

# WP 3: Rotor Structure and Materials

Bert Janssen

ECN

Brussels; October 9, 2008



SIXTH FRAMEWORK PROGRAMME



Energy research  
Centre of the  
Netherlands

UpWind 

# WP 3: Rotor Structure and Materials

WP 3 is subdivided into three Tasks:

- ✎ Task 3.1: Applied (phenomenological) material model (WMC) (based on experiments)
- ✎ Task 3.2: Micro-mechanics based material model (RISØ) (based on fibre/ply modelling)
- ✎ Task 3.3: Damage tolerant design concept (UP) (Based on FEM with properties damaged materials)



SIXTH FRAMEWORK PROGRAMME



ECN

Energy research  
Centre of the  
Netherlands

UpWind 

# Partners of WP 3 (16 from 12 countries)

RISØ/DTU 

Gamesa



WMC



VTT



CRES



UP



STFC



GEGR-E



VUB



ECN



CENER



ISM

IITB

CUMTB

CWMT



SIXTH FRAMEWORK PROGRAMME



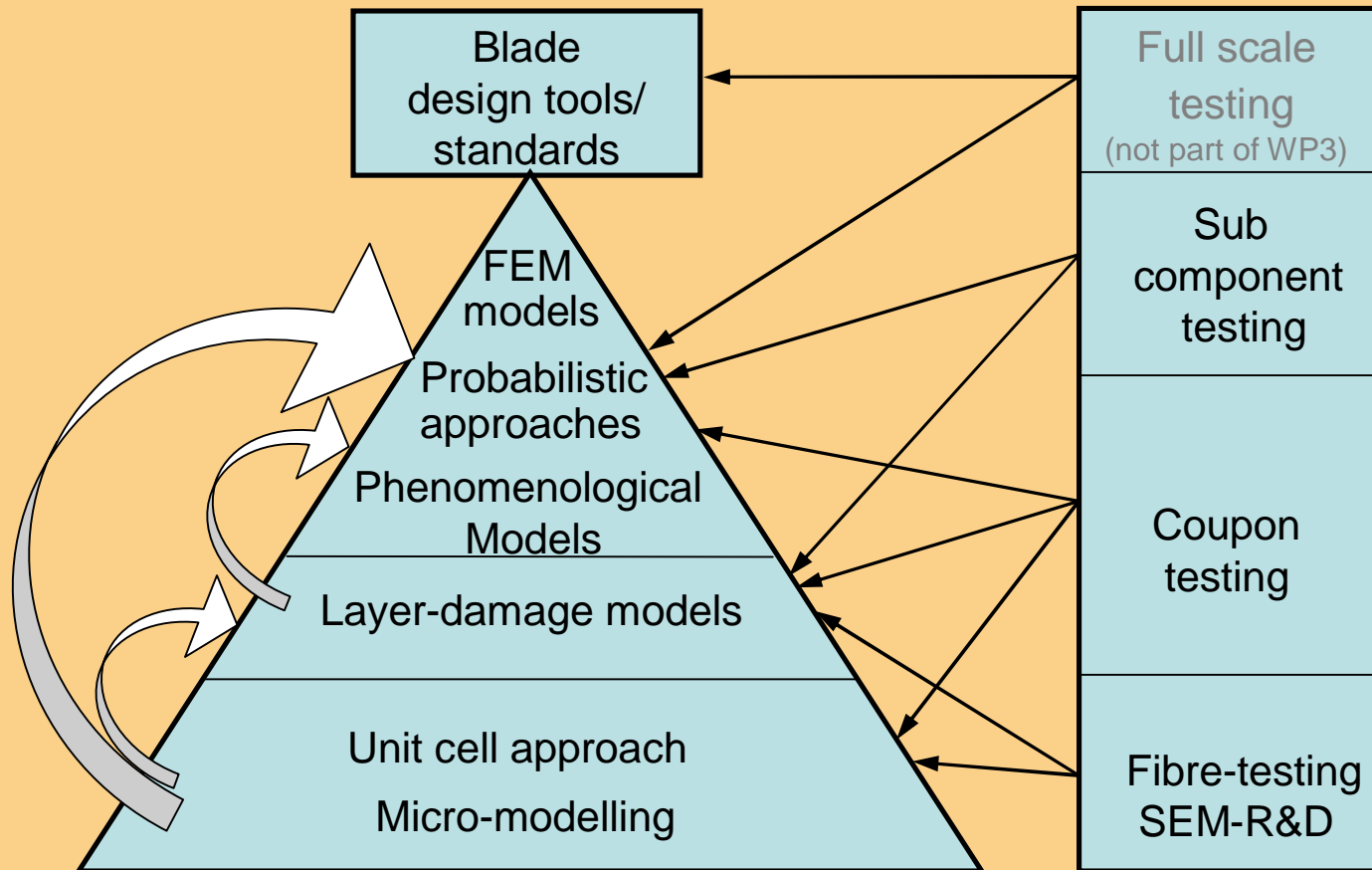
Energy research  
Centre of the  
Netherlands



# Coherence of work within WP3

## Analytical Research

## Experimental Research



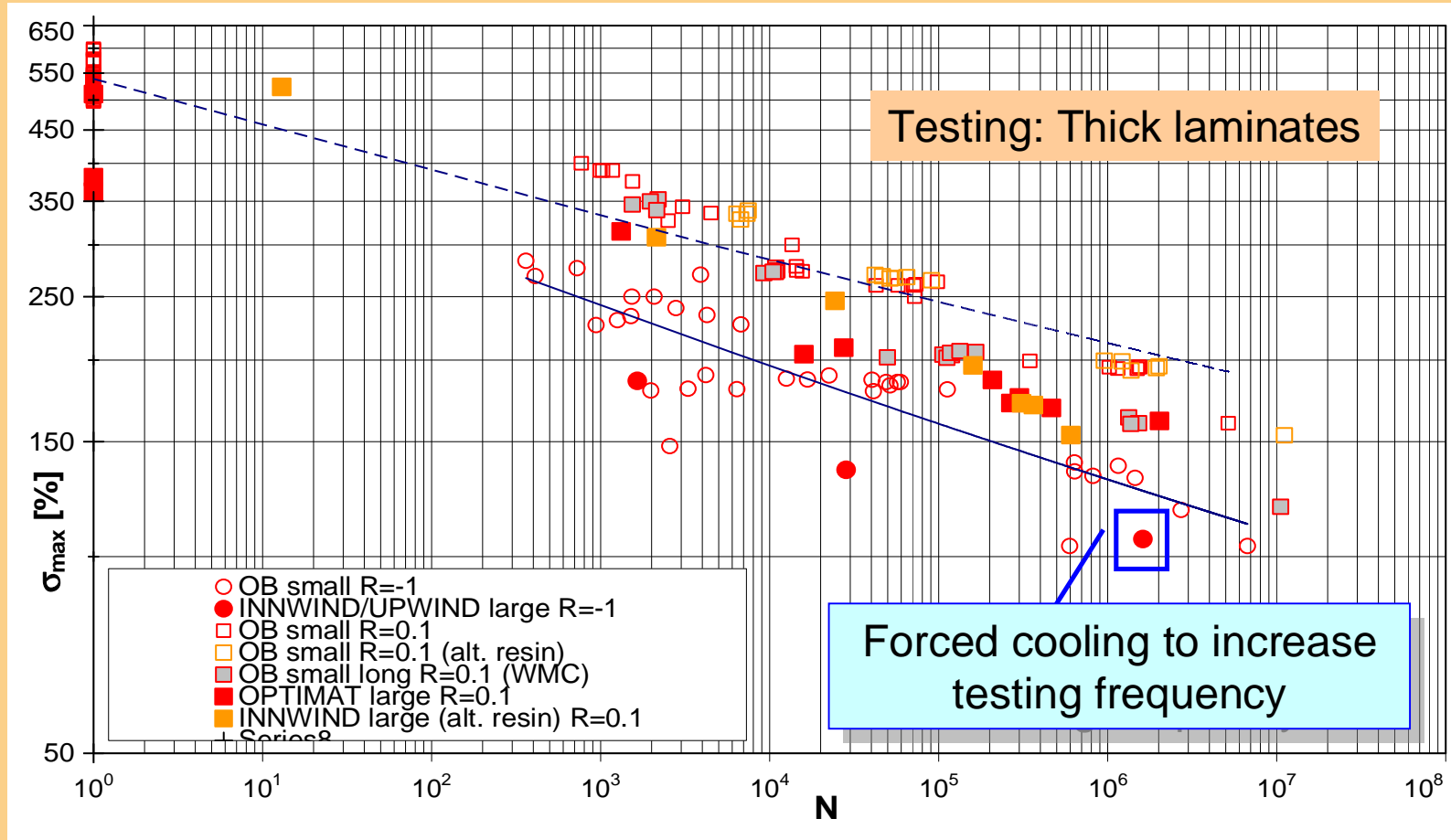
SIXTH FRAMEWORK PROGRAMME



Energy research  
Centre of the  
Netherlands



# Task 1: Phenomenological Modelling



# Task 1: Phenomenological Modelling

## I-Beam Testing

$(\pm 45^\circ, 0^\circ_6, \pm 45^\circ)$

(reference laminate GF/RIM 135 + biax)

Bonding paste

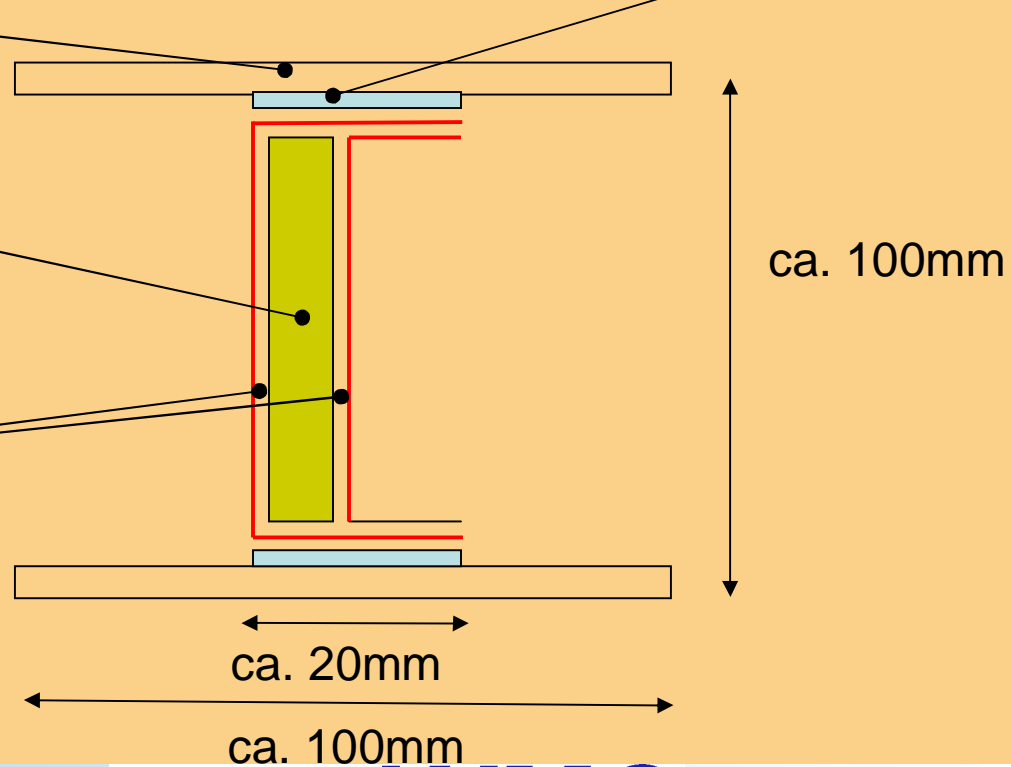
(Hexion Epikote MGS Bonding Paste Resin 135/G3)

Core material

(Airex/Herex C70.55, 10 mm)

$\pm 45^\circ$ 's

(830 gsm, 20 gsm  $90^\circ$ 's, 2 layers)



SIXTH FRAMEWORK PROGRAMME

Knowledge  
Centre

WMC

UpWind

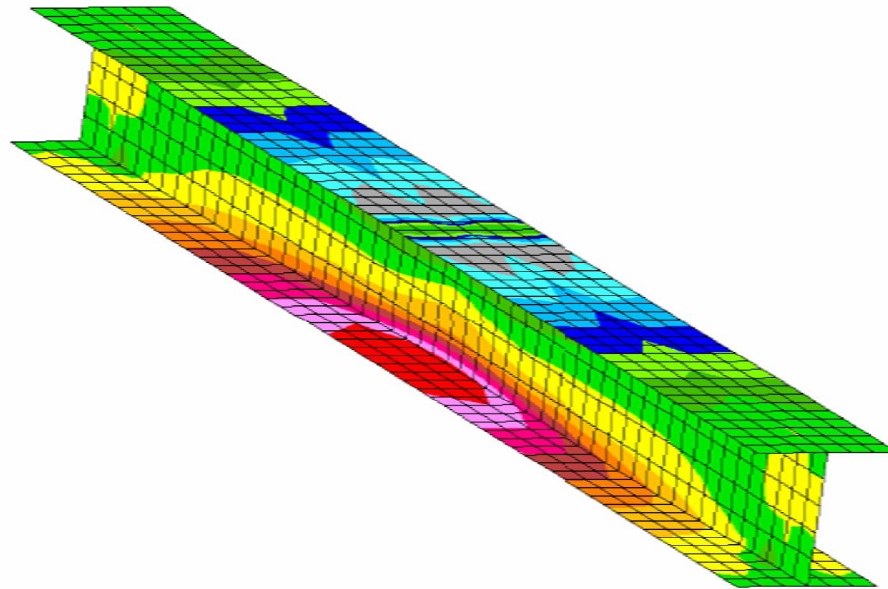
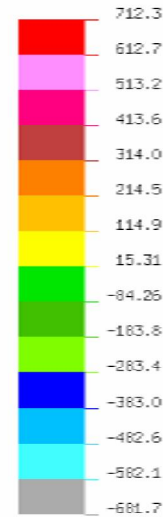
# Task 1: Phenomenological Modelling

DISPLAY [1] - GEOMETRY MODELING SYSTEM (9.0.0) PRE/POST MODULE

MAX-STRS. RESULT

VIEW : -681696.6  
RANGE: 712314.6

(Band \* 1.E03)



EMRC-NIS4V/DISPLAY

SEP/11/08 11:15:54



ROTX  
20.0  
ROTY  
30.0  
ROTZ  
-10.0

3D I-Beam analyses  
3-point bending



LAYER NUMBER 1



SIXTH FRAMEWORK PROGRAMME

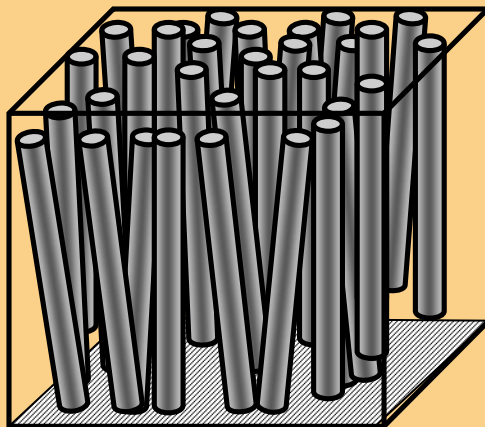
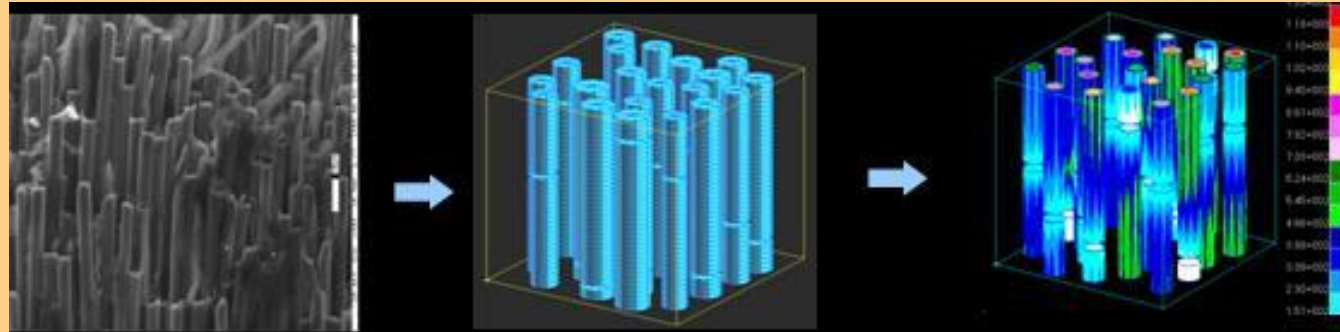


KAPES  
CRES

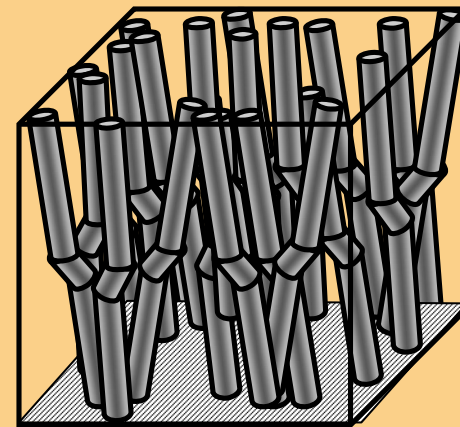


# Task 3.2 - Micro modeling

FE modeling of cracked fibers



High compressive loading leads to kinking



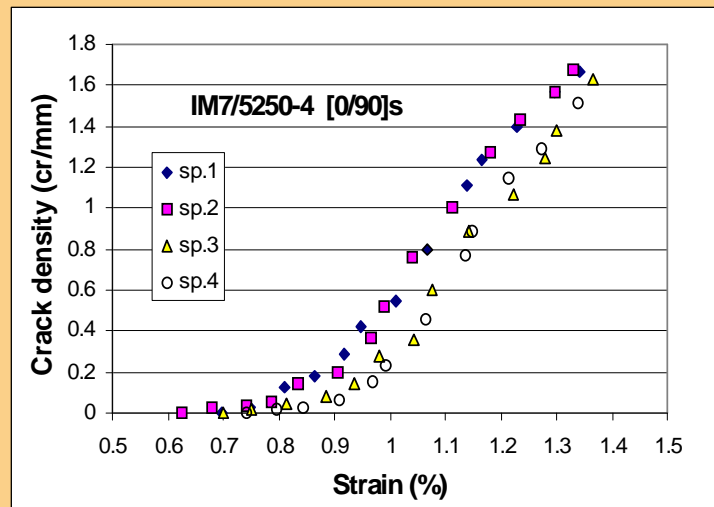
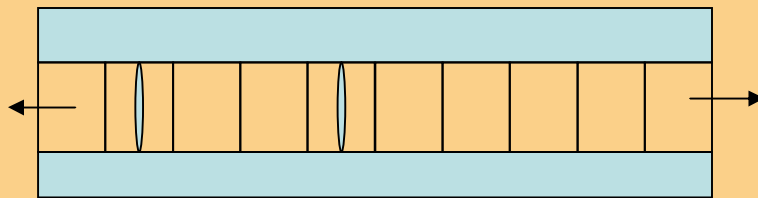
SIXTH FRAMEWORK PROGRAMME





# Task 3.2 - Micro modeling

Damage development in quasi-static tension



Questions:

- Degradation of fracture "resistance"?
- Modification of the probabilistic approach to account for the degradation?

Examples:

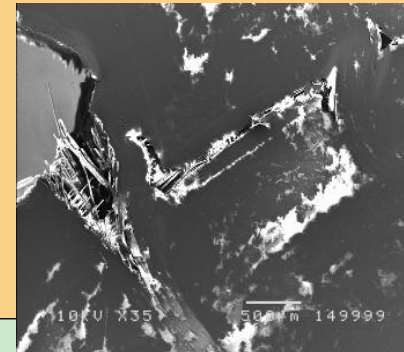
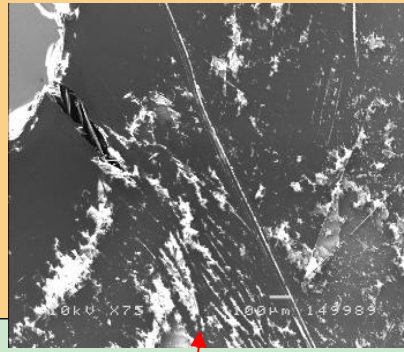
- Thermal aging and cycling tests



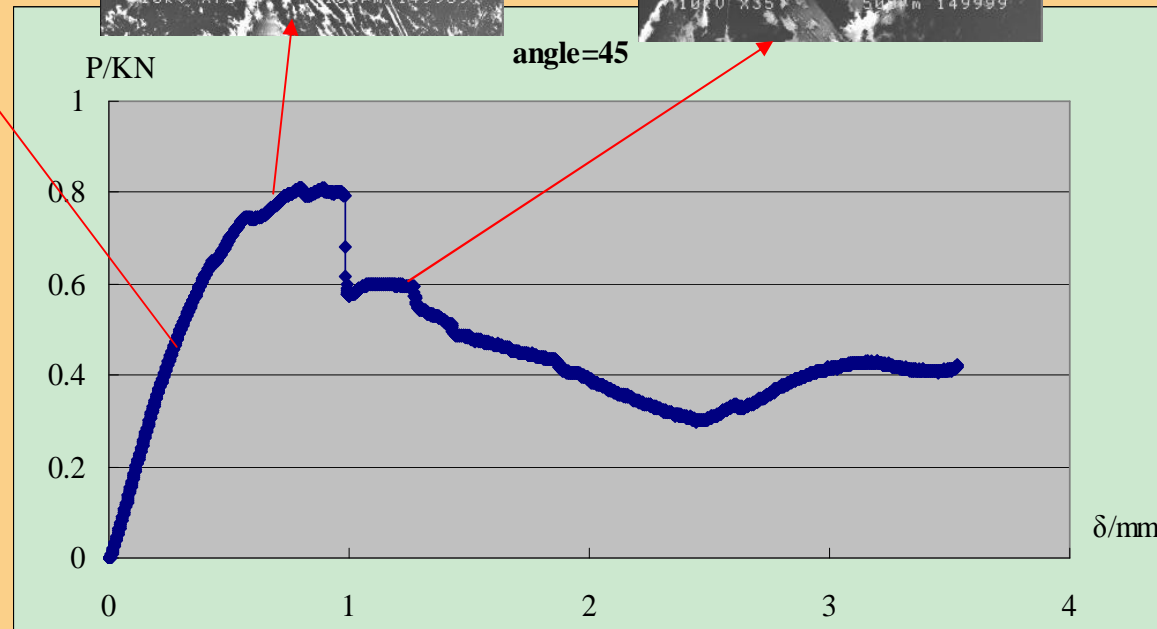
SIXTH FRAMEWORK PROGRAMME



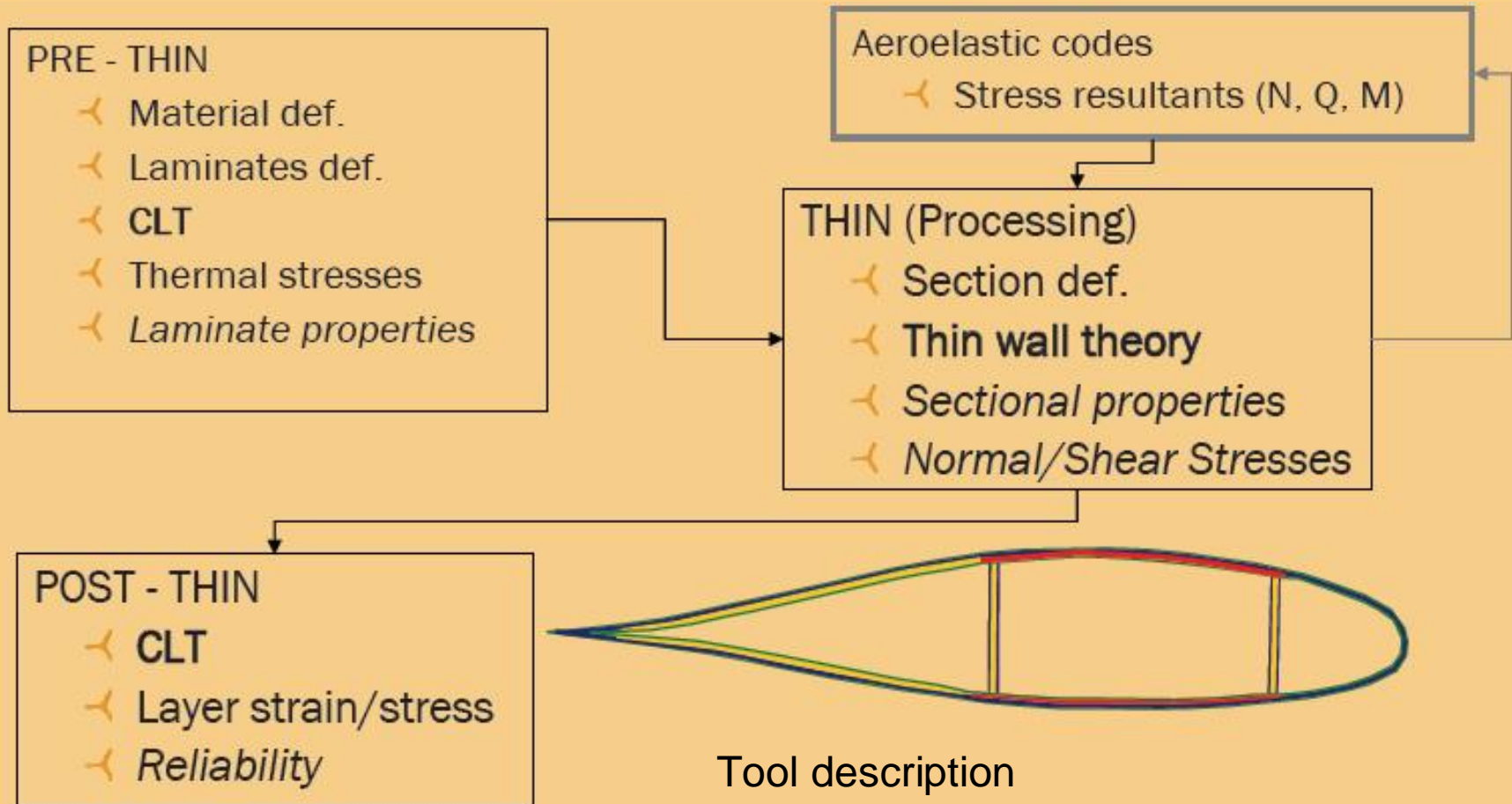
# Task 2: Micro modelling:



Three point bend test  
in SEM at CUMTB:  
  
Load-deformation  
curve and SEM photos

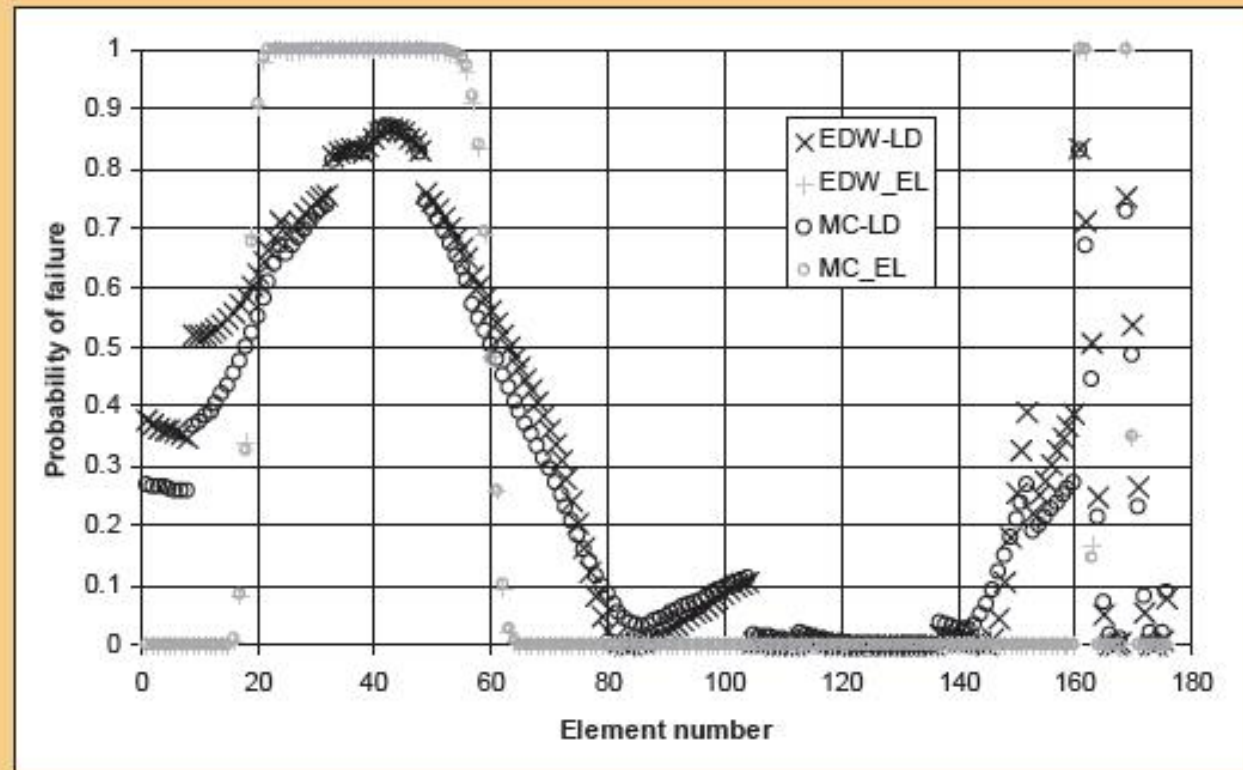
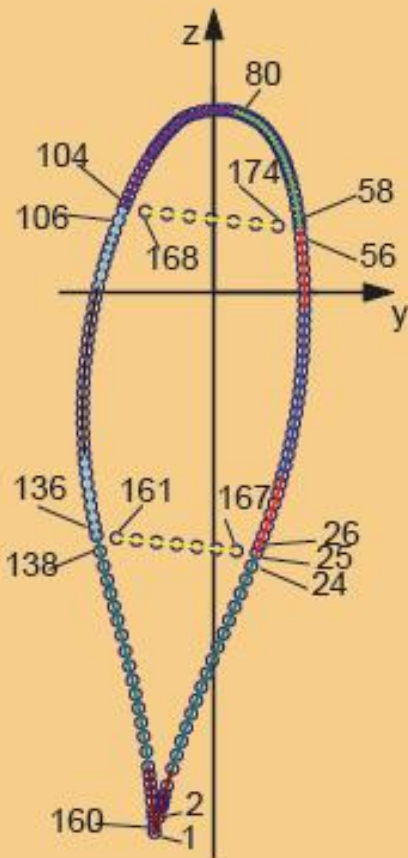


# Task 3: Damage tolerant design



# Task 3: Damage tolerant design

Probability of failure

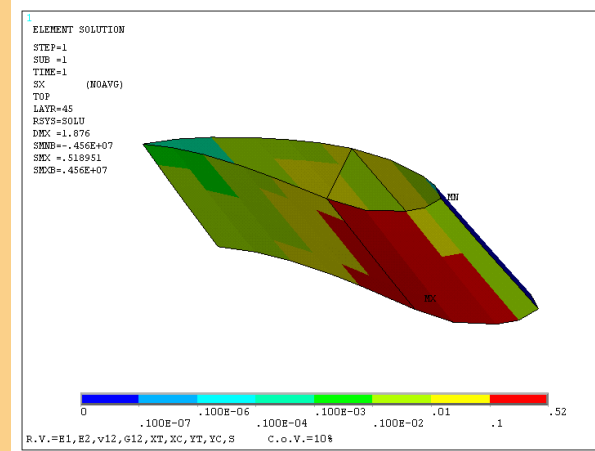
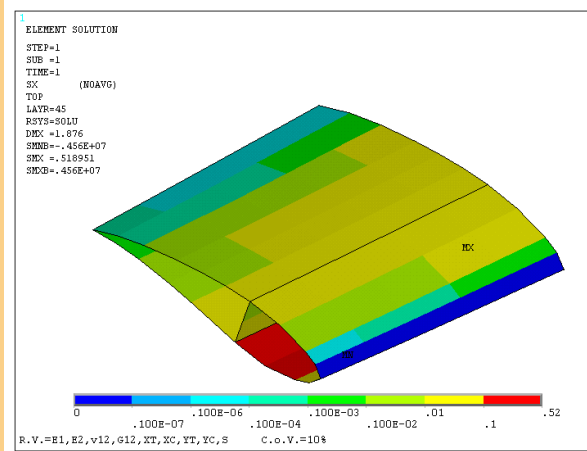


SIXTH FRAMEWORK PROGRAMME

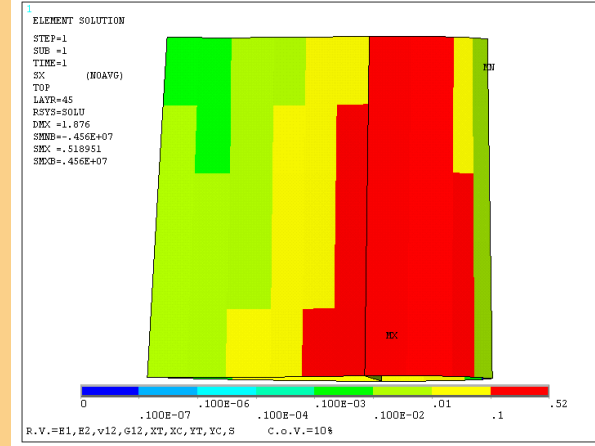
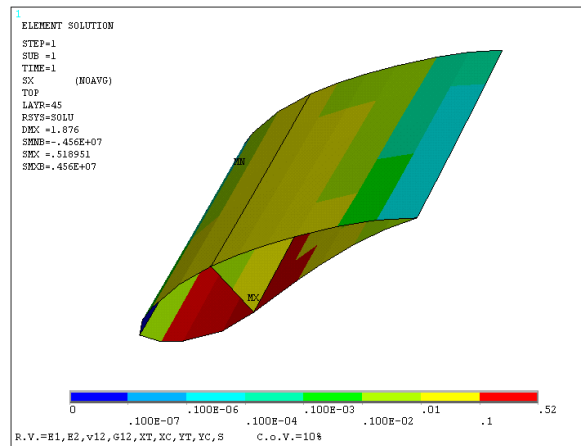


# Task 3: Damage tolerant design

Implementation  
of RSM in  
rotor blades



COV=10%



SIXTH FRAMEWORK PROGRAMME

UNIVERSITY  
OF PATRAS

UpWind

# Integration

## Integrating activities:

- Fatigue testing of Fiber optical sensors (ongoing)
- Testing of material related to 1B1, Innoblade (starting)
- Questions on material aspects in relation with upscaling. 1B4: Upscale (to start)
- New: IEC-TC88 Working Group on Material Testing



SIXTH FRAMEWORK PROGRAMME



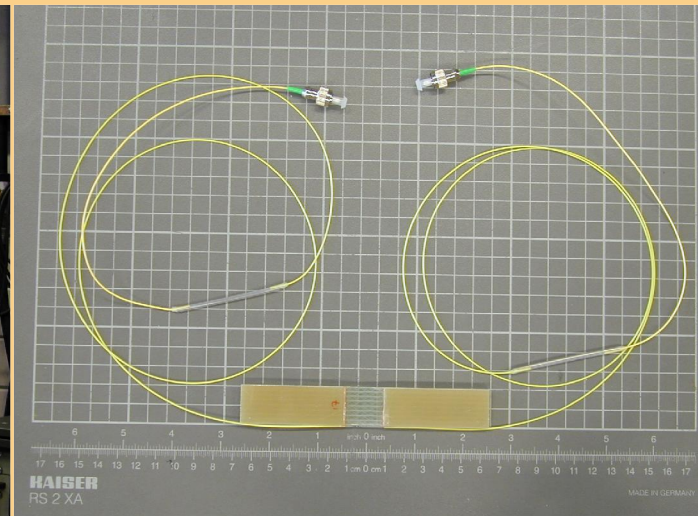
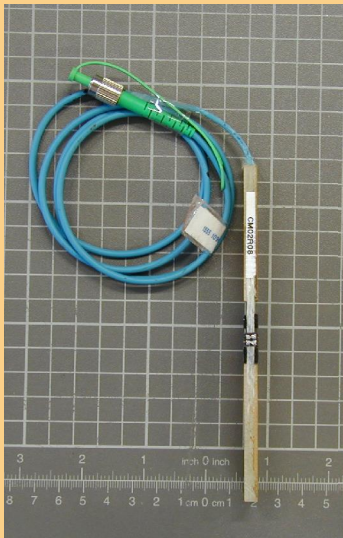
Energy research  
Centre of the  
Netherlands



# Interaction WP 7 UPWIND

## Optical fiber embedding performance

- No negative effects on fatigue performance noted
- Good measurement performance



SIXTH FRAMEWORK PROGRAMME

Knowledge  
Centre

WMC

UpWind

A photograph of an offshore wind farm at sunset. The sky is a vibrant orange and yellow, with a large, dark, horizontal cloud bank in the middle. The sun is positioned behind this cloud bank, creating a bright glow. The sea is dark and choppy, with small waves visible in the foreground. The silhouettes of numerous wind turbines are visible along the horizon line.

Questions