kiteboat project
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Structural optimization of a kite for ship propulsion

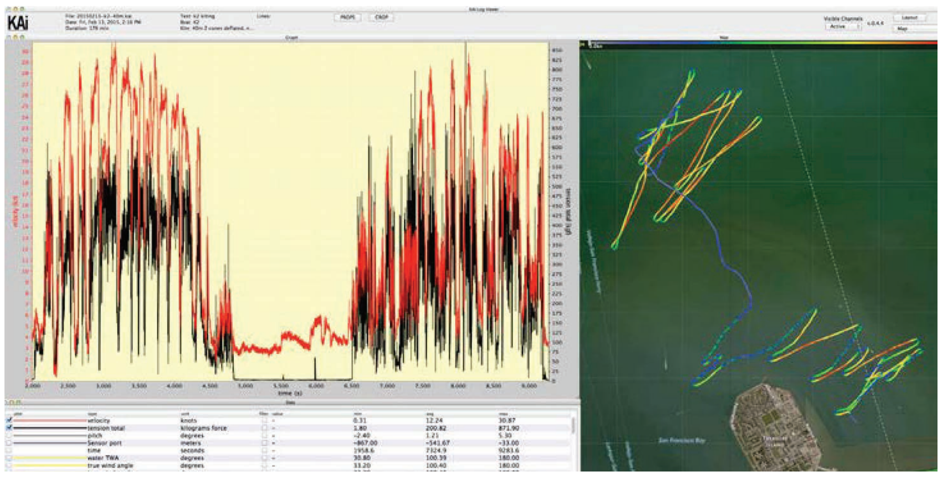
The kite boat project based in Alameda, California has the mission to design a purpose-built vessel that is specifically designed to harness kite power and to advance kite design and kite controls to the point that power-assisted or autonomously controlled kites can be used by a broad audience.

In terms of kite design, one of the big challenges is to predict the fabric stress and overall deformation of a large kitesurf kite. From tests it has become clear that the kites start to deform significantly when the total line load exceeds 5000N. This especially affects the L/D of the kite and therefore the upwind capability of the kiteboat.

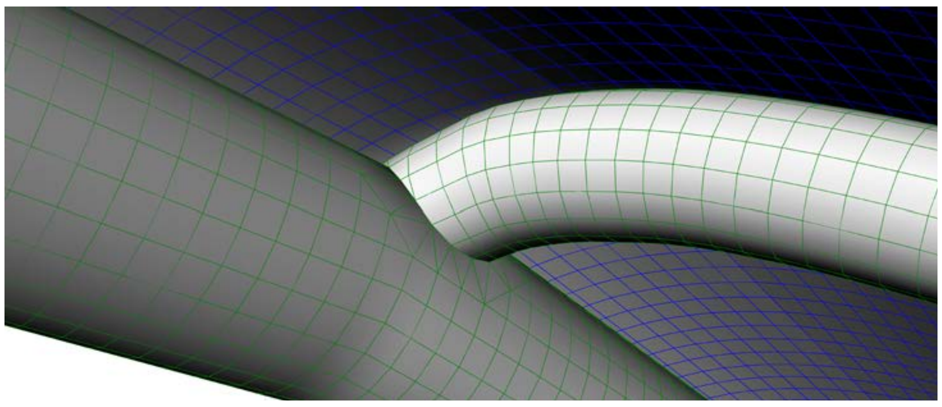
In order to evaluate the structural properties of the kite an approach is developed that uses a combination of real-time simulation, FEA and measurement data. These components interact to both validate the design process and iterate towards improved kite designs.

Description of components:

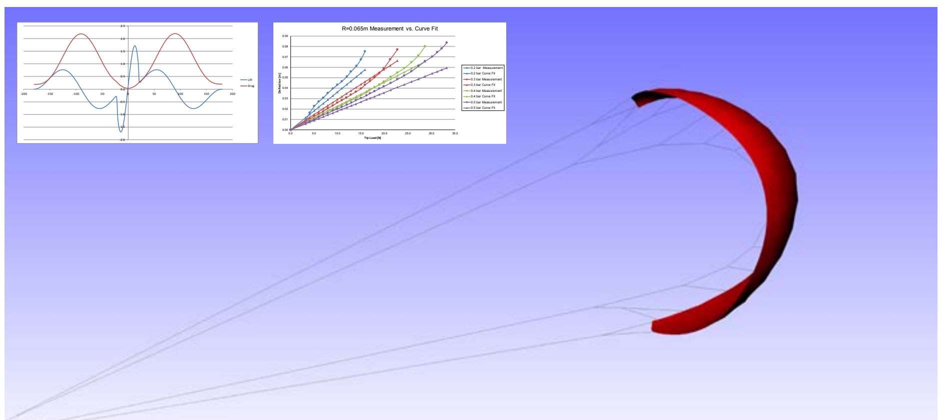
Kite Tests: On the test vessel a large number of sensors are measuring data like boat speed and course, (apparent) wind speed, line load and angle, etc. Also a number of cameras are registering kite deformation and movement.



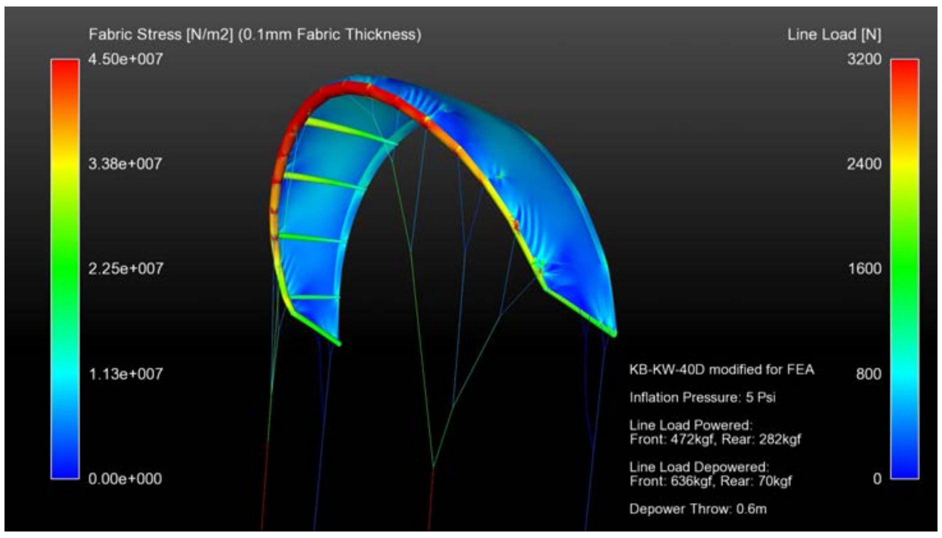
Kite Modeling Software: The software is a parameterized kite design tool but also delivers complete input files for both the real time simulator and the FEA software. A closed canopy and tube mesh, lumped mass bridle, aero forces, inflation pressure and boundary conditions are automatically regenerated after each design change.



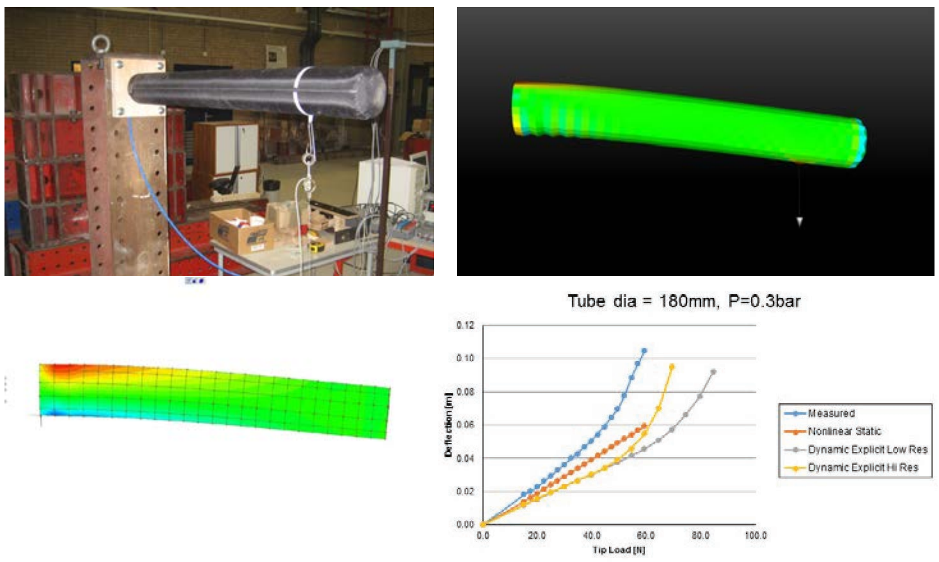
Real-time simulator: The simulation is built with a freely available physics toolkit and solver within the Rhino3D CAD software environment. The kite model is fully flexible and is built along the lines of the ADAMS model of Jeroen Breukels [1]



FEA Analysis: This is done with the open source Calculix FEA package, using a dynamic explicit solving method.



Validation
An example of the validation that has been done is to compare tube bending data from tests with FEA results, using different solving methods and grid densities. The FEA curve follows a similar trend as the measurement results, but shows a higher stiffness up until the point of buckling.



References
[1] Breukels, J.: An engineering methodology for kite design. Dissertation, Delft University of Technology (2011)

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