

OPTIMAT BLADES

Progress until July 2004



Arno van Wingerde
Knowledge Centre WMC
The Netherlands

Knowledge
Centre

WMC



ECN

TU Delft

Delft University of Technology



Problems encountered: Overview

OPTIMAT BLADES

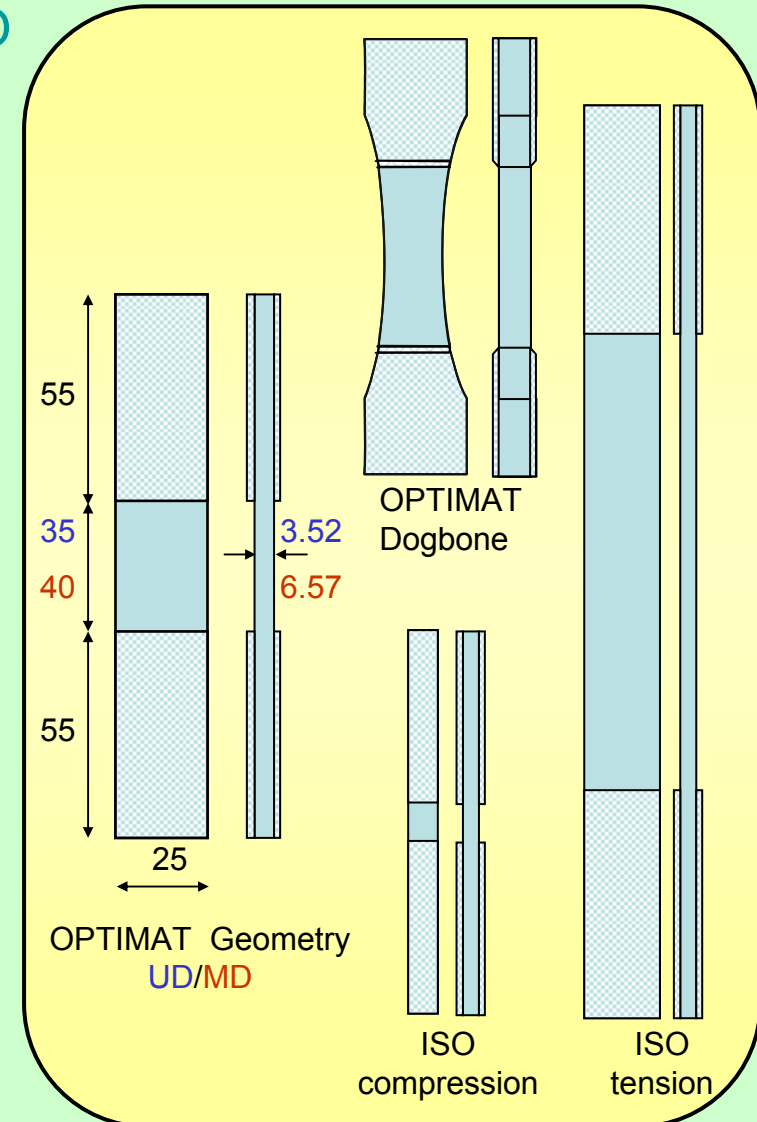
- Test Geometry Determination
- Fabrication of test specimens
- Move WMC
- Low fatigue frequencies
- Extra tests carried out



Test Geometry Determination

OPTIMAT BLADES

- General results comparable to ISO specimens
- Allow measuring techniques
 - Strain gauges
 - Acoustic Emission
 - Infrared imaging
 - Clip gauges
 - Ultrasonic
 - 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

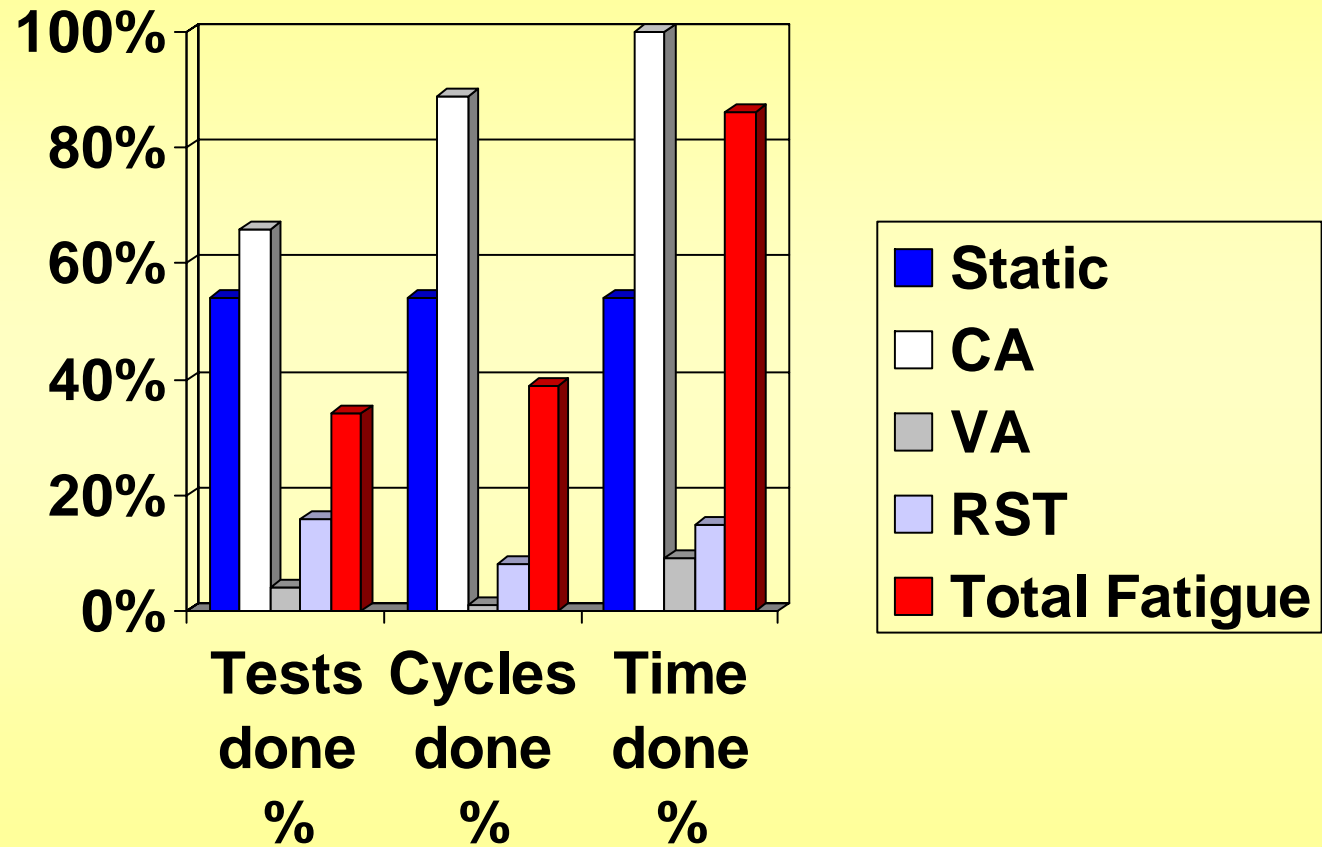
OPTIMAT BLADES

- **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

OPTIMAT BLADES

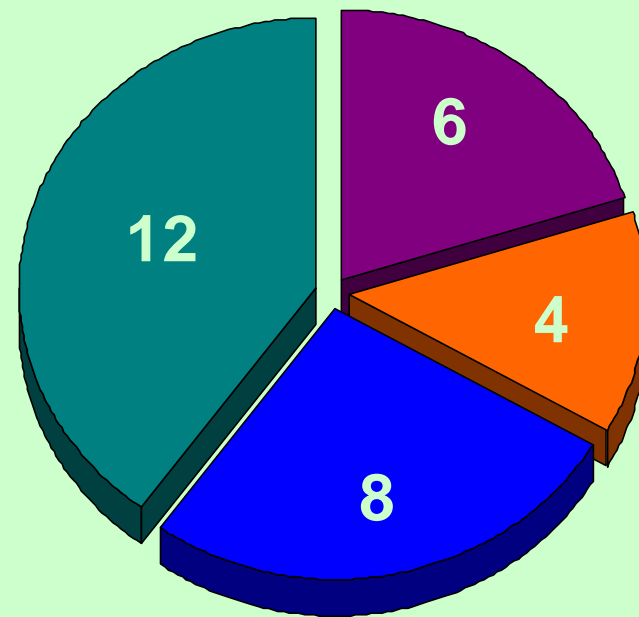




Delays per cause (months)

OPTIMAT BLADES

- **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**



- Geometry
- Manufacturing delay
- Frequency: extra tests
- Frequency: test time



Material testing: lessons learned

OPTIMAT BLADES

- **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

OPTIMAT BLADES

- **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

OPTIMAT BLADES

- **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

OPTIMAT BLADES

- **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 extent the knowledge of material behaviour for the design of next generation rotor blades**
 - Also applicable outside of wind energy