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Ashwin Candade

PhD Researcher
Faculty of Aerospace Engineering
Delft University of Technology

EnerKíte GmbH

Fichtenhof 5
14532 Kleinmachnow
Germany

a.a.candade@tudelft.nl
a.candade@enerkite.de
www.enerkite.de

Development of a Toolchain for Aero-structural Design of Composite AWE Kites

Ashwin Candade[1,2], Maximilian Ranneberg[1], Roland Schmehl[2]
[1]EnerKíte GmbH
[2]Faculty of Aerospace Engineering, Delft University of Technology

The earlier in the design process the trade-offs between a system's cost and its performance can be determined, the easier it is to narrow in on an optimal final design. In order to explore the initial design space for composite carbon kites, it is imperative to assess the load couplings effects and its impact on the aerodynamics of the wing, and ultimately the performance of the system's yield. CFD and 3D finite element methods are currently too computationally expensive to efficiently explore the design space at such an early stage of the design process. This leads to the need for a toolchain that has sufficient modelling fidelity while being efficient enough to be used for conceptual design. An efficient aero-structural toolchain is the focus of this work.

In order to analyse the composite structure of the kite efficiently, instead of a traditional 3D finite element method, a 2+1D method that can capture the effects of fibre orientation, stack up sequence, and other aspects of the internal structure of the wing with sufficient fidelity, while being computationally efficient is employed[1]. This structural model is coupled with the aerodynamics of the kite via a 3D nonlinear vortex step method[2]. The toolchain also includes the effects of the underwing bridle configuration and is able to model the influence of different bridle and pulley configurations on the aero structural performance of the kite. A design space exploration exercise using the toolchain is carried out for a typical EnerKíte wing.

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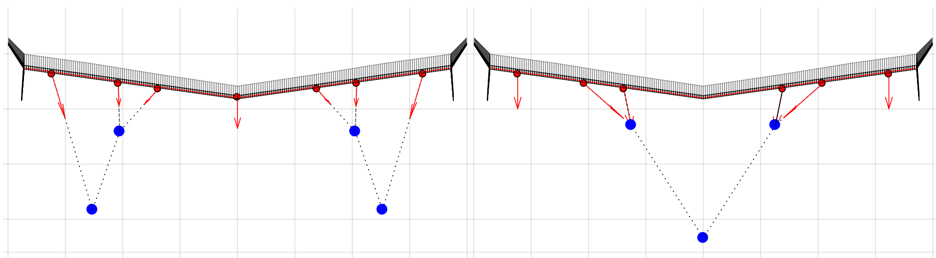

Bridle design space exploration using the described toolchain.