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Uncertainty Quantification of Composite Structures with Manufacturing Defects within the SuCoHS Project

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Due to their high weight specific mechanical properties, fibre reinforced composite materials are increasingly utilized for high performance primary structures within aircraft wing and fuselage components. Yet, further exploitation is often limited due to rather high material and manufacturing costs including post-processing, concessions and rework. Additionally, very conservative engineering allowables are currently applied in order to account for uncertainties arising from manufacturing as well as operation phase. Further significant weight savings are expected for new structural components that are currently made from metals e.g. by reason of combined high thermal, mechanical or fire loading that cannot be bared by state-of-the-art composites.
In order to maintain the leadership of the European aeronautics, the European funded project SuCoHS investigated potential weight and cost savings in expanding the use of composite materials in areas of demanding thermal conditions (temperature and fire). In particular, SuCoHS envisages new structural concepts with novel multi-material composites to provide high robustness against thermal, mechanical and fire loading. These developments also cater for high production rates, providing a cost competitive manufacturing process at minimum material and energy consumption, while reducing the requirement for visual inspection or rework. New solutions for structural health monitoring are considered within the structures to enable condition-based maintenance considering actual loading and structural conditions.
The presentation will give an overview of the project and provide some detailed insight into the developed probabilistic sizing approach. For the latter, randomly occurring manufacturing defects (fibre tow gaps) as well as uncertain temperature distributions are taken into account in a probabilistic multiscale approach. The effect of fibre tow gaps is homogenized using meso-scale models [1] and embedded into Monte Carlo simulations of the macro models using surrogate models [2].

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