



**CENER**

CENTRO NACIONAL DE  
ENERGÍAS RENOVABLES  
NATIONAL RENEWABLE  
ENERGY CENTRE

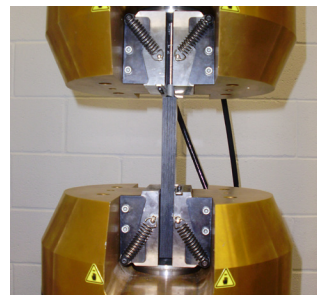


WIND ENERGY DEPARTMENT

## MATERIALS & MANUFACTURING PROCESSES

### MATERIALS SELECTION AND CHARACTERIZATION

When selecting materials for blades their proper characterization is crucial. CENER broad experiences combined with a modern materials laboratory becomes a key factor for design optimization.



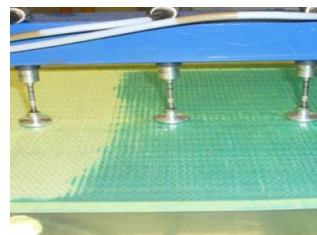
Dynamic Datigue Test



Static Tensile Test

### OPTIMIZATION OF BLADE MANUFACTURING PROCESSES

When a process is required to be improved, the identification of its critical parameters is a must. CENER has a manufacturing workshop where different processes can be replicated, analyzed and finally optimized.



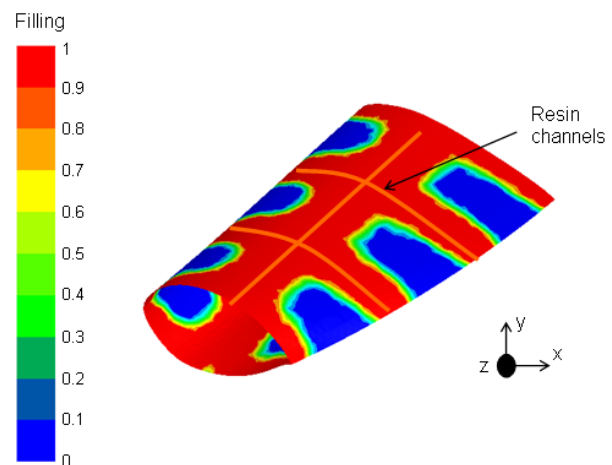
Infusion Process



Oil-Heated Tool

### SIMULATION OF BLADE MANUFACTURING PROCESS

When a VARI process is planned to be implemented, its modelling supports the infusion strategy. The resin characterization and fibre permeability to resin are fundamental inputs for an accurate modelling. CENER has the equipments and knowledge to obtain these parameters.



VARI Simulation



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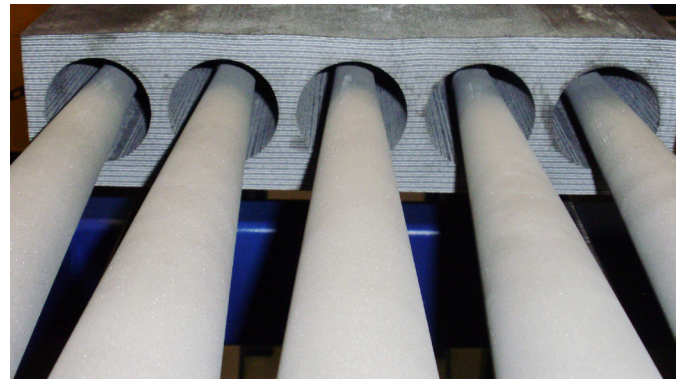
## WIND ENERGY DEPARTMENT

### MATERIALS SELECTION AND CHARACTERIZATION

- Selection of materials/processes for specific application.
- Quality inspection of materials and components.
- Improve of product quality.
- Study and development of monitoring and process control systems.
- Failure analysis.
- Development/Selection of testing and validation methods.
- Characterization of new materials.

### OPTIMIZATION AND SIMULATION OF BLADE MANUFACTURING PROCESSES

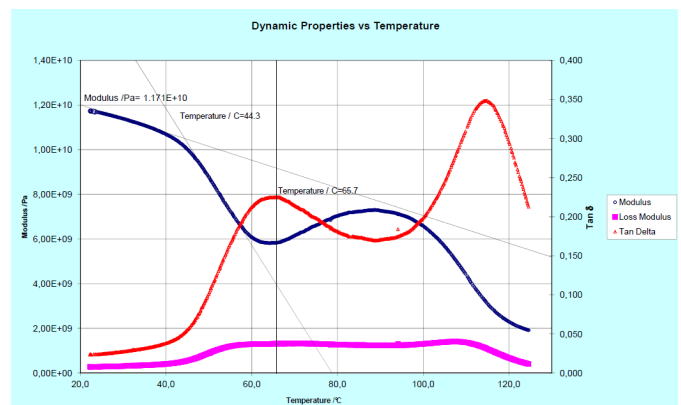
- Optimization of current processes, such as VARI and prepregs.
- Development, validation and implementation of new processes.
- Cost and productivity assessment.
- Integration of metal inserts in blades



Integration of Metal Inserts in Blades

### MATERIALS LABORATORY EQUIPMENT:

- DSC: cure kinetics, Cp measurements.
- DMA: Tg measurements, modulus measurements, elastic/viscoelastic behaviour.
- Brookfield viscometer: resin viscosity and its evolution during curing.
- Gel time: measurements in thermosetting resins.
- Optical microscope with image software: porosity measurements, laminate thickness, fibre alignment.
- Fatigue testing machine: 250 kN capacity.
- Universal testing machine: 600 kN capacity for tensile, compressive, 3 or 4 point bending tests.
- Hot press: 125 Tm capacity.
- Oil heated tool (200°C) and VARTM/prepreg accessories.
- 3D cutting and grinding machine.
- Large area to test sub-components.



DMA of a Fibre Reinforced Plastic