MANUFACTURE & TESTING OF LARGE COMPOSITE STRUCTURES

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OVERVIEW

• Company Background
• Production of wind blades
• Powder Epoxy Technology
• PowderBlade – Powder epoxy technology
• Other research on large composite structures
EIRECOMPOSITES: COMPANY BACKGROUND

• Composites Design, Manufacturing & Testing for Aviation, Space and Renewable Energy

• AS/EN 9100 and NADCAP approved

• Proven track record of research with the European Space Agency and Horizon 2020 program

• Manufacturer of wind blades
  • 14m Blades – for a derivative of the 225kW Vestas V29
  • SD Wind Energy Blades – Glass-fibre reinforced polypropylene (Twintex) thermoplastic wind turbine blades for 6kW and 15kW machines

• Manufacturer of tidal blades, aviation structures and satellite components
• ÉireComposites blades are made using the company’s patented MechTool®, which allows high-temperature processing of materials

• **13m Blades** – for the Vestas V27 machine from glass fibre and epoxy resin

• **14m Blades** – for a derivative of the 225kW Vestas V29

• **SDWinds Blades** – Glass-fibre reinforced polypropylene (Twintex) thermoplastic wind turbine blades for 6kW and 15kW Kingspan machines
POWDER EPOXY TECHNOLOGY

• Neary all wind blades made with liquid epoxies or polyesters
• Powder-epoxy resins have properties that make them suitable as a matrix for the production of composite wind blades
• Technology has been demonstrated on 14m wind blades
• ÉireComposites has developed a production line specifically for powder epoxy prepreg:
  • Can process glass and carbon fibre fabrics from 300 g/m2 to 1800 g/m2
  • Up to 55% FVF demonstrated on both glass and carbon
POWDER EPOXY ADVANTAGES

• Excellent fibre wet-out, even in thick sections
• Reduction in post-processing requirements
• Reduction in material wastage and overall part cost
• Reduction in transportation and storage costs
• Potentially a good matrix material for use with carbon fibre (which are difficult to infuse)
• PowderBlade is a €2.7m Horizon 2020 project to develop large wind blades (50m-100m)
• The project is based on a novel process for manufacturing blades from powder epoxy
• Project focused on blade roots and spar caps
• Project partners are: Eire Composites, Suzlon, WestBIC & the University of Edinburgh
Objectives:

• Design and manufacture a carbon fibre spar and glass fibre root for a full-scale hybrid blade
• Develop a computation model of the cure cycle
• Design and test a torsion box representative of a full-scale wind blade
• Reduce cycle time for blade production
• Commercialise the composite manufacturing technology for large wind blades
Results: Computational modelling

- 3D simulation, in Abaqus, for the processing of a 96-ply thick laminate made from glass-fibre/epoxy-powder
- Temperature within the laminate after 100 mins (top left) and 390 mins (top right)
- Degree Of Cure in the laminate after 100 mins (bottom left) and 390 mins (bottom right)
- Modelling led by the University of Edinburgh
- Processing time of 6 hours achieved
Results: Glass fibre root

• Lot of testing of powder epoxy laminates
• Laminates manufactured and tested to establish mechanical and fatigue properties
• Several trials performed on 96-ply thick laminates – excellent wet-out achieved
• Temperature probes used to validated numerical model
• Blade root sections manufactured for a 54m wind turbine blade
Results: Carbon fibre spars

• Laminates manufactured and tested to establish mechanical and fatigue properties
• First 13-metre demonstrators manufactured but problems found with fibre-alignment
• Second 13-metre demonstrators manufactured and fibre-alignment issue resolved
• Work ongoing to compare powder epoxy costs as to alternative manufacturing methods
Results: Torsion Box

- Testing of glass-carbon interface on 75cm test pieces – broke several test machines
- Design of torsion box – glass/carbon interface – for a 60m blade
- Manufacture of 6-metre torsion box
- Testing of the glass/carbon interface within the torsion box
MOTIVATION FOR LEADING EDGE PROTECTION

• Erosion can reduce annual energy production of a wind turbine by between 4% and 20%
• Offshore blade repairs are expensive and dangerous
• Production losses and maintenance costs as a result of leading edge erosion are a major challenge in the wind sector
• Problem will be worsened due to larger blades with higher tip-speeds
• Blade erosion causes a loss in productivity worth between $168m and $842m a year across European offshore wind sector
THE SOLUTION

• Protective coating for blade leading-edge
  • Recyclable
  • UV resistant
  • Good energy absorption
  • Thermoformable to blade geometry

• Solution demonstrated through lab-scale rain erosion testing

• Excellent performance from initial operational trials
TEST RESULTS

• Following a 2 month operational trial in Shetland, Scotland. All three test blades were inspected

• Operational environment harsh and representative of real life conditions to be experienced offshore

• On Inspection only the unprotected blade showed signs of damage

• Both the TPU and 3M protected blades showed no signs of damage, delamination or pitting of coated surfaces

• Only slight discolouration occurred on TPU coating
CONCLUSIONS FROM LEAPWIND

• There is a massive, growing market for Leading Edge Protection

• The LEAPWind project has developed a novel solution to address this market

• The solution has been tested in a laboratory and in operational trials and shows excellent results

• The technology is disruptive and can place Europe in a globally leading position in terms of offshore wind

• It will also decrease delivery cost LCoE while providing a more sustainable solution
OTHER PROJECTS
TIDAL ENERGY: H2020 CRIMSON

Aims to bring to market an innovative marine power system at reduced cost and increased reliability:

• De-risk the use of recycled carbon fibre material (rCF) in the marine environment

• Design and manufacture a new sustainable Marine HydroKinetic (MHK) turbine

• Prove the structural integrity of the new sustainable MHK turbine

• Perform operational trials at full-scale
RELATED RESEARCH

• FloTEC - Floating Tidal Energy Conversion, H2020 LCE, €9.8m, www.scotrenewables.com/projects/flotec


• MAREWIND - MAterials solutions for cost Reduction and Extended service life on WIND off-shore facilities, H2020, €8m, https://www.marewind.eu/
WAVE ENERGY

- WEC4Ports
  - Hybrid WEC
  - Oscillating column
  - Overtopping device

- Ocean Energy (CTL project)
  - [https://oceanenergy.ie/oe35/](https://oceanenergy.ie/oe35/)
  - Oscillating column
  - Large device in Hawaii
THANK YOU

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