Subcomponent testing of rotor blades

*Multi-Scale Structural Testing and Modeling*

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Scales, scales, scales……..
Rotor Blade Testing……. Something is missing

Increased number of tests
Increased Complexity

Full Scale Test

Sub-Components
(spars, shells, root sections, …)

Elements & Details
(bond line, ply drops in spar cap, …)

Coupons
(consituents, laminae, laminates, core materials, …)

Generic Specimen

Non-Generic Specimen

Source: IEC 61400-5 (draft version)

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Full-scale blade testing

Full scale blade test

70m Rotor blade test stand, Static test 56m blade: Suction side under Pressure

Determination of the test loads

Without further analysis:
IEC: 75% blade width each side
GL: 80% Blade width, each side
Test directions

Leading edge failures seen in the field but not in tests

100% 0% Shear

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Biaxial Test at IWES

Blade components

- Root connections
- Buckling panels
- Trailing edge segments
- Leading edge segments
- Chord, Chord-web
- Transition part
- Bondlines
- Plydrops
A case for subcomponent testing - KompZert

*Aim: verification of blade details*
- A detail failed during full-scale blade test (manufacturing errors)
- Changes in blade details

*Original Plan: describe a number of blade details, boundary conditions etc. and possibilities for lowered partial safety factors*

Problem: it differs a lot what circumstances occur: manufacturer dependent

E.g. in some cases peeling is important load case

More accurate scenarios are necessary
Bending moment vectors due to lead-lag load under field conditions

© Fraunhofer Rosemeier et al. (2018) Benefits of subcomponent over full-scale blade testing elaborated on a trailing edge bond line design validation, Wind Energy Science Journal
Load directions in the field

A novel single actuator test setup for combined loading of wind turbine rotor blade sub-components

Rosemeier et al., 2017
Deformation of the cross-section

- "breathing" or "pumping" effect opens/closes the cross-section depending on the load direction

Research questions

- How significant is the contribution of peeling stresses to the bond line fatigue?
- What is the actual mechanism leading to crack initiation?
Specimen preparation impressions

Grind off, casting

(a)

(b)

(c)
Specimen preparation impressions

SGs, dot pattern
Experimental setup impressions

PS view, ball joint, root adaptor plate, dot pattern
Experimental setup impressions

SS view, hinges
Experimental setup impressions

Overview, actuator, vertical beam, DIC
Experimental setup impressions

Load frame, SG, acoustic emission
Experimental results (LTT load case)

Longitudinal strain along the trailing edge


Rosemeier et al. (2016) Tailoring the design of a trailing edge sub-component test. 3rd annual RPWind/ EERA Joint ProgrammeWind R&D Conference (RPWindconference), Amsterdam, the Netherlands, 1920 September 2016
Experimental results (LTT load case)

Longitudinal strain across the target cross section

Basic principles behind Reliabl(ad)e
Digital twin
Subcomponent testing in blade certification

1. Introduce improved detail to blade
2. Blade with weak spots
3. Compare to model and blade test
4. Test
5. Subcomponent BCs
6. Simplified BCs
Set-Up of the program

• 3 year project, however, set up as 4 year project
  • Project start: 01-11-2018
  • Participation of other partners to be started before 01-01-2020
  • Before that background work

• Set up a basis with two countries, with high chance of getting funding

• Open for participants from other countries
  • Discuss with funding agencies of existing partners in case more partners come in: redistribution of tasks.
  • Bring your won funding: each country pays for its own part
BladeMaker Demo center

- Vorabnahme für 1. Portal in Kiel erfolgt
- Abnahme 2. Portal folgt im Dezember
- Fundamentierung ab Mitte Oktober
- Eröffnung Februar 2016 (Einladungen folgen)
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Thank You For Your Attention

Any questions?

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