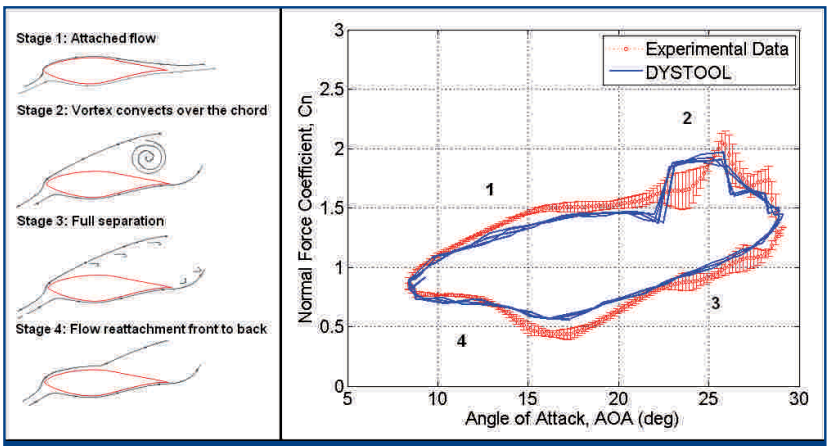
cener
centro nacional de energías renovables
national renewable energy centre

AERODYNAMIC / AEROLASTICITY / AEROACUSTIC

Rotor Design Assessment

DYSTOOL: Unsteady aerodynamics characterization

- DYSTOOL: DYnamic Stall TOOL for unsteady aerodynamic computations of 2D airfoils.
- DYSTOOL integrated into the aeroelastic code FAST for wind turbine computations.

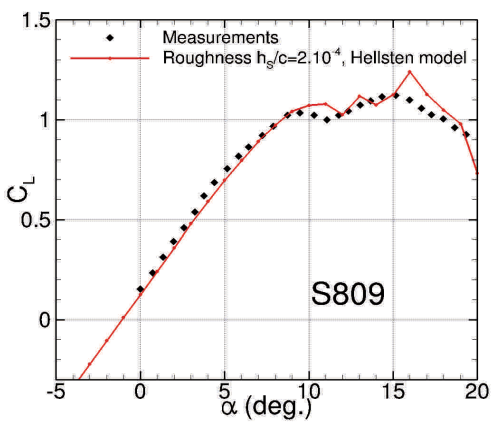


2D S809 airfoil oscillation: a≈20°+10°sin(•), k=0.078, Re=1.01x106, Chord=0.457m

DISTRIBUTED ROUGHNESS

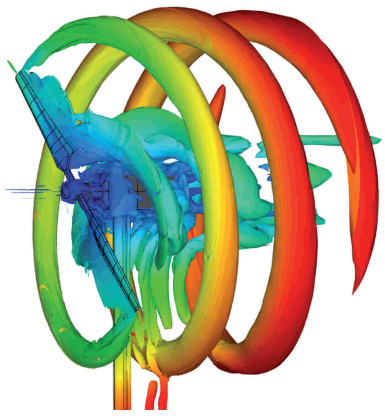
Performing aerofoil static and transient computations (CFD). The aerofoil roughness and dirtiness is taken into account for characterization.

Cl-Fitxa

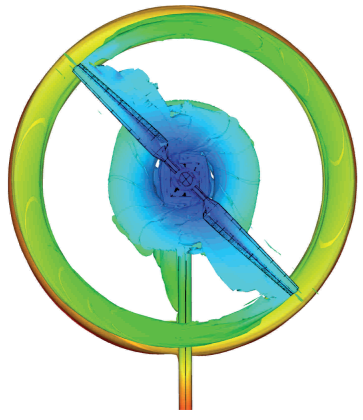


Distributed Roughness CFD computation

General view



Front



Wind turbine Vortex Interaction

- Full rotor simulation – detailed components geometries
- Vortex interactions
- Blade tip study (in plane and out of plane)

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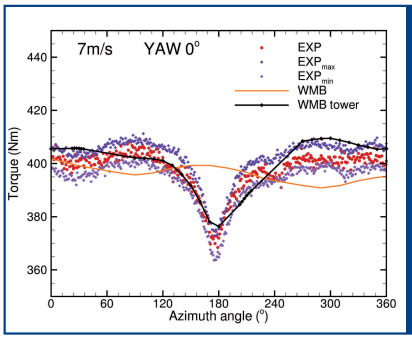
A critical aspect of the aerodynamic modelling of wind turbines is related to the unsteady aerodynamic behaviour of the blades span stations. CENER started in 2006 a research project to generate a new 2D dynamic stall tool based on the Beddoes-Leishman model. The implementation was finished and the tool was extensively validated with unsteady experimental data from the S809, LS(1)0417MOD and NACA0015 2D aerofoils. The results were very promising, showing good matching between the computation and the experimental data. Finally, the aerodynamic tool was presented as DYSTOOL.

DYSTOOL is a 2D airfoil unsteady tool, with the capacity to evaluate the aerodynamic behaviour for rotor design assessment.

In order to improve the performance, DYSTOOL allows an optimized set of model parameters for each airfoil or unsteady condition. The parameter values can be adjusted using an independent tool. This process uses experimental data or reliable computed data as a baseline and optimizes through a methodology of genetic algorithms. In addition to the 2D approach, DYSTOOL has been integrated into the aeroelastic code FAST, taking advantage of the DYSTOOL features for wind turbine modelling. This modified FAST version is available for wind turbine assessment.

WMB (Wind Multi-block) is the compressible CFD code developed by CENER, in collaboration with the University of Liverpool, validated for wind turbine flows. This code and the results have been presented at various international projects, conferences, journal papers and also has been used for commercial purposes with several wind turbine manufacturers and wind farm owners.



This code has been validated through several international projects (i.e IEA annex XX and XXIX). The overall experience and remarkable results brings our simulation methods to an upper level of accuracy.

- Complete wind turbine study: blades, hub, nacelle and tower at upwind or downwind configurations.
- Aeroelastic study of the rotor.
- Computation with fully coupled CFD-CSD with finite element approach – In progress.
- Wake interactions: Tip vortex with tower and root vortex with nacelle and anemometer location.

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