A Revised Finite Element Analysis Approach to Designs and Optimize Composite Lattice Reinforcements and Simulate the Mechanical Properties of Composite Lattice Reinforced Plastics

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ABSTRACT

An earlier investigation, presented at CAMX 2022, identified deficiencies in the Finite Element Analysis (FEA) methods used for ply-based or isotropic materials which are unable to accurately capture the physical properties and behavior of hybrid overmolded structures based on unidirectional tape assemblies. In response, a new ANSYS FEA workflow was developed that combines the principles of Representative Volume Element (RVE) homogenization and submodeling. This workflow involves homogenization of composite lattice structures into RVEs that are then assigned to regions of a geometry to achieve part-level stiffness targets. Submodeling of critical stress regions is utilized to assess the distribution of stresses between the lattice and the molded plastic that makes up the RVE While functional, this RVE and submodeling workflow was time and labor intensive.

The current study presents a revised workflow that reduces manual intervention and the FEA setup time. This is achieved through explicit modeling using Altair HyperWorks, whereby the user identifies lattice designs to be tested for a part and inputs tape materials, tape spacing, layer count of the composite lattice into a script that is then explicitly modeled in the FEA without requiring an actual CAD model for various lattice designs to be tested. This method eliminates the need for submodeling, as stresses in tapes and overmolded material can be probed from the part level model after the FEA is solved. The benefits of this revised FEA workflow will be demonstrated through a case study of an automotive door component, educating attendees on a novel FEA workflow that can be applied to a range of hybrid overmolded composite structures.

Keywords: Hybrid overmolded structures, FEA workflow, Explicit modeling

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