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Aerodynamic Loads on Flexible Bodies for Sailing Simulation

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ABSTRACT

Aeroelasticity phenomena play an important keyrole for aircraft engineering, but also civil applications such as buildings and antennas and other require fluid-structure interaction analysis. Sailing represent a very interesting field since wind effects has a major impact on performance and generally on design activities. Sail system and its constraints are bounded to other deformable structures like mast, boom, rigging etc. that determine sail shape themselves; so a reliable method for predicting fluidynamics loads, structural behaviour and their coupling effects represents an useful aid for designers.

Some well known numerical techniques for fluid-structure interaction are nowadays available but time e costs of simulation usually limit the industrial application also due to the high level skill required and results are not repeatable and satisfactory at all. Anyway also experimental testing can not solve this problem typically for scale and environment problems.

It can be easily recognized that FEM solvers rule the structure simulation with good and certificated results in many cases; CFD solvers, based on Finite Volumes, usually need some post processing and critical analysis for off design condition that unfortunately rule the design processes. The main database and modelling differences also determine complex data exchange interfaces that become critical or prohibitive for unsteady computations. Finally even if accurate and expansive CFD simulation data are available, coupling procedure affects resolution reducing the meaning of the gained accuracy.

In order to resolve the problems of this major issue, here a numerical strategy is presented: it has been chosen MSC.Nastran modelling approach to freeze interfaces and structural environment; PaMS, a BEM solver for unsteady non viscous flows, has been developed and coupled on the same

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FE structural topology. In this way pressure loads are directly computed on structural nodes at each time step; node position changes accordingly to deformation under aerodynamic loads and so it happens for BEM panels updating. FE modelling requires just a few of rules to achieve an acceptable body description; the limited computing time and the simple data processing largely cover the approximation due ideal flow model here adopted. The developed tool is very effective in preliminary design but can also provide important data for structural sizing.

Considering a wing with aileron, the method here shown has been applied to simulate the initial moment of a turning, where aerodynamics and geometry changes interact with basic deformation shape; the results are in good agreement with classical theories (Fig.1). After a model set up to analyze mast and rigging configuration a sail simulation has been afforded considering all bodies involved deformation under wind loads.

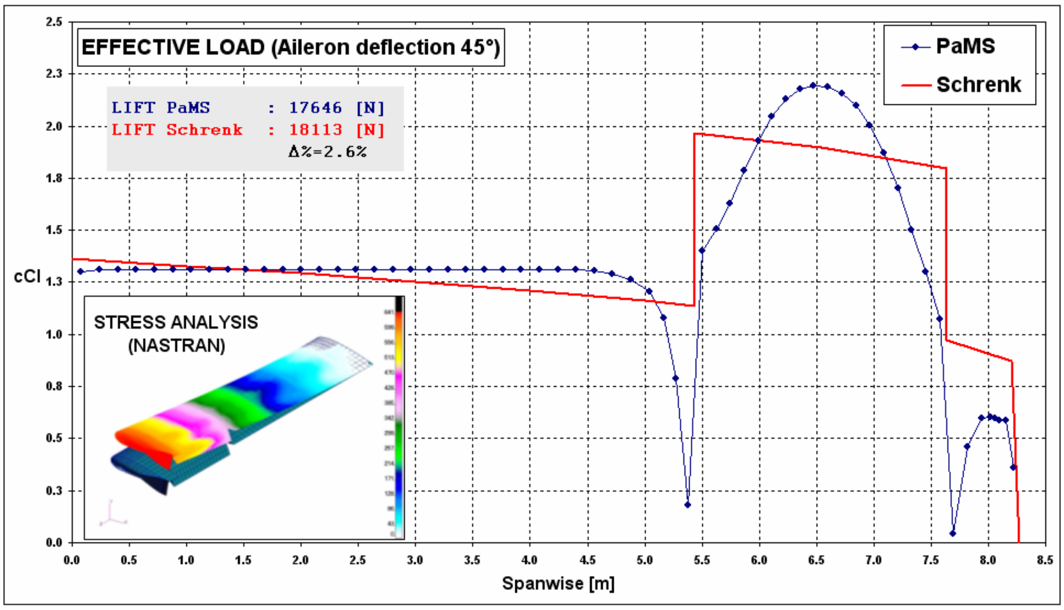

Figure 1: Nastran-PaMS coupling - results compared to a classical preliminary design method (Schrenk)

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