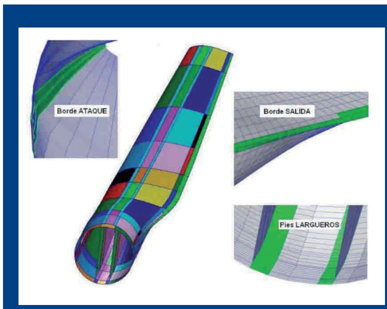
cener
centro nacional de energías renovables
national renewable energy centre

STRUCTURAL DESIGN

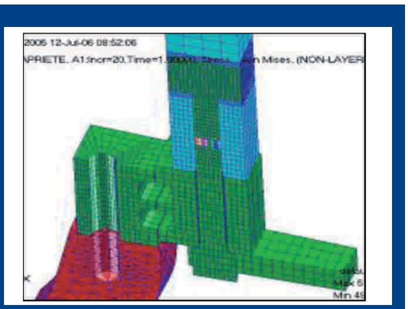
BLADE Design:

"Towards optimized and reliable designs combining analytical applications with advanced tools…Let's anticipate local failures!"

- In-house analytical applications and advanced tools based on FE analysis are efficiently combined in order to obtain optimized blade structure designs.
- Interpretation of complex failure modes and local effects, such as delaminations, debonding and fatigue.



Blade structure



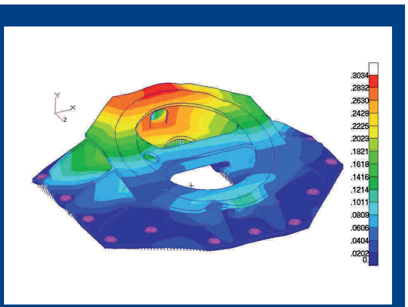
Blade root bearing

HUB & FRAME Design:

"Our philosophy: Cast-manufacturer friendly designs"

- Manufacturing characteristics and requirements are considered in the design phase.
- Working in close collaboration with manufacturers.

FE Model – Mesh done with different 3D topology elements



FE Model – Global deformation results

TOWER Design:

"When design safety factors are extremely conditioned by the geometrical imperfections caused by the manufacturing process…"

- Deep understanding of the structural behaviour of welded and bolted joints.
- Bolted joints design tool according to VDI 2230

  Standard-In-house analytical tools based on VDI2230 have been developed.
- In-house tools were adapted to take into account the recommendations and guidelines defined by the International Institute of Welding.

Ciudad de la Innovación, 7 CP 31621. Sarriguren (Navarre) Spain
T +34 948 25 28 00 • **F** +34 948 27 07 74 • info@cener.com

RESEARCH & DEVELOPMENT:

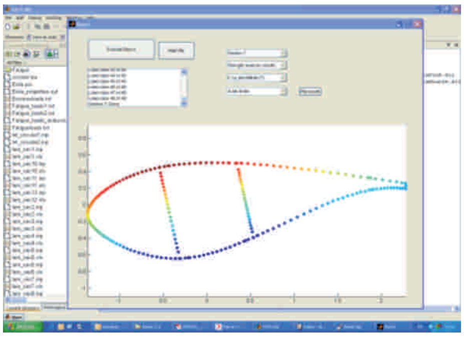
Rotor blades represent approximately one quarter of the total cost of typical wind turbines. They play a paramount role in key aspects such as turbine efficiency and load propagation. Most commonly used techniques are based on mixed analytical and numerical techniques which try to predict the failure of the rotor blade considering ideal laminates with no defects, but accounting for extremely high design factors. But…, are our models sensitive to the real life?, are they skill-enough to estimate local failures due to complex mechanisms?, have rotor blade designers strong confidence in their designs?…

Structural area research lines are focused on the application of rotor blade advanced design techniques (trying to understand local and complex failure modes) challenging the limits of certification. Main research topics are listed below:

BASSF (Blade Analysis Stress Strain Failure):

The tool was developed to perform structural design of composite blades based on 2D analytical formulation.

- Capabilities already developed; mechanical properties of the airfoils generation, direct I/O data communication with BLADED, strength analysis and failure prediction, buckling... Capabilities in developedment; fatigue design based on SN approach and Constant Life Diagram curves, statistical distribution of the material properties and loads, stochastic design, user interface improvement.

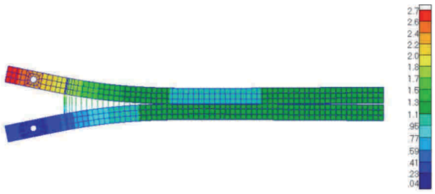


FMAC (Fracture Mechanics Adhesive Calculation):

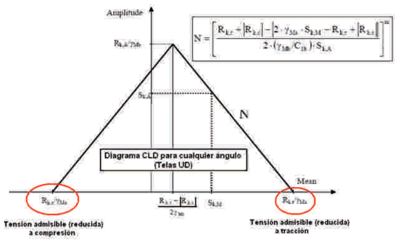
The tool was developed

To perform structural design of adhesive joints which should withstand extreme and fatigue loads.

- Capabilities already developed; VCCT analysis theory implemented, first crack automatic generation capability, crack propagation and direction prediction, compatibility with NASTRAN.
- Capabilities in developement; cohesive element technique integration, user interface development, validation plan definition & execution with representative components.



FATCOMP (Fatigue on Composites): The tool was developed to perform design composite lay-ups loaded under random fatigue complex stress states. In progress - to work with multi-axial fatigue theories based on SN approach and Constant Life Diagram.



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