throughout this procedure, FEM models of the upper level were calibrated with the experimental results of the previous one.

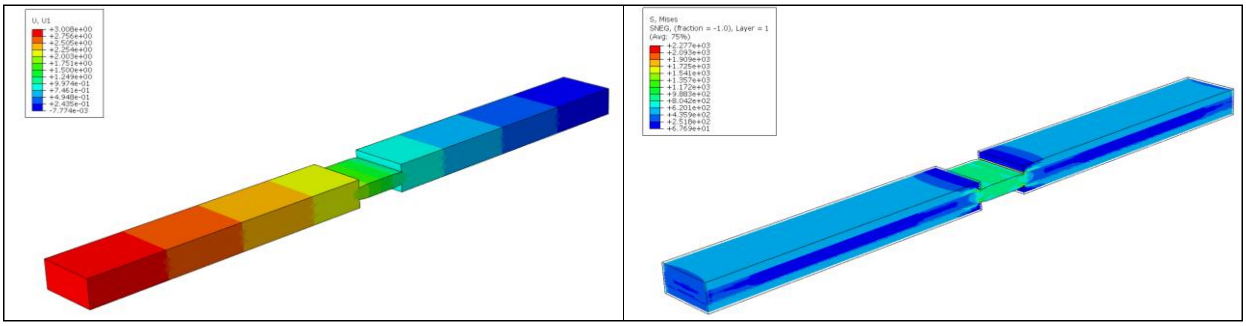

Figure1. Compression 90º model results (displacement and von mises stress)

The material characterization tests gave the information about the mechanical response and the appropriate elastic constants for modelling. Then, the fracture mechanic tests (mode I, II) have shown excellent properties for the thermoplastic matrix composite with high interlaminar fracture toughness. Moreover, due to the high absorption energies, and plasticity of thermoplastic matrix [4], small difference between the compressive strength prior and after impact is concluded. Last, the usage of fasteners, introduce damage to the composite due to excessive delaminations, fibre breakage and stress concentrations around hole. The FEM models come up with very good results and prediction of failure for all the above experiments and can provide eligible estimations for models in upper levels of the "pyramid of tests". In future work, the findings of these tests will provide necessary information for

the modelling (optimization of geometry and stacking sequence) and validation of the demonstrator fuselage panel (element and panel level).

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