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(Article begins on next page)

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Reliability design optimisation of classic composite plates using a CUF-based layerwise approach

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Uncertainties in the manufacturing process of structures may arise at any moment of the fabrication chain. In the case of composite structures, such uncertainties may appear in the material elastic properties as a result of the microscale features of such material or even from manufacturing flaws, such as misalignments, fibre waviness, etc. [1] when assembling the final product. As a result of these defects, the structural response of the final structure might be compromised. Therefore, a reliability analysis is needed. In this work, a reliability-based design optimization (RBDO) [2] regarding the linearized buckling behavior of a straight-fibre composite laminate is carried out concerning homogeneous material elastic properties variation. In order to perform such analyses, Carrera Unified Formulation (CUF) [3] is used, according to which structural theories with low-order accuracy to layerwise models can be implemented in a hierarchical and unified manner. These analyses are then used to build a surrogate model based on Polynomial Chaos Kriging (PCK) [4], which substitutes the finite element model and thus accelerates the optimization process. The final scope of the work is to show that layerwise models can help to broaden the design space that other structural approaches may have shrunk, while subjected to the manufacturing constraints that the industry has imposed through the years [5].

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