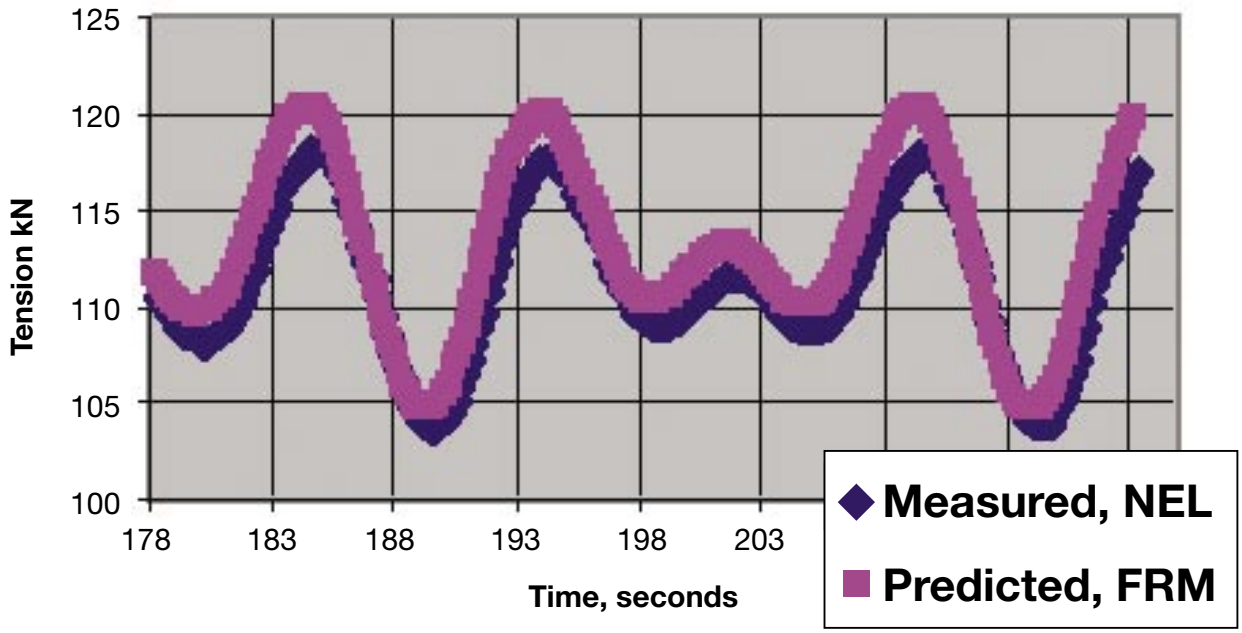
FRM - FIBRE ROPE MODELLER

Computer Modelling for Rope Design and Performance Prediction

Technical Notes 06, January 2005



New major break through computer modelling of modulus modulation
Comparison of FRM modelled load/time biharmonic series against measured in test machine on 80 tonne polyester sub-rope

FRM is an advanced, comprehensive set of computer programs, for use by engineers in the design or selection of synthetic fibre ropes. They are based on work performed by TTI for the US Navy and are intended to supplement or replace expensive prototype rope testing.

The FRM programs are presently available for use in two ways:

- TTI staff can perform analyses to meet the needs of rope makers and rope users.
- TTI can license specific programs for use by experienced rope engineers.

USES OF FRM

When used during rope design and development, FRM replaces the time-consuming and expensive trial-and-error prototype rope production and testing. Alternative yarn properties and construction details can be inputed to predict important properties, for both new and cycled ropes. More precise predictions are achieved when FRM is "calibrated" against known properties of a similar "bench-mark" rope.

Comparison of predicted and measured test results provides a quality check to reveal errors during rope manufacturing. In addition to their immediate utility, the FRM programs can be enhanced to provide manufacturing information, costings, dimensions, and a range of rope properties for all types of rope, cord and cable, according to the needs of clients.

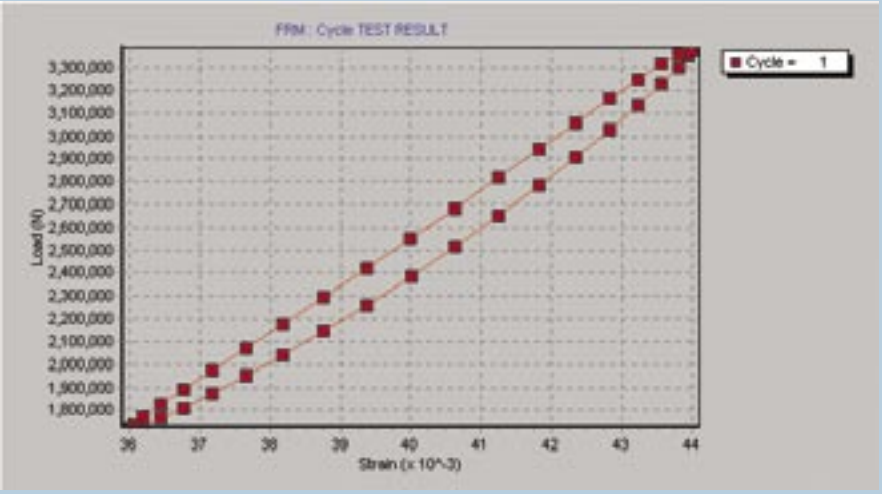
For ease of use, the programs are in a series of modules:

FRM
- accepts input of basic data on the yarn properties and rope construction.
- accepts various constructions, parallel, multilayer, twisted, braid and plait
- predicts load/extension/torque/twist properties of twisted ropes.
- predicts cyclic load performance, e.g. residual strength and the S/N curve
- predicts load/extension and cyclic load responses of parallel-yarn ropes.
- for braided ropes, is planned for implementation when needed.

MECHANICAL PROPERTIES OF TWISTED ROPES

FRM is a highly developed and well validated rope analysis program, intended particularly for high-performance synthetic fibre ropes. It can model almost any form of twisted or laid rope construction, including twisted yarns, simple 2-strand, 3-strand, 4-

Example: Design of a 7-strand Aramid Rope



Example: hysteresis modelling properties of 80tonne braided sub-rope for deepwater mooring

strand structures, multi-layered ("wire-rope" form) ropes of 6, 18 or 36 strands; and parallel-strand ropes. FRM predicts the important mechanical properties of ropes: break load, load-elongation, torque-twist, and interaction of tension and twist. FRM takes account of friction and computes contact forces between components.

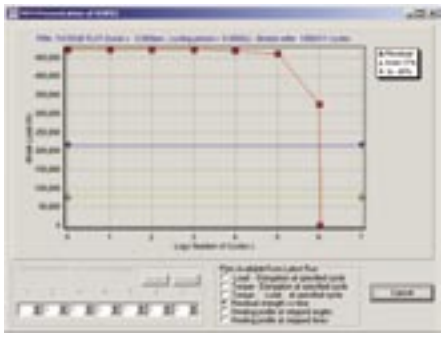
LONG TERM DURABILITY AND EFFECTS OF CYCLING

FRM-F quickly predicts changes in rope performance to cycling over long service life, for example by wave action. With yarn creep property input, it gives good predictions of rope creep rupture. Relative but not absolute predictions can be made of some other effects, because data on relevant yarn properties is limited. It can be used to explore the following problems: heating due to dynamic losses in fibres and friction between fibres, internal abrasion due to components rubbing on one another and "kink-band" failure when components suffer axial compression fatigue due to rope twisting or construction variability.

APPLICATION FOR FRM

Tension Technology International can now use FRM to advise:

- Ropemakers on changes in rope properties resulting from new materials or new constructions
- Fibre producers on the potential of new fibres or fibre finishes in rope applications
- Rope users, such as oil companies and civil engineers, on optimum choices and expected performance in critical situations



Predicted residual strength through lifetime of 7-strand aramid rope

EXAMPLES OF TTI MODELLING CONTRACTS:

- dynamic stiffness mean load and load range of 1900tonne mooring line
- low tension effects of leeward lines, elastic/plastic buckling
- biharmonic load/times series validation FRM against measured data on 80tonne sub-rope
- effect of scale on rope break load
- statistical analysis of length, scale, input fibre properties
- axial stiffness of 600tonne polyester deepwater mooring
- fatigue life of braids
- axial compression buckling modes of tyre cords

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