

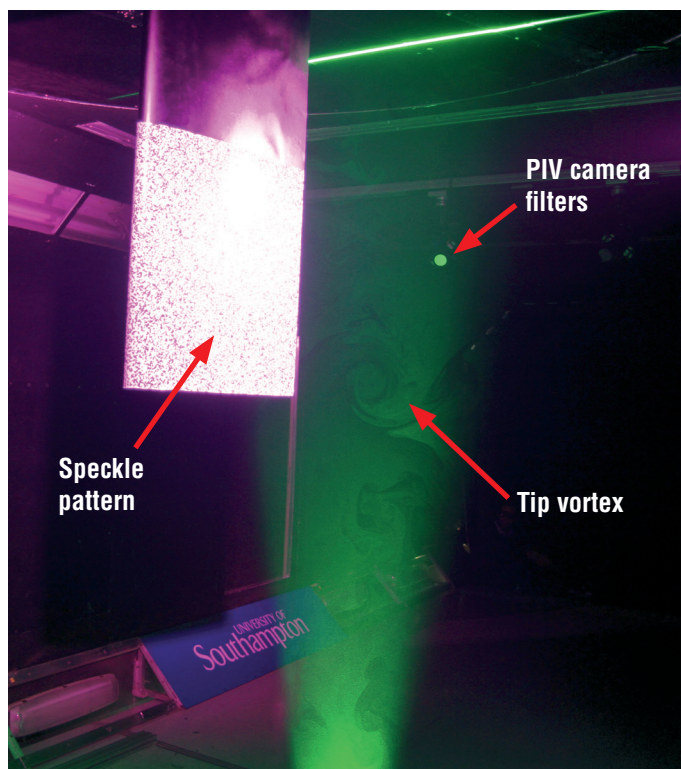
IN APPLICATION

Fluid-Structure Interaction Measurements of Flexible Aerofoil Sections

L. Marimon Giovannetti et al, University of Southampton, Fluid Structures Interaction Group, UK

Introduction

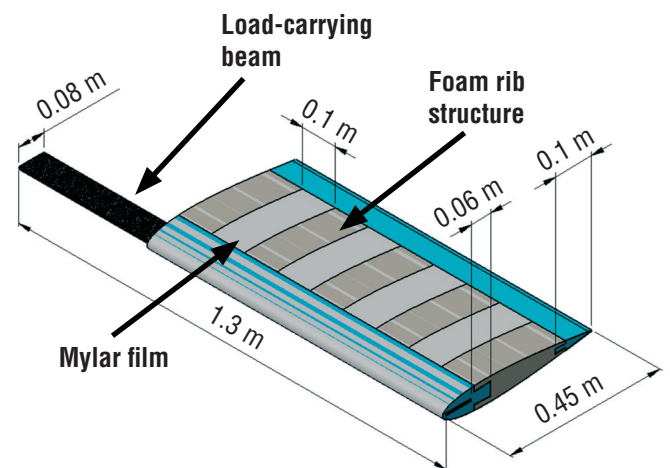
The current research presents an experimental technique that can be used to assess the structural response as well as the fluid behaviour of an aerodynamic structure. To do so a combination of Digital Image Correlation (DIC) and Particle Image Velocimetry (PIV) systems were employed in the R.J. Mitchell wind tunnel at the University of Southampton.



The subject of this study is to measure the change in effective angle of attack of an aerofoil-shaped section with different internal structures. The internal structure is made of carbon fibres and is designed with bend-twist coupling interactions to change the structural behaviour toward feather or toward stall, depending upon the aerodynamic load. The structure under load can therefore decrease or increase the angle of attack depending on the position and orientation of the fibres.

Experimental Setup

The experiments were conducted in the 3.5 m x 2.4 m R. J. Mitchell wind tunnel at the University of Southampton. The investigated flexible aerofoil was a NACA0015 section formed of a foam-rib structure, a load carrying beam (that could be changed to investigate different ply angles) and a Mylar film that transferred the aerodynamic loading to the spar.



Two high-speed SA3 Photron DIC cameras, operated at 0.1-1 kHz, were used to capture the structural deformation. Two high-resolution Imager LX 29M PIV cameras, operated at 2 Hz, were used to capture the tip vortex strength and location one chord downstream of the trailing edge, where the light sheet from the Litron Bernoulli Nd:YAG PIV laser was positioned. The two full-field measurement techniques were optically isolated via the use of appropriate filters: two 532 nm band-pass filters were used on the PIV to capture the laser light, and inverse filters were used on the DIC cameras to isolate the pink illumination

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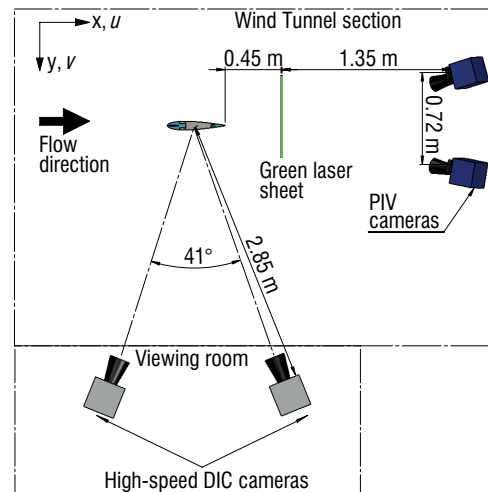
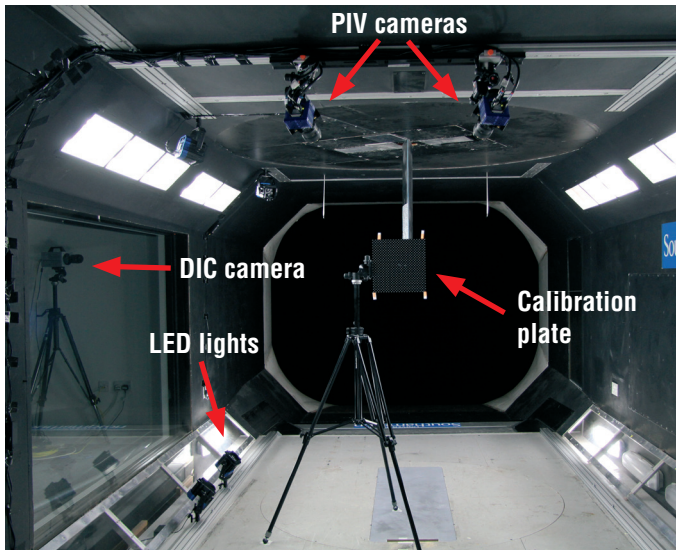
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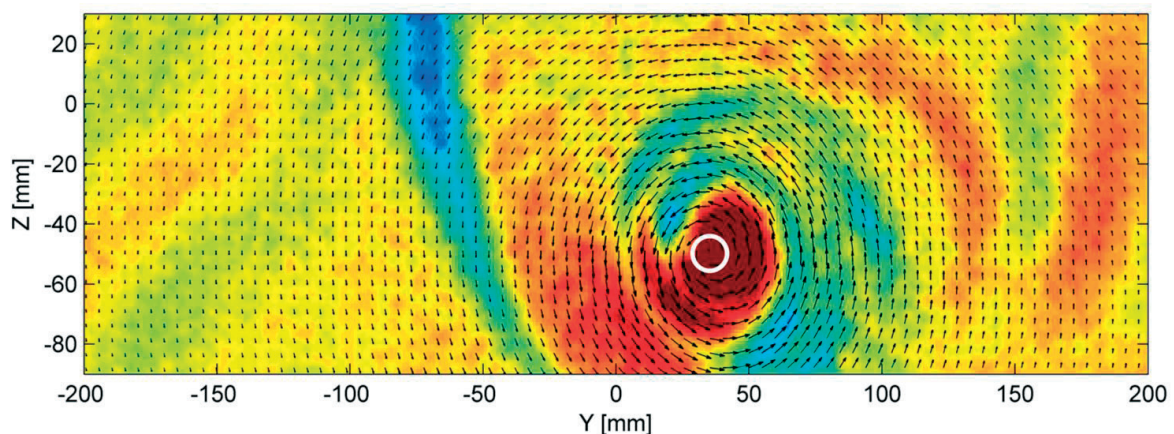
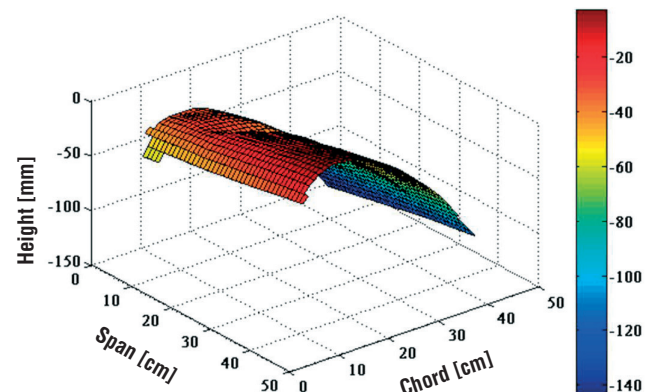
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Results

The structural deformation (right) and the tip vortex location (below) were investigated, so the internal structure that most increased the delay in stall could be selected. The results gave extremely valuable insight into the behaviour of novel load carrying structures and their ability to react to the applied aerodynamic load. It also allows validation of computationally expensive FSI simulations. The described methodology and results have a wide range of potential applications including aerospace, marine and energy industries.



For more information please see “Developing tools for assessing bend-twist coupled foils”, in Numerical Towing Tank Conference NuTTs 2015, available September 2015 by L. Marimon Giovannetti, J. Banks, S. R. Turnock, S. W. Boyd

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