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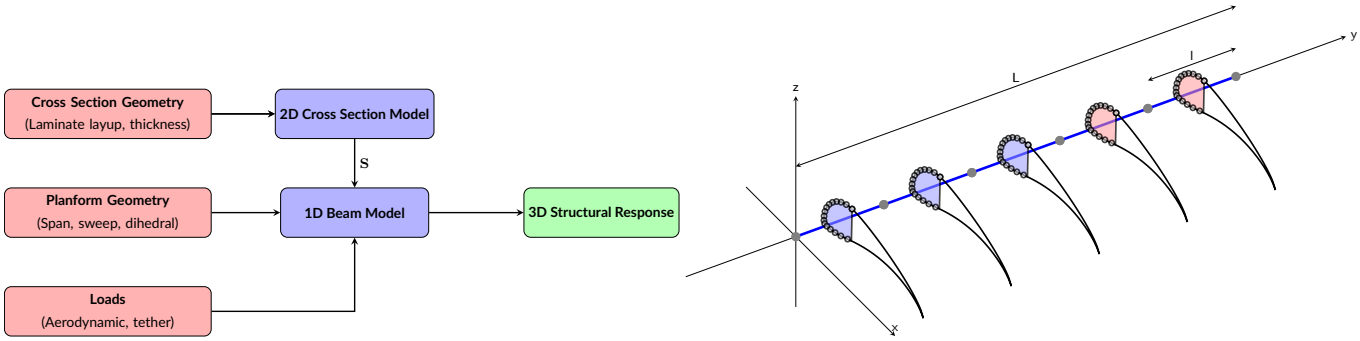
Multidisciplinary System Design, Safety and Cost Optimisation of Airborne Wind Energy Systems

In analogy to aircraft and space systems, comprehensive models for system functions and performance are required for a comprehensive system model for Airborne Wind Energy systems – especially in the fields of aerodynamics, flight-dynamics, structures, along with economics, environmental sensitivity, loads and power grid integration. The development of such a model is the focus of this PhD. This system model will then be applied to obtain designs that optimally integrate the airborne unit, avionics, bridle and tethers with the ground machinery and the electrical power system. Utilising the pre-existing technology and models, from other fields such as electrical machines, storage technology, the task at hand will focus more on specialised areas that are unique to AWE, namely the airborne unit, the bridling and tethers and the landing and launching mechanism. A part of the research is dedicated to the structural modelling of rigid composite kites, with the aim to develop reduced order models for structural optimisation of AWE kites. Complete 3D finite element analysis of such composite structures is computationally expensive, and thus uncommon for optimisation and initial design. In this research, the 3D composite shell problem is solved by determining the complete anisotropic 2D cross sectional stiffness, which is then utilised in a 1D beam analysis. This approach serves to reduce the 3D problem to a 2+1D finite elements problem which is computationally fast, while being sufficiently accurate for initial design and optimisation.



(a) 3D structural response for MDAO of composite kites (b) 2+1D reduced order representation of kite structure

Reduced order structural modelling of composite AWE kites

Research Interests

- Multidisciplinary design analysis and optimisation
- Structural modelling of slender composite members
- Shape and topology optimisation
- Reduced order models for optimisation

Project Partners

EnerKite

AWESCO Airborne Wind Energy System Modelling, Control & Optimisation

TU Delft Delft University of Technology

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