University of BRISTOL

Bristol Composites Institute

Fatigue and Damage Tolerance of 3D Woven Composites

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BCI PGR Symposium 2025

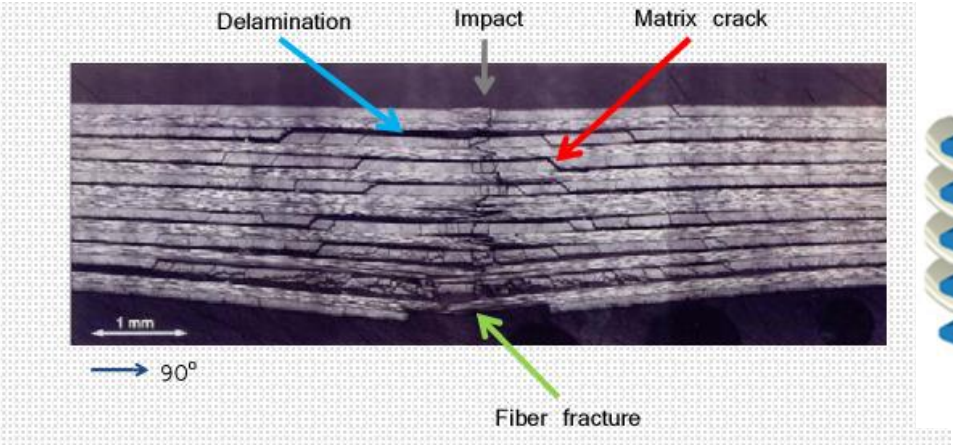
8th April 2025

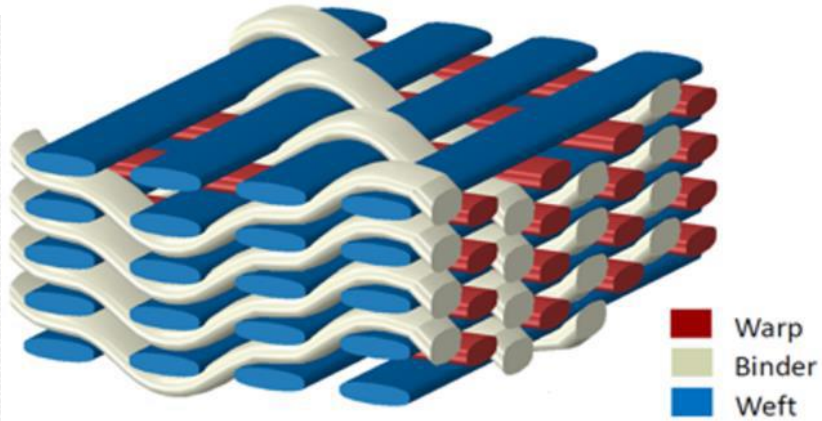
UKRI Engineering and Physical Sciences Research Council

University of BRISTOL

EPSRC Centre for Doctoral Training in Composites Science, Engineering and Manufacturing

Context

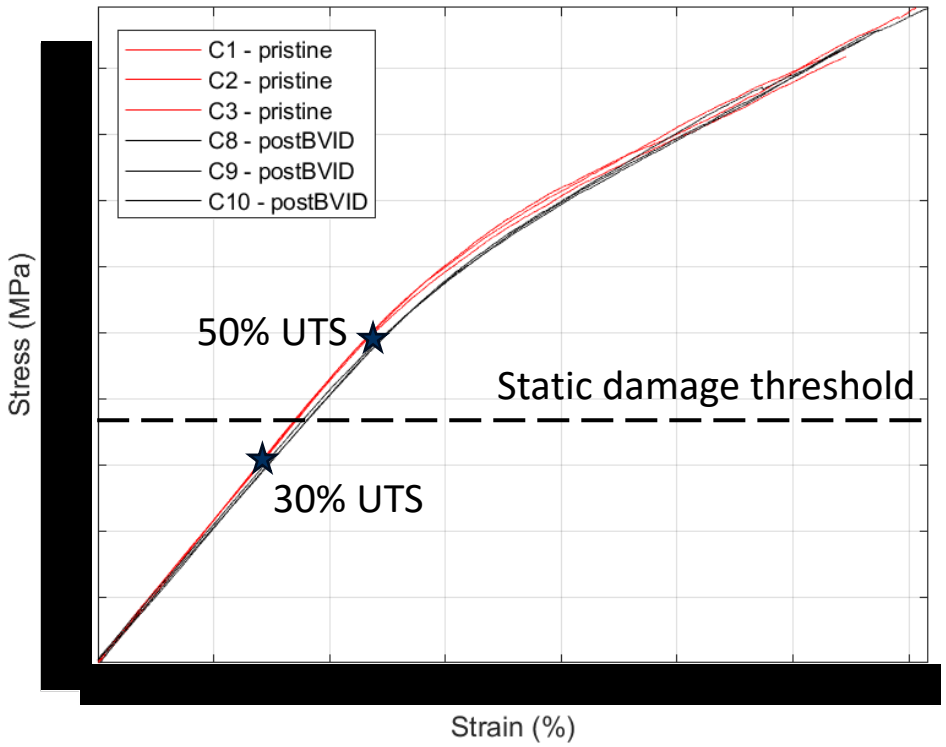

Delamination
Impact
Matrix crack
1 mm
90°
Fiber fracture

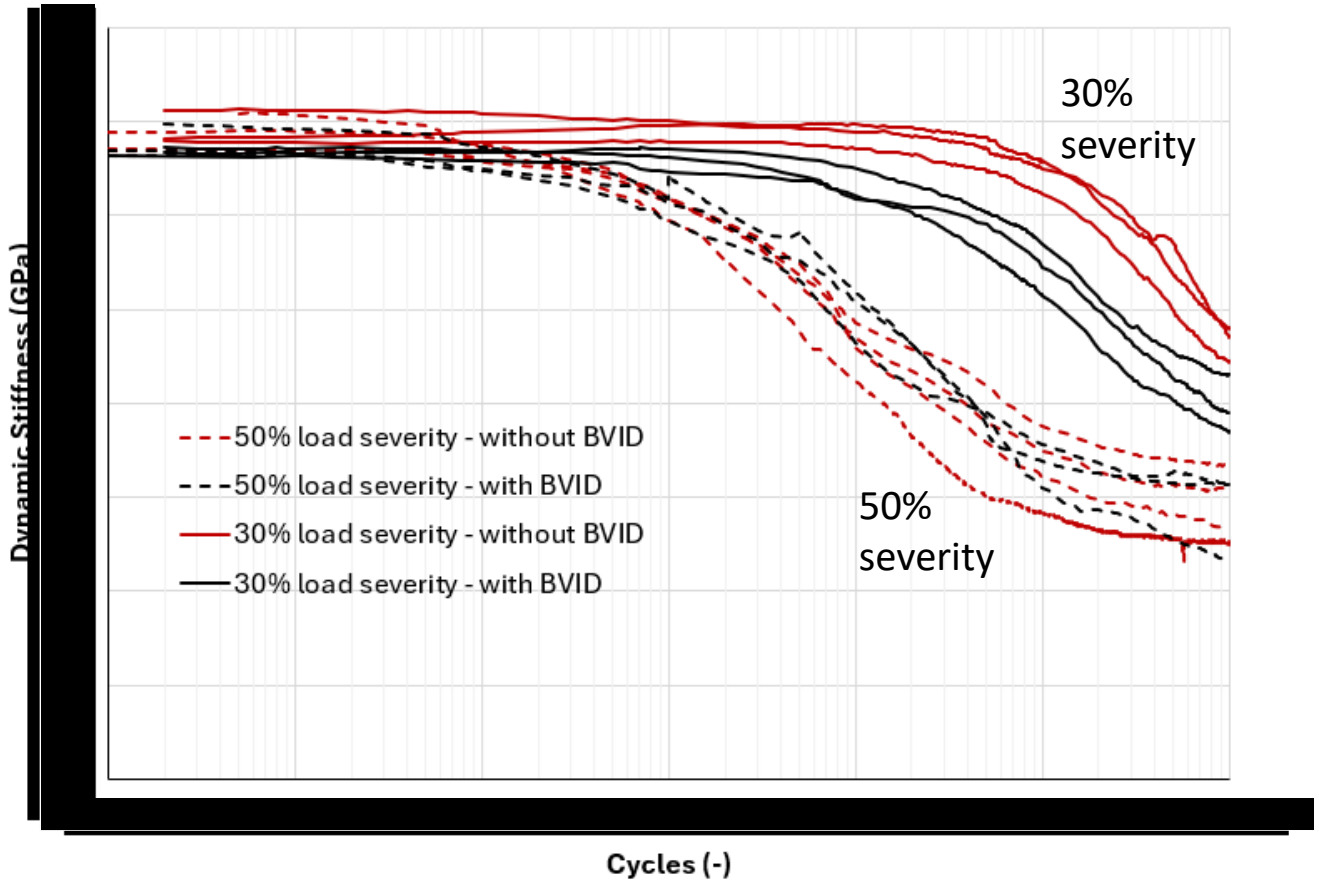

Warp
Binder
Weft

Aims & Outline

1. Experimental investigation on the effect of BVID on tensile static and fatigue loading
2. Modelling the effect of BVID on fatigue
3. Conclusions and ongoing work

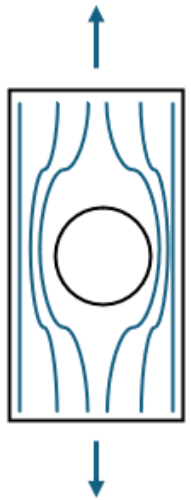
Effect of BVID on tension fatigue



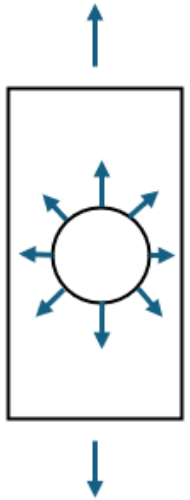


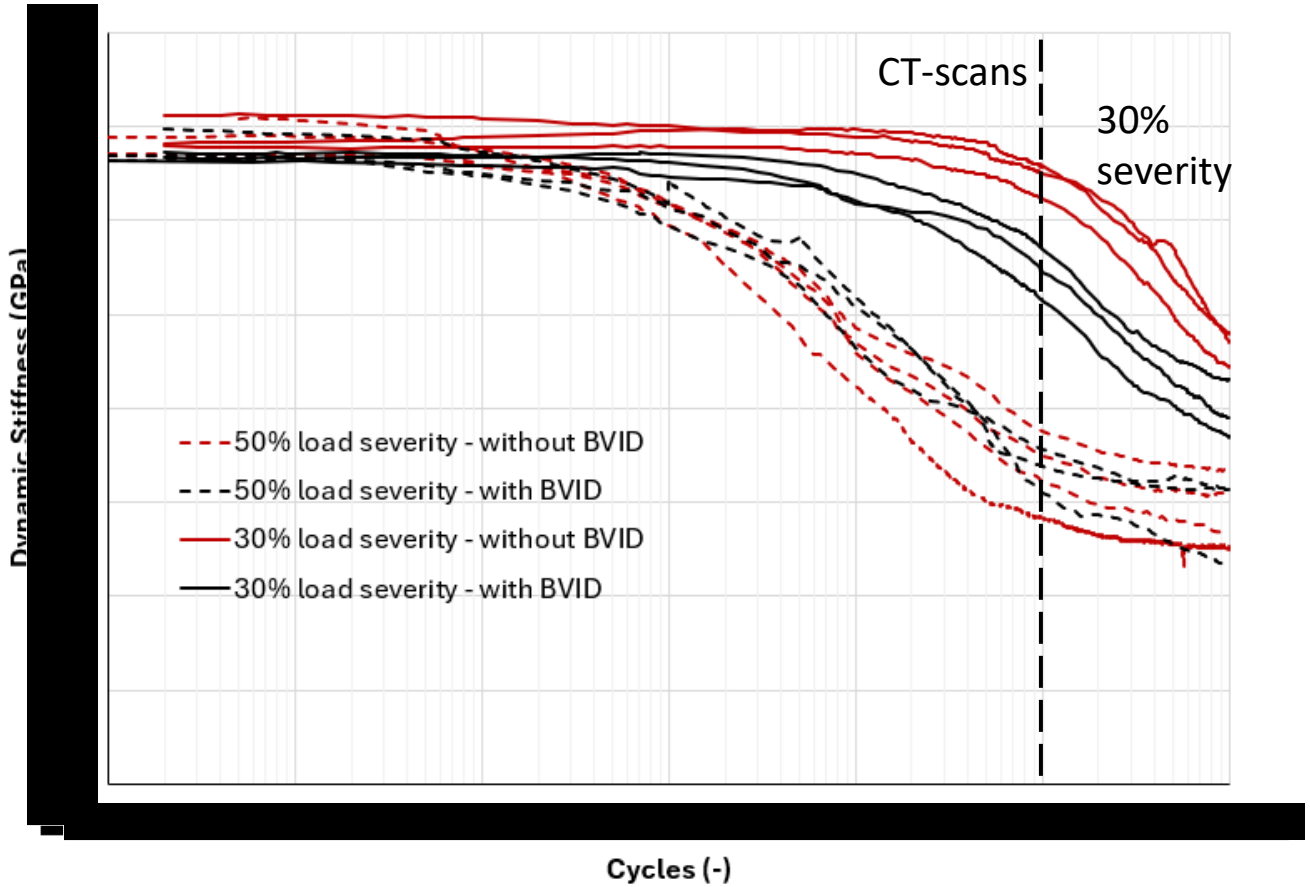
Effect of BVID on tension fatigue

Stress redistribution?



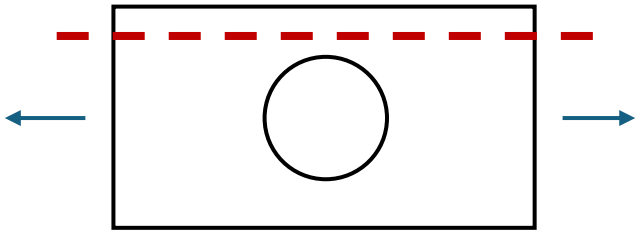
Propagation of pre-existing BVID?

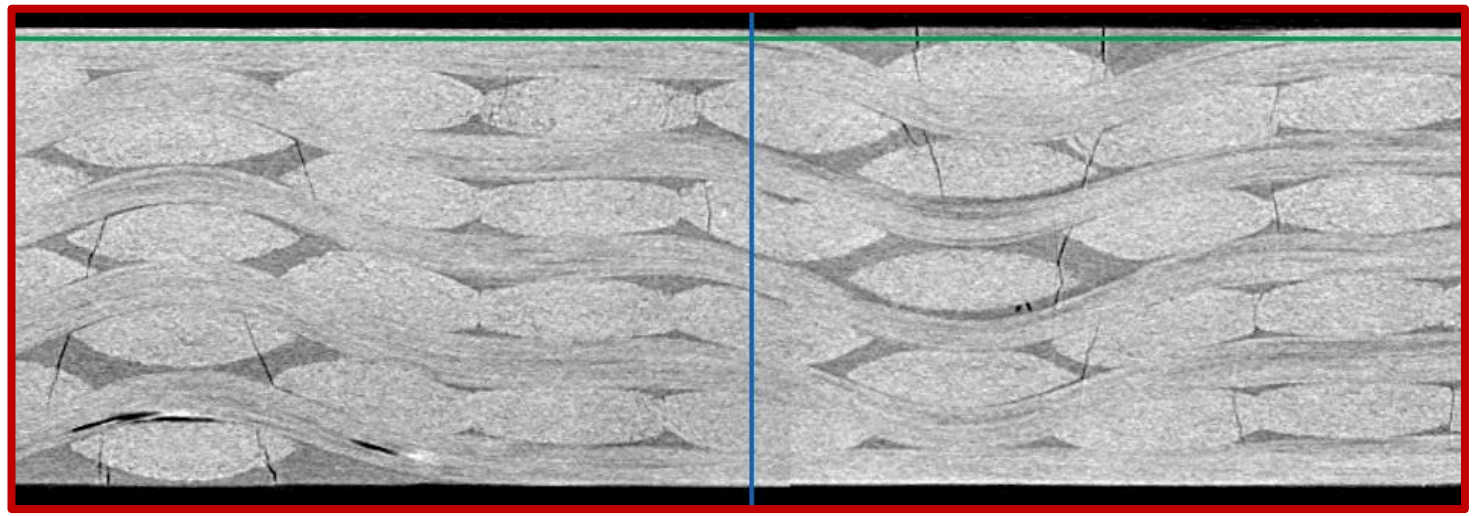




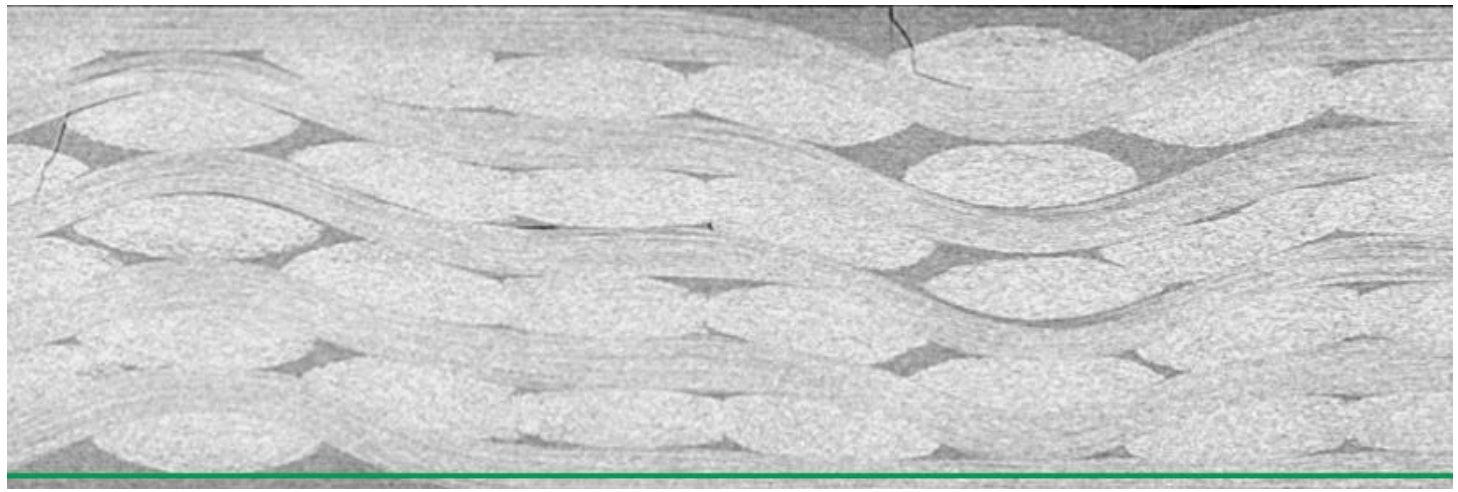
Fatigue damage development

BVID sample:





Pristine sample:



Modelling the effect of BVID

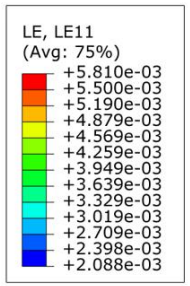
Calibrate static/fatigue material behaviour

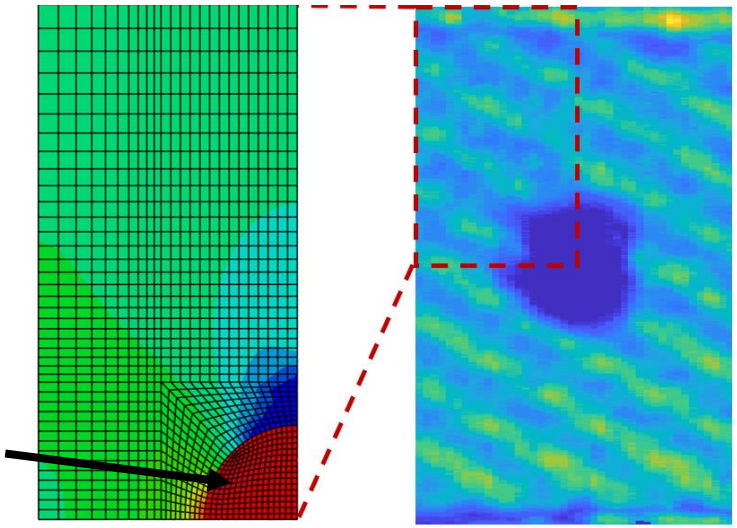
Incorporate effect of BVID in finite element (FE) model

Validate model prediction against experiment

Macroscale modelling

Calibrate static/fatigue material behaviour → Incorporate effect of BVID in finite element (FE) model → Validate model prediction against experiment

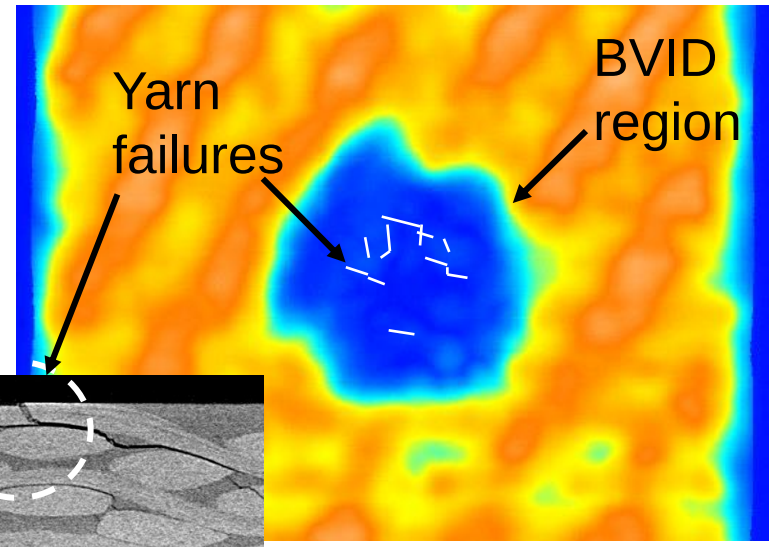


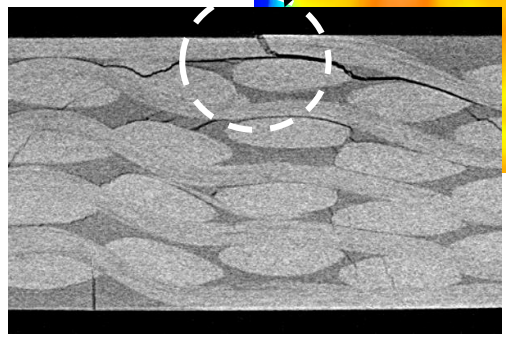


Region of reduced stiffness

Equivalent quarter model

C-scan showing BVID region



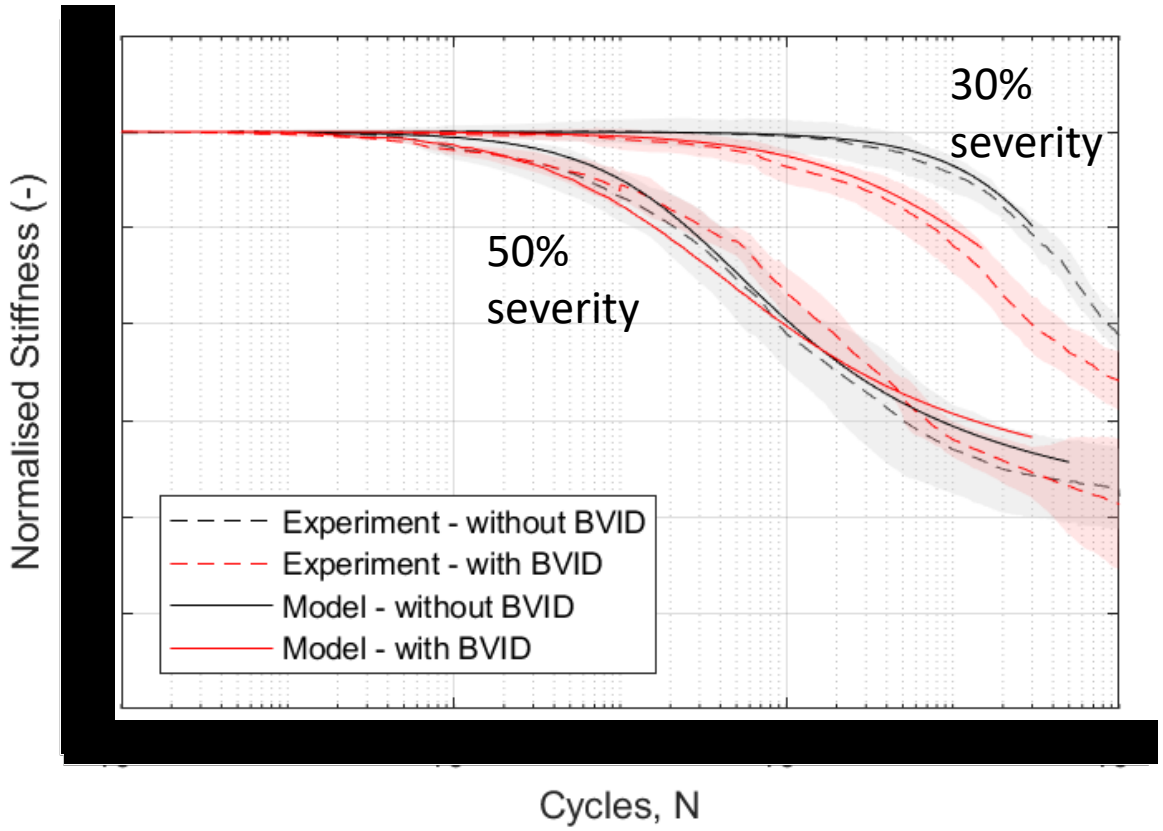


Modelling results

Calibrate static/fatigue material behaviour

Incorporate effect of BVID in finite element (FE) model

Validate model prediction against experiment



Conclusions

- Investigated effect of BVID on static tension and fatigue behaviour of 3D woven composites.
- BVID has negligible effect on static tensile behaviour.
- Fatigue loading *above* static threshold, effect of BVID is negligible.
- Fatigue loading *below* static threshold, effect of BVID is notable.
    - Earlier fatigue onset is due to load redistribution caused by presence of BVID.
- Developed macroscale model (and simple approach) to capture the effect of BVID on the fatigue behaviour at the macroscale, with a view to employ at component scale.

Ongoing work:

- Capture yarn debonding under fatigue at the mesoscale, to gain further insight on the dominant damage mechanisms during fatigue loading.

Acknowledgments

- The author acknowledges Rolls-Royce PLC’s support through the Composites University Technology Centre (UTC) at the University of Bristol, UK and the Engineering and Physical Sciences Research Council (EPSRC).

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Thank you!

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