BRAIDING SIMULATION FOR RTM PREFORMS

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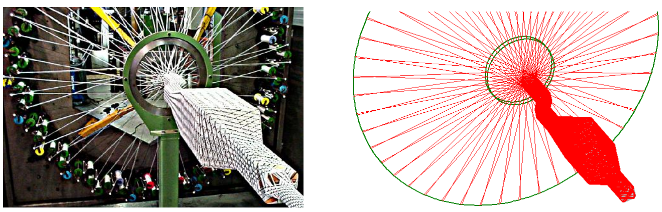
Introduction

Automated braiding [1] is a suitable process to manufacture reproducible preforms for Resin Transfer Moulding (RTM). The highly interlaced structure of braids makes it possible to cover components with sharp curvatures and non-circular cross-sections, varying along the length of the component. The trailing arm of the NH-90 helicopter landing gear is a typical example of such a complex shaped component.

NH-90 composite trailing arm. Courtesy Stork SP Aerospace

Process Description

Two or three groups of yarns can be mounted on the horn-gear braiding machine. The warp and weft yarns rotate in opposite directions in the spool plane, forming a closed biaxial fabric. Stem yarns can be inserted through the horn gears, leading to a triaxial reinforcement in the axial direction of the mandrel. A pair of guide rings leads the yarns towards the mandrel.

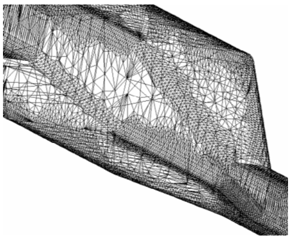


Overbraiding: experiment at Eurocarbon and process simulation

Discrete Approach

A geometric model was developed, based on three assumptions:

1) *Zero fibre-fibre interaction before deposition*
2) *Total interlocking of the fabric after deposition (no slip)*
3) *No separation of the fibres from the mandrel (no fibre bridging)*

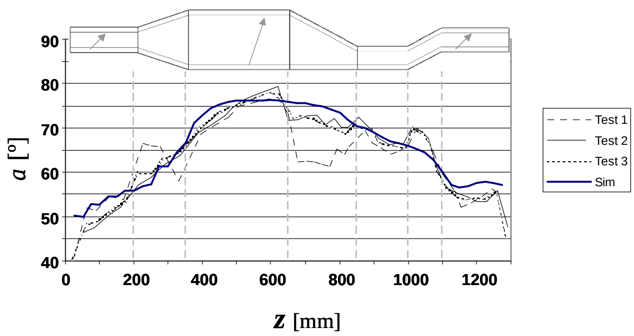


A fast simulation model for braiding on arbitrary geometries was implemented in a user friendly software package. A standard triangular element mesh can be used as the geometry input.

Validation

A complex preform was used for validation purposes, as previously presented [2]. The overbraiding experiments were performed at Eurocarbon (NL), using glass and black polyester yarns. Digital image analysis was used for subsequent fibre orientation measurements.

The correlation between simulation and experiment is good as long as fibre slip is absent after deposition. Tests 2 and 3 were performed with an adhesive layer on the mandrel, Test 1 without. The no-slip results are accurate within the experimental scatter.



Braid angles: measurements vs. simulation results

Discussion

The braid angle predictions are accurate within the experimental scatter for complex mandrels with smooth geometry transitions. When the geometry transitions are more pronounced, the results are particularly sensitive to the guide ring settings. Fibre slip after yarn deposition leads to poor control of the braid angles. It inherently leads to deviations between experiment and simulation where this slip is ignored.

Acknowledgements

The support of the National Aerospace Laboratory NLR and Eurocarbon is gratefully acknowledged.

References

1.Ko F.K. ‘Braiding’ in: Engineered Materials Handbook 1, ASM International, 519-528, 1987.
2.Kessels, J.F.A. and Akkerman, R. Composites Part A, 33: 1073-1081 (2002).