Multi-Scale Characterisation and Modelling of Tufted Composite Structures

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www.bris.ac.uk/composites
1. Scope and Objectives
2. Micro-Scale Modelling
3. Meso-Scale Modelling
4. Future Work
5. Acknowledgments
Scope and Objectives

Application of a developed modelling strategy\textsuperscript{1,2} to tufted composites

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Micro-Scale Modelling

Single Tuft Testing ➞ Analytical Modelling ➞ Micro-Scale FE Models

Pristine

Release film

Failed

Tuft fracture

Debonding

4 mm

0°/90° carbon fibre NCF, 410 gsm
• Carbon fibre thread (Tenax-J HTA40)
• Epoxy Momentive 935/936

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Micro-Scale Modelling

Single Tuft Testing

Simulation of tuft bridging mechanisms

Analytical Modelling

Micro-Scale FE Models

The analytical model is calibrated against experimental bridging laws

Bonded Regime

Debonding Regime

Multi-Scale Characterisation and Modelling of Tufted Composites
Micro-Scale Modelling

Single Tuft Testing

Analytical Modelling

Micro-Scale FE Models

- Abaqus 6.14, Explicit
- Tuft-composite and yarn-yarn interfaces modelled with cohesive contact
- Post-cure cool down thermal step
- Implemented failure criterion for yarns in each thread segment

1 mm Resin pockets

Top half

Bottom half

Impregnated tufting thread segments

Multi-Scale Characterisation and Modelling of Tufted Composites
• Two sets of cohesive elements: ply- ply interface and tufted interface.
• User defined material (VUMAT) to incorporate tuft constitutive bridging law in the models.
Future Work

- Single Tuft Testing
- Coupon Tests for Arrays
- Complex Test Cases

Cohesive zone modelling
- Micro-Scale FE Models
- Meso-Scale FE Models
- Modelling of Complex Cases

Analytical Modelling

- Is it possible to define *bridging maps* for tufts?
- Application of the models for failure prediction of structural parts (tufted T-joints).  

3. J. Kratz et al., Improving the damage tolerance of composite joints with tufting, *ICCM20*, 2015
Acknowledgments

Thank you!

Any questions?