Modelling of residual stresses in rubber pressed composite products

S. Wijskamp, E.A.D. Lamers, R. Akkerman

University of Twente
Twente Institute of Mechanics
P.O. Box 217, 7500 AE Enschede, The Netherlands
phone +31-(0)53-4892426, e-mail s.wijskamp@wb.utwente.nl

Introduction

Continuous-fibre-reinforced thermoplastic composites can be shaped into complicated products with the rubber pressing process, which has a short production cycle relative to the forming of thermosets.

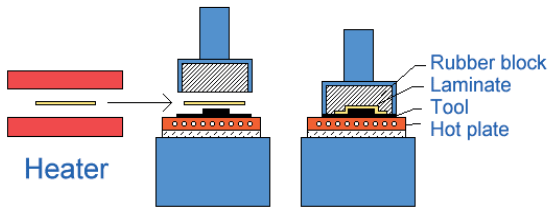

Figure 1 Moulding cycle of a thermoplastic composite

During the moulding cycle, residual stresses build up that cause unwanted distortions in the final product. These stresses are caused by:

- anisotropic shrinkage
  - thermal
  - morphological (crystallisation)
- non-symmetric process conditions
  - temperature profile through the thickness
  - contact

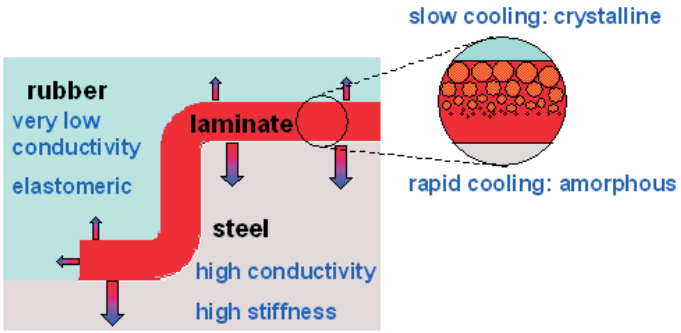

Figure 2 Sketch of the non-symmetric moulding process and the resulting morphology

Objectives

The objective is to model the build up of residual stresses during the rubber pressing process and the shape distortions they cause in the final product, resulting in a "first time right"-design of the tool.

Previous studies showed[1] that the largest part (75%) of the residual stresses is caused by anisotropic thermal shrinkage. Now, attention is focused on the stresses due to the temperature profile during pressing and the resulting morphology.

Methodology

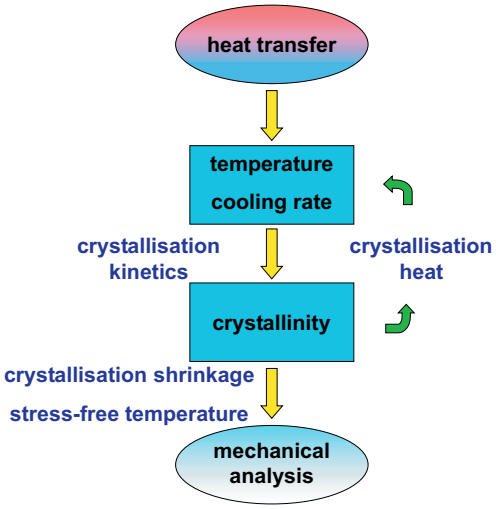

Figure 4 Schematic representation of the model

Results

The heat transfer problem with the temperature and cooling rate dependent crystallisation kinetics was solved using an explicit finite difference method.

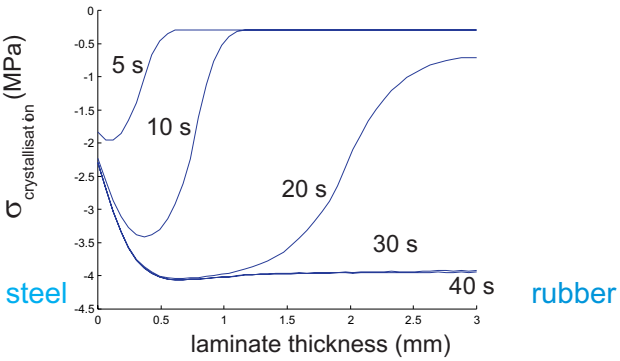

Figure 4 Evolution of the internal stress caused by crystallisation shrinkage in a non-symmetrically cooled laminate

Discussion

As a first approach, a simple model for the prediction of residual stresses due to crystallisation was proposed. It needs verification by a experimental program. It is expected that FEM is needed to include thermal contact and the non-symmetric mechanical boundary conditions.

1 S. Wijskamp, E.A.D. Lamers and R. Akkerman, Effects of out-of-plane properties on distortions of composite panels, in: A.G. Gibson (editor), *International Conference on Fibre Reinforced Composites FRC2000*, Woodhead Publishing Ltd, 2000.