University of BRISTOL

Bristol Composites Institute

Towards Multi-Stage Topology Optimisation Design of Wind Turbine Blade Structures

Alex Moss, Terence Macquart, Ajit Panesar, Mark Forrest, Peter Greaves, Alberto Pirrera

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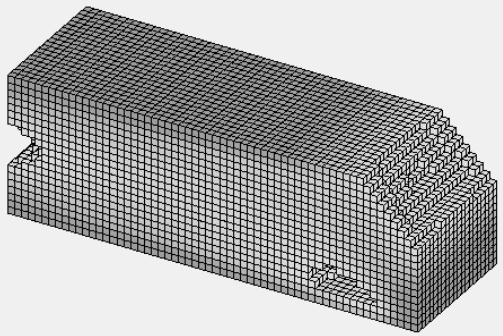
Introduction

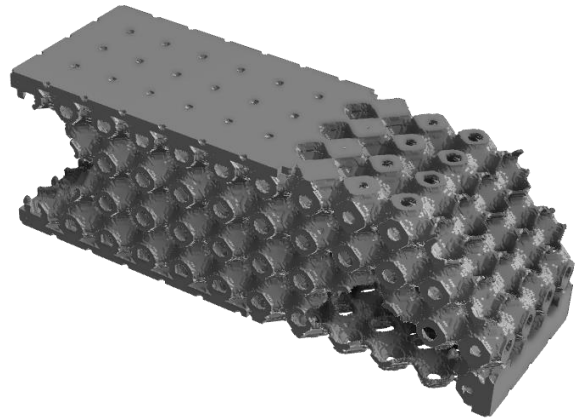
'[Topology optimisation is] the determination of features such as the number and location and shape of holes and the connectivity of the domain' - Bendsøe and Sigmund 2004

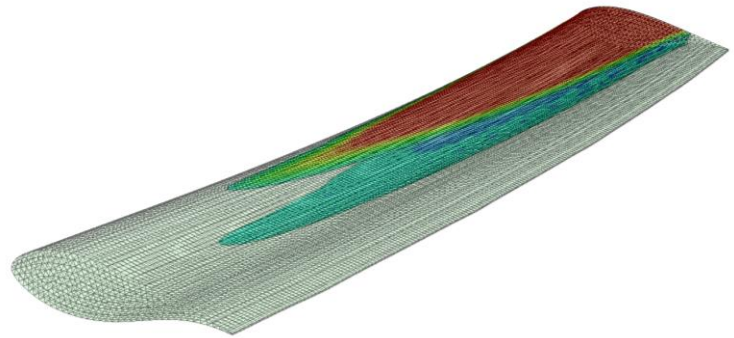
Identification of the main load paths

Solutions used to design functionally graded lattices

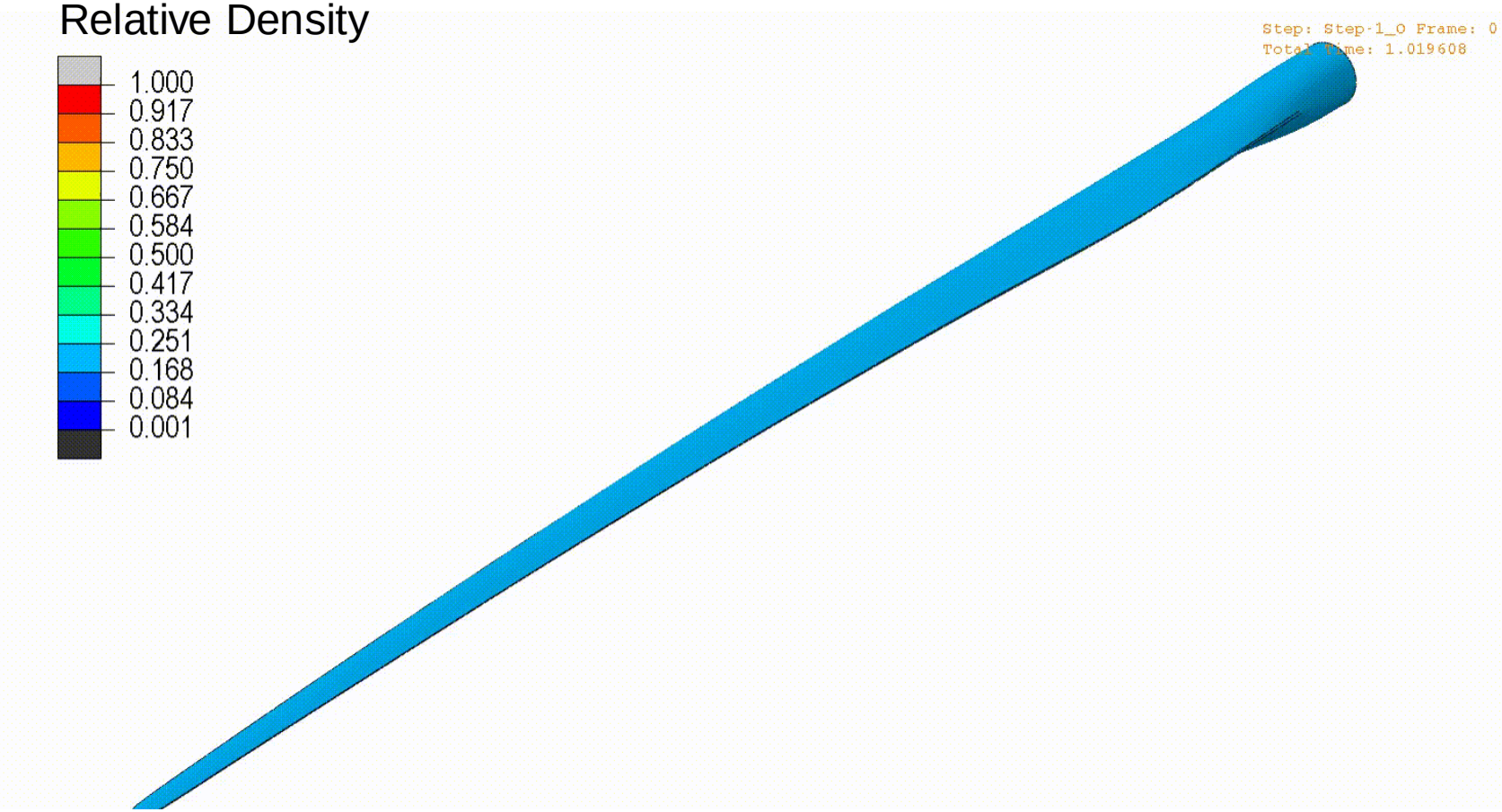
Intuitive sizing of composite laminates







Design Stage 1 - Free Topology Optimisation

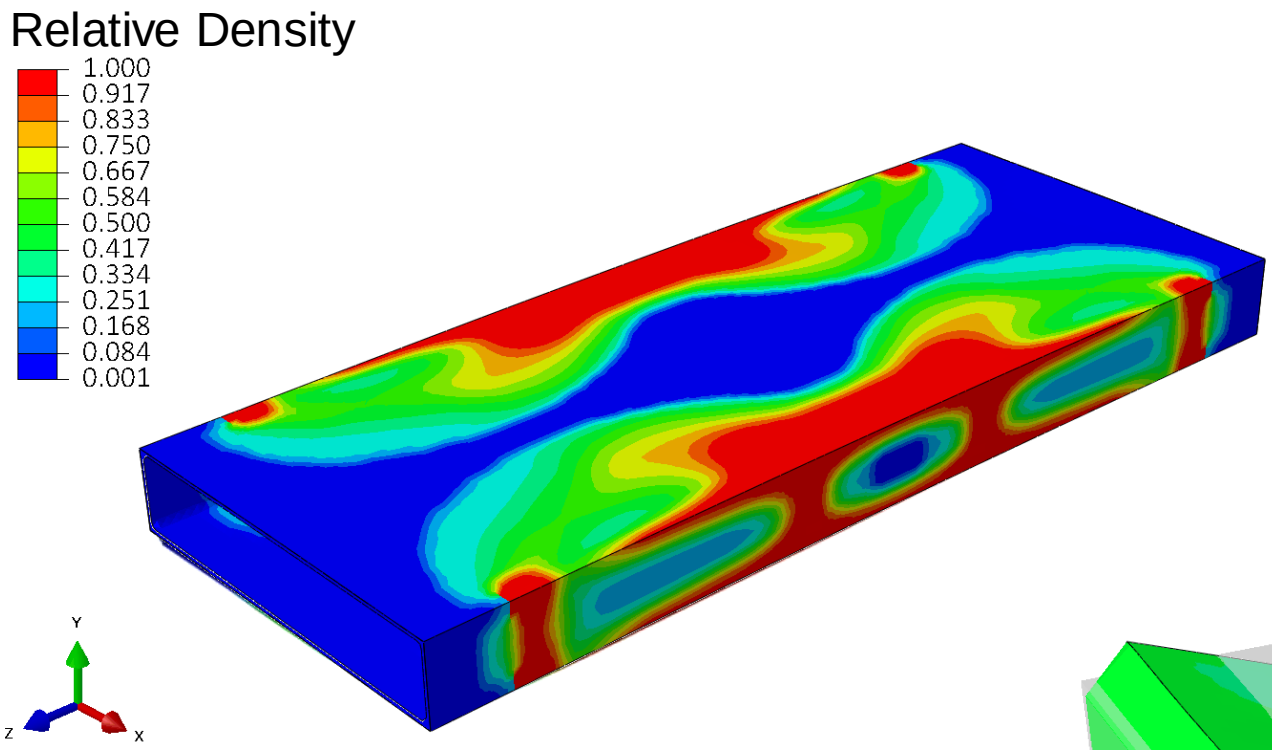


Optimal distribution of material for blade load case identified

Any region below a specified relative density threshold is neglected

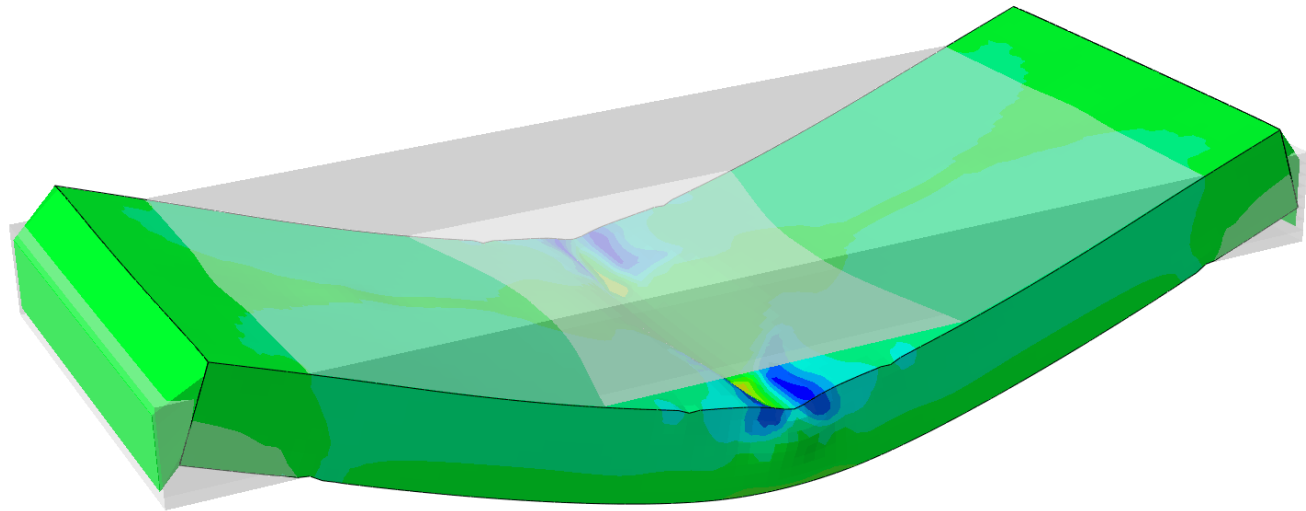
The remaining structure defines the composite laminate shape and size

Design Stage 2 - Lattice Topology Optimisation



1. Freeze the composite regions from stage one
2. Apply accurate properties to each region
3. Optimise the lattice region

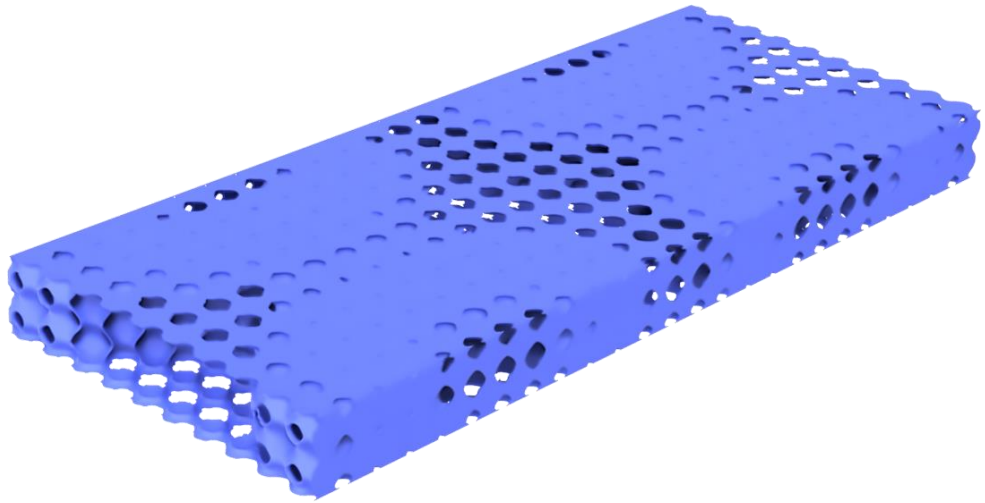
Optimised structure is modelled and tested to failure

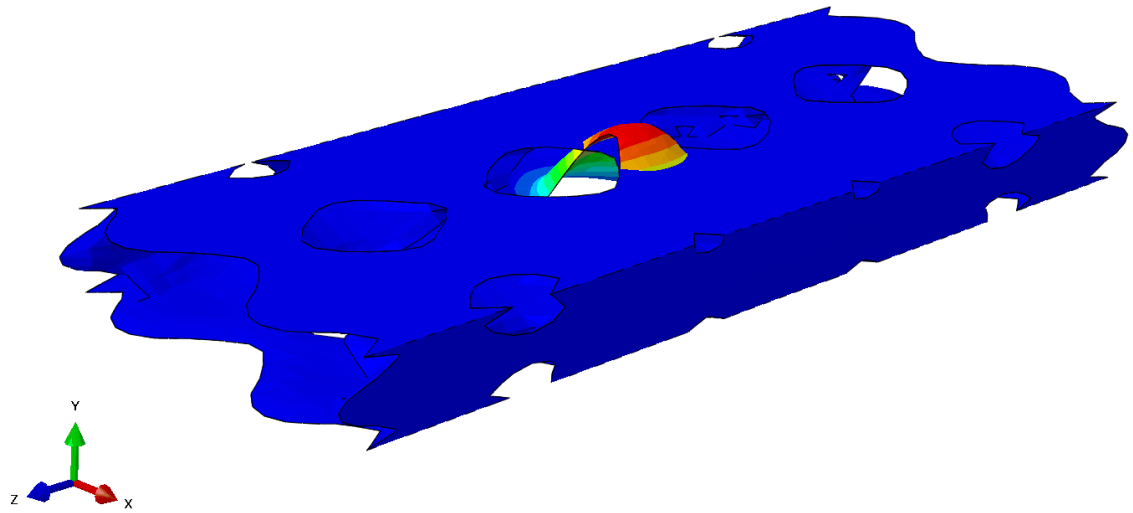


Design Stage 3 - Conversion to Lattice

Optimised density field is mapped to graded lattice using LatTess

The lattice geometry is imported into Abaqus for failure analysis

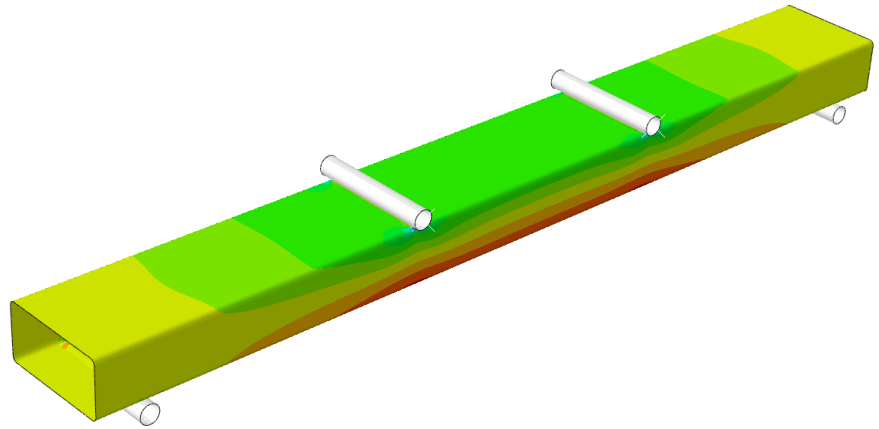




LatTess - Innovative DEsign and Advanced manufacturing Lab – A. Panesar

Future Work

- Experimental testing of hybrid laminate-lattice sandwich beams
- Extraction of effective properties from optimised structures
- Validation against conventionally designed composite structures
- Application of design process to reference blade geometry



Acknowledgements

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Alex Moss

alex.moss@bristol.ac.uk

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