On a Local Study of a Fishing−net

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Introduction

Since many years, official fishing organizations need to understand the marine ecosystems and more efficient fishing–net technologies are required to improve the selectivity to preserve halieutics ressources. Computations [1] involve many numerical schemes and homogeneization methods, where a net is modelized by a macroscopic heterogeneous discrete network. For such complexe flexible structures, the local scale concerns few twines and one needs [2] to understand how static and hydrodynamic forces are distributed from one node to another.
In this work, we focus our attention to this local scale and we consider pedagogical and experimental plane assembly of few meshes made of elastic twines.

□ Package loading

□ Pictures Import

Efforts are locally applied at some nodes yielding the observation of the effective stresses configuration. We took pictures with a numerical camera of initial stress quasi free configuration (picture 1: we firstly realize a small preloading to avoid that some twines fall in a rather random way) and final stressed equilibrium state (picture 2);

Pict.1: quasi free configuration

Pict.2: loaded configuration

◻ Digitize these pictures

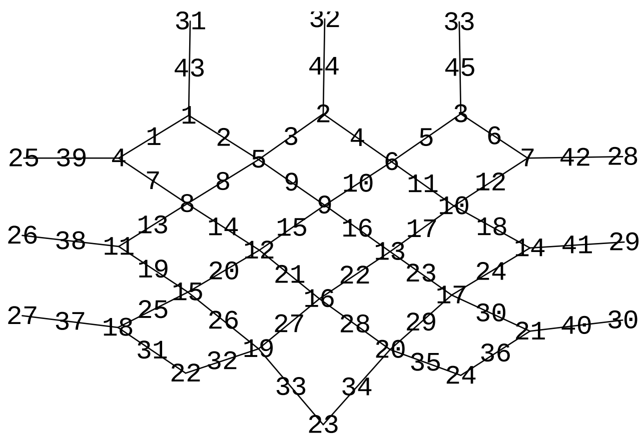
The corresponding jpg−images are digitalized to nodal−position data coded by lists of integers (pixel coordinates). For example, we   digitalize "AAphoto2.jpg" with "AAdigital2.nb".

These data (in pixel) will be converted in mm/100 ; for example, "AApixel2mm2.nb" corresponds to picture 2 (evaluate this notebook).

All acquisitions in mm/100 on picture1 and picture 2 are grouped in "AAFilets.nb " and we define the geometry :
filet1→ indiceinitial=1, filet2→indicefinal=2, 45twines, 33nodes   (evaluate this notenook) .

First, let us give numbers to each twine and node; acquisition of picture 2 becomes:

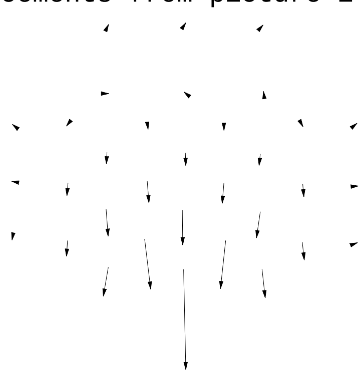
Picture 2: Twines & Nodes



◻ Displacement and twine−extension fields

Substractions between "Filet[2]" and "Filet[1]" (e.g lists corresponding to fishing−net 2 and 1) yield pictures of the corresponding displacement and twine−extension fields, from the free configuration to the loaded one (the so−called kinematical experimental view). Nodal displacements are represented by arrow−vectors

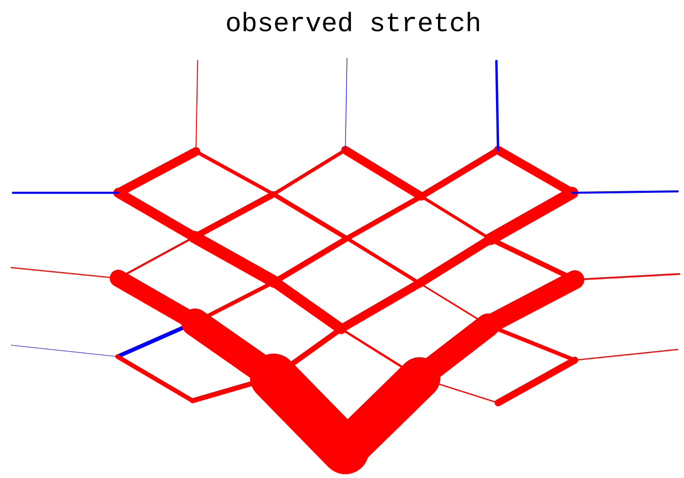
nodal displacements from picture 1 to picture 2

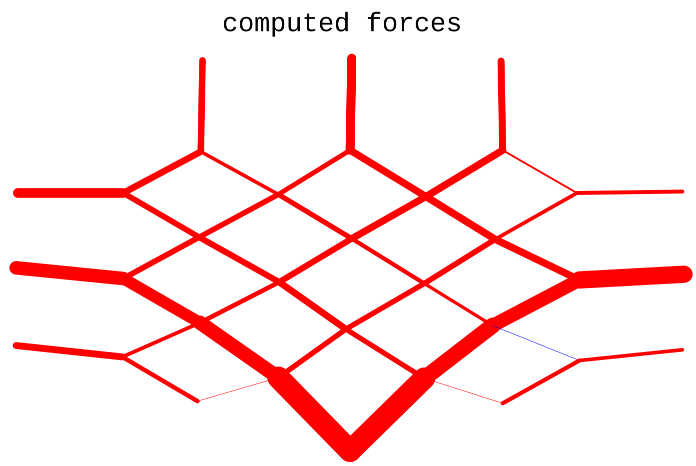


◻ Forces

The net is then assumed to be a planar truss loaded in its own plane, twines stand for weightless beams assembled by means off ball–and–socket joints and the loading is due entirely to concentrated forces applied at the joints. Given the position of each node for the stressed state, we use the well–known [3] algebraic solution called "method of joints" to compute the force supported by each twine (the so called static computed view).
Let us calculate the force supported by each twine; we assume the assembly we have done is an isostatic meshing (evaluate " AAAFilet_treillis.nb")

We establish that the experimental and computed views are similar for moderate loading, e.g. when twines behaviour remains roughly in the linear elastic domain:
– see the configuration of observed length–stretchs of the twines from picture 1 to picture 2 (the thickness is proportionnal to the lenght–increment)
– and compare with the configuration of calculated tensile–forces in the twines from picture 1 to picture 2 (the thickness is proportionnal to the tensile–force in each twine)

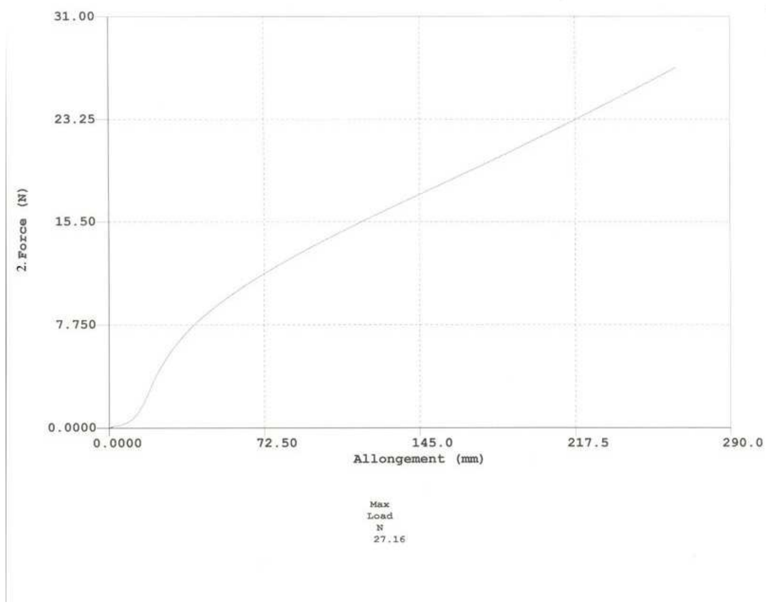




don't look at twines N° 37–>45 : they correspond to the rigid small rods linking the fishing–net to the support

Traction experiments were performed using a EZ 20 Loyd traction−machine, the sample used was constituted with two parallel twines. Below, experimental data suggest a non linear elasticity.

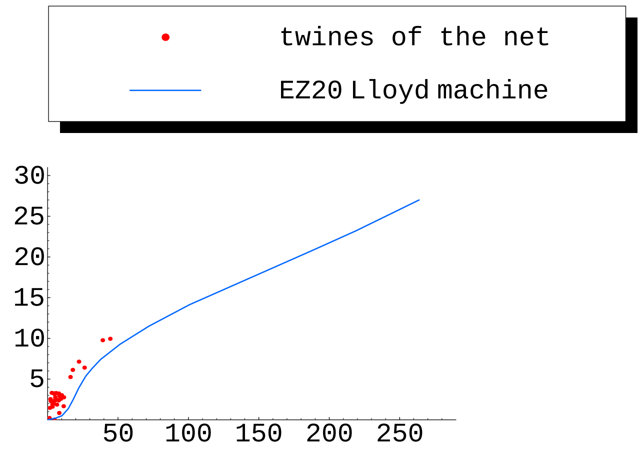
Picture 3: non linear behavior



Via the notebook "AAElasticiteNonLineaire.nb" (check the command: NotebookOpen[ToFileName[setdirectory,"AAElasticiteNonLineaire.nb"]]) we have digitalized the above experimental non−linear curve to obtain a list of data (evaluate the cell called "DIN").

□ Conclusion

We have shown that the computed view is similar to the observed experimental view.
Consequently, below, for each twine of the net (e.g. the red points) , we can correlate the observed− stretch (horizontal axis) with the corresponding computed force (vertical axis) and compare with the stretch due to the Lloyd machine (blue line).
The difference of level between red points and blue line is due to the preloading of the net, we see that some twines approach the second stage of this non−linear behavior.



Analyses with various and moderate loading–conditions are in progress and give good results with respect to this classical elastic–static model: let us note that we have to take care in this assembly to joints from twine to twine (how to make knots) and to joints from twine to the support (to ensure isostaticity) .
Digitital image processing and computations used *Mathematica* [4].
This basic apparatus constitutes a pedagogical way to work with elementary notions of mechanics and may also introduce a future study of more complex hydrodynamical systems
(3D geometry + hydrodynamic–forces along the twine) associated with non–linear models.

□ References and acknowledgements

[1] H. Le Dret, R. Lewandowski, D. Priour, F. Chagneau, *Numerical Simulation of a Cod End Net. Part 1: Equilibrium in a Uniform Flow*, Journal of Elasticity, Vol 76, pp. 139–162, 2004.
[2] Rapport final– Contrat IFREMER 2003, N° 2 2 2030299 France.
[3] J. Salençon, , Handbook of continuum mechanics : general concepts : thermoelasticity Berlin : Springer , 2001.
[4] S.Wolfram, *The Mathematica Book*, 5th ed., Champaign/Cambridge: Wolfram Media, Inc./Cambridge University Press, 2003.

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