Durable Structure Reinforcement for Large Traction Kites

First Internal Research Review – ESR10 Paul Thedens

AWESCO SkySails TU Delft

About myself

- From Hamburg, Germany
- B.Sc. and M.Sc. in Aerospace Engineering at TU Delft and Technical University of Denmark
- At SkySails since November 2015
  Bernd Specht as supervisor

About SkySails

Founded in 2002 with a vision to reduce ship fuel consumption

2009

SkySails Power 55kW functional model

AWESCO SkySails TU Delft

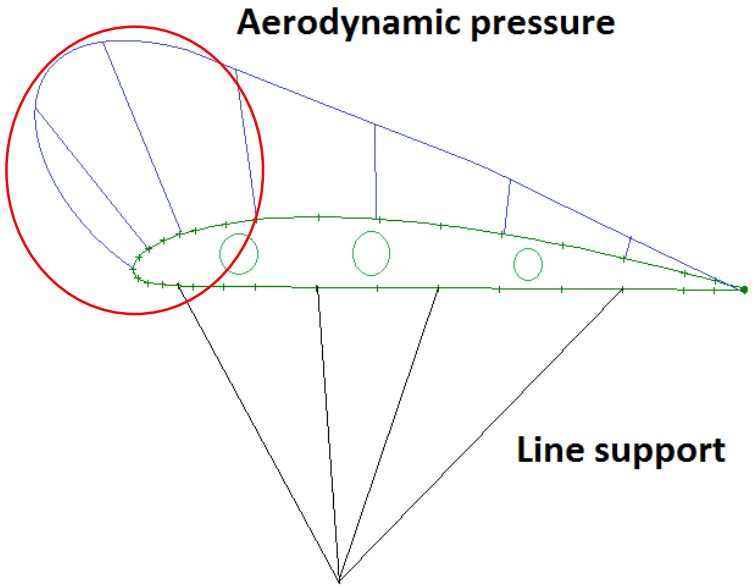
Their kites

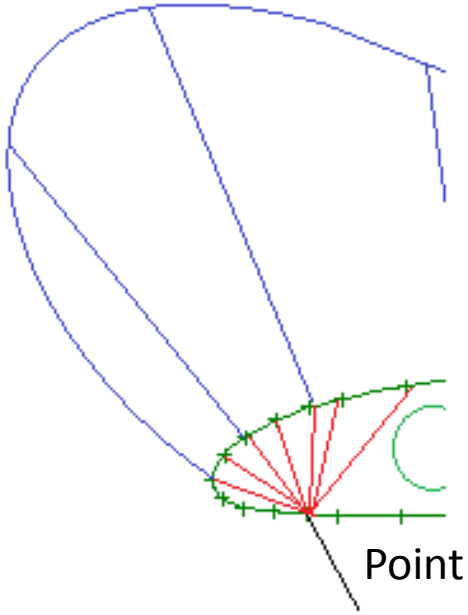
- Ram-air kites
- Surface area from 30 to 400m²

400m².... What does that mean?

Problem statement

- Larger kites are heavier → higher wind speeds required for launch
- Thinner fabrics can reduce weight





Point load of approx. **1000kg**!!!!!

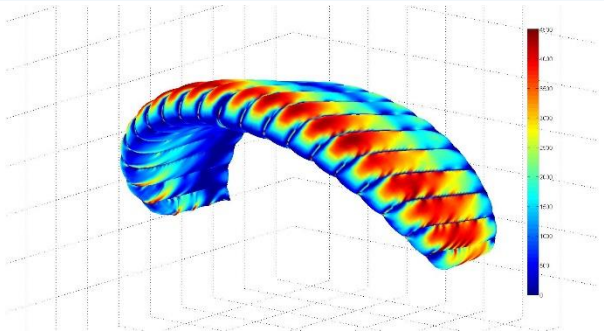
Remidy: Add reinforcements to the fabric

But how to arrange them?

Analysis of the kite

Computational Fluid Dynamics (CFD)

Input: Kite geometry
Output: Pressure



Finite Element Analysis (FEA)

Input: Pressure, Geometry
Output: Deformed geometry

For the FSI possible collaboration with TU Delft

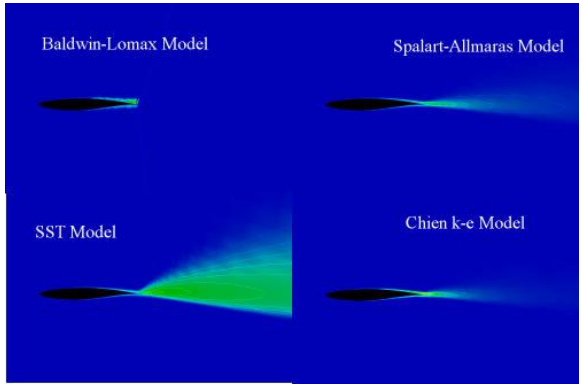
Reinforcement Optimisation

CFD

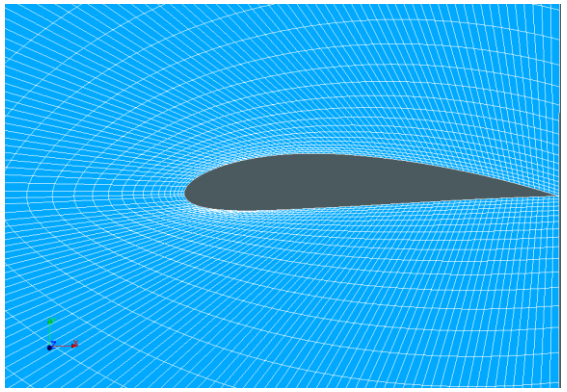
Computational Fluid Dynamics → Software: OpenFOAM → Turbulence model → Mesher

Aim: Obtain an accurate and efficient pressure approximation acting on the kite

OpenFOAM



K-omega SST

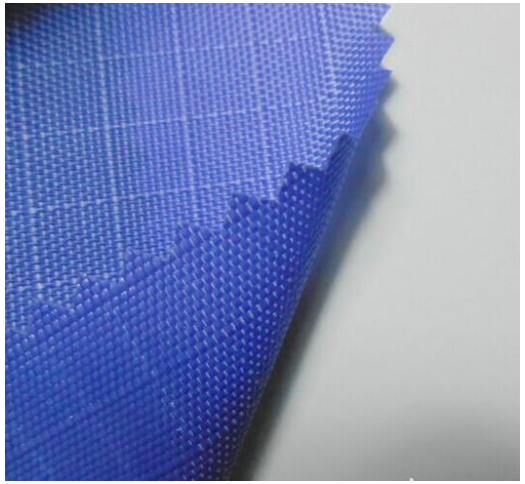


e.g. Blender or Salome

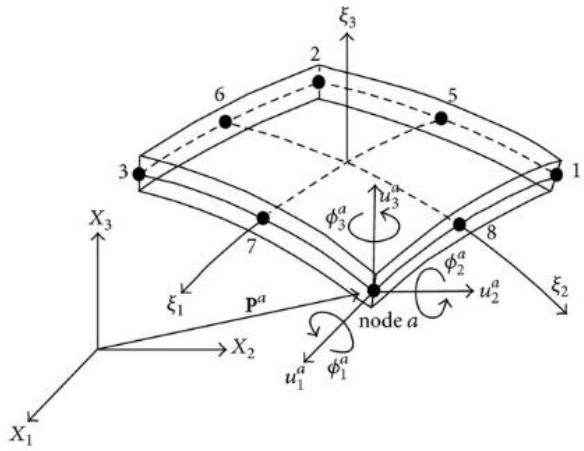
FEA of coated woven fabrics

Finite Element Analysis → Material Model → Element Type → Validation

Aim: Obtain an accurate stress approximation in the kite structure

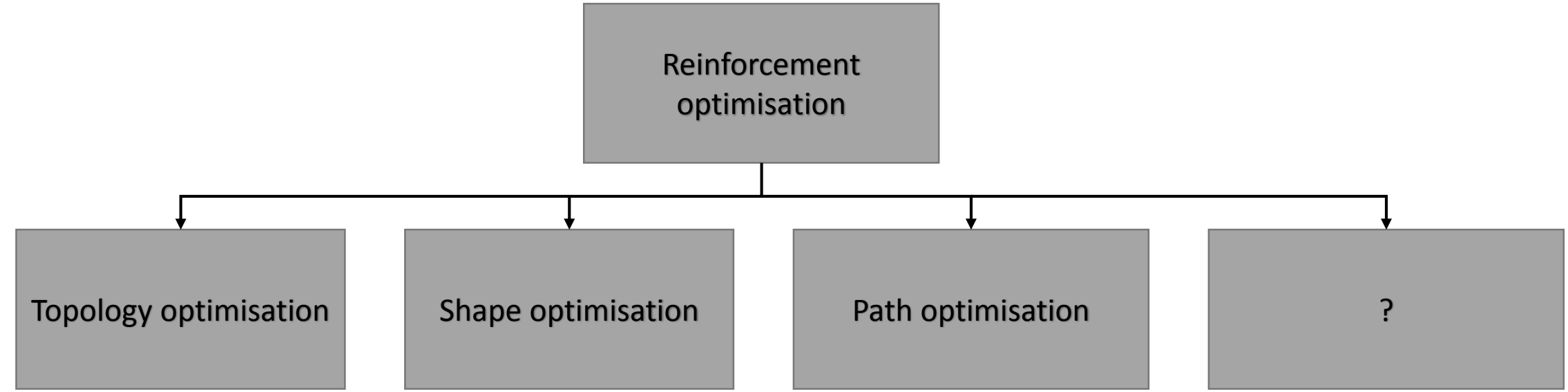


Coated woven fabric: Orthotropic non-linear material behaviour



Shell element with non-linear strain tensor to account for large displacements

Reinforcement optimisation



Progression

Literature Study

- Scaling laws of traction kites
- Membrane elements for FEA
- Material laws used for woven fabrics
- Turbulence modelling in OpenFOAM

Side Project

- FEA of force transmission point attachements of 55kW functional model

Conclusion

- Multidisciplinary approach (CFD, FEA, FSI, structure optimisation) to optimise reinforcements for weight reduction
- Possible collaboration with TU Delft
- Next steps: Implementation of FEA work package

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