Master's Thesis Defense Announcement
Mechanical and Aerospace Engineering Department
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Investigating a Finite Element Model Updating Methodology for Characterizing Mechanical Properties of NCF composites.

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Abstract

Composite materials have been a key breakthrough in developing aircraft structures. Their superior strength and stiffness-to-density ratio, which are unmatched by no other materials, allow engineers to create high strength and ultra-lightweight aircraft structures. Recently, non-Crimp Fabric (NCF) composites have emerged as attractive alternatives to traditional autoclave pre-impregnated composites allowing for lower production costs, better handling and improved shelf life while maintaining excellent in-plane mechanical properties compared to other types of textile composites. NCF out-of-plane mechanical properties can also be enhanced by stitching a high tensile strength yarn throughout their entire laminate thickness, improving the resistance to delamination. However, stitch-reinforced NCF materials remain complex multiscale materials and the development of constitutive models able to accurately capture deformation and failure mechanisms in a virtual design platform is required before they can be utilized effectively in more aerospace applications. Accordingly, this thesis work is part of an on-going research effort at UTA's Advanced Materials and Structures Laboratory (AMSL) focusing on the development of a methodology for characterization of stitched-reinforced NCFs. In particular, characterization of the constitutive shear properties of unstitched NCF using a Short-Beam Shear (SBS) data driven method developed at AMSL is considered. The approach implements a Finite Element Model Updating (FEMU) method that uses full-field strain data obtained from Digital Image Correlation (DIC) measurements to capture nonlinear shear properties. A commercial FEA software, Abaqus, is utilized to perform the finite element analysis and a Python code is implemented for data processing as well as for conducting optimization. Several factors that may affect the value of material inputs generated are also studied, including mesh density, accuracy of the Jacobian matrix and initial approximation of material properties. Finally, the practicality of a new feature available in the latest version of the DIC software used in this work that may streamline the FEMU process is investigated.