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Prediction of internal strains during curing, post-curing and demoulding of thick glass/epoxy composite – Analysis of different constitutive models

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In order to withstand large in-service loads, composite structures, such as wind turbine blades, require thick load carrying laminates. One of the challenges met in manufacturing these large composite structures is avoiding the development of process-induced shape distortions and residual stresses. For implications, see e.g [1-3]. **In the research presented here, different thermomechanical constitutive formulations used in composites process modelling are compared. in order to determine their validity when modelling the manufacture of thick, slow curing composites.**

A 52mm thick laminate plate is manufactured. Several embedded optical fibres with Fibre Bragg Grating (FBG) sensors are used to monitor internal strains during vacuum infusion, post-curing and demoulding at different intervals through the plate thickness. **The measured strains are compared to numerical predictions.** Numerical models based on different constitutive formulations are used; (i) cure hardening instantaneous linear elastic (CHILE), (ii) path-dependent (PD) and (iii) linear viscoelastic (LVE). The path-dependent approach is a limiting case of linear viscoelasticity proposed by Svanberg [4]. Results show that the PD and LVE approaches predict shape distortions well during vacuum infusion. However, as the PD approach lacks time dependency, the resulting post-curing and demoulding strain predictions are poor. The CHILE approach generally overestimates the strains throughout the process due to the lack in accounting for viscoelastic stress relaxation or creep behaviour. **Hence, it is shown that process modelling of slow curing thick polymer matrix composites, numerical models based on viscoelastic constitutive formulations are shown to predict internal strains well.**

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