1. PARAFIL® Types

Parafil® ropes consist of a closely packed core of high strength synthetic fibres lying parallel to each other, and encased in a tough and durable polymeric sheath.

The parallel fibre structure ensures that Parafil® ropes have high strength and modulus characteristics coupled with excellent tension-tension fatigue performance and low creep values.

To benefit from the extremely high levels of performance offered by Parafil® rope, it must be used in combination with proprietary terminals from Linear Composites. The function, use and maintenance of Parafil® Terminations are discussed in detail within the dedicated section towards the end of this document.

Three standard types of Terminations are available: Fork (see Figure 1), Eye and Pre-Stressing Terminations however, custom designs can be produced to meet specific client requirements.

Figure 1 ~ Parafil® Rope Termination in "Fork" format

There are three main types of Parafil®, defined primarily by the type of fibre used in the core – Types A, F and G. Each has a choice of sheath from three standard materials (other materials are available for use under special circumstances). The basic product range is shown in Table 1.

Table 1 ~ Standard Configurations of Parafil® Rope

Yarn Type	Sheath materials and Types			
	Polyethylene (LDPE)	Polyethylene Copolymer (EVA)	Polyester Elastomer (Hytrel)	Flame Retardant Cross linked Polymer
High Tenacity polyester	Type A	Type A (C)	Type A (H)	Type A (X)
Standard Modulus Aramid	Type F	Type F (C)	Type F (H)	Type F (X)
High Modulus Aramid	Type G	Type G (C)	Type G (H)	Type G (X)

<u>Type A</u> ropes use high tenacity polyester fibres in the core. These fibres offer high tensile strength, low density and an excellent resistance to cyclic loading coupled with very high environmental resistance and durability in handling.

<u>Type F</u> ropes use standard modulus aramid (Kevlar®) fibres in the core. These fibres offer very high tensile strength, high modulus of elasticity, very low density, small values of creep and very low sensitivity to temperature.

<u>Type G</u> ropes use high modulus aramid (Kevlar®) fibres in the core. These fibres offer very high tensile strength, extremely high modulus of elasticity, very low density, small values of creep and very low sensitivity to temperature.

A specially formulated low density polyethylene is the most commonly used type of sheath. Its performance is suitable for the majority of general applications. Polyethylene copolymer sheath is more flexible and is often used where low temperature performance is required. Polyester elastomer sheaths are specified where clients require a higher resistance to abrasion and raised temperatures. Cross-linked polymer sheaths are used to offer a level of flame retardance such as for products required in underground applications.

The standard ranges of Parafil® ropes and their principle technical characteristics are shown in the following tables 2 and 3. It should be noted that Types F and G are dimensionally identical and so they share the same table. Other rope sizes and strengths (not shown here) are available to suit specific client requirements.

Table 2 ~ Basic Characteristics of Type A Parafil® Ropes

Nominal Breaking Load (NBL) (Tonnes)	Nominal Diameter (mm)	Nominal Diameter of Fibre Core (mm)	CSA of Fibre in the Core (mm^2)	Approximate Weight in Air (kg/100m)	Estimated Weight * in Seawater (Core Flooded) (kg / 100m)
0.3	4	3.0	5.19	1.2	-
0.5	7	3.7	7.97	3.7	0.05
1	8.5	5.3	15.94	5.4	0.2
2	11	7.5	31.88	9.4	0.5
3.5	13.5	10	55.8	14.5	2.1
5	17	12	79.7	22	2.1
7.5	20	15	119.6	30	4.6
10	22	17	159.4	37	5.0
15	27.5	22	239.1	56	7.5
20	31	24	318.8	73	9.3
30	36	29	478.2	99	13.4
50	47	39	797	165	25
60	53	42	956	215	32
100	64	56	1594	310	77
200	90	77	3188	622	143
250	99	86	3985	763	153

Table 3 ~ Basic Characteristics of Type F and G Parafil® Ropes

(NOTE: Type G ropes have a higher elastic modulus than Type F ropes but other performance characteristics are identical.)

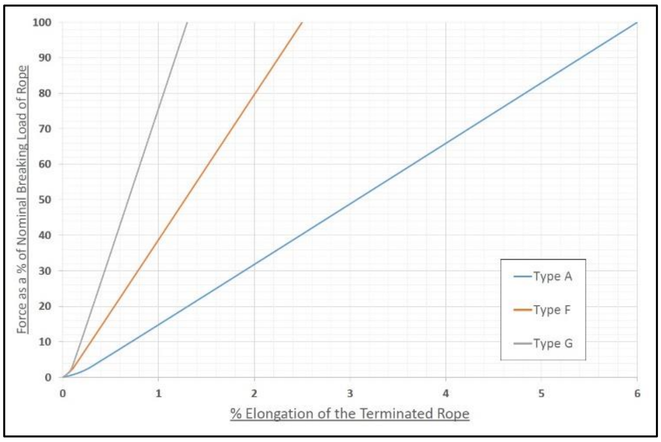
Nominal Breaking Load (NBL) (Tonnes)	Nominal Diameter (mm)	Nominal Diameter of Fibre Core (mm)	CSA of Fibre in the Core (mm^2)	Approximate Weight in Air (kg/100m)	Estimated Weight * in Seawater (Core Flooded) (kg/100m)
0.75	4	3	4.8	1.2	-
1.5	7	4	7.64	3.7	0.13
3	8.5	5.4	15.28	5.4	0.34
4.5	9.5	6.6	22.92	6.9	0.6
6	11	7.6	30.55	9.1	0.8
8	13	8.9	40.73	12.9	1.5
10.5	13.5	10	53.47	14.9	2.6
15	17	12.5	76.38	21.5	3.7
22.5	20	15	114.6	30	5.8
30	22	17	152.8	37	7.2
45	27.5	21.5	229.2	60	7.5
60	31	24	305.5	72	8.2
90	36	29	458.3	100	16
150	47	39	763.8	170	29

(*Parafil® ropes consist of a closely packed core of cylindrical filaments meaning there is always an air space within the core, amounting to 25-30% of its cross sectional area. If the ropes are sealed to prevent the ingress of water then they will float in water. If the ropes are allowed to become fully saturated then their weights would be measured as shown.)

2. Tensile Properties

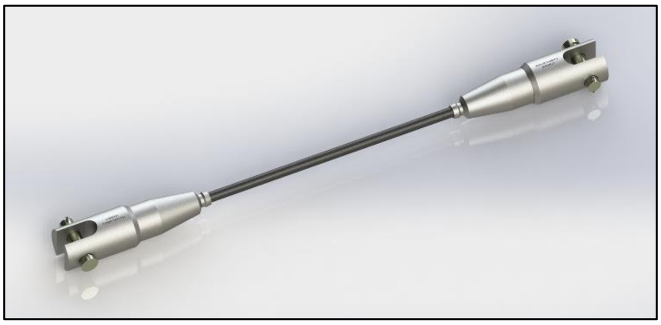
The characteristic load-extension curves of the three main types of Parafil® rope are shown in Figure 2. These data were obtained after pre-tensioning to 60% of Nominal Breaking Load and then relaxing for 1 hour, following the fitting and bedding of a Parafil® Termination to each end of the test length (shown in Figure 3).

Figure 2 ~ Load Extension Curves for Type A, F and G Parafil®



(NOTE: More Detailed Load Extension curves are available from Linear Composites Ltd.)

Figure 3 ~ Terminated Parafil® rope sample used for tensile testing.



The primary tensile properties for the three main types of Parafil® rope are presented in Table 4. The tensile properties are determined solely by the type and quantity of fibre used in the core and are independent of the sheath type. The values

Linear Composites Limited
Vale Mills
Oakworth
Keighley, West Yorkshire
BD22 0EB, UK
Phone: +44 (0) 1535 643363
Fax: +44 (0) 1535 643605
Email: sales@linearcomposites.com
Web: www.linearcomposites.com
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given are based on the actual working cross sectional area of fibre in the core of the rope.

Table 4 ~ Tensile Strength and Elastic Modulus of Parafil® Ropes

PARAFIL® Rope	Tensile Strength at NBL kNmm⁻²	Elastic Modulus (Young's) kNmm⁻²
Type A	0.6	9.8
Type F	1.9	77.7
Type G	1.9	125.6

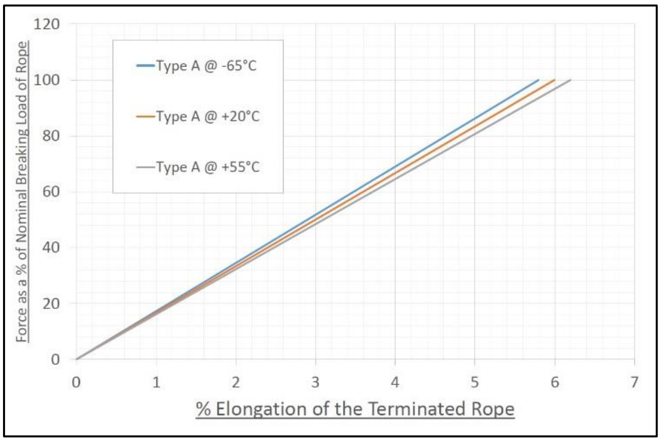
(NOTE: All Type A Parafil® ropes have the same core and therefore the same tensile properties. This is also true for the F and G series of Parafil®.)

3. Effect of Temperature

The Parafil® family of ropes have extremely good resistance to the effects of temperature. Type F and G aramid ropes particularly, undergo very little variation of technical performance with change in temperature.

In controlled laboratory testing at temperatures of between - 65°C and + 55°C Type A Parafil® ropes were found to undergo extremely small changes in breaking loads, while there were minor changes in extension as sown Figure 4.

Figure 4 ~ Load-extension curves for Type A Parafil® ropes at different temperatures.



Following long term exposure to high temperatures, 80 to 100°C, the polyester fibres will have undergone minimal permanent changes in mechanical capability however, if the fibres were tested at these temperatures, they would show a small reduction in strength. (It is important to distinguish between the results of testing fibres that are at high temperatures and testing fibres after they have been exposed to high temperatures). If exposed to extreme heat, polyester fibres would be found to begin to melt at 260°C.

In controlled laboratory testing at temperatures of between - 40°C and + 80°C Type F Parafil® ropes were found to undergo no detectable changes in mechanical performance. Aramid fibres exposed to a temperature of 150°C over long periods of time showed no detectable change in residual strength after returning to room temperature. Aramid fibres exposed to temperatures of 200°C for over 20 hours showed a strength loss of only 5% after returning to room temperature before testing. Aramid fibres do not melt but they will undergo thermal decomposition at temperatures between 427°C and 480°C.

Sheath specification is important if severe temperature requirements are to be met. Where Parafil® ropes are to be used at temperatures above 80°C for long periods of time or at high loads it is recommended that a polyester elastomer sheath should be used.

4. High Speed Loading

Type A Parafil® ropes have been tested under conditions of high speed loading by the National Engineering Laboratories in the UK. At a loading speed of 15.2m/sec (50ft/sec) on a 6m (20ft) long sample, breaking loads 10-15% below nominal were recorded. The energy absorbed was measured as 2000 joules (1500ft.lbf) per tonne of breaking load (measure in a 6m length).

5. Resistance to Environmental Effects

5.1 Corrosion Resistance

The ability of a rope to resist deterioration over long and continuous exposure to the environment is of prime importance. With this in mind Parafil® ropes have been evolved from materials which not only possess a high degree of mechanical toughness but which are extremely chemically inert. Both the core and sheath components used in Parafil® have outstanding resistance to the corrosive action of salt water, most inorganic salts, inorganic acids and many organic solvents.

5.1 Marine/Saltwater Exposure

Type A ropes are often used for deep sea mooring and riser arch applications. Laboratory analysis performed on rope that had been in continuous service in this environment for over 20 years showed that the ropes were found to be clean and in good condition. Tensile testing of both the whole rope and individual core fibres revealed no significant decrease in strength.

5.2 Marine Build-up

Resistance to marine biological attack is extremely high and the smooth sheath inhibits build-up of marine growth.

5.3 Resistance to Sunlight/UV

The carefully selected polymers used for the sheathing of Parafil® ropes are especially formulated for maximum resistance to Ultra Violet degradation. Laboratory testing of the black Polyethylene compounds to Florida sunlight (an accelerated aging test) simulating 29 years' exposure showed no significant degradation or embrittlement.

5.4 Resistance to Sunlight/UV

Where Parafil® ropes could be exposed to direct flame or flash conditions, self-extinguishing flame retardant sheath (type X) should be used. This approach is adopted for antenna stays which may be affected by brush fires.

Type F and G Parafil® ropes can be used where flame conditions are possible. Military testing of highly loaded 60te Type G ropes in prolonged contact with flames demonstrated that the rope cores continued operation even though the sheathing melted and burned.

Type A rope is not suitable for prolonged exposure to flame conditions although it can be provided with flame retardant sheath where required.

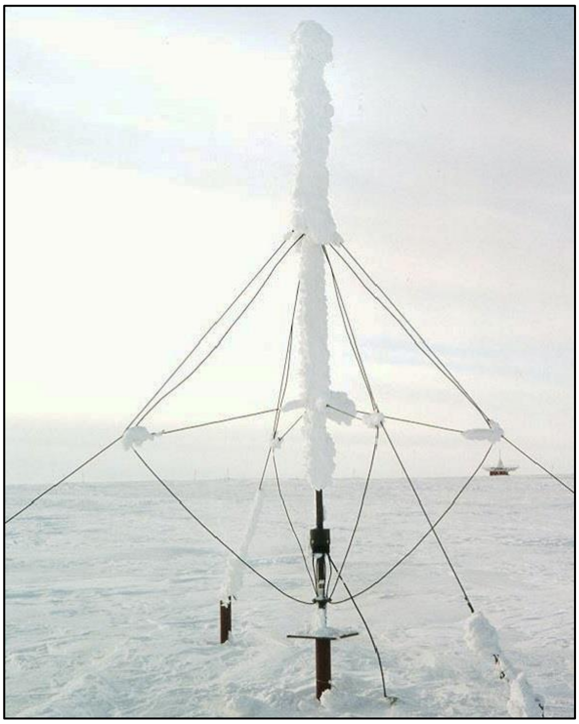
5.5 Icing

The smooth and water repellent surface of Parafil® rope sheaths result in very poor adhesion of ice. This was clearly demonstrated in tests carried out in the British Aircraft Corporation climatic chamber.

Sea trials on fishing vessels in Icelandic waters have shown that Parafil® mast-stays freed themselves of ice when aided by the ships vibration being transmitted through the rigging.

The North American Air Defence System (N.A.D.S.) antennae (Figure 5), installed in the North American Arctic, are supported by Parafil® guys in order to avoid the accumulation of ice causing disturbance to the signals (case history available on request).

Figure 5 ~ Ice-free Arctic Parafil Guys



Linear Composites Limited
Vale Mills
Oakworth
Keighley, West Yorkshire
BD22 0EB, UK
Phone: +44 (0) 1535 643363
Fax: +44 (0) 1535 643605
Email: sales@linearcomposites.com
Web: www.linearcomposites.com

6. Background

For some applications, particularly in structural and civil engineering where design life requirements commonly exceed 100 years, it is necessary to know how materials behave under load exerted over prolonged periods of time.

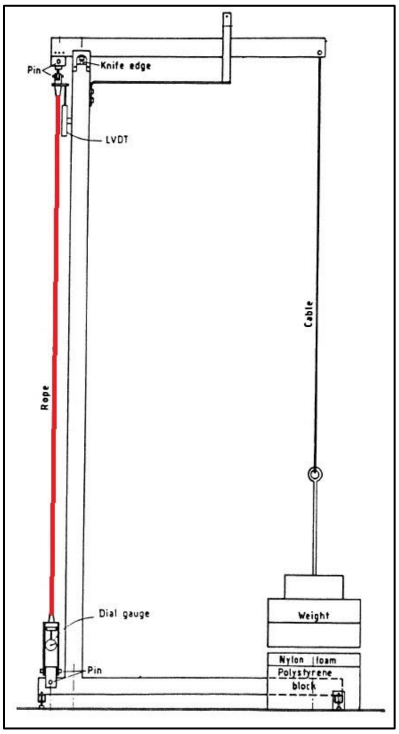
This note outlines the results of extensive field and laboratory work which has been carried out over numerous decades on Parafil® ropes, and in some cases, is still in progress.

7. Creep

7.1 General

Creep is the continuing extension of a material under constant load. All materials creep to a greater or lesser extent but the modern, high modulus synthetic fibres used in Parafil® ropes have relatively low levels of creep.

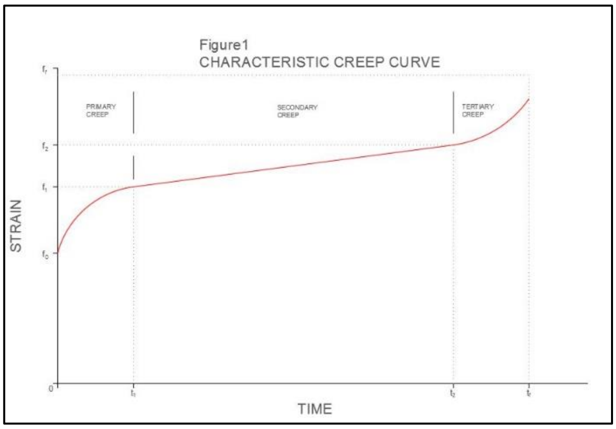
For the creep and stress relaxation tests reported in this brochure the Parafil® ropes were pre-tensioned to 60% of Nominal Breaking Load (NBL), and then allowed to relax for one hour, before the commencement of the tests. This procedure helps to ensure that there is no residual disorientation of the fibres caused by coiling.



The prepared sample is then installed into a custom made creep rig (see Figure 6 - right) for the testing to commence. The sample (red) is kept under a constant load by a mass which is suspended from the moving arm of the frame. The extension of the sample is then recorded along with the time of the measurement.

The general form of the creep curve is shown in Figure 7. This curve is characteristic of many synthetic fibres.

Figure 7 ~ Synthetic fibre creep curve



Typically, the period 0-t_1 is measured in mins/hours, the period t_1-t_2 in years (assuming loads are as normally used, say 20-60% of Nominal Breaking Load (NBL) and the period t_2-t_f in days.

The period t_2-t_f for Parafil® ropes has still to be determined as no failures have yet occurred during testing with loads in the range 20-80% of NBL on tests that commenced on 11th Nov 1995.

One single failure has been recorded in a 2.8te Type A (high tenacity polyester fibre) Parafil® rope in a long term creep test. The sample was under 82% of actual breaking load and it was found to have failed at a time (t_f) of 21 years.

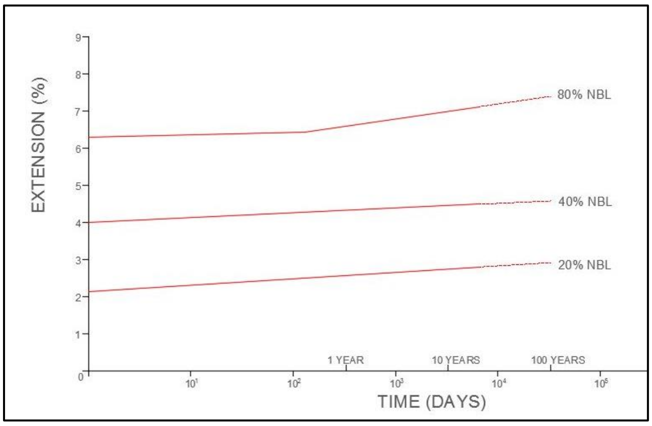
7.2 Type A Parafil® (polyester)

Fig 8. shows the creep behaviour from 24 hours after the load has been applied, for Type A Parafil® ropes at 20%, 40% and 80% of NBL. The creep in the first 24 hours was recorded as:

0.69% at 20% NBL

0.41% at 40% NBL

Figure 8 ~ Creep of Type A Parafil®



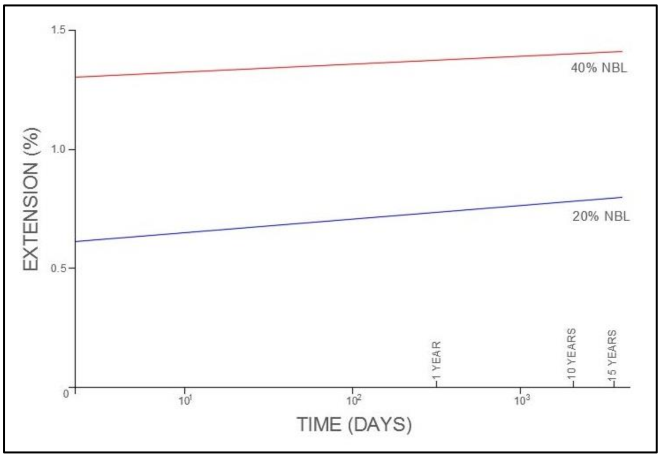
7.3 Type F Parafil® (Standard Modulus Aramid)

Fig.9 shows the creep behaviour of Type F Parafil® ropes. The creep is much smaller than that of Type A Parafil®. The creep in the first 24 hours was recorded as:

0.09% at 20% NBL

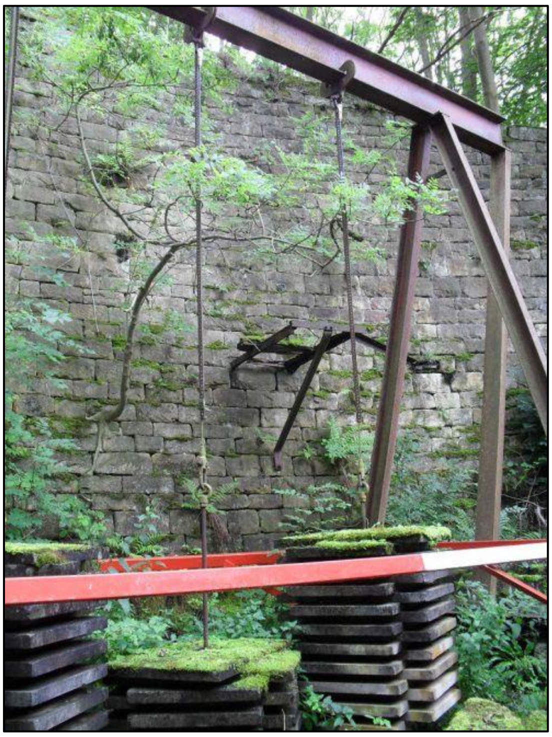
0.09% at 40% NBL

Figure 9 ~ Creep of Type F Parafil®



Linear Composites started, what is now the world's longest running continuous creep test, on 06th April 1976. 2.25m long samples of 3te NBL Type F Parafil® rope, terminated with proprietary Parafil® fittings (shown in Figure 10), were installed into a custom built frame outside, in the Linear Composites factory yard.

Figure 10 ~ Ongoing, outdoor 40 year (to 2016) continuous creep test apparatus.



The ropes were hung with concrete weights, the loads from-which represented 20% and 40% of NBL. Readings taken at specified intervals over the last 40 years have produced the findings presented below in Table 5, and show that for the 40% NBL creep test, the rope has only undergone 0.04% elongation over the last 20 years.

Table 5 ~ Long term creep test data

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

7.4 Type G Parafil® (High Modulus Aramid)

Measurements have shown that High Modulus Aramid fibres have a creep value of only 40% of that of Standard Modulus Aramid Fibres.

Measurements made on Parafil® Type G have given the following data for the creep coefficient:

$0_t = (0.012 \pm 0.003) \log_{10} t$ *(Ref.1)*

Linear Composites Limited
Vale Mills
Oakworth
Keighley, West Yorkshire
BD22 0EB, UK
Phone: +44 (0) 1535 643363
Fax: +44 (0) 1535 643605
Email: sales@linearcomposites.com
Web: www.linearcomposites.com

Where creep coefficient 0t is defined from the equation

$$0t = \frac{\varepsilon_C(t)}{\varepsilon_0}$$

Where $\varepsilon_c(t)$ = creep strain at time t and

Where ε_0 = initial strain and

Where t is expressed in seconds.

Observations from stress-rupture work and creep data analysis show that Type G has a limiting creep strain, irrespective of initial stress, between 0.10 and 0.12%.

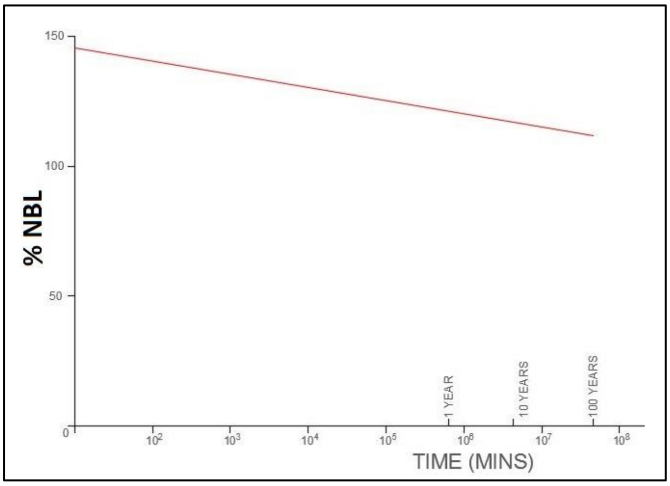
Ref. 1: "Creep behaviour of a parallel-lay aramid rope". C. J. BURGOYNE and G. B. GUIMARAES. Journal of Materials Science 7 (1992) 2473-2489.

8. Stress Rupture

8.1 Type A Parafil® (polyester)

Type A Parafil® ropes have a fibre content higher than that required to achieve the Nominal Breaking Load (NBL). With current Parafil®-specific proprietary terminations, actual Breaking Loads are well in excess of the stated Nominal Breaking Loads. The Stress Rupture curve for Type A Parafil® is shown in Figure 11.

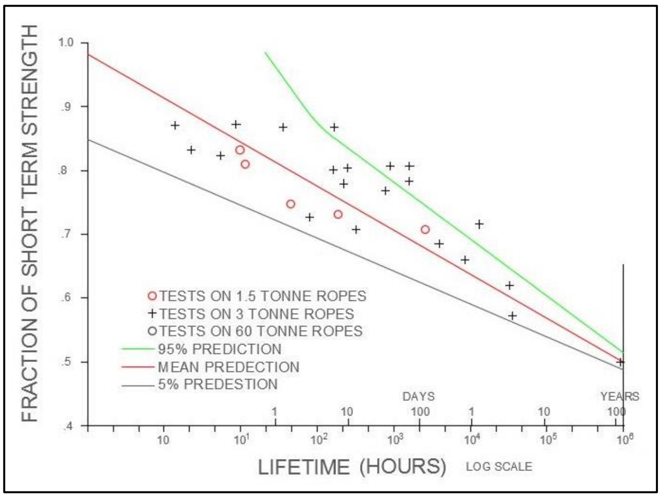
Figure 11 ~ Stress Rupture Curve for Type A



8.2 Type G Parafil® (High Modulus Aramid)

The Stress Rupture of Type G Parafil® has been studied extensively at both Imperial College and Cambridge University in the UK, using 1.5, 3 and 60 tonne Parafil® ropes. A summary of the information to date is shown in Figure 12. This indicates that if the initial stress is restricted to less than 50% of Ultimate Tensile Strength a life of 100 years can be achieved.

Figure 12 ~ Stress Rupture Data for Type G



9. Stress Relaxation

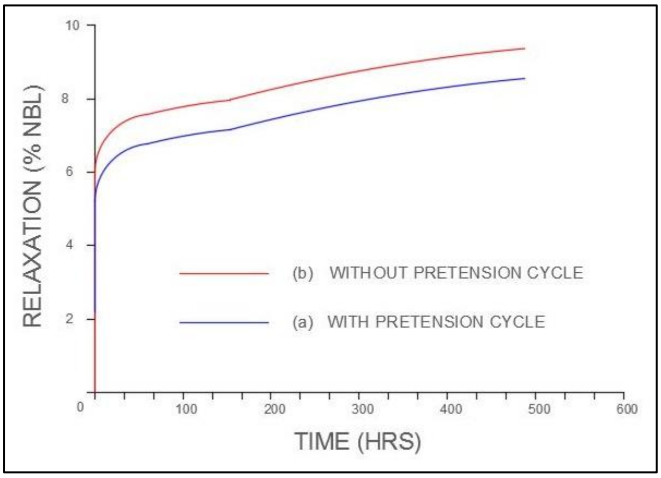
Stress relaxation is the load loss occurring over time within a tensioned member that is restrained between two spatially-fixed attachments.

Stress relaxation occurs over an exponential timescale with the majority of the total relaxation occurring within the first seconds and minutes, depending on the type of fibre being loaded.

Typical Stress Relaxation Curves for Type A Parafil® over 500 hours are shown in Figure 13; the two curves relate to (a) with and (b) without a pre-tension cycle to 60% of NBL.

The actual relaxation, expressed as a percentage of NBL, from an initial stress of 40% of NBL was 7.86% for the sample given the pre-tension cycle and 8.75% for the sample given no pre-tension cycle.

Figure 13 ~ Stress relaxation curves for Type A Parafil® ropes with terminations



Stress Relaxation test results for Type F Parafil® ropes are 6.29% and 8.82% respectively.

Higher modulus Type G Parafil® ropes have been studied even more extensively at Imperial College. These ropes are of particular interest for pre-stressing applications *(Ref: 2)*. Relaxation results are shown below in Table 6.

Table 6 ~ Stress relaxation on Type G ropes

Initial Stress	Relaxation at 100 hrs	Relation at 100 years
% NBL	% NBL	% NBL
30	2.9	7.0
40	3.5	7.4
50	3.8	7.8
60	4.5	8.2
70	4.5	8.6

These results conform to the relationship shown in Figure 14:

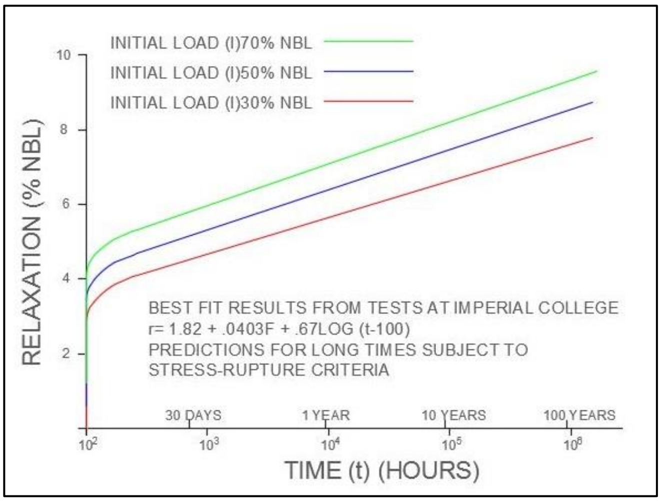
$$r = 1.82 + 0.0403\ f + 0.67\ \log_{10}(t-100)$$

where r = stress relaxation expressed as %NBL.

f = initial stress expressed as %NBL

t = time in hours

Figure 14 ~ Stress relaxation curves for Type G Parafil® ropes with terminations



Note that the relaxations are expressed as percentage of Nominal Breaking Load. Relaxation figures are higher when expressed as percentage of Initial Stress: e.g. at 60% NBL Initial Stress, the relaxation over 100 years is 8.2% NBL. This equates to a relaxation of 13.6% Initial Stress.

Although relaxations are higher than the relaxations associated with steel, the total loss of pre-stress force in a concrete beam pre-stressed with Parafil® is very similar to that in a beam pre-stressed with steel. The losses due to relaxation of the tendon are higher but the losses due to elastic shortening of the concrete are lower because of the lower elastic modulus of Parafil®. The amount depends on the detailed design, which will differ for structures designed with steel or Parafil® tendons, but for most cases the two effects act to effectively cancel each other out.

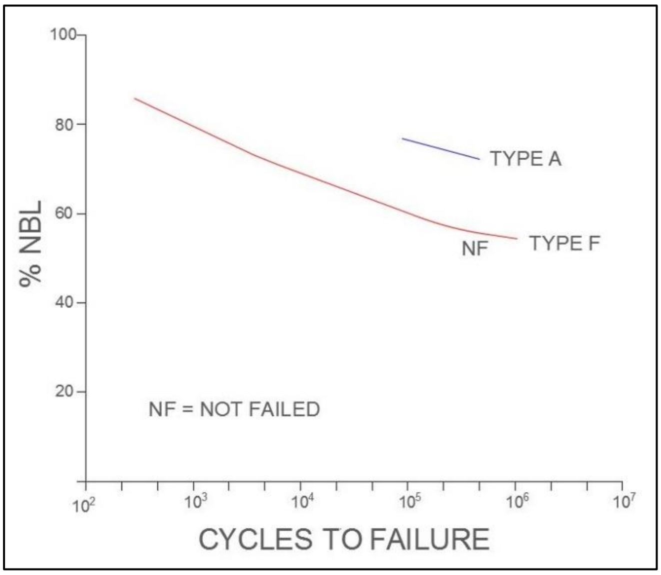
Ref.2 Chambers J.J., "Parallel Lay aramid ropes for use as tendons in pre-stressed concrete". PhD. Theses, University of London 1986.

10. Fatigue Performance

In general terms the tension-tension fatigue performance of parallel-lay ropes is excellent and is superior to that of most other forms of rope construction. This is due primarily to the avoidance of fibre cross over points which cause fibre 'fretting' and high stress concentrations in twisted or braided structures.

The fatigue performances of Type A Parafil® (10 tonne NBL) and Type F Parafil® (6 tonne NBL) are shown in Figure 15. The curves were constructed by recording the number of cycles to failure in cycling from a constant lower limit corresponding to 7.5% NBL to the upper load limit depicted by the curve.

Figure 15 ~ Tension-Tension Fatigue Performance of Parafil® Ropes



Tests on Type G Parafil®: (6 tonne NBL) have been carried out under different load amplitudes. Typical results are shown below in Table 7.

Table 7 Fatigue performance of Type G Parafil®

Mean Load	Load Range	Cycles to Failure
% NBL	% NBL	x 10^6
30	± 25	0.5
30	± 15	3.4
40	± 15	2.9
40*	± 5	>10

(* The residual strength was measured at 6.5 tonnes force.)

11. Environmental Conditions

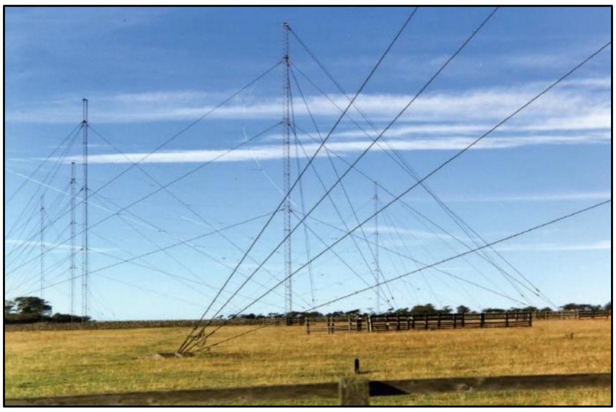
Parafil® ropes consist of two components - a technical fibre core overlain by an extruded sheath which maintains the shape of the rope and serves as a protection to the core fibres.

Most Parafil® ropes use a polyethylene sheath. Polyethylenes are regarded as chemically inert materials and are not attacked by water, inorganic acids and alkalis, aqueous salts or other materials normally found in soils or the environment even during long term exposure.

The specific grade of polyethylene used for standard Parafil® sheaths is stabilised with carbon black (and other additives). Tests over a 20 year period in areas of high U.V. activity on carbon stabilised grades have shown no detectable change in properties of the sheath. More recently, Linear Composites have developed a technique to further enhance UV resistance of sheaths which is an option that can be offered for products intended for extended use in areas with high UV intensity such as the poles, equatorial deserts and Australasia.

Parafil® ropes were first used as primary mast stays at Ministry of Defence installations in the UK (Figure 16). Many erected in 1966/67 are still in service. When samples were examined and subject to laboratory testing after 20 years' constant use their properties were found to be unchanged.

Figure 16 ~ Parafil® military mast stays, UK



Extended exposure to marine conditions can be achieved through the use of both polyester and aramids are durable fibres. They are highly resistant to most chemicals and water.

The reaction of polyesters with water (hydrolysis) has been subject to intense investigation. Test results show that selected polyesters will only suffer a 3% strength loss after 100 years of continuous immersion in water at 20 °C. (results published separately by Imperial College).

Tests by DuPont have shown that aramid fibres are not attacked by water at normal temperatures. (For detailed physical and chemical properties of the fibres, refer to the manufacturers technical information: "Kevlar® Technical Guide" available from Du Pont.)

11.1 Extended marine exposure

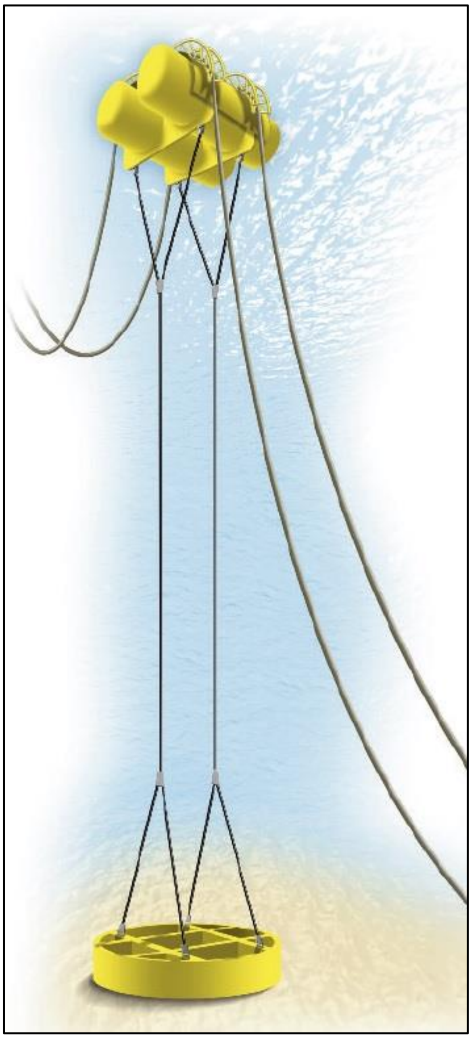
Since mid-2014 Linear Composites has been performing high temperature salt water, accelerated aging tests on Aramid Parafil® ropes in accordance with the API 17L (American Petroleum Institute 17L) standard. The testing involves submerging whole product samples in hot saline water baths at 60°C for extended periods of time. Immersion periods of years are used before samples are recovered and subject to mechanical testing.

The test results can be used both to directly assess the residual mechanical performance of the product following exposure to continuous hot-submarine conditions performance and also to develop a mathematical extrapolation of the available results to calculate the residual mechanical performance of the product after long term exposure to ambient temperature marine conditions.

The API 17L 60°C saline testing of whole Parafil® ropes has produced results independently verified results. The results from subsequent tensile testing were extrapolated using linear regression, this allowed a projection of the degradation of the Parafil® over a period of time, expressed as a percentage of the initial strength. During the first year of exposure the product underwent a reduction in strength of 3.68%. Data extrapolation predicts a further 0.66% reduction between years 1 to 10 followed by a further reduction of 0.67% over years 10 to 100.

The conclusion of the testing is that in the real world (Figure 17 for example), whole Parafil® products used submerged in sea water will have a projected retained strength of 95.94% after 100 years of continuous exposure.

Figure 17 ~ Rob-Roy Field Riser Arches using 100 tonne NBL Parafil® Ropes, UK.



12. Parafil® Terminations

12.1 Overview and Function

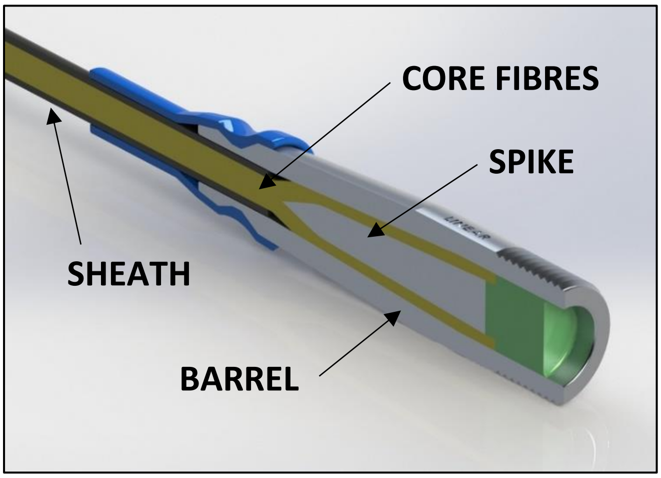
Parafil® ropes contain a parallel laid fibre core which is solely responsible for the mechanical strength and performance of the rope.

In order to efficiently transmit forces into all of the core fibres, in a reliable manor, it is necessary to use proprietary Linear Composites Terminations.

These Terminations are individually designed by Linear Composites, with each Termination, specifically matched to a given rope. The Terminations allow efficient and repeatable transmission of forces exceeding 100% of the rope NBL.

The Termination technology relies on two main components the 'Barrel' and the 'Spike' as shown in Figure 20.

Figure 20 ~ Barrel and Spike Terminations



The Barrel is the outer annulus and it features a tapering central hole. The Spike is a two-part tapering conical wedge which sits centrally within and axially parallel to the Barrel taper. In operation the core fibres, which are equally distributed around the Spike, are trapped between the outer surface of the Spike and the inner surface of the Barrel taper by friction alone. No bonding of the fibres is required and no additional compounds or materials are required to allow successful operation of the Termination.

Terminations are supplied in three main forms: 1) "Fork", 2) "Eye" and 3) "Pre-Stressing" pictured below in Figures 21a, 21b and 21c respectively.

Figure 21a

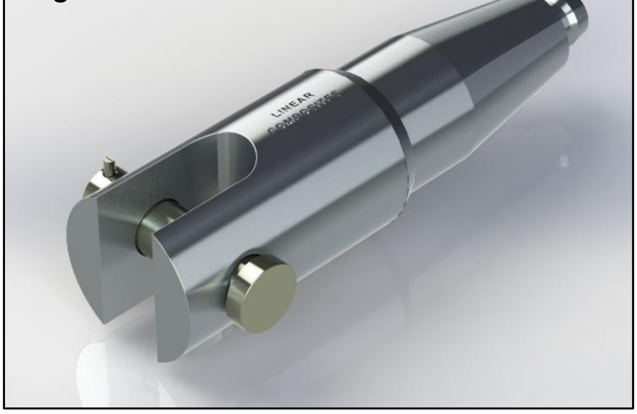


Figure 21b

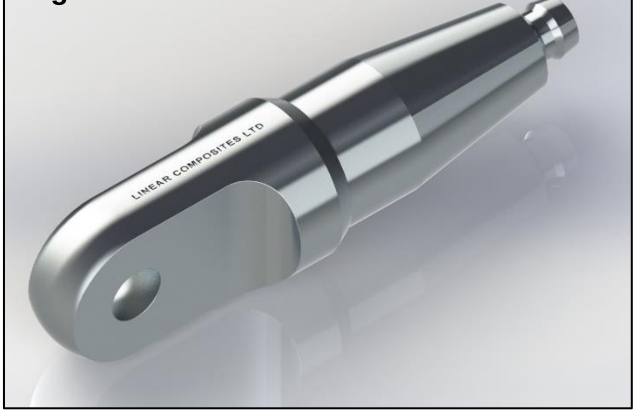


Figure 21c

Linear Composites Limited
Vale Mills
Oakworth
Keighley, West Yorkshire
BD22 0EB, UK
Phone: +44 (0) 1535 643363
Fax: +44 (0) 1535 643605
Email: sales@linearcomposites.com
Web: www.linearcomposites.com

12.2 Termination Fitting

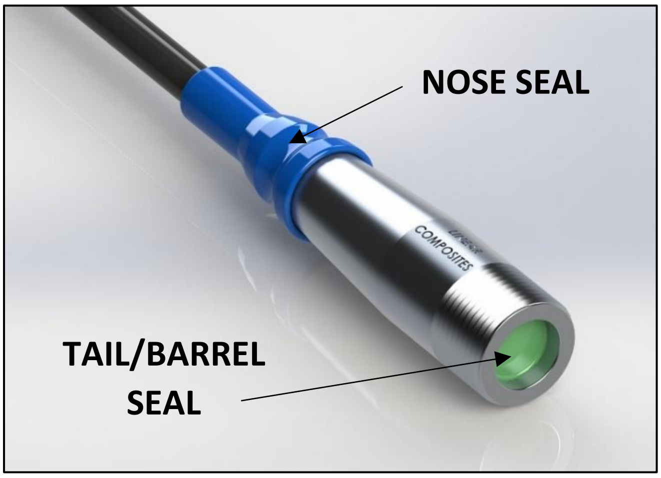
Linear Composites Parafil® Terminations must be fitted in strict accordance with the instructions document, issued with the Terminations.

A critical stage in the fitting process is a tensile pull on the assembled rope-Termination system. This stage is necessary in order to ensure a firm grip between the Barrel, Spike and core fibres and also to prevent any further dimensional change in the 'eye-to-eye' length of the terminated rope.

The final stage in the Termination fitting process is the application of water sealing systems (where required). It is good practice to take steps to prevent ingress of water into Terminations used on aramid fibre Parafil® ropes. The sealing is applied to two regions the junction between the 'nose' of the Termination and the rope and into the 'tail' end of the Barrel as shown in Figure 22. The nose seal is made of two components, a short length of silicone rubber which is over-wrapped by self-amalgamating tape while the tail seal is typically formed using a proprietary silicone mastic compound.

Full details on the Termination fitting process, along with proprietary seal product specifications are contained in the relevant Linear Composites product manual which is available on request.

Figure 22 ~ Parafil® Termination Sealing



12.3 In-Use Inspection

As with all engineering equipment, Parafil® ropes and Parafil® rope + Termination assemblies should be inspected on a regular basis for signs of mechanical damage, deterioration or corrosion of terminations.

The frequency of the inspections will depend on the location and the local environment and must be defined at design stage by the relevant specifying engineer. It is however, recommended that the inspection frequency should be no less than once per year.

A suggested minimum inspection protocol is shown in Table 8 however, different sites and different application areas will require other additional considerations.

Table 8 ~ Minimum Parafil® and Termination Inspection Protocol

Condition severity	Sheath condition	Termination condition	Action
Undamaged	Smooth black surface	No visible corrosion	No action needed
Slight/ moderate Damage	Abrasion or cutting of rope sheath – core fibres NOT visible	Light scratches, slight corrosion or damaged seals	Repair sheath, replace seals apply corrosion inhibitor to Termination
Severe Damage	Abrasion or cutting with core fibres exposed/ visible or damaged	Extensive mechanical damage, heavy corrosion, penetrative cracking	DO NOT USE rope assembly must be replaced.

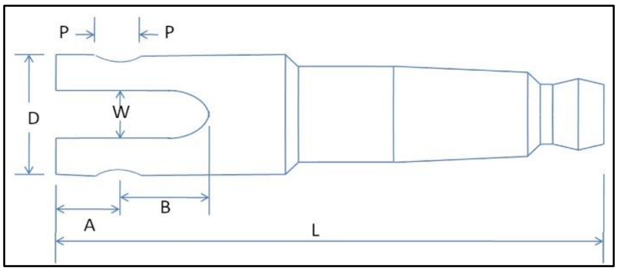
12.4 Design Life and Maintenance

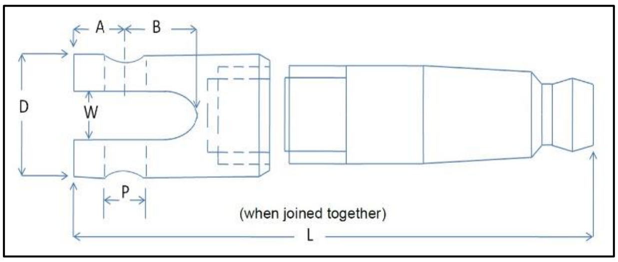
Parafil® ropes, combined with Linear Composites Terminations have proven track records of achieving continuous-service working lives of in excess of 40 years without the need for significant maintenance operations. Terminations are available in a variety of material types in order to match weight and environmental/corrosion resistance requirements.

12.4 <u>Type A</u> Parafil® Termination technical dimensions

Standard Type A Parafil® rope Terminations are made in a "one-piece" body design up to 30 tonne N.B.L. Beyond this N.B.L. the Termination body is composed of two separate parts. A key to the stated dimensions are shown in figures 23a (one-piece fork design) and 23b (two-piece fork design).

Rope Size	Termination Dimensions						Approximate Assembly weight including seals etc	
NBL Tonnes	L mm	D (Dia) mm	P (Dia) mm	W mm	A mm	B mm	Aluminium Alloy Kg	Steel Kg
0.5	79	19	6.4	7	8	13	0.04	0.11
1.0	98	22	8.0	8	10	16	0.10	0.17
2.0	123	30	9.6	10	12	19	0.15	0.34
3.5	156	38	12.7	17	16	25	0.33	0.63
5.0	188	44	16.0	20	20	32	0.48	1.13
7.5	224	54	19.1	23	24	38	0.79	1.45
10	254	60	22.3	26	29	44	1.16	1.87
15	305	76	25.4	33	32	51	2.10	2.75
20	340	86	28.6	36	36	56	2.95	5.22
30	416	102	38.1	42	48	76	5.40	12.8

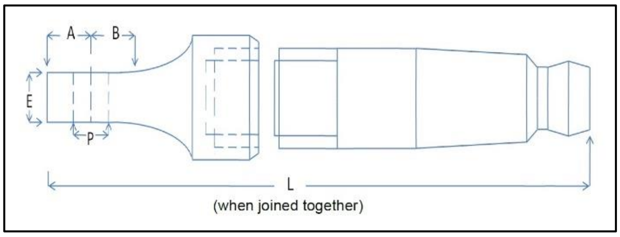


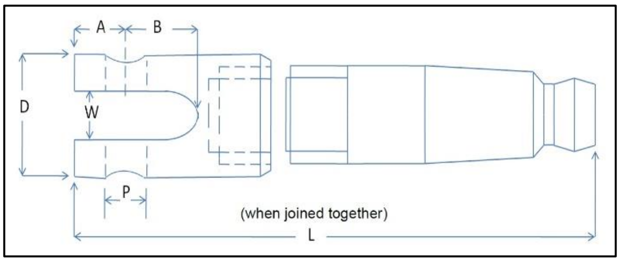


12.4 <u>Type F and G</u> Parafil® Termination technical dimensions

Standard Type F and G Parafil® rope Terminations are all made in a "two-piece" body design (except for the strengths marked with an *). A key to the stated dimensions are shown in figures 24a (two-piece fork design) and 24b (two-piece eye design).

Rope Size	Termination Dimensions						Approximate Assembly weight including seals etc	
NBL Tonnes	L mm	D (Dia) mm	P (Dia) mm	W mm	A mm	B mm	Aluminium Alloy Kg	Steel Kg
0.75*	74	14.2	5	4.5	6.5	13	0.03	N/A
1.5*	92	25	8	8.5	10	16	0.09	0.23
3.0*	132	38	12.8	17	16	25	0.25	0.57
4.5	151	41	15	18.5	18	29	0.33	N/A
6.0	168	44	16	20	20	32	0.45	1.1
10.5	225	60	22.4	26	29	44.5	1.0	2.4
15.0	257	76	25.5	33	32	51	1.6	4
22.5	305	83	28.7	36	36	56	2.4	6.1
30.0	371	102	38	42	48	76	4.9	12.25
45.0	440	127	44.7	48.3	57.4	89.4	8.4	N/A
60.0	501.36	146	51.2	55	63.5	101.6	13	N/A





Linear Composites Limited
Vale Mills
Oakworth
Keighley, West Yorkshire
BD22 0EB, UK

Phone: +44 (0) 1535 643363
Fax: +44 (0) 1535 643605

Email: sales@linearcomposites.com
Web: www.linearcomposites.com

MACCAFERRI