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A new Geometric Modelling Approach for 3D Braided Tubular Composites base on Free Form Deformation

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Abstract: The micro-geometry of three-dimensional (3D) braided tubular preform is more complex than that of rectangular one, especially for the interfaces between yarns. The yarn interfaces are difficult to analyze theoretically, and if two sides of the interfaces do not fit perfectly in the model, the final result will contain overlapped yarns, which is bad for Finite Element Calculation. This paper focuses on the microstructure of 3D four-directional braided tubular composites and presents a modelling approach based on Free Form Deformation (FFD) theory. First, the planar and spatial yarn paths are analyzed and three geometrical mapping equations from rectangular unit-cell to tubular sub unit-cell are derived. The modelling approach was then developed to establish the sub unit-cell model. Finally, the established models are compared with micro computed tomography (μ-CT) scans of a dry specimen of the circular braided preform. The model not only solves the yarn-overlapping problem, but also accurately describes the key characteristics of the preform.

Keywords: 3-Dimensional reinforcement; Microstructures; Radiography.

1. Introduction

Three-dimensional braided composites have received enormous attention due to their outstanding performances, such as high transverse strength, high shear stiffness, low delaminating tendency and high damage tolerance [1]. These good mechanical properties have resulted in a significant increase in the application of braided composites, which can be found in various industries especially in aerospace, aviation, automobile, marine, and civil construction for producing structural elements with a variety of different fiber architectures [2].

Mechanical properties of braiding composites largely depend on their preform micro-geometries, such as pitch length, braiding angle and fiber volume fraction. Therefore, a reasonable model for predicting the

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