MARINCOMP
Novel Composite Materials and Processes for Offshore Renewable Energy

www.marincomp.eu — ***Project Newsletter: Jan 2015***

Consortium Meeting – Dec 2014

In December 2014, a MARINCOMP Consortium Meeting was hosted by the University of Ulster. The meeting took place in the Northern Ireland Advanced Composites & Engineering (NIACE) facility in Belfast. Running over two days, the meeting involved discussions on specific project work packages and researcher secondments as well as administrative issues. The attendees were also treated to a tour of the NIACE facility. The next meeting is scheduled for EireComposites facility in Inverin, Galway on February 19-20th 2015.

Project Website Launched

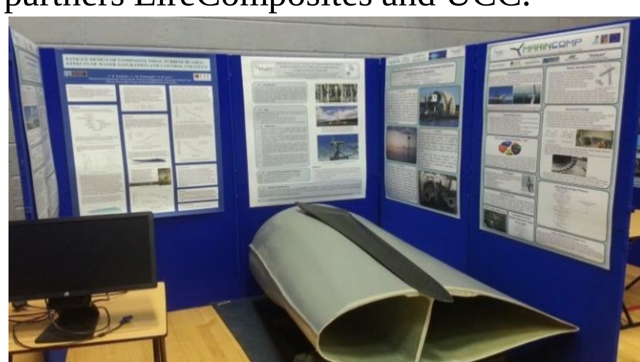
The MARINCOMP Project Website, ***www.marincomp.eu*** has been launched. The website contains information about the Project as well as profiles of different Project partners and the researchers involved. The site will be used to keep the public informed of progress over the lifecycle of the Project

First Secondments Completed

2014 saw the commencement of researcher secondments. The secondment of researchers between industrial and academic partners is a key principle of any Marie Curie IAPP project. The secondment of researchers aids for the transfer of knowledge between the partners. 2015 will see an increased umber of secondments along with the recruitment of new Marie Curie researchers by three of the Project Partners: UCC, UU, EireComposites

MaREI Industry Open Day

Marine Renewable Energy Ireland (MaREI) hosted an Industry Open Day for researchers and industry partners on the 30th January 2015. The event took place at the National Maritime College of Ireland in Ringaskiddy, Co. Cork and was attended by Minister Alex White and Mr Mark Ferguson, Director General of SFI. The MARINCOMP project research poster was on display on the day. Attendees were also given the opportunity to meet and chat with Project partners EireComposites and UCC.



MARINCOMP Research Poster

A research Poster for the MARINCOMP project has been produced. The poster is based on the work carried out during Dr Vesna Jaksics secondment at EireComposites Teo.

MARINCOMP

Novel Composite Materials and Processes for Offshore Renewable Energy

Project Partners: UCC University College Cork, Ireland · ÉIRECOMPOSITES · University of ULSTER · SE BLADES · TORAY Toray Carbon Fibers Europe

Introduction

Marine renewable energy is a small but growing sector of the energy industry which is garnering particular attention in Ireland due to the vast natural resources available. With respect to tidal turbines, there is the additional advantage that much of the technology used today for wind turbine blades can be readily transferred; however, the marine environment presents its own unique problems.

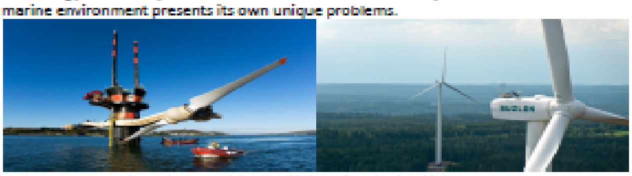


Fig 1: Similarities between tidal turbine blades and wind turbine blades.

MARINCOMP aims to reduce the cost of offshore wind and tidal turbine blades and enable the drive toward lower cost per kilowatt renewable energy for both industries.

Project Objectives

1. Develop a manufacturing process for optimisation of thick (up to 150mm) carbon fibre structures using a novel powder-epoxy formulation,
2. Develop the in-situ cure monitoring of thick (up to 150mm) carbon-fibre laminates using fibre-optic and associated sensing technologies,
3. Develop a database of composite durability properties in fatigue and seawater immersion and employ it in offshore wind blade designs,
4. Develop 3-D stitched carbon fabrics for transition regions of turbine blades,
5. Develop a cost-performance-processing model for composites usage.

WP1 Technology Evaluation - Cost

Fig 2: Cost of Onshore Wind Turbine [1]

Blade development can affect the load and cost of other components. In a study using a new slender blade design, chord length was reduced by 16.7%, leading to a reduction in extreme loads by up to 24% and fatigue loads by up to 16% [1]. Hence, the design is the key issue in blade scale-up. It is estimated that by replacing glass fibre with carbon allows a 10-15% weight saving on the blade [2] which reduces the design loads. The use of composite simulation software for design can also contribute to cost reduction.

Challenges

The key design challenge is to eliminate the failures of carbon spars. In that regard the design attention should be focused on following:

- Carbon has a relatively low damage tolerance,
- Fibre-straightness,
- Wet-out of fibres during vacuum,
- The fracture toughness,
- Fatigue at the ply drops,
- Stiffness change due to glass carbon transition.

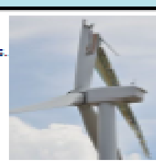
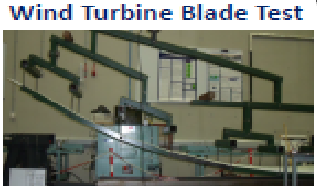


Fig 3: Blade Failure

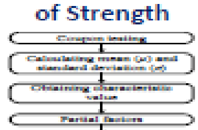
Design Process

The choice concerning a blade design concept in a commercial project is difficult since it is very site-specific with dependence on turbine-size, hub-height and metocean condition. The design process tends to be iterative and long. A prototype glass fibre polyester blade takes around 9 months to develop and testing takes a further 6-12 months. The important part of the design is managing loads on blades, as the optimal loading can maximise the windswept area and increase energy production.

Wind Turbine Blade Test



Calculation of the Design Allowable Value of Strength



Blade Aerodynamics

- Length determines how much wind power can be captured according to the "swept area" of the rotor disc.
- Aerodynamic profile in cross section creates lift & rotation.
- Platform shape gets narrower towards the tip to maintain constant slowing effect across the swept area.
- Thickness increases towards the root to take loads.
- "Flatback" sections used near the root to improve aerodynamic efficiency.

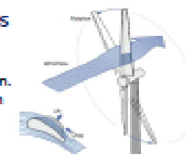


Fig 4: Turbine Aerodynamics

- Twist maintains optimum angle of attack of the blade section to the wind.
- Typically rotational speed ensures the tips are moving at 7-10 times the wind speed.
- At very high rotational speeds, blades become aerodynamically inefficient & noisy.
- Above optimum wind speeds, blades are pitched either into the wind (feathering) or away from the wind (active stall) to reduce the generated power and regulate loads.

Structural Design

- Blade thickness has a strong effect on the cost of electricity generated.
- The structural design process must take into account aerodynamic shape, material properties under extreme and fatigue loading, and manufacturing method.
- Glass fibre reinforced laminates offer good strength to weight ratio.
- Carbon fibre is more expensive but much stiffer and stronger.
- To resist bending of the spar caps, unidirectional fibres run along length of blade.
- To be effective, spar caps must be joined by a shear web of diagonal fibres.

Fig 5: Blade Cross Sections

- The aerodynamic shape is formed by shells. Thin skins, usually of glass reinforced plastic, are placed either side of a light weight foam core.
- Where blade is bolted to hub (root), the spar must be circular and the laminate thickened.

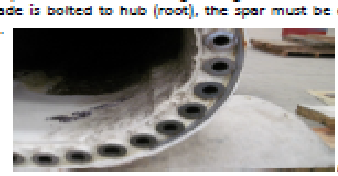
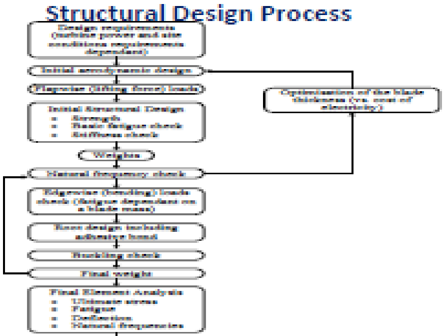


Fig 6: Blade Root

- The blade must be strong enough not to break and stiff enough not to strike tower.
- 20 year design life, blades flex circa ten million times which causes fatigue. Testing of material shows how many cycles the material can withstand at a given stress.

Structural Design Process



Acknowledgements & References

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Sources: Fig1: Siemens/Suzlon. Fig3: wind-watch.org. Fig4: howstuffworks.com. Others: EireComp & Dr Jaksic
[1] AMIConferences, *Wind blade composites market grows as offshore wind energy advances (A review of the Wind Turbine Blade Manufacture conference organised by AMI)*, A. Conferences, Editor. 2012, Renewable Energy focus.com.
[2] Wood, K., *Wind turbine blades: Glass vs. carbon fiber.* Composites World, 2012.