SAILSetc bowsie and Dyneema yield loads

Limiting loads for SAILSetc bowsies and Dyneema

Introduction

On the SAILSetc website **Dyneema line** is categorised by its breaking strain (technically speaking it is a load rather than a strain) and diameter. **Bowsies** are categorised by their size and suitability for different diameters of line.

Experienced sailors will know from historical performance what size line and bowsies work best for the different applications on their boats. The SAILSetc Rigging Guide gives guidance to help those who do not have this historical experience.

This document gives some insight into the way lines and bowsies behave and puts some figures to the limiting loads i.e. the loads at which bowsies slip and the breaking loads of the bowsies themselves.

SAILSetc plastic bowsie design

The design of the SAILSetc plastic bowsie provides high strength, grip and adjustability while keeping the windage low by having the line and the knot recessed into the surface of the bowsie itself. The method of rigging the bowsie also minimises windage by keeping the doubled lines next to each other rather than spaced apart.

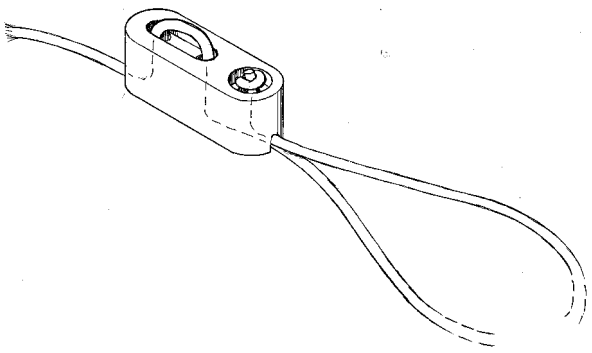

Figure 1 - SAILSetc plastic bowsie/line system rigged as intended

SAILSetc metal bowsie design

The design of the metal SAILSetc bowsie provides high strength and grip at a very small size. Ease of adjustability is lower than for the plastic bowsies and the likelihood of abrasion of the line is high leading to a risk of failure unless the bowies/line system is carefully used and maintained.

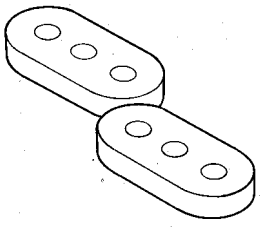

Figure 2 - SAILSetc metal bowsie

Bowsie manufacture/construction/use

57X - micro

The **micro** size **metal** SAILSetc bowsie is made by etching stainless steel. This produces a massively strong, minimum sized, bowsie that is well suited to making a termination in the upper end of a shroud on the inside of a metal mast. On an IOM this produces a low windage and weight termination that will withstand massive load without risk of failure – it can be used for flat wire, single strand wire or for seven strand wire.

The metal bowsie can also be used in a conventional way with line providing care is taken. The etching process leaves sharp edges to the holes which will easily cut the line under load and abrade it during adjustment. This effect can be reduced, but not eliminated, by de-durring the holes using a 1.2 mm diameter drill.

57-100 - micro

The **micro** size **plastic** SAILSetc bowsie is made by 3D printing using unfilled black Nylon. At present demand for this size of bowsie does not warrant the relatively large cost of having injection mould tools made. The tooling cost would be high because the holes in the bowsie need to be small for the part to work well and this would require precisely made and aligned pins for the moulds to function reliably in the long term.

The quality of finish is not as high as the injection moulded SAILSetc bowsies, but they work well and provide a means of adjustment for light lines where the loads are not large. Perfect for boats of 700 mm or less, and on larger boats where the load is low.

No special care is required in its use other than to respect the intended manner of rigging as shown in Figure 1.

57-120 - small

57-100 - medium

The **small** and **medium** size plastic SAILSetc bowsies are made in equal quantities by injection moulding. The tooling is super high quality and the parts are consistently formed using red or black glass filled Nylon which gives them a high breaking load.

No special care is required in its use other than to respect the intended manner of rigging as shown in Figure 1.

As the larger of these two sizes is less popular, we have excess stocks of the larger size which are priced lower.

SAILSetc Dyneema line

General

Dyneema line is now the only line supplied by SAILSetc. The lines are tightly braided from 8 strands of uni-directional filament and have a firm round section. Lines are stocked in 15, 25, 35, 55, 75 and 100 kg breaking load. We normally have a choice of colour for the lighter lines (yellow, orange, blue, black and white) but the 100 kg breaking load line is only available in white.

Dyneema has a far higher breaking load for a given weight/metre and diameter than Dacron. Of greater importance, although not necessarily as well understood, is the fact that Dyneema line has a much greater stretch resistance than Dacron. Whereas Dacron will stretch a lot under load, and actually continues to stretch the longer it is loaded even at the same load (creep), Dyneema stretches less and does not continue to stretch under a constant load. This is important if the rigging adjustments we make to tune the rig are to remain as intended.

Choice of line size

The lightest line supplied by SAILSetc has a 15 kg breaking load - this is large enough for almost all rigging loads up to and including those on A Class boats. However, there are many reasons why we choose to use heavier lines. These include:

Knots decrease the breaking load of a piece of rigging – this is usually expressed as a % reduction in the breaking load of the line and may be around 50%.

Stretch resistance – as mentioned above – is a more important consideration than breaking load. This is especially important for the main sheet line that comes off the winch drum where stretch resistance improves the consistency of the ‘full in’ boom sheeting angles.

Abrasion of the line will reduce the breaking load - it occurs wherever the line is in contact with another surface e.g. the main sheet post, fairleads, sheet attachments/bands, winch drum and is worsened where the line runs over the other surface.

Slippage of bowsies is related to the size of line – larger diameter lines have to pass through larger angles on any given size of bowsie and this affects the grip of the bowsie on the line.

Shock loads are greater than the static loads – short duration peak loads can be much higher than the static load in steady sailing conditions. These usually occur due to factors totally unrelated to the normal use of the boat e.g. when the boat is being handled out of the water and the rig is stressed by collision with fixed objects. They also occur at times of collision with other boats and during rescue by overworked and less careful boat crews.

The lines suggested on the SAILSetc Rigging Guide take these factors into account in the same way that experienced sailors will have developed their own sense of what are the correct lines to use i.e. by experience.

Tests

Bowsies and lines were rigged in the recommended way. A loop was formed in the single end and this was anchored to a fixed point. A set of luggage scales, maximum load 25 kg, was used to load the other end of the system.

The hook of the scales is made from 6 mm diameter steel. Repeating a test with a 1 mm diameter hook for the line did not change the slipping load, so it is thought the following results are representative for the way in which rigging loads are applied.

The following results were found:

Bowsie	Line	Slipping Load	Breaking Load
57X	D15	2 kg!	2 kg!!
57X	D25	3 kg!	3 kg!!
57X	D35	5 kg!	5 kg!!
57X	D55	9 kg!	9 kg!!
57-100	D35	3 kg	7 kg
57-100	D55	> 7 kg	7 kg
57-120	D55	8 kg	25 kg #
57-120	D75	11 kg	25 kg
57-120	D100	14 kg	25 kg
57-150	D75	11 kg	>25 kg**#
57-150	D100	14 kg	>25 kg

! There was no slip of the bowsie at the breaking load. Failure was of the line rather than the bowsie. The breaking load of the metal bowsie/line system seems to be about 20% of the breaking load of the line.

!! The true breaking load of the metal bowsie is thought to be in the region of 85 kg.

The slipping load applied did not break the plastic bowsie, so it was necessary to test for the breaking load of the bowsie in a different way. The method used was to tie a loop of line to each of the end holes in the bowsie, anchor one loop to a fixed point and load the other until breakage occurred.

** The scales used have a maximum reading of 25 kg at which load the 57-150 size did not break.

In all combinations several cases were tested. The loads quoted are the lower figures obtained.

Note that the slipping load seems to be entirely dependent on the breaking load of the line rather than on the bowsie itself. Nevertheless it is good practice to use the smallest bowsie consistent with other factors as this will reduce the weight and windage as well as reduce the chance of un-wanted adjustment of the bowsie/line system e.g. when it is off the boat and not under load or when being subjected to shaking/flutter.

Increasing the slipping load

Note that increasing the size of line increases the slipping load of the bowsie/line system. Avoid using light lines for crucial adjustments e.g. forestay, backstay, sheets.

Experience shows that the slipping load of well chosen bowsies and lines normally in use on the different classes is sufficient for all practical applications. That is, adjustment lines do not slip, and bowsies do not break, under load except in abnormal situations. It may be that slipping of adjustments in those abnormal situations prevents the failure of a more critical part of the rig or boat e.g. the rigging line itself or a mast or boom spar.

However, if it is required to increase the holding power of a bowsie/line adjustment at the end of a piece of rigging, this is best achieved by creating a 2:1 purchase as shown in Figure 3. This halves the load on the bowsie/line system and effectively doubles the holding power.

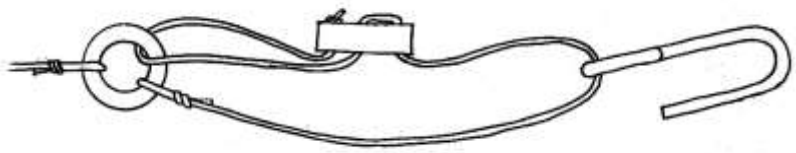

Figure 3 - 2:1 purchase system doubles the holding power

Use of the 46B ring at the end of the line on the left means it is easier to adjust the bowsie of the purchase system but is not required if adjustments will not be made regularly.

Maintenance

Once a bowsie has slipped on a piece of line there will be some abrasion, and therefore smoothing, of the bowsie. This reduces the slipping load of the bowsie/line system in the future. The bowsie should be replaced if the original holding power is to be restored.

end