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Abstract

Sandwich panels are increasingly used in aircraft structures due to their high specific bending stiffness and hence excellent buckling stability. The objective of this work is to find rough sizing process of a composite sandwich panel incorporating multi-scale modelling techniques to substantiate structural capability of each level of test pyramid, and find a minimum number of tests required to validate the approaches. The numerical analysis of such hybrid structures by means of the finite element method (FEM) requires specific strategies regarding the degree of homogeneity of each component. The common modelling approach for solid laminate of carbon fibre reinforced plastics (CFRP) structures using an extended layered shell element formulation can also be applied in modelling of sandwich panels in the global FE-model. The sandwich core, which is thicker compared to the solid laminate CFRP skins, can be formulated as an additional layer between the two face skin layers. For more detailed modelling of the sandwich structure, e.g. a cut out of the global FE model (GFEM), a solid shell approach can be applied. Both of the monolithic skins are idealised using layered shell, while the sandwich core is represented by solid elements. For a hard foam core the solid elements are assigned to the core system according to their type, isotropic material for unreinforced foam or homogenised, anisotropic properties for a reinforced foam core system. The homogenised mechanical properties of the reinforced foam core can be determined using analytical or numerical approaches, in which for a numerical approach the textile profile or needles shaped foam reinforcements are modelled with shell and beam elements respectively. With some modifications the meso-mechanical FE-model can further be used e.g. through the application of explicit FEM for the determination of an impact damage or using the virtual crack closure technique (VCCT) method and a higher level of FE discretisation to assess the growth behaviour of damages. The non-linear FE analyses show a good agreement with the recorded panel deformations.