Virtual Design and Simulation of Expedition Tents

Majid Hojjat, Falko Dieringer and Kai-Uwe Bletzinger

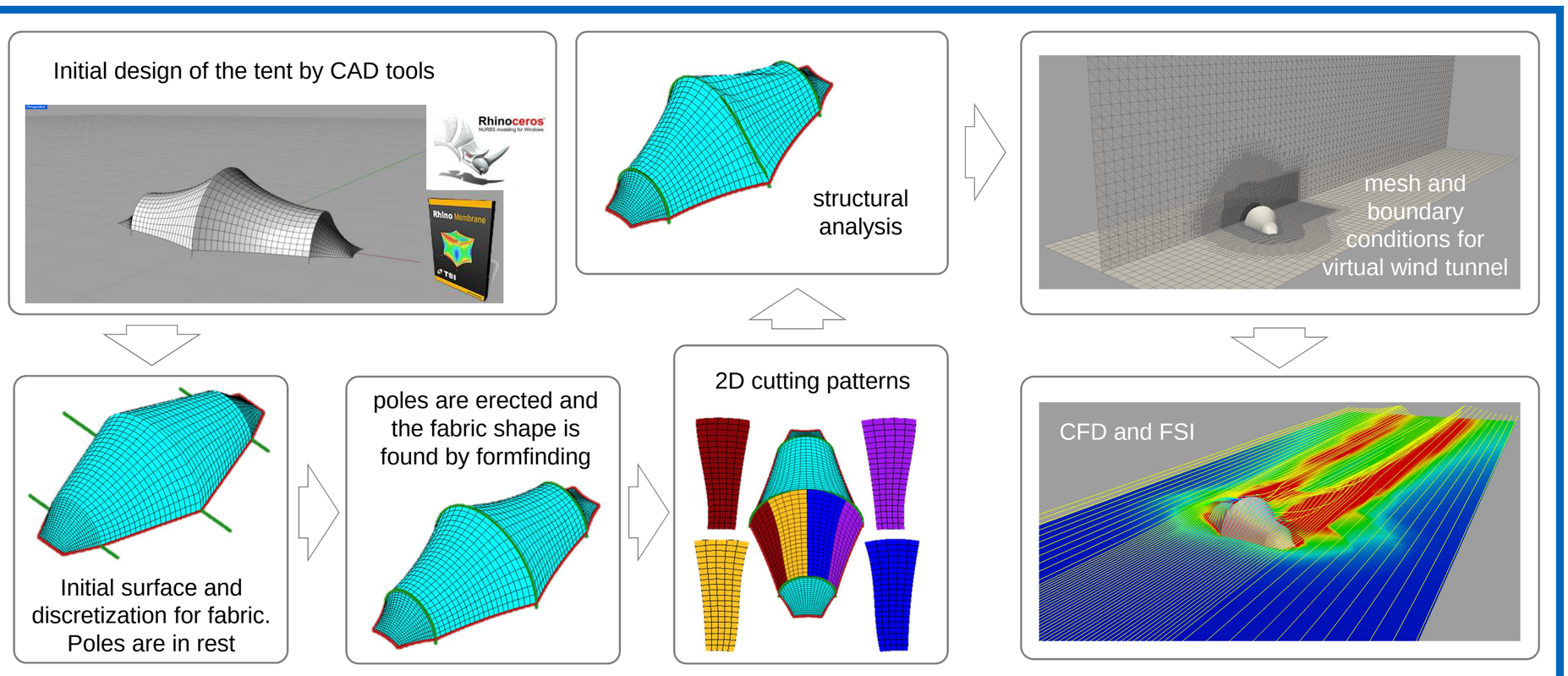
In collaboration with “Mid Sweden University”

Expedition tents are light and flexible structures which consist of two major parts, an elastic frame of poles and pieces of textile material covering the area between the poles. Experienced tent making industries have established robust and optimized design workflows for high quality tents over several years. However, these workflows often require many iterations and construction of several prototypes. This project tries to reduce the design time and cost by enhancing the workflow by numerical techniques, both in geometrical modelling and in mechanics of the tent.

Numerical workflow:

Based on the demands of customers a new tent with specific characteristics is designed by the designer in CAD software. This geometry is then used for constructing the finite element structural model as well as the wind model.

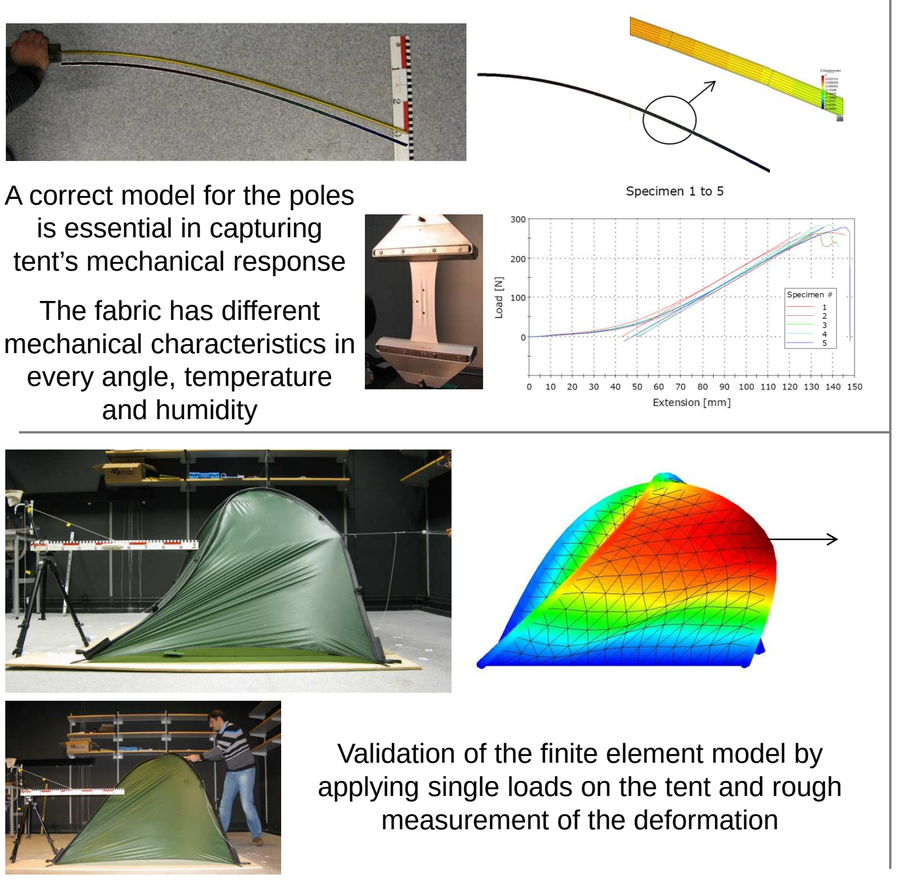
In order to assist the traditional workflows, individual modules or the whole virtual workflow can be employed.



Numerical simulation and validation:

In order to achieve an accurate model, first individual components of the tent are modelled and validated. In the next step, the structural behaviour of the tent is compared to the experiments.

CFD analysis of the wind flow around the tent helps finding the wind loads as the main load applied on the tent. These simulations are performed in different setups (steady RANS, LES, stochastic wind inlet, different angles and wind speeds, etc.) according to individual needs.



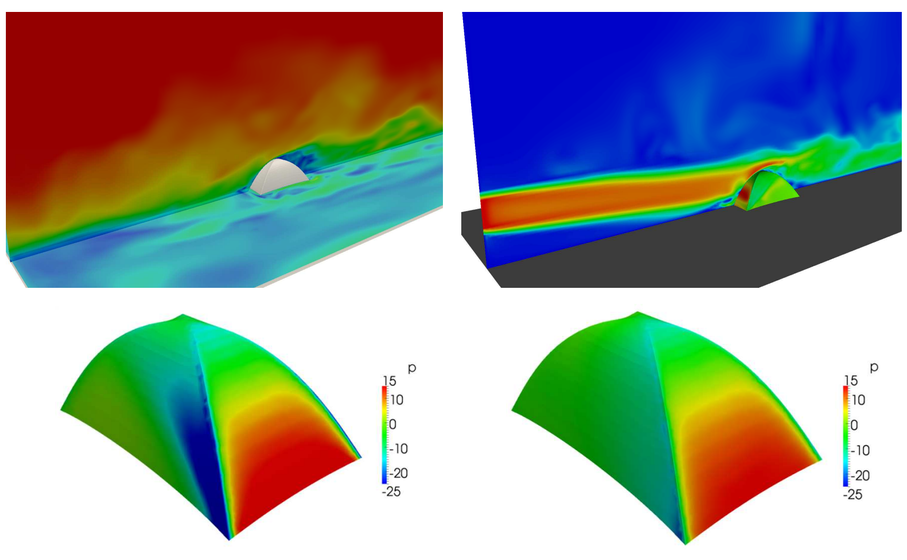
A correct model for the poles is essential in capturing tent’s mechanical response

The fabric has different mechanical characteristics in every angle, temperature and humidity

Validation of the finite element model by applying single loads on the tent and rough measurement of the deformation

First, in order to validate the workflow, a similar wind condition as in the wind test is performed

Then, loads on the tent in case of a realistic atmospheric wind with desired speed and turbulence can be calculated



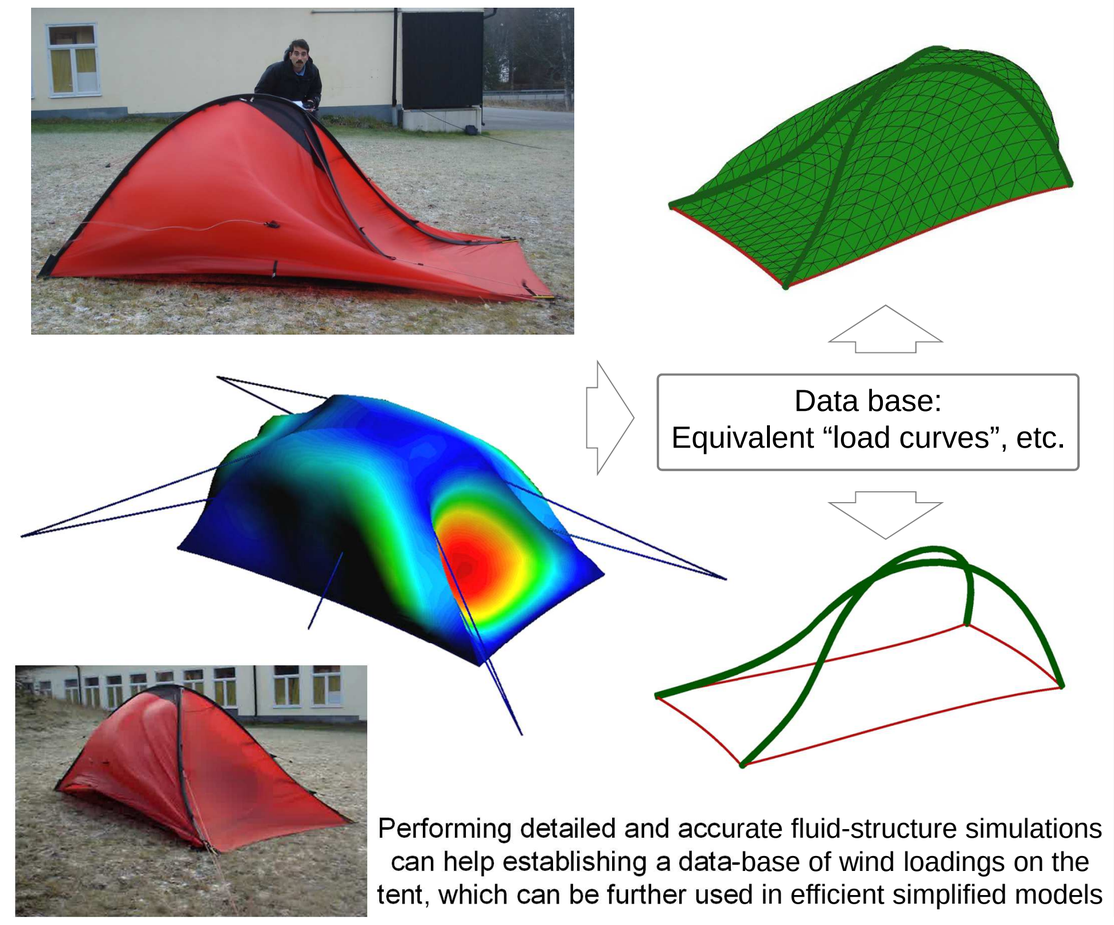
FSI simulation:

Due to the extremely low weight of the structure and its flexibility, the FSI problem is very challenging in numerical sense. Solution of such a problem requires strong and suitable coupling techniques.

In many cases, it is possible to extract and process the FSI results in order to construct an intelligent data-base for fast and efficient prediction of the wind loads.

Using the workflow:

An industrial user can easily and in a short time experience various design alternatives w.r.t geometry and structural response, as well as improving the tent design.



Performing detailed and accurate fluid-structure simulations can help establishing a data-base of wind loadings on the tent, which can be further used in efficient simplified models