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Process modeling and simulation

ECCM19-ABS-1405

Simulation of simultaneous squeeze-bleeding flow for the consolidation of unidirectional viscous prepregs

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Second topic:

2.4 Material science: Prepregs

Third Topic:

3.19 Material and Structural Behavior - Simulation & Testing:

Advanced computational strategies

Abstract text: When a stack of uni-directional prepregs is subjected to compressive forces in order to consolidate into a laminate, two main types of flow can be observed. The first type of flow is called the bleeding flow which occurs when the viscosity of the resin is sufficiently low, the drag forces due to resin movement are incapable to convect the fibres in the transverse direction and the resin flows in longitudinal direction between the fibres. The second type of flow is called squeeze flow which occurs when the resin viscosity is sufficiently high so that it convects the fibres in the transverse direction.

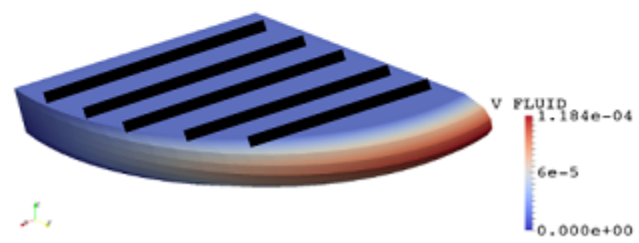
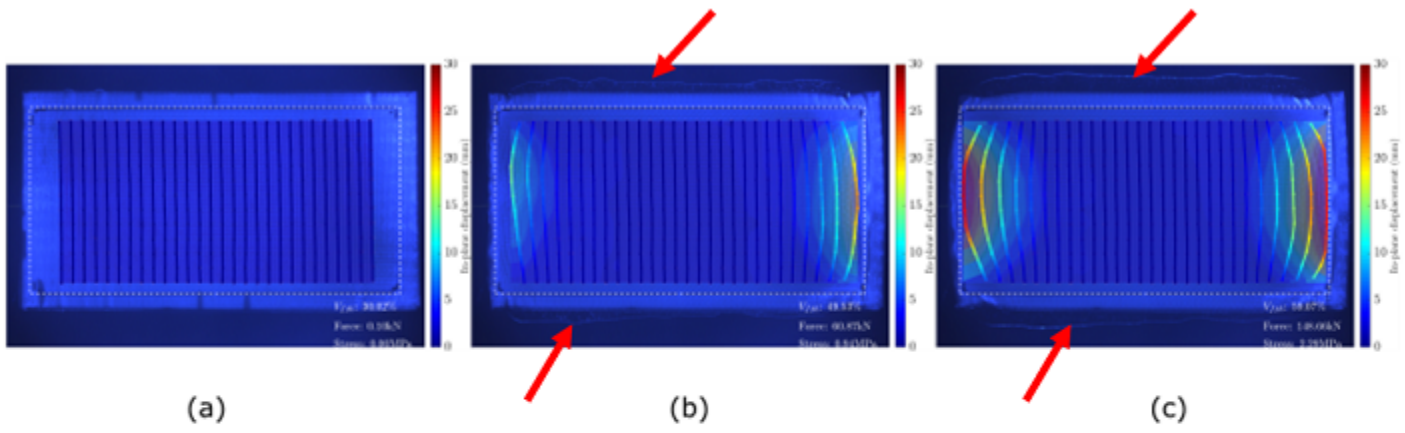
Simulation of consolidation process requires modeling of both these mechanisms. However, in the previous works, this modeling is based on the postulate that these two mechanisms do not occur simultaneously and thus generally involves the process modeling of the squeeze flow or the bleed flow individually and a criteria to switch from one mechanism to the other.

In this work, a new continuum based numerical model is proposed which unifies both the mechanisms of squeeze and bleed flow so that they can occur in parallel. This model is proposed based on the experimental observations as shown in [Figure 1]. [Figure 1 (a), (b) and (c)] show the in-plane displacement field observed from the experiment at different stages in the consolidation process with $V_f=30\%$, $V_f=50\%$ and $V_f=59\%$ respectively. As V_f increases both the squeeze flow (indicated by the transverse movement of the fibres in Figure 1) and resin bleeding flow (indicated by the resin exiting the sample along longitudinal direction shown by red arrows in [Figure 1]) were found to occur simultaneously.

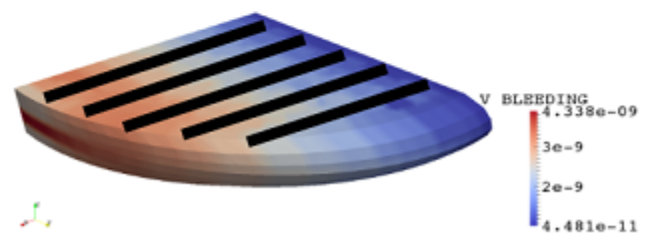
The numerical simulations are carried out for a cylindrical sample of unidirectional prepreg undergoing consolidation. The fibres are oriented along X direction. [Figure 2 (a)] shows the composite transverse squeeze velocity whereas [Figure 2 (b)] displays the velocity of the pure resin that bleeds in the fibre direction. The results obtained from the simulation were qualitatively compared with the experiments.

In conclusion, this work proposes a unified framework which allows both the squeeze and bleed flow phenomena to take place simultaneously, which is closer to the actual observed physics of the process and also eliminates the need of an additional switching parameter.

Image:



(a) Composite transverse squeeze velocity



(b) Fluid bleeding velocity

Disclosure of Interest: Aucun conflit à déclarer

Keywords: consolidation, Numerical modeling, Prepreg, Process simulation