



Assess Impact of Fiber Waviness on Composite Structure Performance by Finite Element Modelling

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Assess impact of fiber waviness on composite structure performance by finite element modelling

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Resource Abstract

Composite materials have been used for decades in the aerospace industry to design lightweight structures with high mechanical performances, i.e. stiffness and strength. Defects are present in composites, mainly as a result of the manufacturing process. It is essential to assess their impact on the strength and the stiffness of the structure. The defect of interest in this study is the fiber waviness across the laminate thickness. It appears because of the difficulty to impose homogenous compaction pressure in regions of geometric complexity, e.g. at the corner between skins and hat (omega) stiffeners. Specimens were first manufactured with the specific defect and compression tests were conducted to determine the effect of the defect on the mechanical performance when compared to sound specimens. Advanced material modelling was used with Simcenter Samcef finite element solver to simulate the response of the specimens under compression. Intra and inter-laminar damage models were taken into account to represent the progressive failure of the plies and delamination, respectively. The parameters of the damage models were identified based on testing at the coupon level. However, this model homogenises the properties at a fixed matrix volume fraction. As some plies, in the waviness zone, contain variation of the thickness, some corrections based on homogenisation

formula were applied on the identified material properties. Two approaches were followed: a fine one in which the properties are corrected at each element and a coarser one in which the correction is averaged over the global waviness zone. Once available, this information is used in the model of the specimen including the fiber waviness, and non-linear finite element analyses are conducted. A methodology was developed in order to generate a faithful geometry (involving the mesh) to capture the waviness effect. Test and simulation results were compared to challenge and discuss the modelling assumptions and their influence on the quality of the simulation results.

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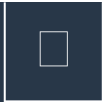
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