Jussi: **Predicting Properties for Ropes from Yarns**

10 NOV. 1989.
P. SARGENT.

Variability & Viscoelasticity of aramid ropes (parafil = Kevlar 49) creep.

Little or no twist of fibres in yarns. ∃ an optimum twist because broken fibres can still carry load ≃ 7°/metre.
No twist of yarns in ropes.

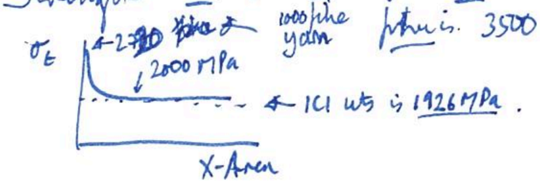
$\epsilon(t,\sigma) = \alpha(\sigma) + \beta(\sigma) \cdot f(t)$
(α: t=0 response)

$f(t) = t^n$
$\simeq \lg(a+bt)$

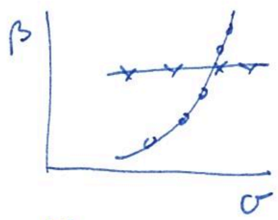
A	Terylene	3 types of parafil.
F	Kevlar 29	
Type G	Kevlar 49	higher stress, higher modulus, lowest breaking strain.

is $\beta(\sigma) = K \cdot \sigma$?!
conflicting report !!

Strength and E and ϵ_f all decrease as rope size increases.



over 300 yarns in 60 tonne rope.

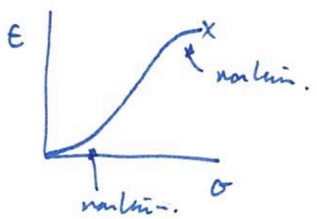


Models used to Describe Behaviour

using scatter in fibre properties

		60 tonne rope.
Daniels	- equal area + stiffness each yarn - linear σ-ε	0.9
Phoenix	- consider slack	0.85
bundle strength / fibre strength		0.7 ← exptl.

NB. ropes are prestressed.



$\sigma(t) = \epsilon_0 \cdot L(t)$ stress relax
$\epsilon(t) = \sigma_0 J(t)$ creep compliance

& relate J & L.
to all exps in terms of $\epsilon(t)$ and t.
Better to use $\dot{\epsilon}(\epsilon)$ to

New Model

variation in yarn area ! (expt.)
stiffness NOT constant → load sharing shift as yarns break
↳ non linear stiffness.
incl. slack.

$$\sigma_i(\epsilon) = \begin{cases} f(\epsilon, A_i, b_i) & \epsilon < \epsilon_{f_i} \\ 0 & \epsilon > \epsilon_{f_i} \end{cases}$$
(b_i: slack)

assume A_i, b_i, ϵ_{f_i} are independent distributions.

But fibres are independent.

bundle stress function:
$$S_n(\epsilon) = \frac{1}{n}\sum_i^n \sigma_i(\epsilon)$$

$$U(\epsilon) = E[\sigma_i(\epsilon)]$$ mean estimated stress of fibre bundle.

just like Phoenix except for a non-linear σ/ε curve..