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Institut de Recherche Dupuy de Lôme
CNRS FRE 3744

EUROMECH 29/09/2019

Characterization of the long-term mechanical behavior and the durability of polyamide mooring ropes for floating wind turbines

ANR-10-IEED-0006-16

BEXCO

BUREAU VERITAS

FRANCE ENERGIES MARINES

NAVAL ENERGIES

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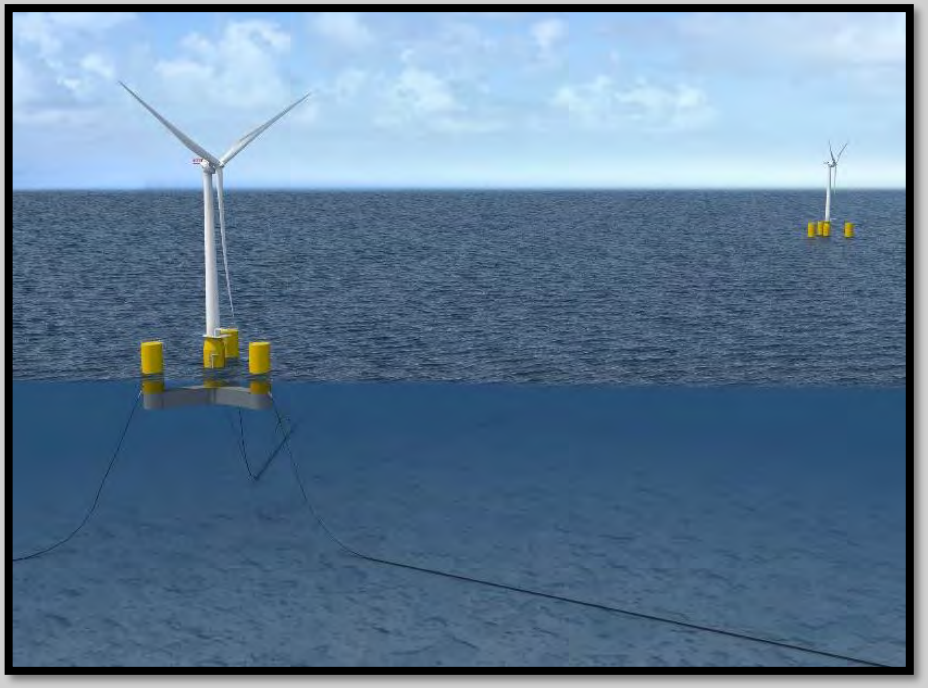
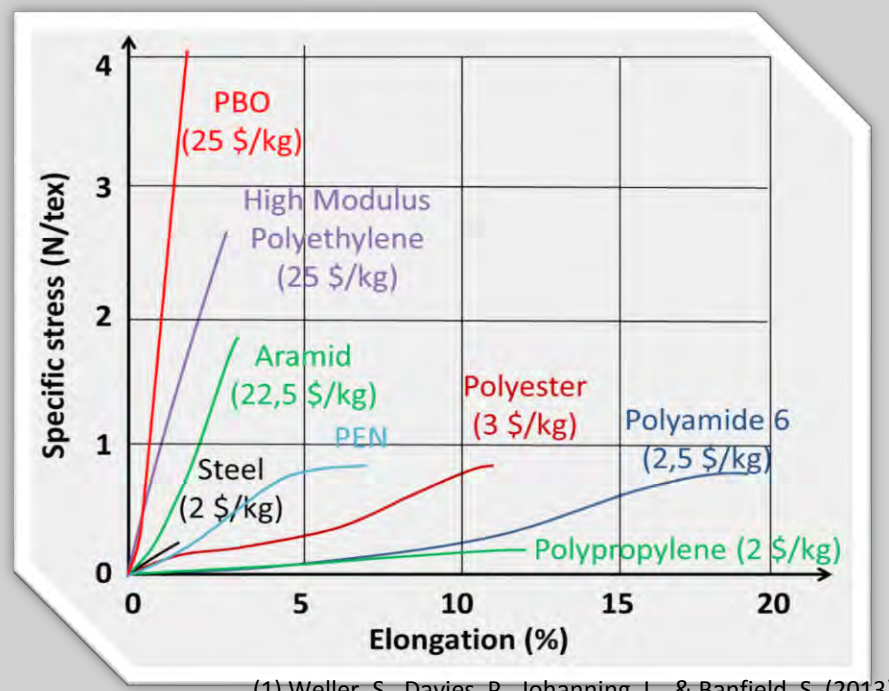
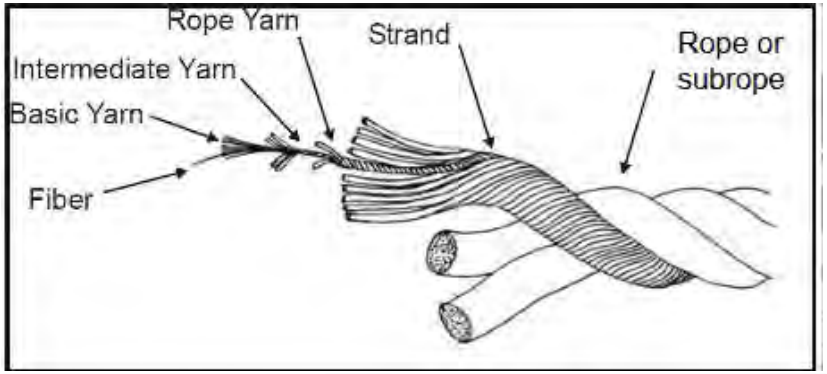
Is Polyamide 6 usable for permanent mooring?

Potentially an ideal solution





(1) Weller, S., Davies, P., Johanning, L., & Banfield, S. (2013).



Issues for polyamide 6 permanent mooring?

Complex behavior

- Design software for floating wind turbine modeling => elastic laws for PA6.
  - However comportment very elasto-visco-plastic.
- Predict the tension and effect of loading history => characterization.

Long term behavior

- Very costly to re-tensioning the rope.
- Effect of creep on this rope for long term creep unknown.
- Creep study of one year.

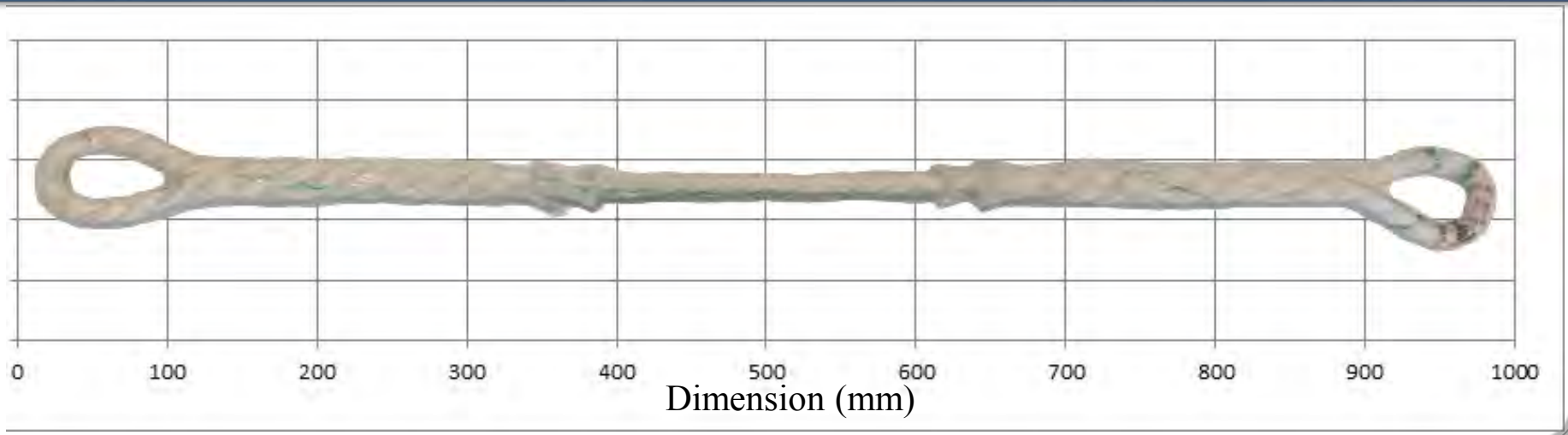
Fatigue data

- Early studies -> very short fatigue lifetimes (1).
- A few recent data for TTI -> indicate better fatigue performance (2).
- To validate on different rope -> Standard fatigue testing.

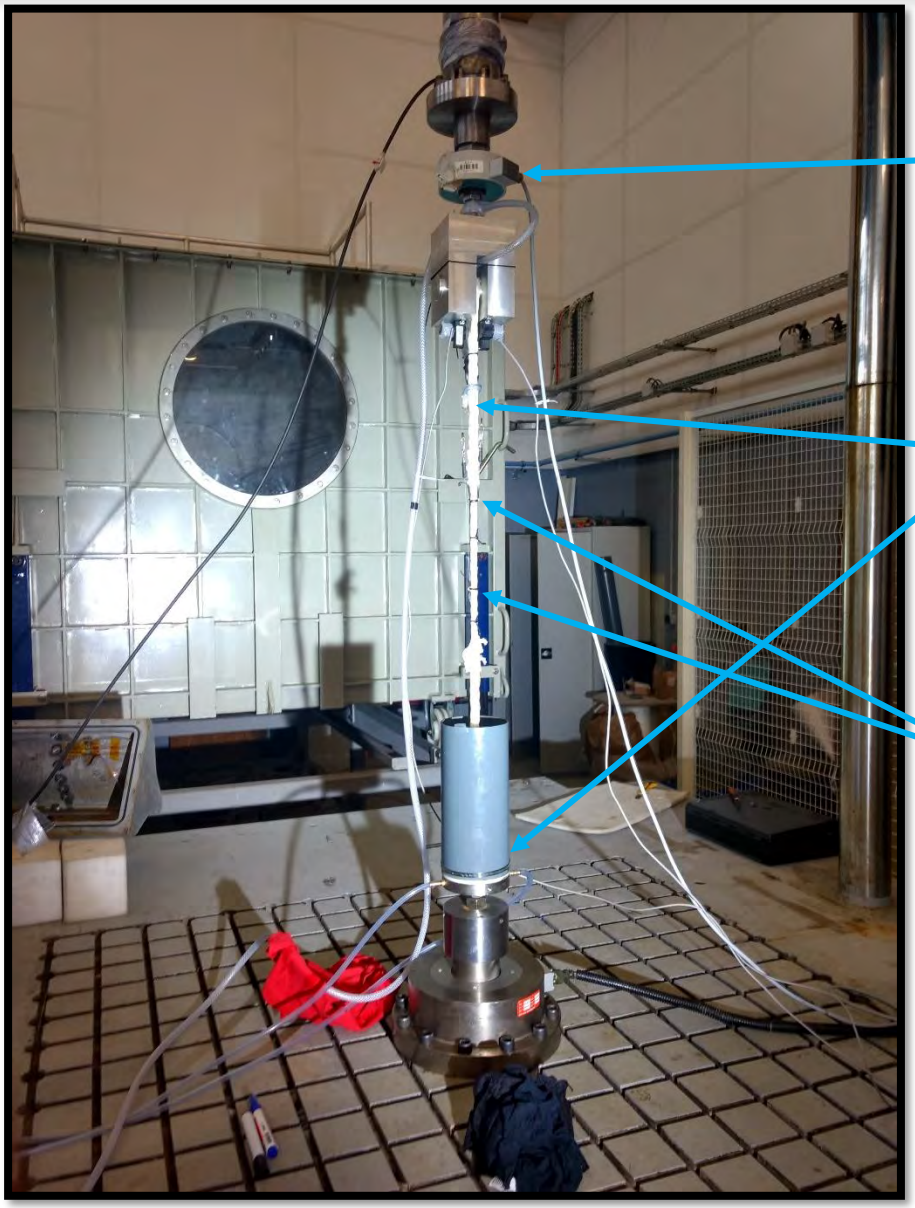
(1) Kenney, M. C., Mandell, J. F., & McGarry, F. J. (1985).
(2) Ridge, I. M. L., Banfield, S. J., & Mackay, J. (2010).

Specimen difficulties ?

Length		
Termination	Lay length	Termination



How the characterization tests are done?



Load sensor

Water system

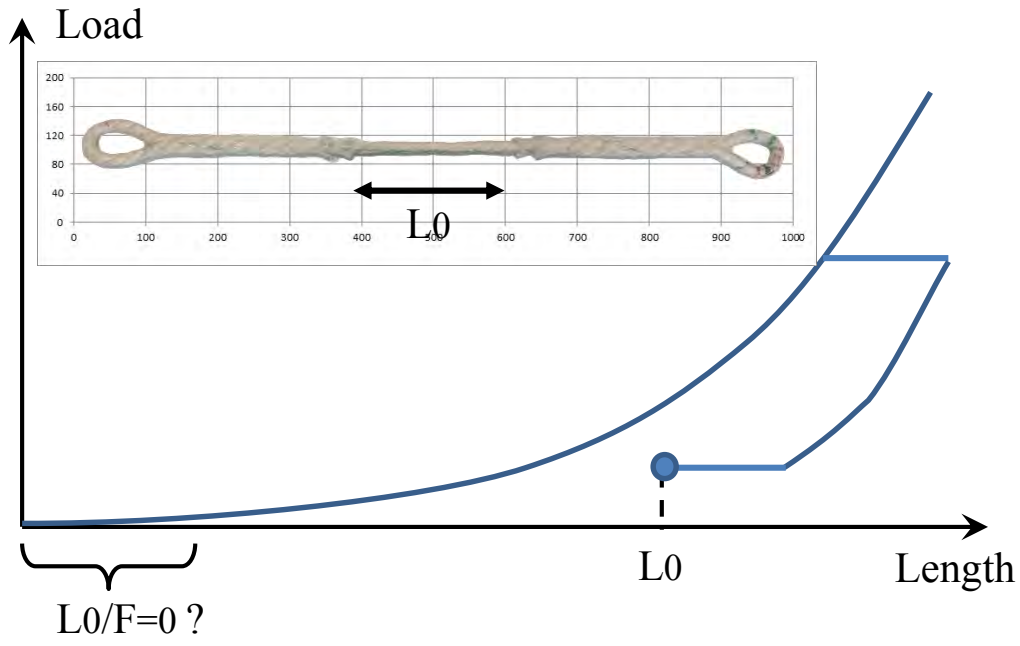
Wire sensor system

Camera

Reference length for tests ?

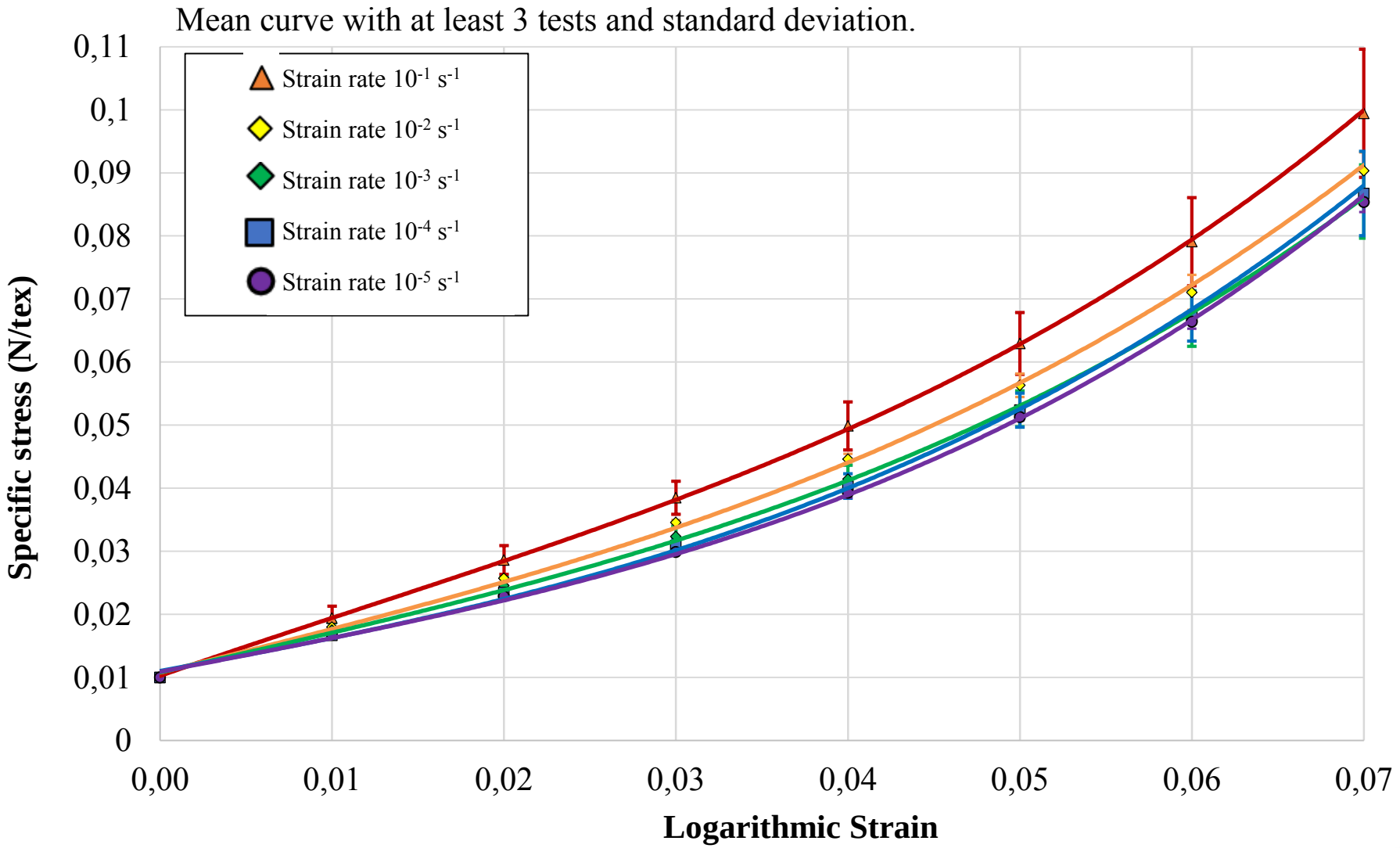
Bedding in (pre-stretching)

- Procedure used with synthetic mooring system.
- Two objectives:
  - Set up the rope structure and behavior.
  - Stabilize the length of the rope under tension, to reduce re-tensioning operation.
- Reference point for the strain equal 0% after our bedding in.

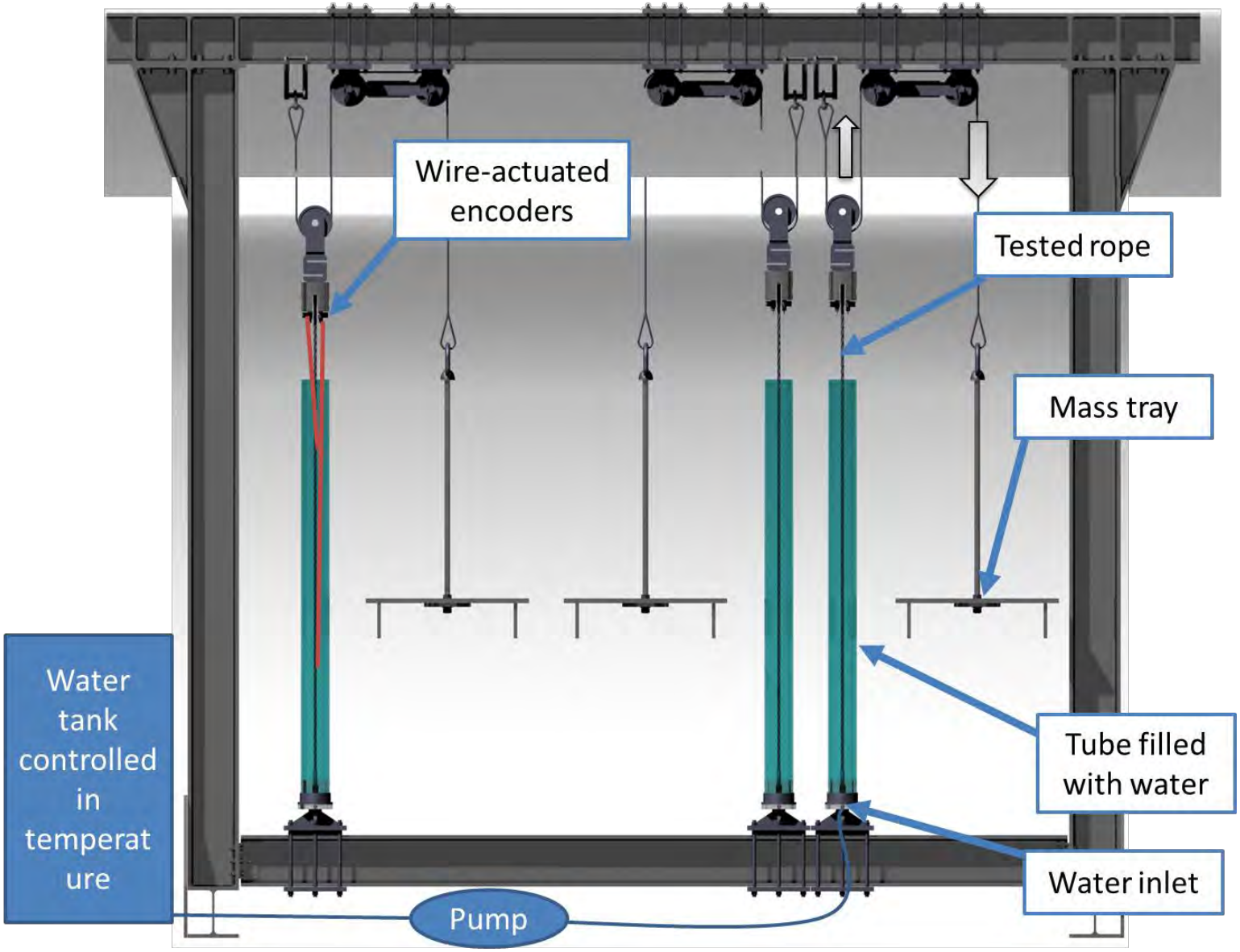


Sensitivity of stress to strain rate ?

- Illustration on monotonous tensile tests at different strain rate

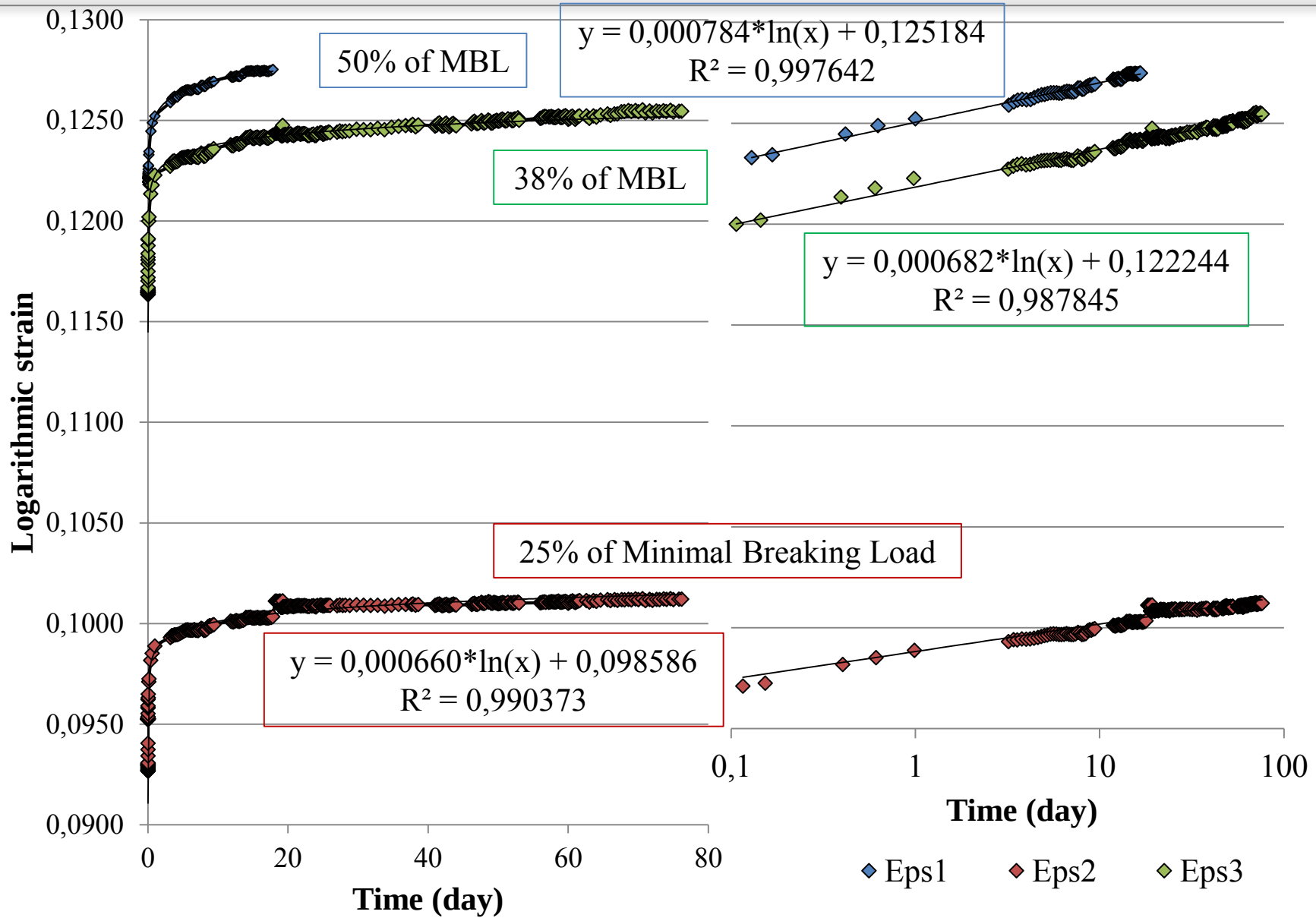


How to get long term creep data on rope?



How to get long term creep data on rope?

Evolution of strain rate in time ? Stabilization ?



Standard fatigue test protocol

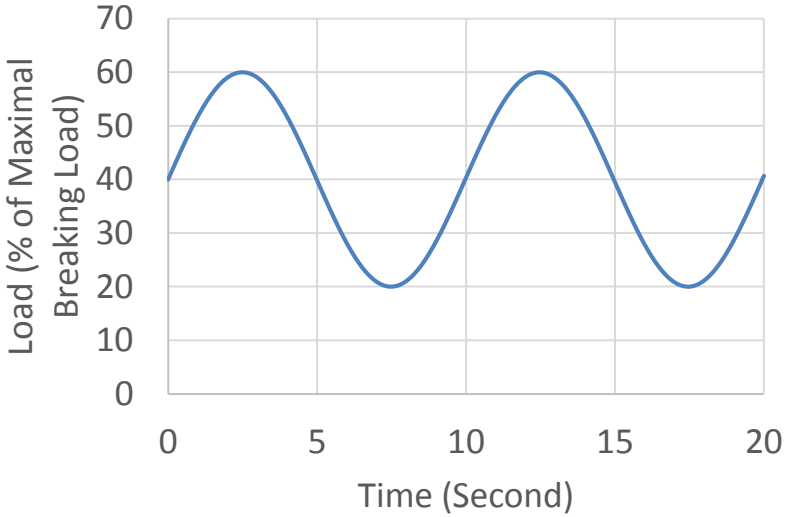
(1)

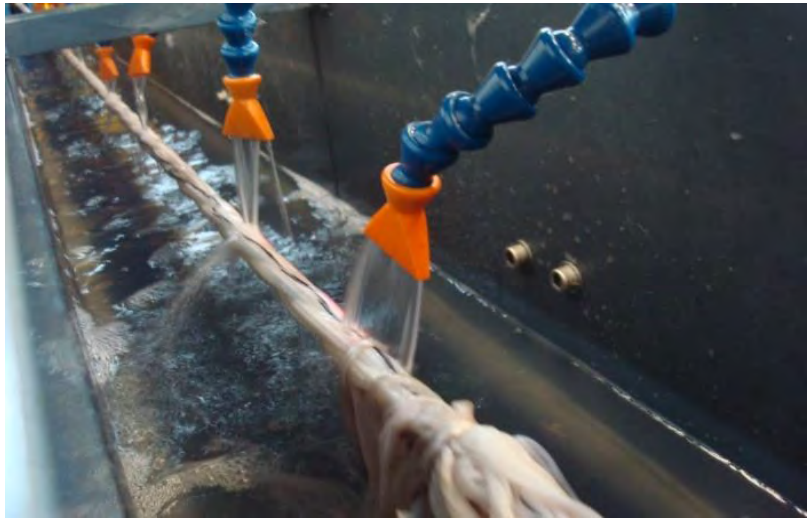
Rope characteristics

- Three stranded rope
- 6 meters long (pin to pin)
- Maximal break load 75 kN

Test method

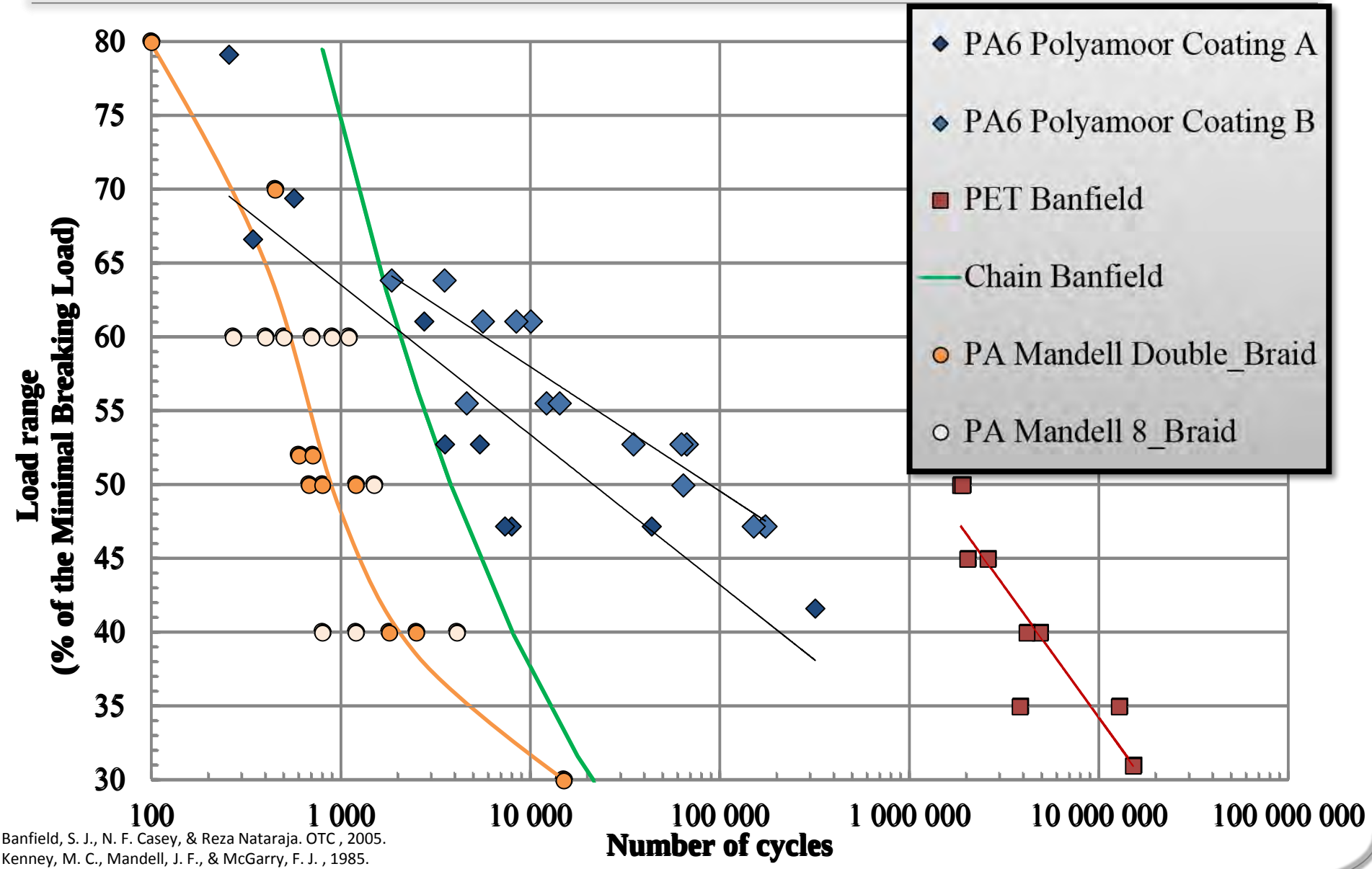
- Rope maintained wet during the test
- Mean-load of 40% of nominal break load
- Frequency of 0.1 Hz.





(1) Weller, S., Davies, P., Johanning, L., & Banfield, S. (2013).

Standard fatigue results compared to previous result

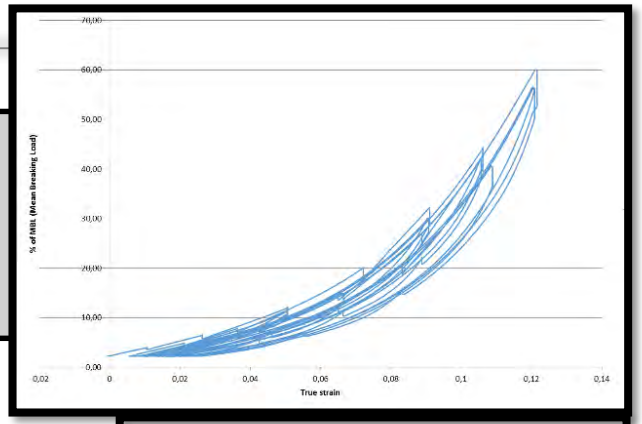


Banfield, S. J., N. F. Casey, & Reza Nataraja. OTC , 2005.
Kenney, M. C., Mandell, J. F., & McGarry, F. J. , 1985.
Norme ISO 18692, 2007.

Summary

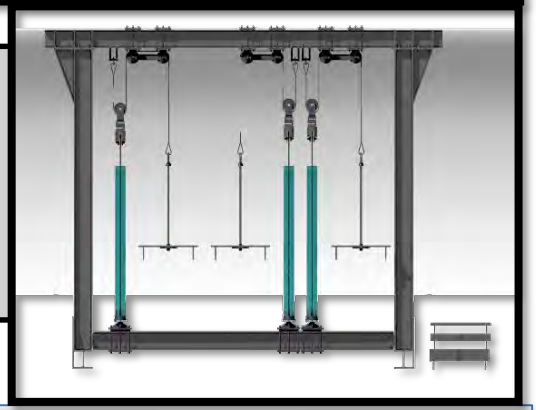
Short term behavior

- Characterization completed
- Identification on the way



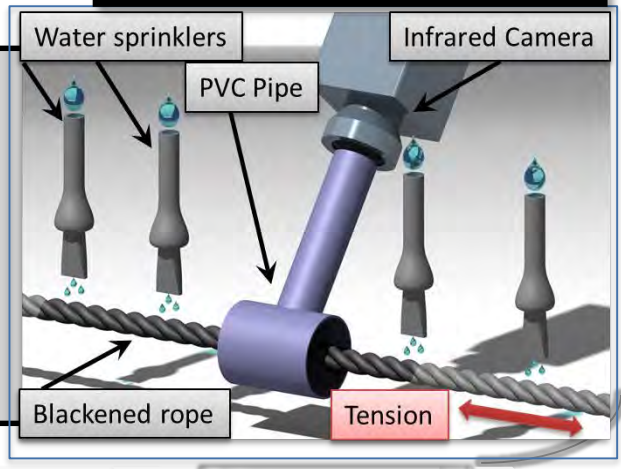
Long term behavior

- Logarithmic evolution of the strain.
- Test planned to continue for up to 1 year.



Fatigue tests

- Fatigue properties of this nylon rope are lower than polyester rope but better than chain.
- Lifetime seems sufficient for our application.
- Accelerated procedure tested : heat build-up



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Thank you for your attention

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