Chloé Duport

PhD Researcher
ENSTA Bretagne
Institut de Recherche Dupuy de Lôme
CNRS FRE 2744

2 Rue François Verny
29806 Brest Cedex 9
France

chloe.duport@ensta-bretagne.org
www.ensta-bretagne.fr

Institut de Recherche Dupuy de Lôme

Kite as a Beam Modelling Approach: Assessment by Finite Element Analysis

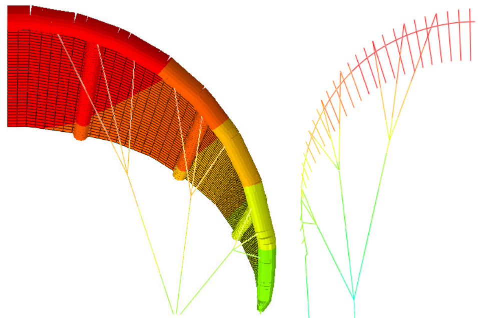
Chloé Duport, Antoine Maison, Alain Nême, Jean-Baptiste Leroux, Kostia Roncin, Christian Jochum
IRDL ENSTA Bretagne CNRS FRE 3744

The *beyond the sea*® project attempts to develop a tethered kite system as an auxiliary propulsion device for merchant ships. Since a kite is a flexible structure, fluid-structure interaction has to be taken into account to calculate the flying shape and aerodynamic performances of the wing [1]. For this purpose, two fast and simple models have been developed.

The fluid model is a 3D nonlinear lifting line [2]. This extension of the Prandtl lifting line is intended to deal with non-straight kite wings, with dihedral and sweep angles variable along the span, taking into account the non-linearity of the lift coefficient. This model has been checked with 3D RANSE simulations and shows good consistency, with typical relative differences of few percent for the overall lift.

The purpose of the structure model, Kite as a Beam, is to model the kite as a succession of equivalent beams along its span. The kite is considered as an assembly of elementary cells, each one composed of a portion of the inflatable leading edge, modeled as a beam, two inflatable battens, modeled as beams of half stiffness due to cell connectivity, and the corresponding canopy, modeled as a shell. The tangent stiffnesses of the equivalent beam are finally calculated in two steps. First of all, the cell is put under pressure and then subjected to different linear displacement perturbations [3].

The validity of this fluid-structure interaction model has not been checked so far. The aim of the present study is to compare the results of this fast structure model with a more time-consuming Finite Element (FE) method.



Complex FE model with shell and beam elements (left), Kite as a Beam model (right). The color scale represents the displacement magnitude.

References:

*[1] Bosch A., Schmehl R., Tiso P., Rixen D.: Dynamic non linear aeroelastic model of a kite for power generation. AIAA Journal of Guidance, Control and Dynamics **37**(5), 1426-1436 (2014) DOI:10.2514/1.G000545*

[2] Duport C., Leroux J.-B., Roncin K., Jochum C., Parlier Y.: Comparison of 3D non-linear lifting line method calculations with 3D RANSE simulations and application to the prediction of the global loading on a cornering kite. In: Proceedings of the 15th Journées de l'Hydrodynamique, Brest, France, 22-24 Nov 2016.

[3] Solminihac A., Nême A., Duport C., Leroux J.-B., Roncin K., Jochum C., Parlier Y.: Kite as a Beam: A Fast Method to get the Flying Shape. In: Schmehl, R (eds) Airborne Wind Energy, Green Energy and Technology, Chap. 4, pp. 77-95. Springer (2017).