Project: Topological Optimization of Additively Manufactured Wind Blades with a Graded Lattice Core

Key focus: Development of a rational design basis for the inclusion of additive manufacturing in the production of wind blades

Researcher: Alex Moss

Supervisors: Mark Forrest, Peter Greaves, Terence Macquart, Ajit Panesar, Alberto Pirrera

Background

The inclusion of additive manufacturing in the production of wind blades has the potential to reduce manufacturing time and costs. Additively manufactured internal structures for wind blades would remove the requirement for expensive female moulds. As the male mould will be part of the blade structure, it must be designed for minimum weight while still providing the required structural properties. For a given domain, topology optimisation generates the optimal material distribution for a specific parameter set. This material distribution is often described by a field of varying density where higher density material is placed along load paths and lower density or void regions are generated to reduce weight where material is not needed. To aid in the manufacture of the topology optimisation solutions, cellular architectures made up of repeated unit cells can match the density distributions and therefore provide the required structural properties and a male mould for the layered composites.

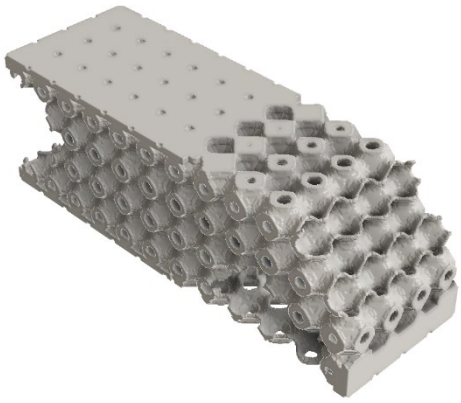

Figure 1 – Example of a Graded Lattice Structure which matches the Density Distribution of a Topology Optimisation Solution

Project description

The project will focus on developing a rational design basis for the inclusion of additive manufacturing in the production of wind blades. This research will consider a combination of concepts to achieve improved performance of wind blade structures. Its aim is to develop new topology optimisation design paradigms and tools. Graded unit cell architectures (lattices) and layered composite components will be topologically optimised in combination, to achieve the desired improvement in structural performance within a design for additive manufacture framework.

Research outcomes/impact

This project aims to develop a density-based topology optimisation approach to design novel wind blades with hybrid layered composite-graded lattice architectures. This will improve manufacturability and structural performance, thereby enabling lower LCOE. As blade sizes increase, this novel design framework will enable further increases in the total installed capacity of wind power.

Project Sponsorship:
This research is sponsored by the Wind Blade Research Hub, a collaboration between ORE Catapult, and the University of Bristol.