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Programme Area: Marine

Project: ReDAPT

Title: ReDAPT: Full-Scale Validation Study of Tidal Bladed

Context:

One of the key developments of the marine energy industry in the UK is the demonstration of near commercial scale devices in real sea conditions and the collection of performance and environmental data to inform permitting and licensing processes. The ETI's ReDAPT (Reliable Data Acquisition Platform for Tidal) project saw an innovative 1MW buoyant tidal generator installed at the European Marine Energy Centre (EMEC) in Orkney in January 2013. With an ETI investment of £12.6m, the project involved Alstom, E.ON, EDF, DNV GL, Plymouth Marine Laboratory (PML), EMEC and the University of Edinburgh. The project demonstrated the performance of the tidal generator in different operational conditions, aiming to increase public and industry confidence in tidal turbine technologies by providing a wide range of environmental impact and performance information, as well as demonstrating a new, reliable turbine design.

ReDAPT: Full-scale validation study of Tidal Bladed

Steve Parkinson

2015-10-21

SAFER, SMARTER, GREENER

Overview

1. Tidal Bladed validation study

2. Method; collection of measured data

3. Results
   - Steady state
   - Dynamic

4. Summary

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Introduction - ReDAPT

- Project is commissioned and co-funded by the Energy Technologies Institute (ETI)

- DNV GL is a contributor to the Reliable Data Acquisition Platform for Tidal (ReDAPT) project.

- Project aims
  - Install a 1MW tidal turbine at the European Marine Energy Centre in Orkney (Scotland)
  - Test performance of tidal generator in open sea trials and to increase confidence by providing wide range of environmental and performance information

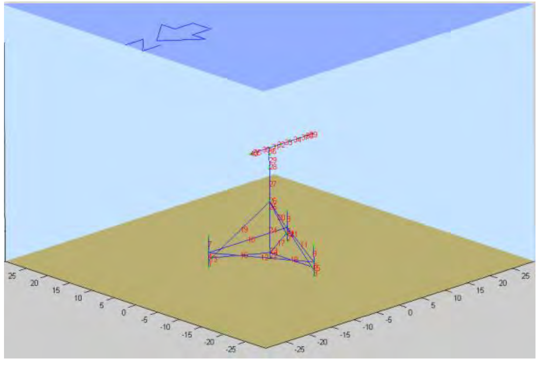
Tidal Bladed

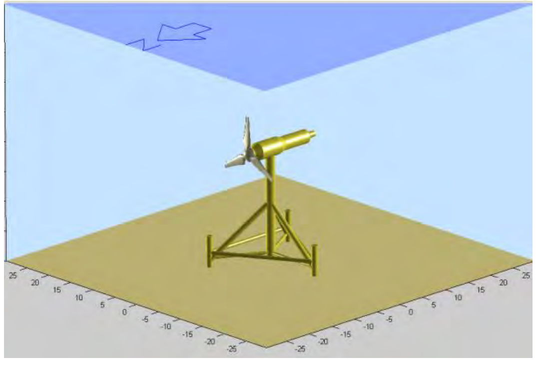
- **Design software** for loads and power performance analysis of **tidal stream turbines**

- **Coupled** multibody modal structural dynamics, BEM hydrodynamics and control **system dynamics**

- Designed to provide **fast** time domain **simulations**

- Used by **most major** tidal turbine **manufacturers**





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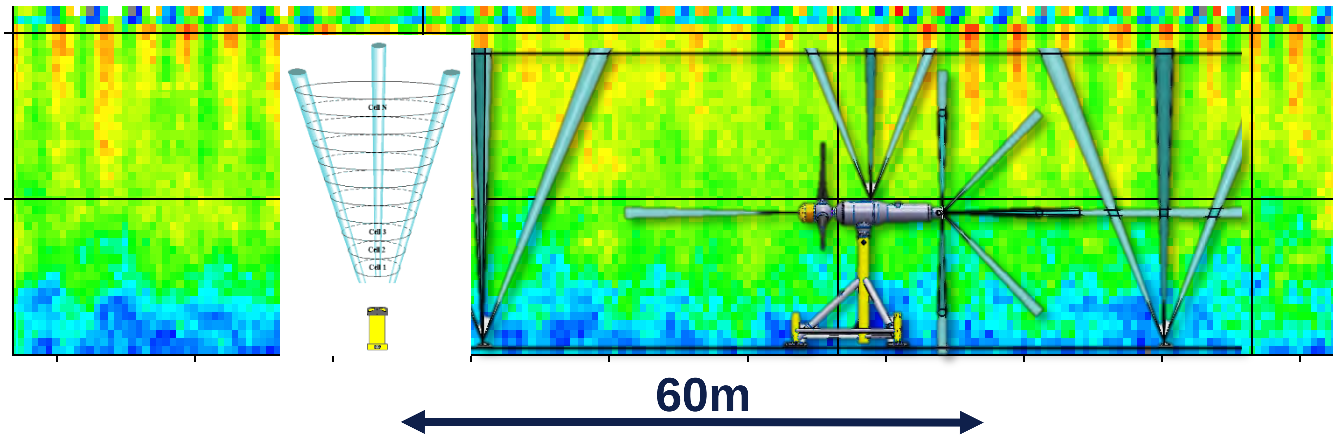
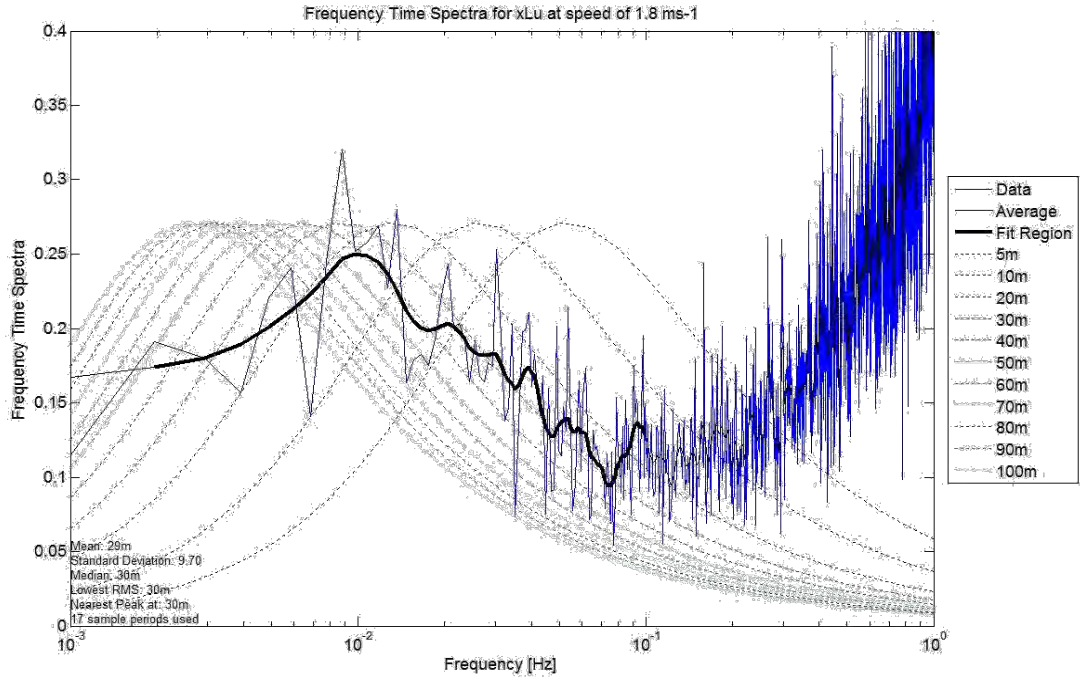
Methodology – Site characterisation



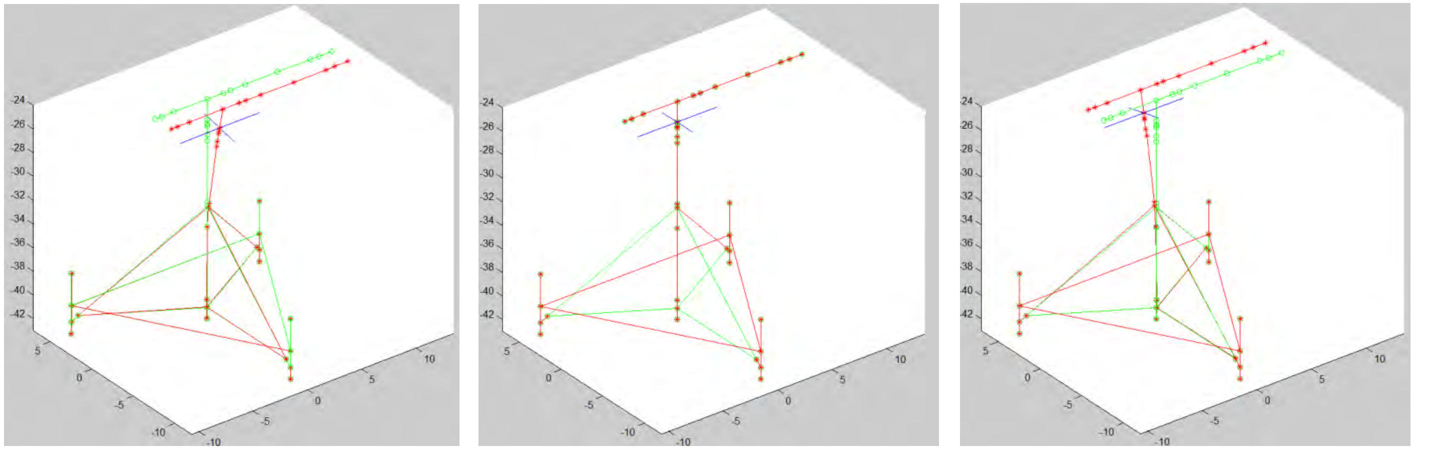
- Flow speed and direction in water column
- Flow shear
- Turbulence intensity
- Turbulent length scales

Methodology – Derive turbulent length scales

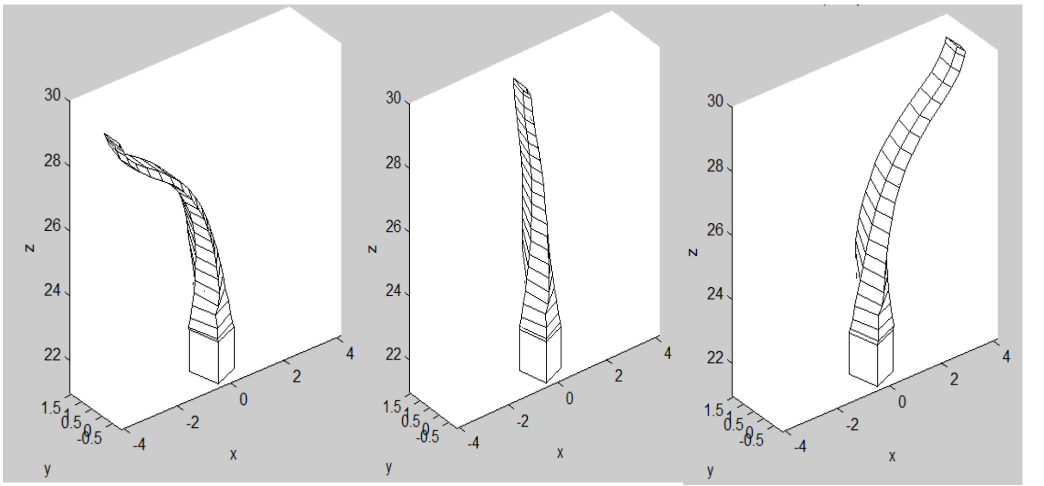


- Monitoring of the marine environment to characterise flow shear and turbulent parameters
- Determination of length scale via comparison of Von Karman spectrum to the observed spectrum

Skirt and blade bending

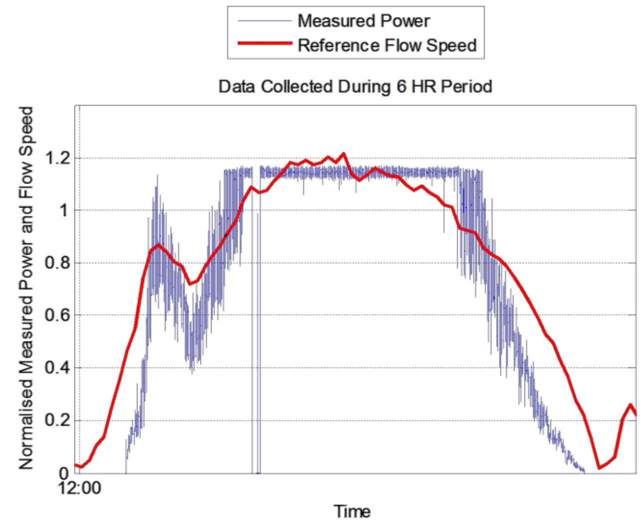


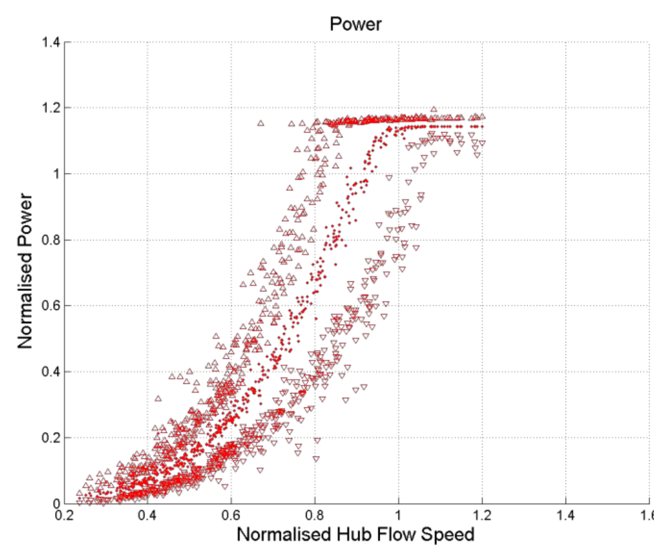
- Model responses to operational loads
  - Skirt pitch (fore-aft motion)
  - Skirt roll (side-to-side)
  - Skirt torsion
  - Near-root flapwise bending



Methodology – Machine observations

- Analyse concurrent flow speed and machine data
- Calculate min, mean, max of each 10 minute sample
- Over 500 ten minute samples were used for comparison with Tidal Bladed
- Tidal Bladed - Conduct 6 x 10 minute simulations per reference speed with different turbulence seeds





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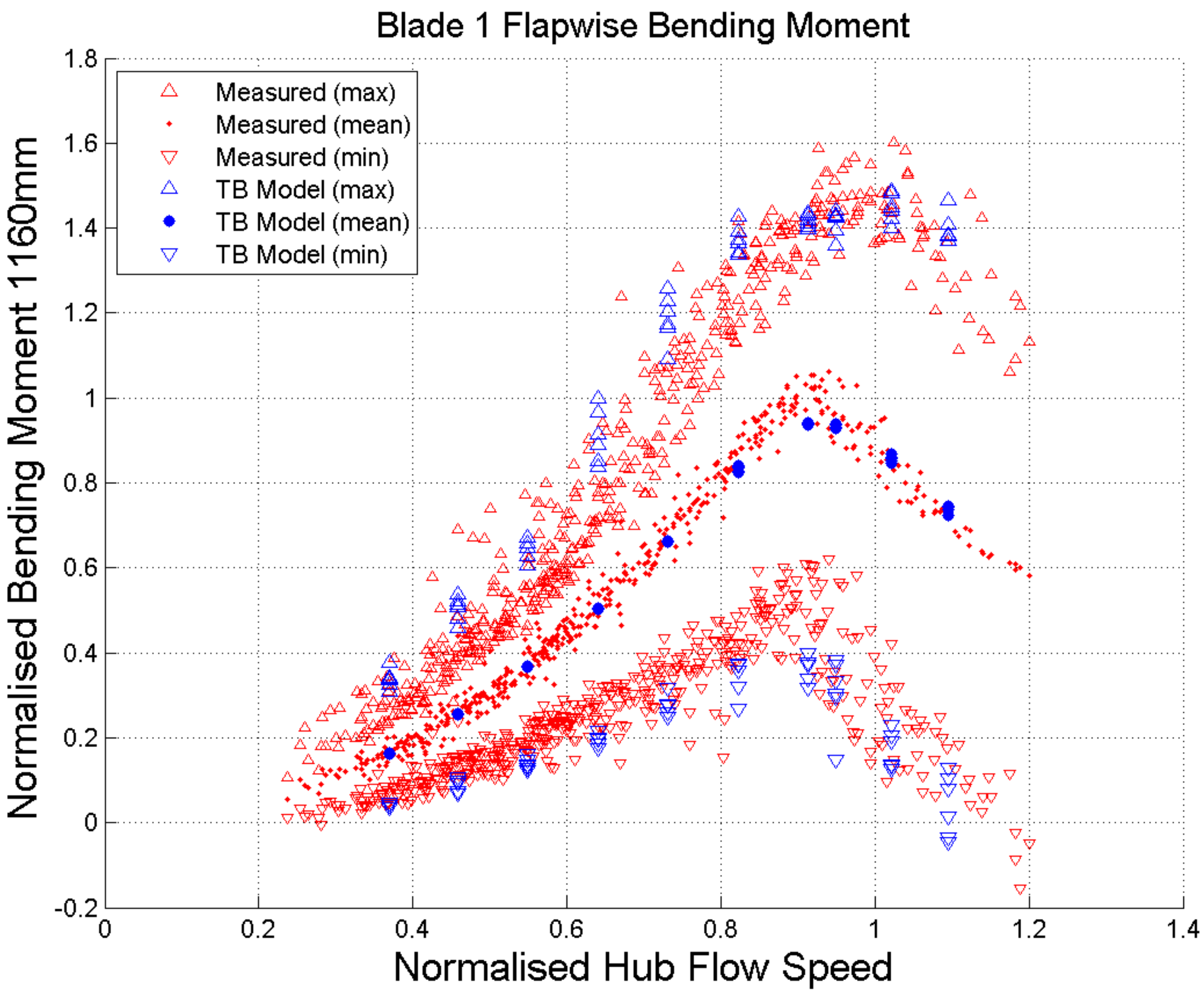
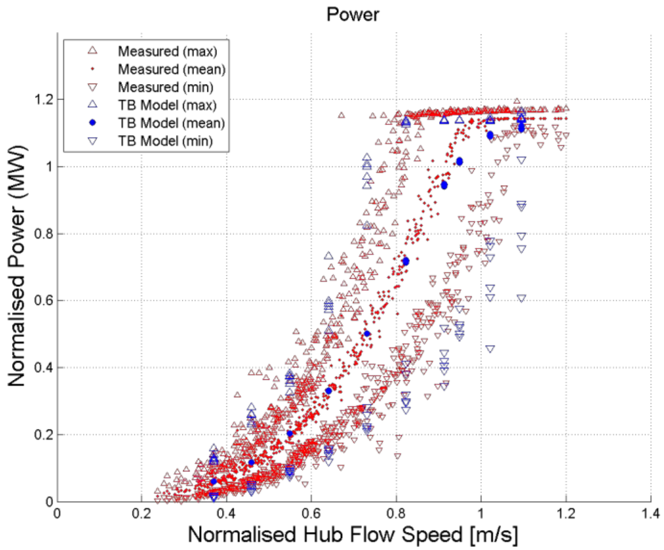
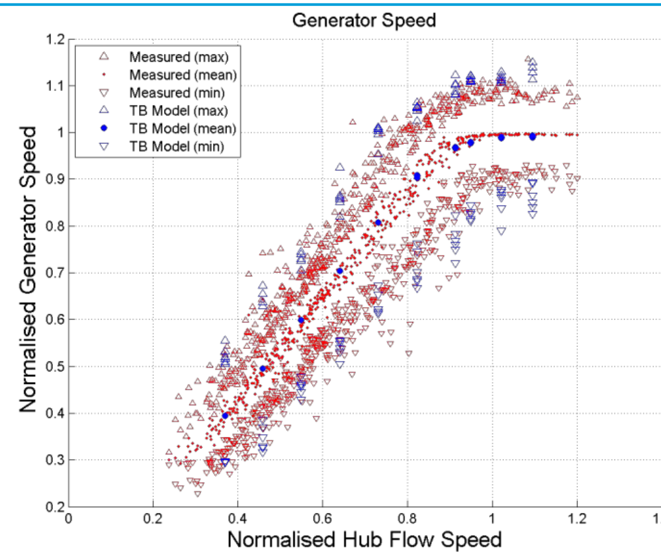
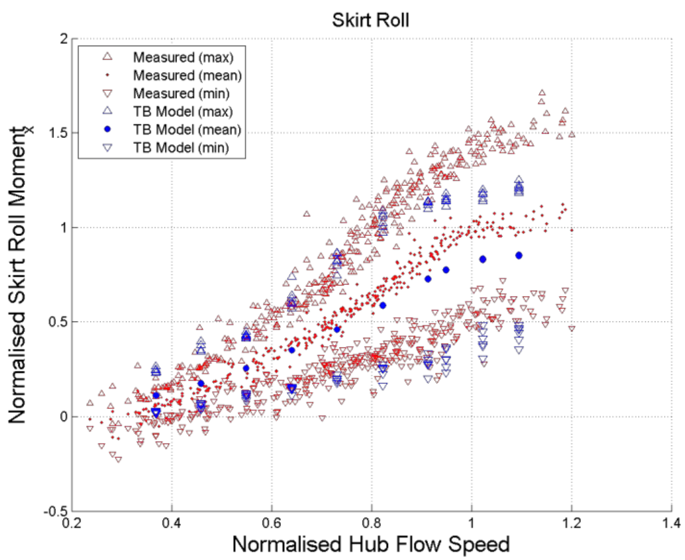
Results – Normalised flapwise blade root bending moment

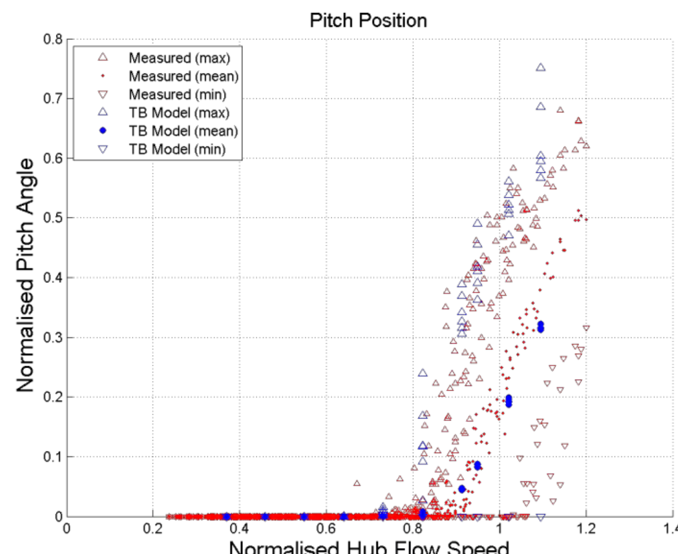


Results – Normalised skirt roll









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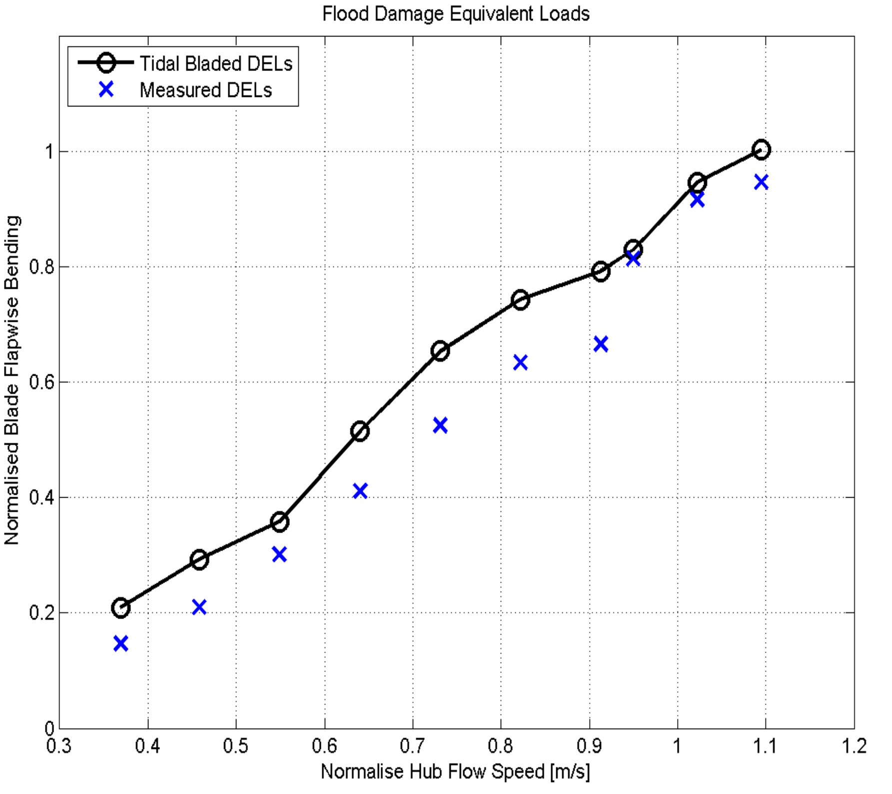
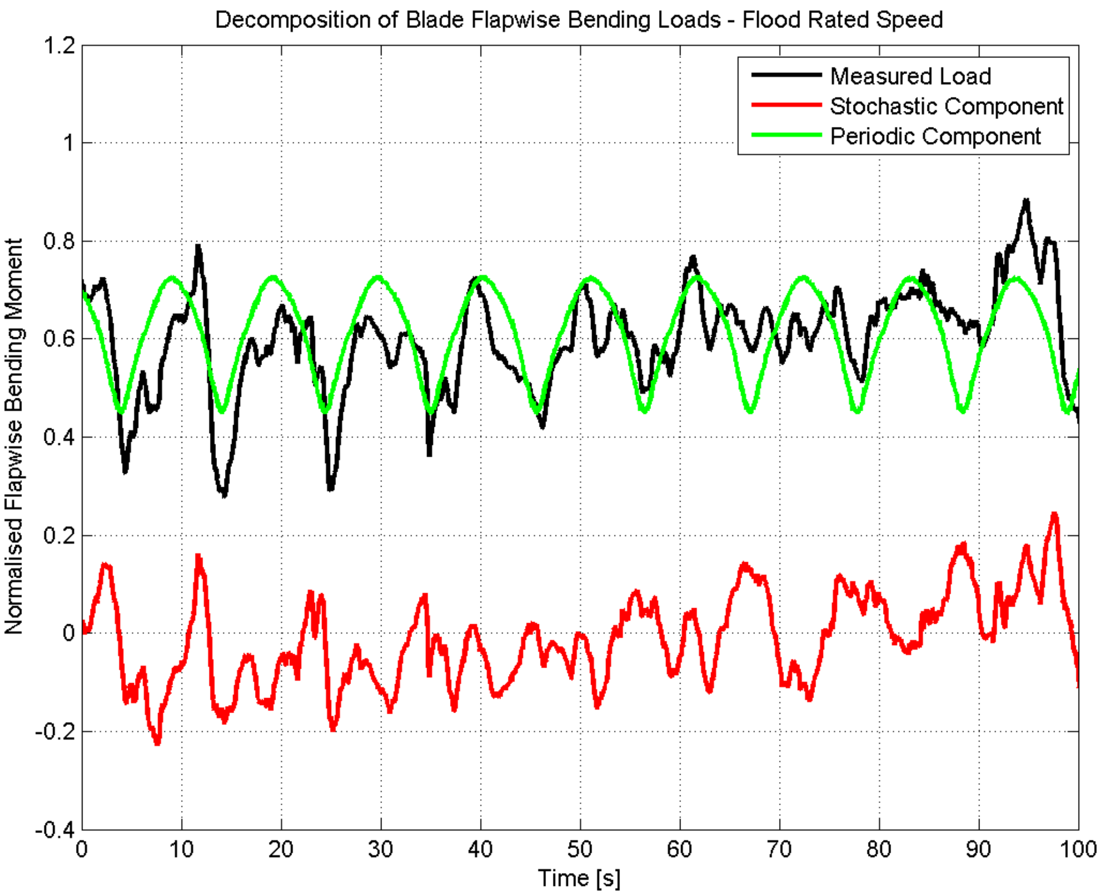
Results – Total damage equivalent loads (DELs)

- Compare the fatigue loads of blade flapwise root bending
- Conduct rainflow cycle counting on measured and simulated samples and use Miner’s Rule to calculate DELs.
- DELs are well matched for the total blade loads (stochastic + periodic)



Decompose load time histories



- Consider stochastic and periodic loads separately

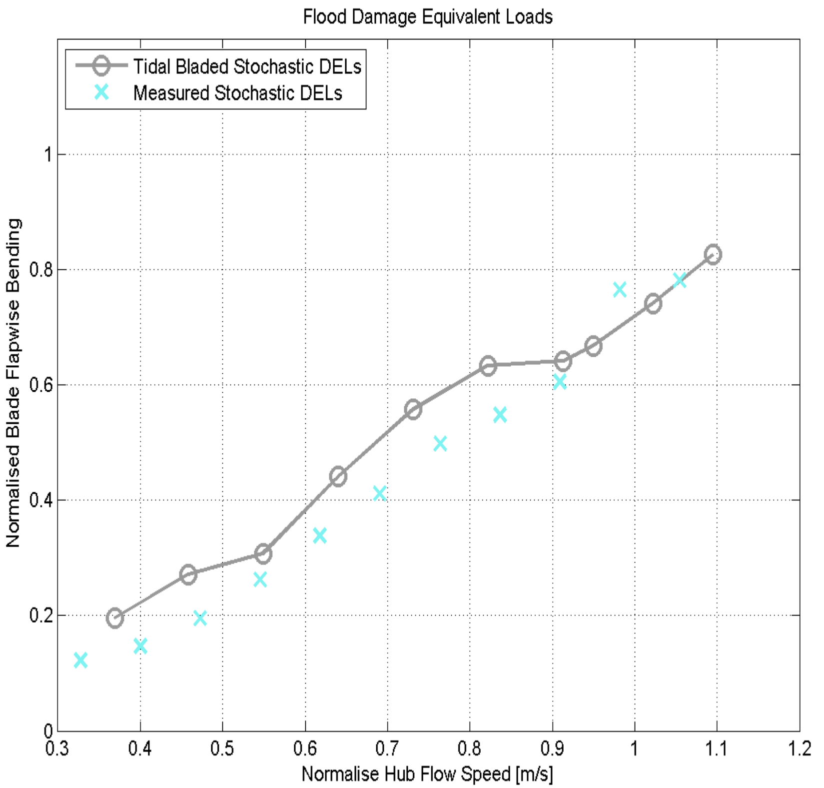
Results – Stochastic DELs

- Compare the measured and simulated fatigue loads of the stochastic component of the blade flapwise root bending

- Conduct rainflow cycle counting to compute DELs

- DELs are well matched for the stochastic damage equivalent load

- Indicates that the VK spectrum provides a suitable representation of turbulence



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Summary

- Type of instrument used for turbulence monitoring important.
- Tidal Bladed model provides good results of the damage equivalent loads of tidal stream turbines

- Tidal Bladed widely used by OEMS and universities
  – Publication: EWTEC 2013 (more on the way!)

- Validated software increases confidence in the development and design of tidal stream energy converters.
  – Controller design
  – Mechanical design
- Tidal Bladed continually under development and will work with OEMs to improve
  – Model floating concepts
  – Multi-part blade

Thank you for listening

ReDAPT: Tidal Bladed Validation study
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