

Scantling of sailing yacht mast and sail deformation simulation using Finite Elements.

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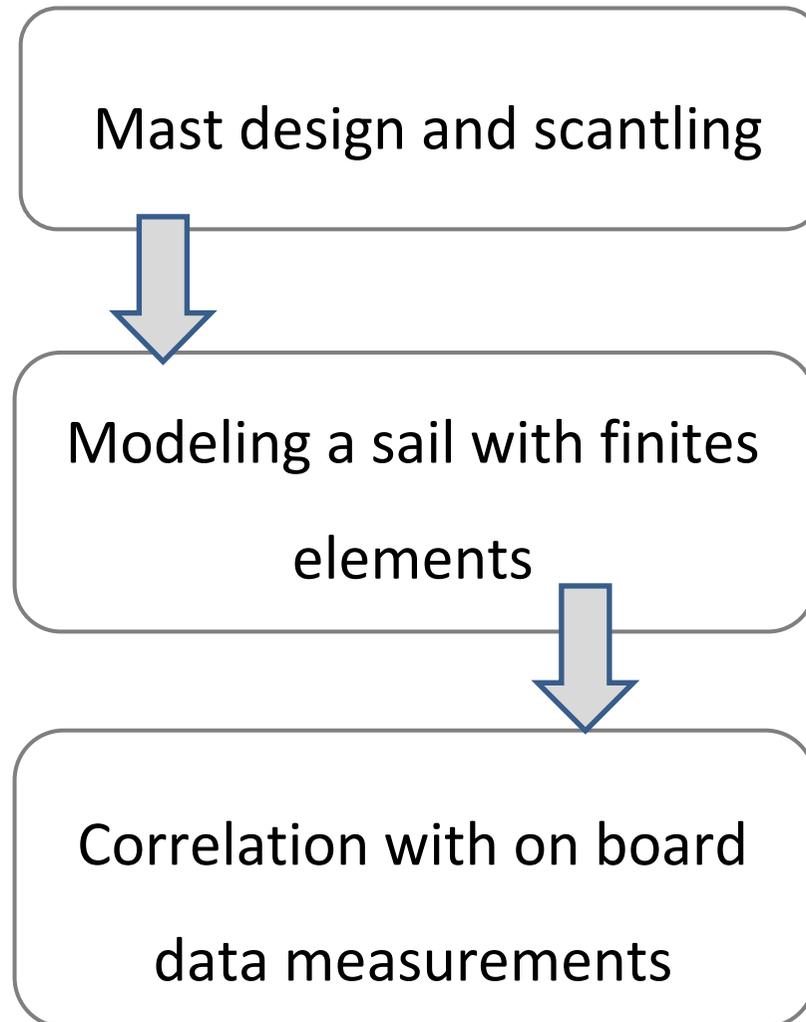
Under the supervision of Pr Dario Boote



UNIVERSITÀ DEGLI STUDI
DI GENOVA



Content



Accuracy in mast scantling

Why?



Mirabella V
Carbone mast
90m
42 T
440 T on mast base



PERINI NAVI



Salute
Aluminium mast
70m
30 T
350 T on mast base

Accuracy in mast scantling

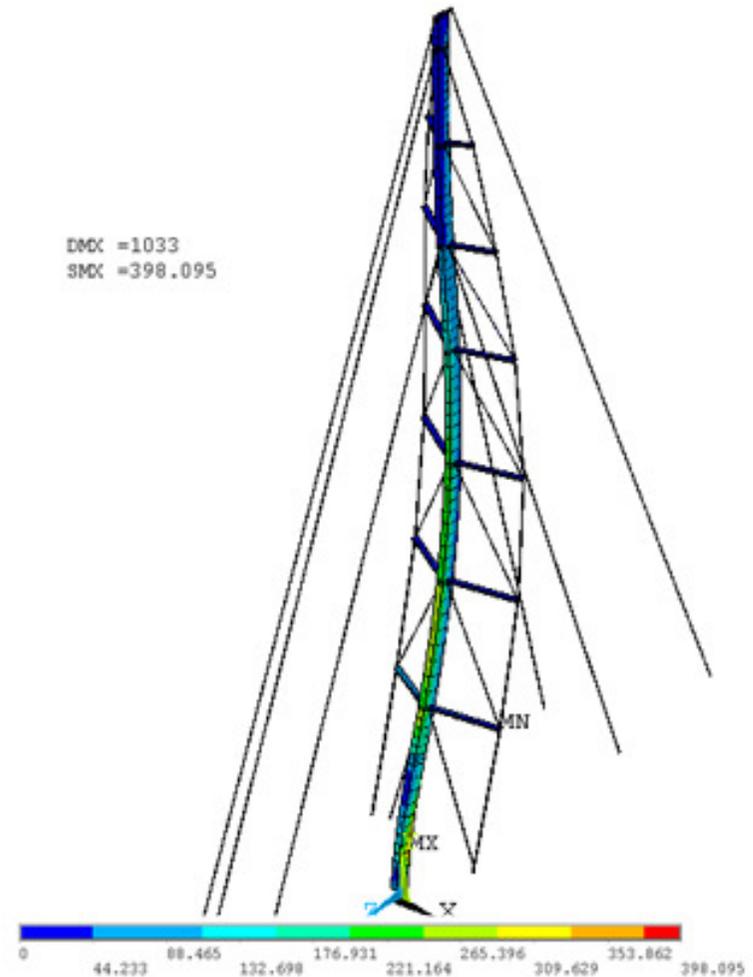
- How?

Finite Elements Analysis

3D geometrie

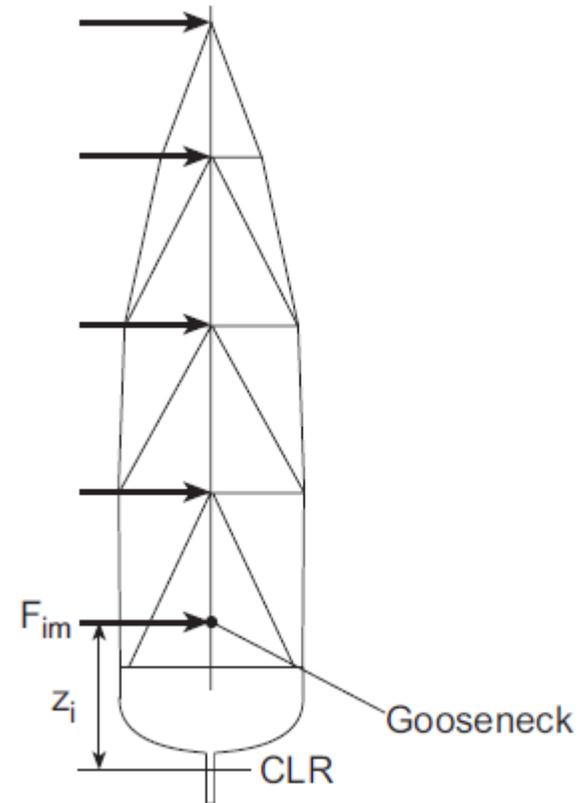
Non linear analysis

- INPUTS?



Accuracy in mast scantling

- Sail loads : rules



Modeling a sail with FE

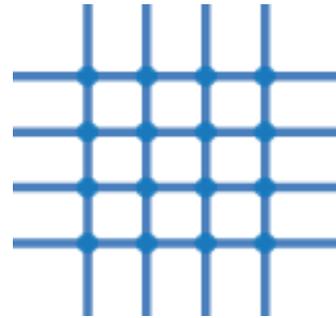
Why not modeling the sails with the mast?

How to model a sail?

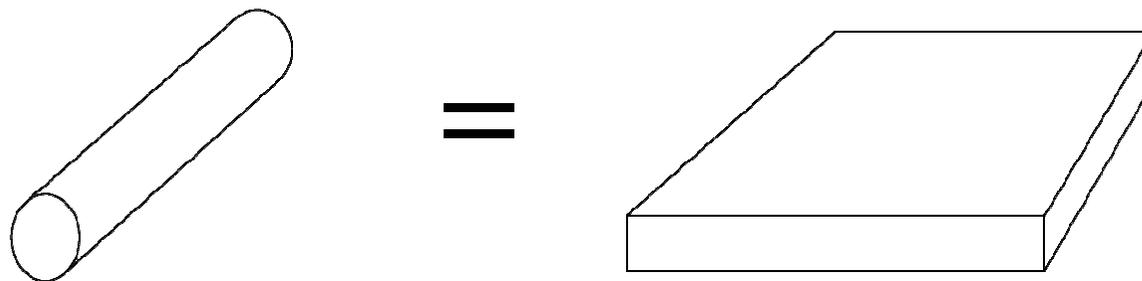
- Membrane
- Cable net

Modeling a sail with FE

- What is a cable net?

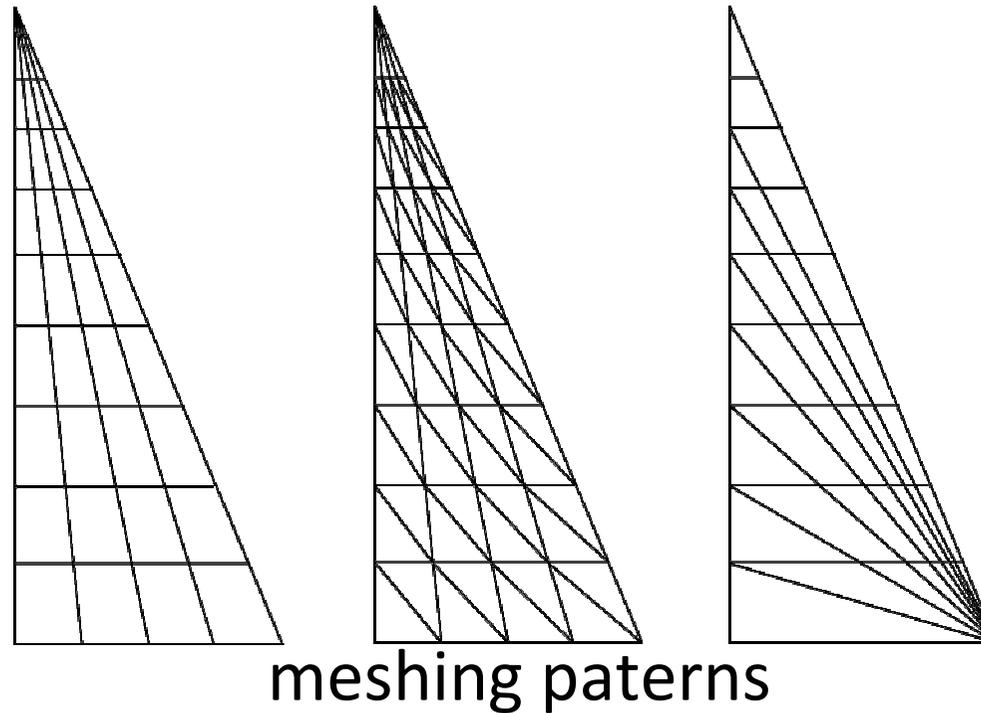


- Equivalent cross sections



Modeling a sail with FE

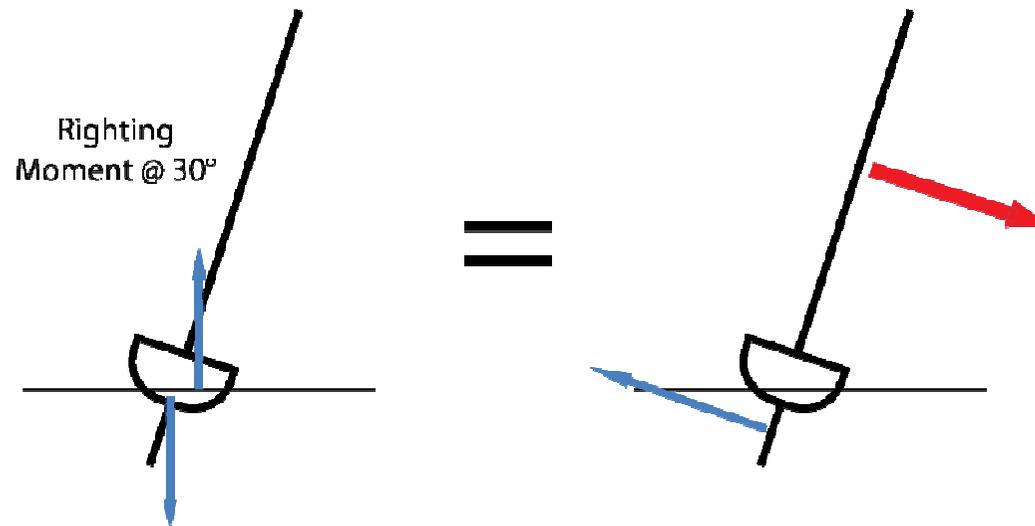
- Cable element Sails



Orientation of the elements

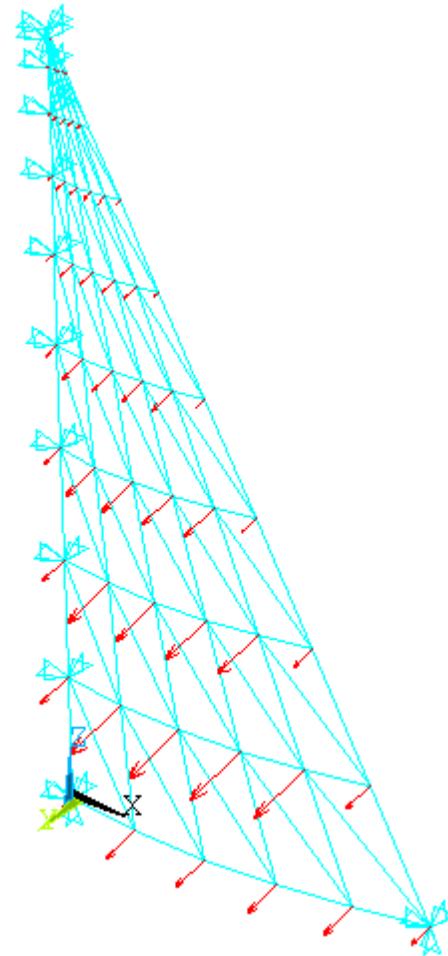
Modeling a sail with FE

- Loads
Uniform pressure
- Righting moment at 30°



Modeling a sail with FE

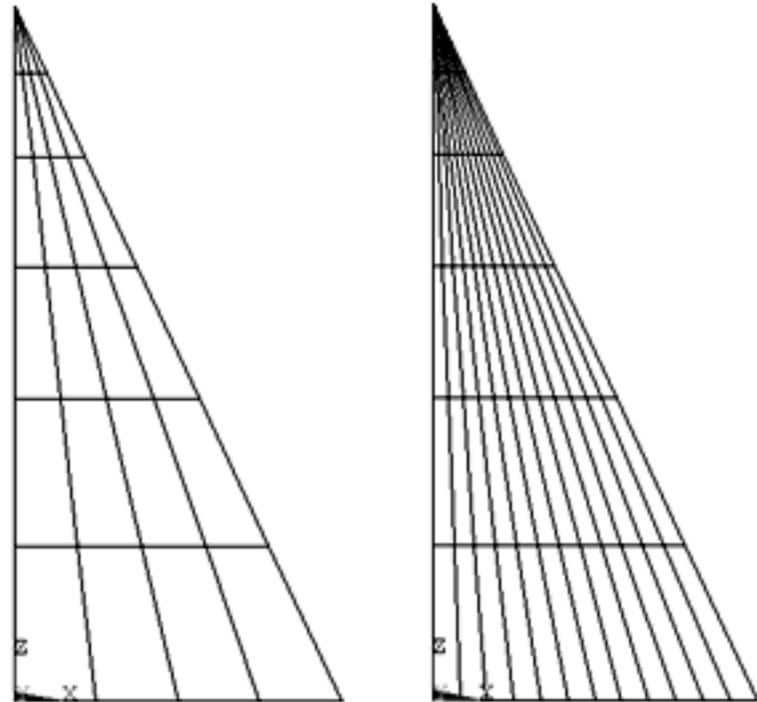
- Boundary conditions



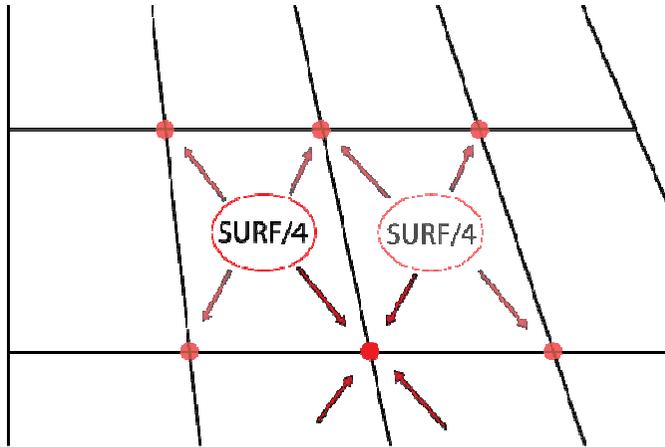
Pre-processing of Sail FE model

- Necessity of an automated computation
 - Sail dimensions
 - mesh density
 - Discretization of load and cable diameter

→ Pre processing using
Matlab

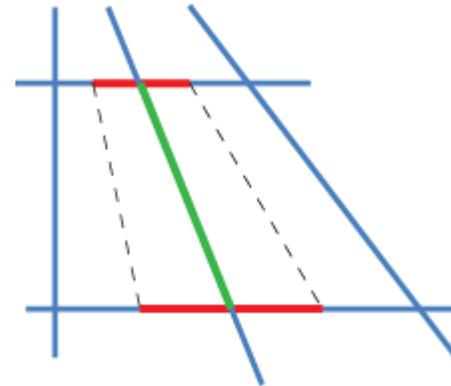


Pre-processing of Sail FE model

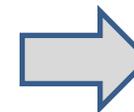
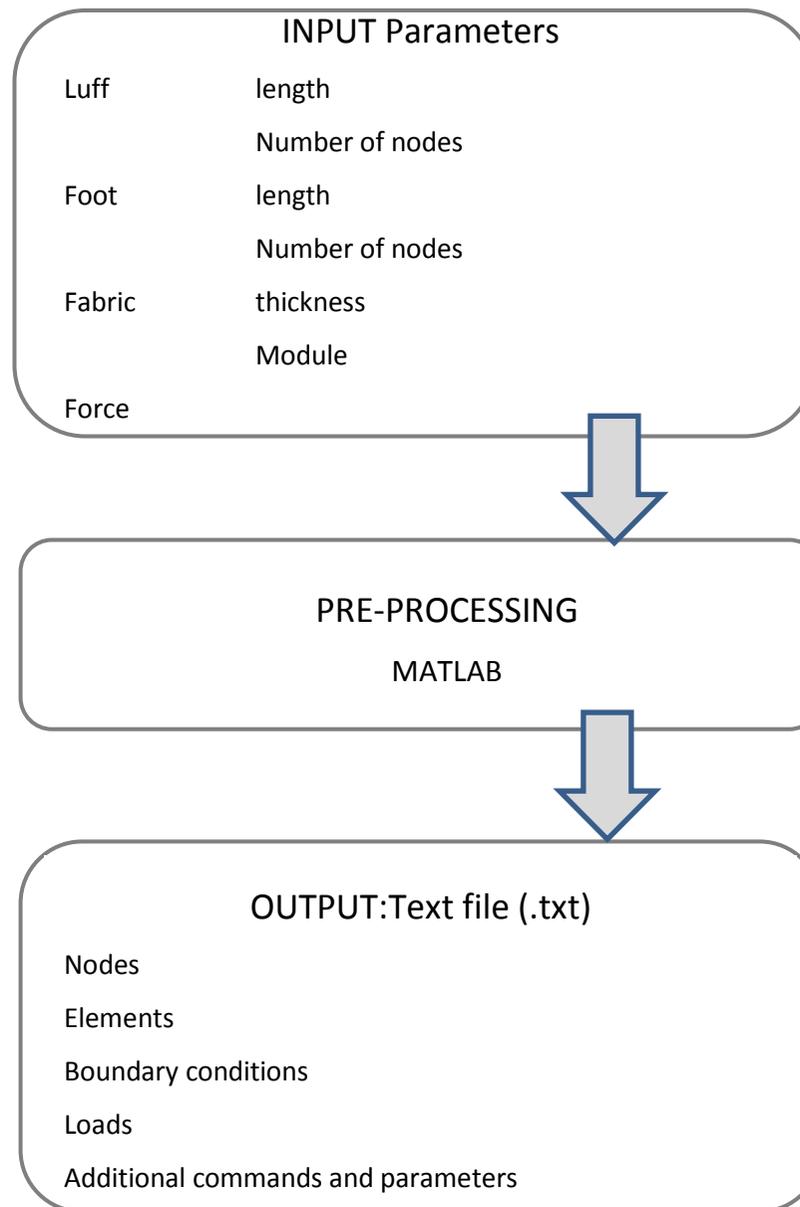


Load discretization

Cable diameter
discretization



Pre-processing of Sail FE model

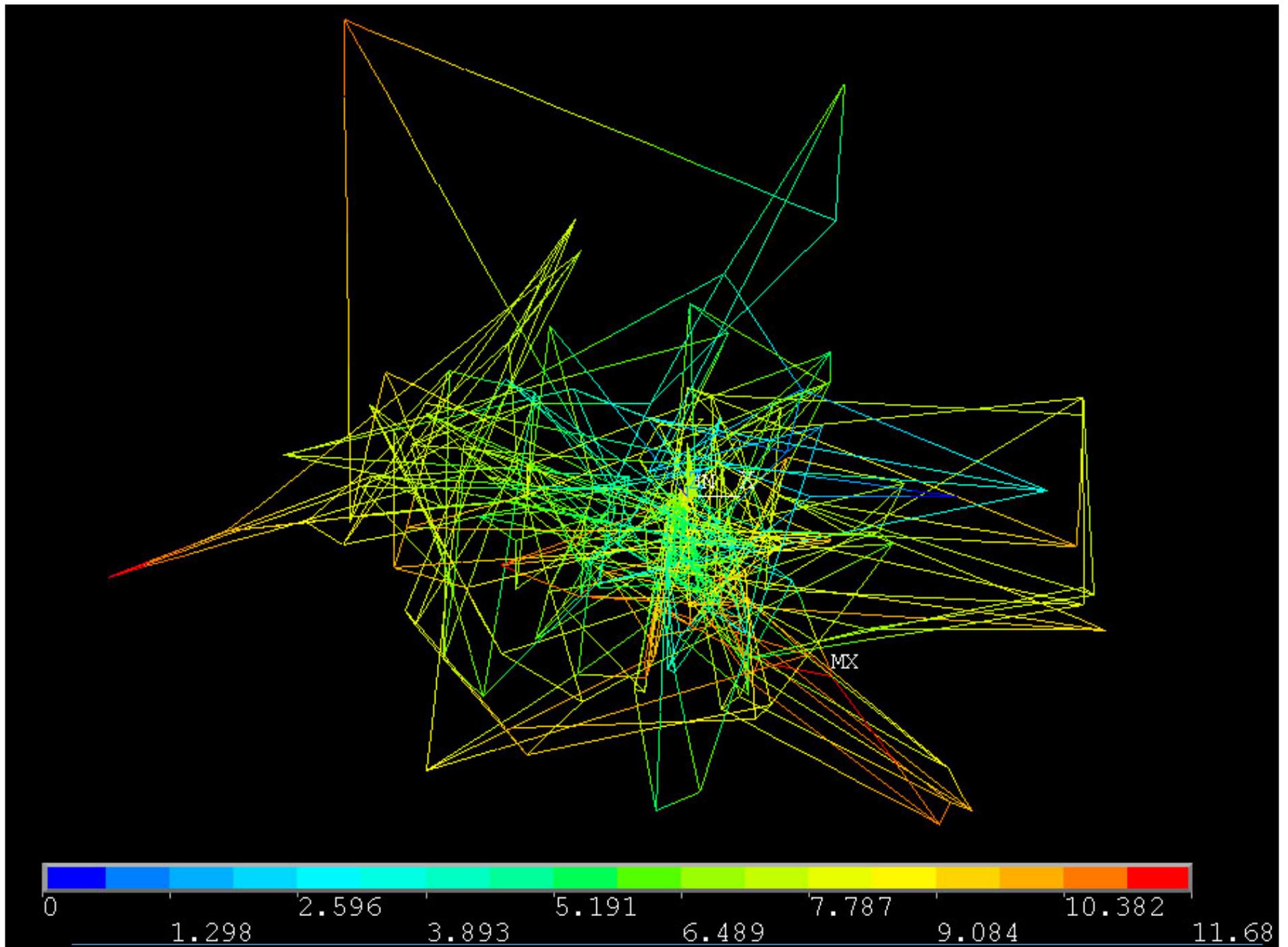


ANSYS

Sail FEA results

Preliminary results:

Problems of stability and convergence



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Sail FEA results

Stiffness of the sail in compression ?

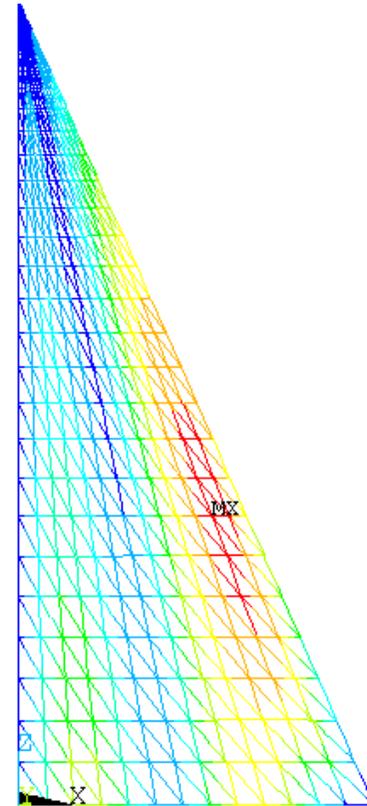
- Element type

Link 10 no compression stiffness

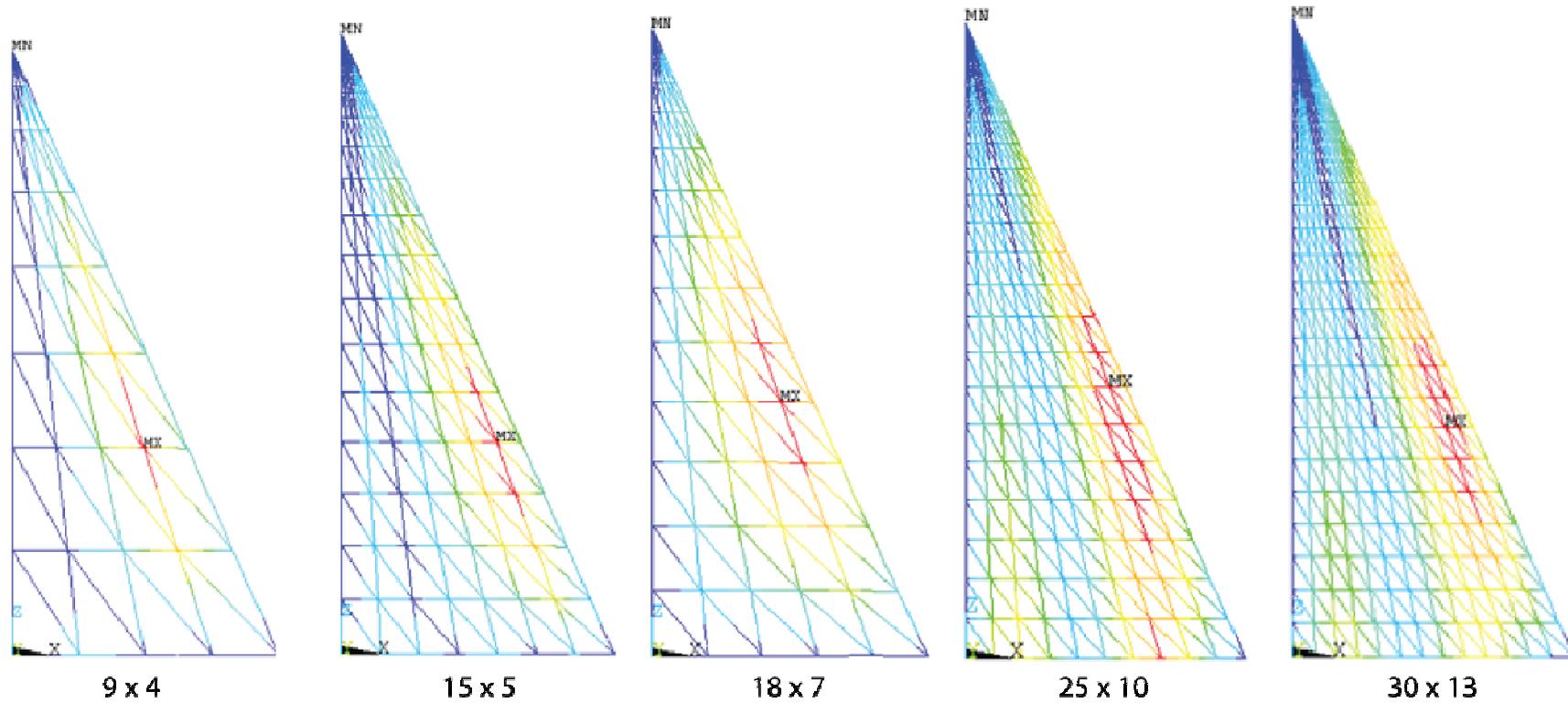
Link 8 compression stiffness

Sail FEA results

- Deformation : less than 1%
- Deformation pattern correct



Sail FEA results



Sail FEA results

- Element strain : less than 1%
- Deformation pattern correct
- Reaction loads : correct order of magnitude

Data processing

- Super sailing yacht *Riela*



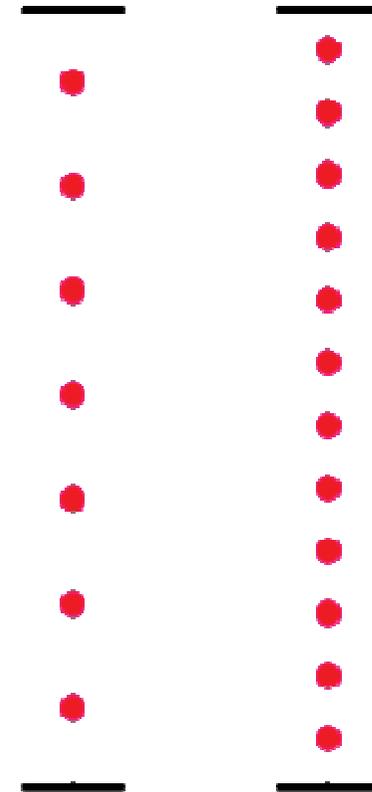
PERINI NAVI

- On board data recording system
 - Loads data (shrouds, mast base)
 - Navigation data (speed, heel angle,...)
- 2 months of recording
- Final data file 10 GB

Data processing

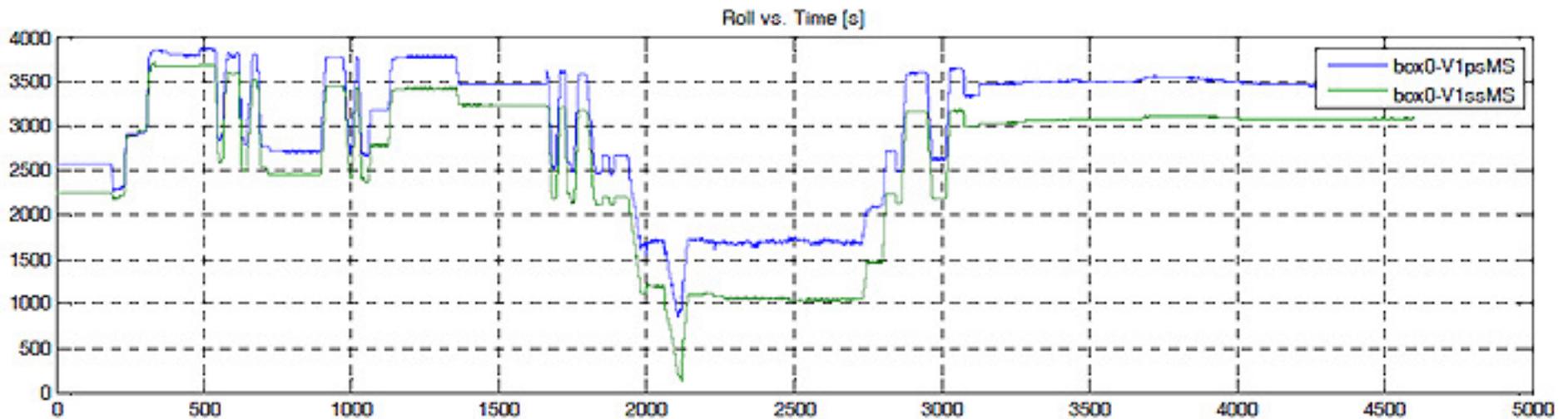
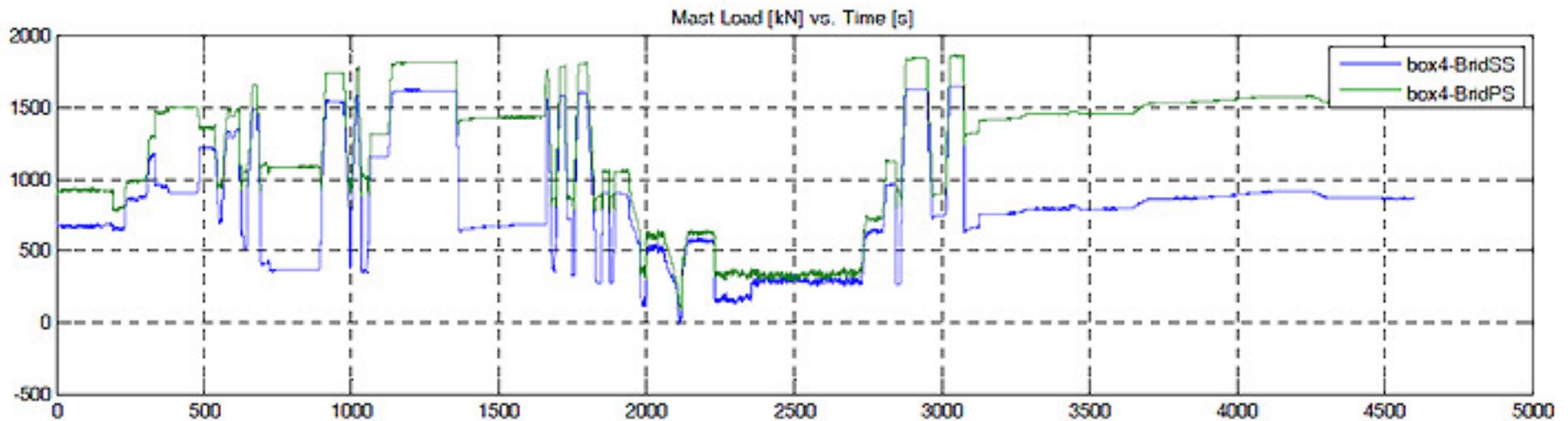
2 different recording system:

Different sampling frequencies



Necessity of a more advanced data processing

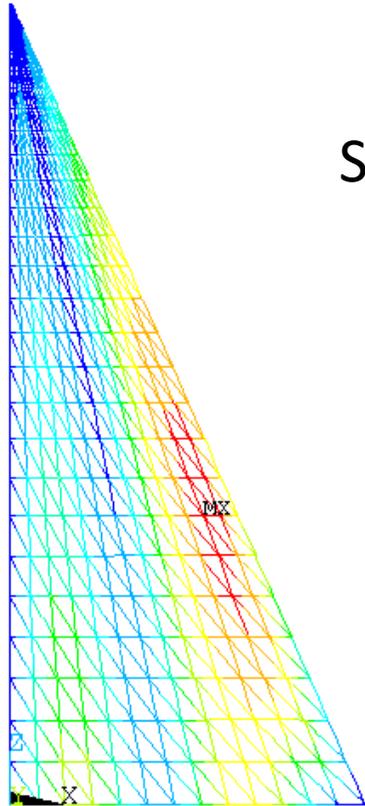
Data processing



Qualitative analysis

Scantling of sailing yacht mast and sail deformation simulation using Finite Elements.

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- Integration of the sail FEM to mast model
 - More advanced data processing and results correlation.



Scantling of sailing yacht mast and sail deformation simulation using Finite Elements.

Grazie per l'attenzione
