



CASE STUDY

## Ropes made with DuPont™ Kevlar® stand the true test of time

Unmatched 0.23% creep after 34 years constant load



On Tuesday, April 6, 1976, engineers at Linear Composites Limited (LCL) of Keighley, West Yorkshire, England, the leading manufacturer of synthetic ropes, subsea strapings and textile reinforced plastic composite materials, set up an external test rig to measure the actual creep strain performance of two types of the company's ParaFil® ropes under all weather conditions. Each rope, rated at 3 tons nominal breaking load (NBL) and made with DuPont™ Kevlar® brand fibre, was placed under a constant 600kg (20% NBL) and 1200 kg (40% NBL).

Today, over 34 years later, in what is believed to be the longest continual rope test on record, those engineers have long retired, but the ropes are still under the same loading, having resisted three decades of exposure to the British weather. But what is more remarkable than the time elapsed is the almost imperceptible creep in the ropes made with Kevlar®. Most impressive is the performance of the rope under 1200 kg (40%) load which exhibited just 0.035% creep per decade, and only 0.23% over the duration.

Creep is a key parameter of rope performance. Creep strain is the continued extension of a material under constant loading. If left unnoticed, a rope can creep over time and then rupture, leading to catastrophic, possibly life threatening, failure.

### **Unmatched test of time**

In the world of ropes and cables, long-term dependability is everything, especially if lives and livelihoods depend on it. Accelerated ageing tests are used to predict performance over decades. But such tests, commonplace in the industry, can only approximate the reality of rope performance and weathering over 10 or 20 years. But the sustained 30+ years LCL creep test of ParaFil® ropes made with Kevlar® is believed to exceed the duration of any other comparable rope test.



**Kevlar.**

“To my knowledge, this level of testing is unmatched in the industry. As a result, a constant loading of 40% of tensile strength can now be used as a model for design where real-time testing has been carried out to prove the long-term performance of ParaFil® rope made with Kevlar® reinforcement,” said Tim Balderson, Business Development Director, Linear Composites.

“At the outset of the test in 1976, extension measurements were taken daily for the first month, and then bi-monthly. Due to the lack of measurable creep-strain these readings became much less frequent, and were eventually taken annually until 1996. Measurements then lapsed until 2003 when technicians from LCL and DuPont started measuring again. It was then we realized the value of the data which exhibited an almost total absence of creep in the ropes made with Kevlar®,” he explained.

There is no substitute for the true test of time. But few engineers will wait for over 30 years to know how much a rope will creep, or when it will break. Instant data is demanded in making purchase decisions for ropes that must take the strain on ships, oil rigs, salvage and towing systems – in fact, anywhere where rope performance is critical. However, LCL has the actual long-term data — following 34 years of measurement — that ParaFil® ropes made with Kevlar® can withstand the test of time.

Time	Actual load	% NBL	Creep	Log t
34 Years	600 kgs	20%	0.09	0.013
	1200 kgs	40%	0.23	0.035

Creep measured on the 40% NBL rope over the last 20 years equates to only 0.04%. Assuming the same creep rate to continue, and no other change in ambient temperature/weather conditions, the prediction is that the rope will actually break in an astonishing 992 years time.

### Looking ahead

“Although the longevity of the rope and the LCL designed end terminations are as expected, we will continue to keep the tests going for the foreseeable future, and will consider carrying out residual strength testing to determine other performance milestones achieved by these ropes, as they approach the fourth decade under load,” said Tim Balderson.

The results of LCL’s long-term testing have implications for ropes and other products made with Kevlar®. Technical designers can now have added confidence in the 20+ year guarantees offered with many such products.

### Parafil® ropes with Kevlar®

ParaFil® ropes with Kevlar®, currently available from Linear Composites Ltd., are:

- (i) ParaFil® Type F – standard modulus Kevlar® 29 brand fibre.
- (ii) ParaFil® Type G – high modulus Kevlar® 49 brand fibre.



*Tim Balderson, Business Development Director, Linear Composites, confirms total creep of only 0.23% in a Parafil® rope made with Kevlar® after 34 years continual load of 1200 kg (40% of NBL).*

Each commercially available rope has a core of closely packed parallel Kevlar® fibres, encased in a protective polymeric sheath.

ParaFil® ropes made with Kevlar® are used in over 40 countries as antennae stays, buoy moorings, mooring ropes, yacht and ship rigging and guard rails, catenaries, and support for urban transport systems, cable stayed bridges and pre-stressing tendons. LCL also uses Kevlar® for Paraloop® straps used for sub sea strapping systems.

They provide a high strength-to-weight ratio, and excellent resistance to chemicals, UV degradation and tension-tension fatigue over a wide temperature range, and remain unaffected by sea water, ice and other extreme environmental conditions.

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