MODELLING OF 3D-WOVEN COMPOSITES PERFORMANCE TO SUPPORT THE VIRTUAL DESIGN PROCESS

Khilov P.A.[1,6], Pakhomenkov A.V.[1], Pyatunin K.R.[1], Kotov V.V. [2,7], Bartošek J.[2], Pokorný J.[2], Huehn D.[3], Müller S.[4], de Luca P.[5]
[1] PJSC UEC-Saturn, Russia,
[2] MECAS ESI s.r.o., Czech Republic,
[3] ESI GmbH, Germany,
[4] ESI SW, Germany
[5] ESI Group, France
[6] NNSTU, Russia
[7] UrFU, Russia

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There is today a massive trend in weight reduction and improvement of performance of individual components in aerospace industry, and it calls for implementation of new sophisticated materials like 3D woven composites. 3D composites offer high mechanical performance for generally loaded structures and its implementation for many heavily loaded parts is logical step to investigate. However, the complex architecture of the reinforcement makes challenging the design and manufacturing process using existing simulation tools. Note also that the traditional trial-and-error approach suffers from an additional drawback resulting from the very large number of different types of local behaviours found in a 3D composite structure.
This contribution presents a comprehensive approach to simulate the mechanical performance of a 3D woven composite structure. The presented approach is implemented into dedicated software tool created for automatic assessment of a woven composite design in predefined scenarios: quasi-static tests or impact tests. The developed tool is based on automatized multi-scale approach, which enables to generate homogenized material parameters for structure areas with similar weaving patterns used for the design of a structure.
The Multi-scale methodology is based on following approaches: homogenization at the micro-scale level of the roving characteristics; homogenizations at the meso-scale level on representative volume elements of the 3D-composites and final assignation of the various sets of material data to the corresponding sections over the complete composite part. This methodology makes possible to fully account for local variations in the structure stiffness / strength across a 3D woven composite part. Component tests, which were used for validation of the methodology, will be also presented. There were tested samples of various thicknesses and weaving patterns in configuration of tensile test, compression test, shear test and also drop tests with spherical impactor. The tests configurations were respected via prepared FE models and material model was generated via multiscale scale approach. There was also compaction process considered during representative volume segments generation.