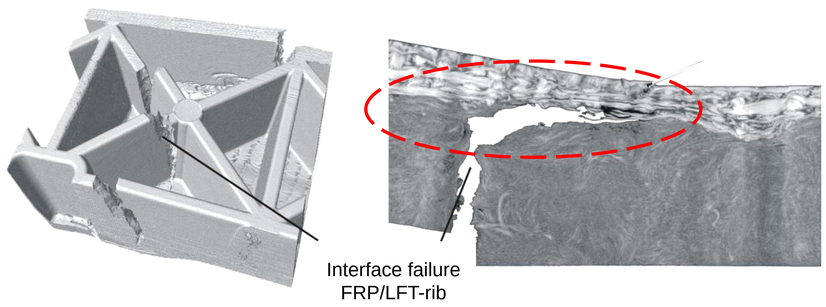
Embedding of locally functionalised textiles by injection moulding

A. Alzuabidi, A. Michel, N. Benhouidga, I. Roth-Panke, L. Kroll
Institute of Lightweight Structures (IST), Chemnitz University of Technology, Germany

TECHNISCHE UNIVERSITÄT CHEMNITZ

Motivation

- Fibre-reinforced polymer (FRP) structures with injection-moulded ribs exhibit abrupt stiffness transitions between the laminate and the polymer ribs.
- Reinforcing fibres are predominantly oriented within the laminate plane, load transfer at the interface relies mainly on the polymer matrix.
- Resulting stress concentrations cause interfacial failure and premature structural damage.

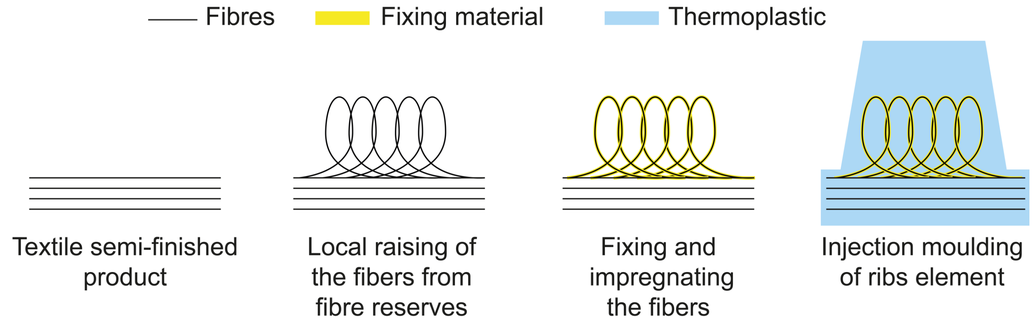


Computed tomography image of rib failure.

Objectives

Development of locally graded FRP structures integrating out-of-plane fibre reinforcement into injection-moulded ribs, focusing on:

- Fibre stability and positioning during mould filling.
- Matrix impregnation of the reinforcement.
- Mechanical performance and failure behaviour of the rib-base transition.



Materials and experimental methodology

Reinforcement concepts

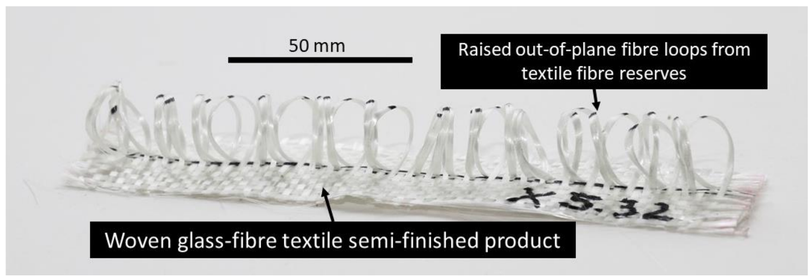
- Fibre loops from textile fibre reserves.
- Stitched glass-fibre rovings.
- Coarse and fine glass-fibre grids.

Prefixation methods

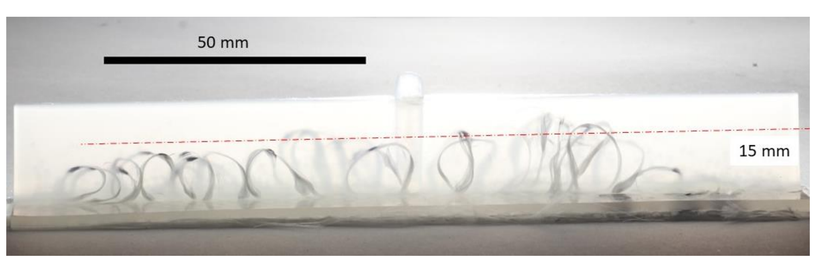
- Epoxy resin: EPIKOTE 935 / RIMH 936.
- Spray adhesive: INFUTAC Clear.

Characterisation

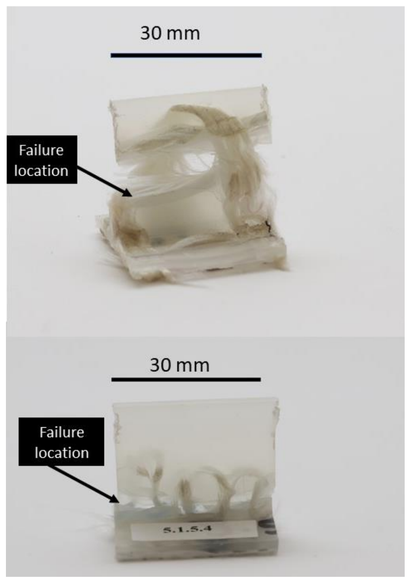
- Assessment of matrix impregnation and fibre positioning.
- T-pull-off testing to investigate mechanical failure behaviour.



Textile semi-finished product with fixed out-of-plane fibres.



Injection-moulded polypropylene rib with embedded fibre loops.

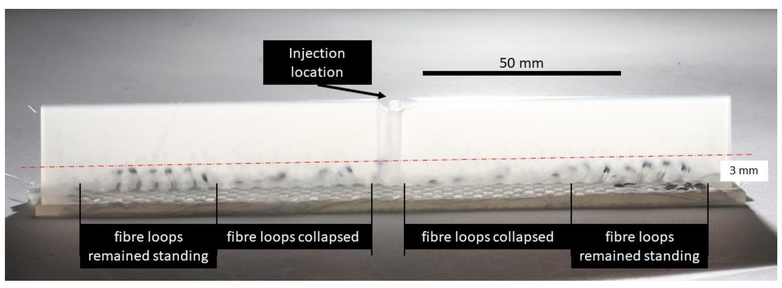


T-pull-off test specimens failure.

Experimental results

Fibre loops

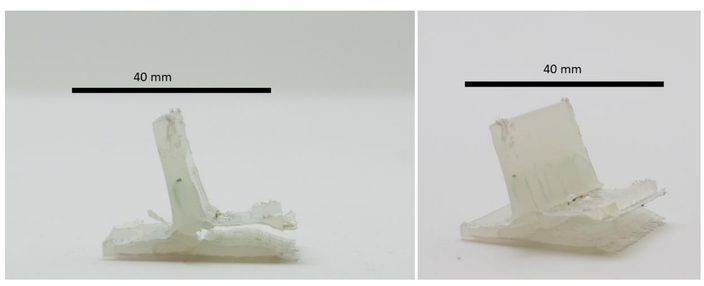
- Increasing loop height extended the reinforced region.
- Melt-induced deformation and local impregnation defects limited reinforcement effectiveness.



Injection-moulded polypropylene rib with embedded fibre loops.

Epoxy-stabilised loops

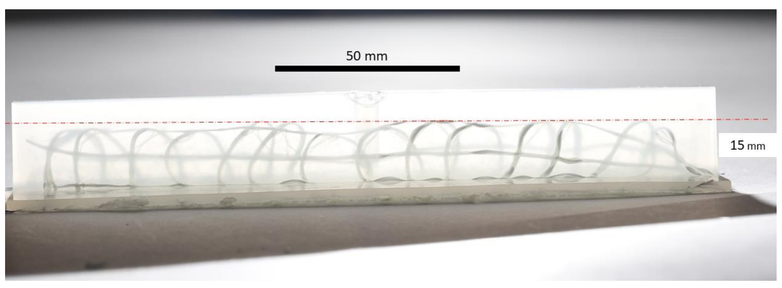
- Improved stability of out-of-plane fibre geometry.
- Insufficient PP embedding caused separation between matrix and textile reinforcement.



Epoxy-stabilised specimens after T-pull-off testing.

Glass-fibre grids

- Fine grids showed good impregnation and stable positioning.
- Coarse grids exhibited exposed fibres and premature failure due to insufficient embedding.



Injection-moulded rib with embedded glass-fibre grid.

Conclusions

- Effective reinforcement requires both **geometrical stability** and **sufficient matrix impregnation**.
- Raised fibre loops: susceptible to melt-induced deformation.
- Epoxy fixation: improved stability but reduced embedding quality.
- **Most promising selected preforming concept:** fine glass-fibre grid fixed with spray adhesive, combining reinforcement stability and good matrix impregnation.

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Contact
Ahmed Alzuabidi
+49 371 531- 39318
Ahmed-zahoo-faleeh.alzuabidi@mb.tu-chemnitz.de
www.strukturleichtbau.net

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Dresden University of Technology
UNIVERSITY OF TECHNOLOGY IN THE EUROPEAN CAPITAL OF CULTURE CHEMNITZ
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