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EFFECTIVE PERMEABILITY AVERAGING SCHEME TO ADDRESS IN-PLANE ANISOTROPY EFFECTS IN MULTI-LAYERED PREFORMS

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Abstract

In Liquid Composite Molding (LCM) processes, fabric layers are stacked in a mold which may be a few meters long and wide to build up a thickness of not more than a few millimeters. Resin is introduced to fill all the empty spaces between the fibers. As the in plane dimensions are a few orders of magnitude larger than through the thickness, flow of resin through the preform can be modeled using the two-dimensional Darcy's law, neglecting the through-thickness velocity and assigning the preform an arithmetic averaged permeability from the layers. However, there are situations in which the through-thickness flow is significant where this assumption is no longer valid or justified. To address such cases, a modified averaging scheme was proposed by Calado and Advani [1] to account for the transverse flow between adjacent layers of a preform and consequently derive an homogenized one-dimensional value of effective permeability. In the current work, such a model is extended to account for the effect of anisotropic off-axis layers in the stack. The result is a generalized scheme for effective permeability averaging layers of heterogeneous preforms, capturing both through-thickness and in-plane effects into a one-dimensional permeability value. This methodology was validated and a parametric study was conducted with different combinations of in-plane and through-thickness permeability values to identify the influence of preform in-plane dimensions and thickness and to define a criteria that relates the material and geometric parameters to the transverse flow.

Keywords: A.Layered structures, B.Permeability, C.Process modeling, E.Liquid composite moulding

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