OPTIMAT BLADES
Progress until July 2004

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Problems encountered: Overview

- Test Geometry Determination
- Fabrication of test specimens
- Move WMC
- Low fatigue frequencies
- Extra tests carried out
## Test Geometry Determination

- General results comparable to ISO specimens
- Allow measuring techniques
  - Strain gauges
  - Clip gauges
  - Acoustic Emission
  - Ultrasonic
  - Infrared imaging
  - Temperature
- No buckling
- Not too thick
  - Maximum load: 100 kN
  - Load introduction through tabs
- Acceptable and/or consistent failure mode
- Bi-axial specimens
  - Cruciform
  - Tubes
- Delay in manufacturing
Low fatigue frequencies

- Originally, a frequency of 5…10 Hz was expected
  - Based on experience of all testing labs
  - High frequencies => significant heating
    - Can reduce fatigue properties
  - First results showed wide scatter
    - Extra meeting necessary
    - Added plan of action
    - Many extra tests done
    - First frequency per load established by preliminary tests
    - Round robin tests redone
    - Many results discarded
    - Longer test times
Tests carried out vs. planned

- Tests done:
  - Static
  - CA
  - VA
  - RST
  - Total Fatigue

- Cycles done:
  - Static
  - CA
  - VA
  - RST
  - Total Fatigue

- Time done:
  - Static
  - CA
  - VA
  - RST
  - Total Fatigue
NB: numbers are rough “guesstimates”

Total delay is considerably smaller due to:

- Overlap in delays
- Extra effort by the partners
  - Dedicating more test machines and effort

Overall delay is about 12 months
Material testing: lessons learned

● Unexpected material behaviour and testing effects encountered
  ● Would never have been revealed in a number of smaller, unrelated projects
    ● Plate-to-plate variation, specimen variation within a plate varies by type test (R-value etc.)
    ● Influence of test methods
    ● Highly sensitive for some parameters
  ● Gives deeper insight in the material behaviour

● Lab-to-lab variation appears to be small

● Basis for future procedures, standards
  ● Much knowledge gained on the value and uncertainties in future material specification by testing
  ● New test standards (e.g. ISO)
    ● Test specimen for fatigue and residual strength
    ● Test frequencies and procedures
    ● Possible spin-off to standard bodies outside of wind energy
Deliverables

- **OPTIDAT**: extensive material database
  - Major bonus for future research projects
  - Largest European wind turbine material database (larger than FACT)

- **OPTIMAT website**: with all documents available on-line
  - Efficient documentation management

- Already many scientific publications

- Enhanced and unique knowledge about the material behaviour and testing effects

- Standard Optimat test specimen geometry

- Knowledge for (making standard for) material characterisation
Consortium Strengths

- The consortium includes unique expertise
  - Proven capabilities to handle a huge amount of test results by developing a unique database: OPTIDAT
  - Fully automatic document database to handle the enormous flow of information: http://www.ecn.nl/optimat

- Strong consortium that is intensifying its cooperation during the project and acts as a centre of excellence
  - Partners all want to continue and are prepared to cover the extra efforts and costs themselves
  - Good cooperation between partners; even with all the technical problems encountered and overcome

- Given the problems encountered:
  
  This is probably the only consortium that can resolve the current and future questions regarding rotor blade material behaviour and characterisation
Conclusions

- After the delays: the consortium now at full speed
- Major new knowledge has been generated by the consortium
  - Also extending beyond the proposal in the field of material testing
- The consortium needs to go ahead, because it is probably the only chance to resolve the issues at hand
  - No other conceivable consortium would have this background in material testing for wind turbines
  - Setting up another project of this magnitude on material testing for wind turbines by the EU would be next to impossible
- After the project, the consortium with its unique expertise should continue to extend the knowledge of material behaviour for the design of next generation rotor blades
  - Also applicable outside of wind energy