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LIGHTER THINNER STRONGER

APCO's Anatoly Cohn unravels the mysteries of paraglider cloth

Since the first days of paragliding cloth has always been a major issue, so it makes sense to stop and take a closer look at it. Sometimes manufacturers like to present the issue as very complicated, high-tech stuff, but actually it is simple and uncomplicated. This article is designed to deconstruct the myths and jargon that surrounds paragliding cloth. We'll start with the basics. It helps to know first that the cloth used by the industry is commonly known as paragliding ripstop material – usually nylon with a ripstop square pattern.

WEIGHT AND STRENGTH

The lighter the cloth, the lighter the wing. The general belief is that light is good and means less volume, less bulk, less weight and more passive safety.

All paragliders are made from cloth made in a similar way. Basically, it is all woven from the same nylon filament (thread) – which is 30-denier filament of high-tenacity nylon, known as nylon 6.6. (Denier is a unit of textile measurement, and denotes the weight of the filament for a fixed length – the lower the denier number, the lighter, thinner and weaker the thread.)

Paragliders cloth is made from cloth woven in a typical ripstop pattern, generally thought to prevent runs – small tears. However, this is not necessarily the case and there is no problem making gliders from plain weave cloth (it even has some advantages – see the Porosity Testing box).

In any case, the weight of the cloth will depend on how tight the weave is. You can build the cloth (which can be imagined as a net) very tightly, placing each filament side by side with the next filament, or make a loose net with big holes.

The industry reference is that good-quality cloth should have at least what is called 100T count, meaning you have 50 threads weft and 50 threads warp constructed tightly per square centimetre of cloth.

If you want to produce lighter cloth it's easy: just reduce the count to a 40 x 40 thread construction per cm (usually referred to as ends and peaks) and you will have it 20 % lighter in no time.

You can go further and reduce the count even more, to 35 x 35 ends and peaks (some do). Obviously, the lower the count the lighter the cloth. It will also be cheaper to produce: less filament, faster to weave etc.

For the manufacturer this looks like the stairway to heaven: lighter cloth plus lower costs plus higher price tag on sale equals better profits

But there is a downside to this: the cloth will also be weaker and ensuring it is not porous will be a more difficult task. As they say, there's no such thing as a free lunch.

So, next time you buy a wing made from lighter cloth, be aware that its tensile strength and aging deterioration is in direct correlation to the thread count. Do not get confused by claims of 'high tech' this or that, or that it is lighter, but stronger and more expensive – it's never true. (The exception is when cloth is made from even lower number denier: 20-denier nylon 6.6 has been developed recently, but it is not really used for mass-produced standard paragliding wings.)

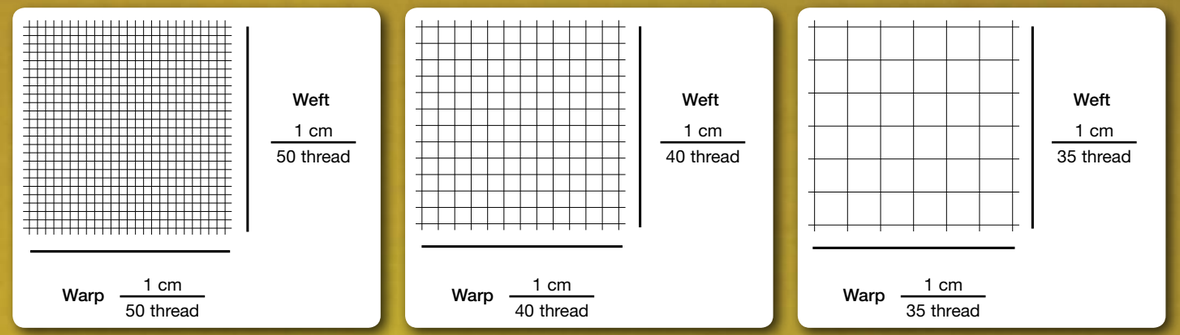
POROSITY AND COATING

For cloth to be used for paragliding it must be airtight. By definition the woven net is a net full of holes, allowing all the air to get through, which is not good.

To remedy that a coating needs to be applied to seal the holes. A lot of acrylic, polyurethane or silicon has been spilt over this issue, all trying to convince you that "our acrylic is better than their silicon" and vice versa.

In practice the coating has to be light, flexible enough to bend, have a certain elasticity and be resistant to deterioration and delaminating for as long as possible with prolonged use.

> "'Sexy' light cloth will be light with a very thin layer of coating"



The weight of cloth depends on how tightly woven it is. Industry standard is 50 x 50 threads. To make cloth lighter cloth manufacturers simply use less thread – 40 x 40 is common and 35 x 35 is used for some lightweight paragliders.

Again, there are no magic tricks. It is like having a slice of bread: the more butter you spread, the tastier the sandwich. You can use whatever you want to coat – acrylic or polyurethane – but the final result depends on how much of it and how many times you spread it on the cloth.

The coating process is relatively simple. Coating polymer, which is a creamy thick residue, is applied to the face of the cloth. The thickness of the coated layer is monitored and manufacturers decide what thickness of polymer they wish to apply.

'Sexy' light cloth will have a very thin layer of coating. Polymer has a certain weight and cost, and again the less applied the lighter and thinner (and cheaper) the cloth.

However, you have a much better chance of making airtight (zero porosity) cloth if instead of one layer of coating, two layers are applied. Three or even four layers are preferable and it is better if each coated layer is thicker. Each layer of coating is a time-consuming process and costs more, which has to be paid for by you at the end. In this way heavier, more expensive cloth is produced – but it will last longer and deteriorate a lot more slowly.

A number of different approaches have been taken in an effort to work out the magic formula of less weight (cost) in, more price (profit) out.

Today, no paragliding cloth manufacturer offers cloth with just one layer of coating – most use cloth with two layers of coating, but here opinion divides.

Some apply two layers of coating to the same side of the cloth. Others apply one layer of coating to each side. Applying two coated layers to one side is less expensive and faster than applying one layer to each surface. I guess the more expensive alternative is also the better one.

In the past some manufacturers used to go even further and constructed cloth from minimum 50 x 50 thread count and then coated four times: two coats of polyurethane polymer, one to each surface, and then again two coats of silicon, one on each surface to protect the polyurethane surface, providing the ultimate in paragliding cloth performance. They were known for the legendary durability of their cloth, but for a price and extra weight.

In conclusion, more coating and more layers means lower cloth porosity (more airtightness). But it will be more expensive to produce, heavier and thicker.

ELASTICITY

So far we have discussed two parameters of cloth – weight and air permeability. The third parameter is elasticity – the cloth's elongation under load in different directions and its ability to recover to its original dimensions when a load is not applied

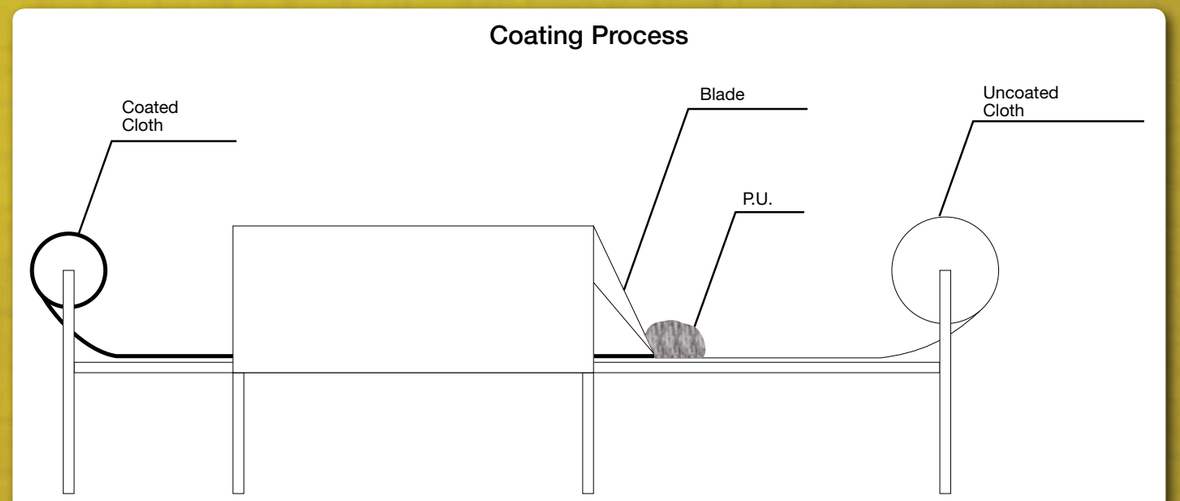
Again, there are a host of opinions regarding what is good and bad for paragliding cloth. Should it be rigid or is it better to allow some elasticity? Should it be crunchy, or is a silky-smooth feel preferable?

The answer depends on who you ask. This is what I think – and again, it's simple.

Since all types of paraglider and parachute cloth are made from the same nylon filament, the basic elasticity characteristics of the cloth before calendaring (a process where the cloth is folded in half and passed under rollers at high temperatures and pressure), coating and finishing will be quite similar.

Woven cloth before being finished (known as grey goods) will have quite low elasticity and good recovery parameters on both warp and weft (along and across the cloth). On the bias (the diagonal 45 degree direction to warp or weft), the cloth is not as stable. It is easy, if applying tension on bias, to change the dimensions of the cloth construction. Then, after the load is released, deformed cloth will not recover back to its original shape. The coating overcomes this problem.

The layer of coating material bonding the threads together creates a frozen-like construction and could be imagined as a thin layer of ice frozen on netting. The ice will make the net rigid in all directions (including bias) as well as



Cloth is coated with acrylic, polyurethane or silicon to make it airtight. How it is best coated - front and back or just one side – and with how many layers is a matter of much debate. More coats mean more durable cloth, but also make it heavier. In the basic process shown here the uncoated cloth is rolled through a mill, coated with polyurethane (PU), dried and then rolled again. It is then ready for use.

airtight. Properly made, coating locks the thread construction in a way that prevents the relative movement of thread in the woven cloth, making it more rigid in all directions, as well as airtight.

If you imagine that the cloth is coated with material like ice (rigid, but brittle), when applying load in different directions ice will crack contributing to the deformation of the cloth and increased air permeability.

So a certain degree of elasticity in the coating material is desirable in order to prevent cracking (known as white breaks – white lines on the cloth that mark the cracked edges of coating). And the ability of coating to stretch under load as little as possible without cracking and then to regain its original shape when the load is released is a desirable feature. A proper blend of minimal elasticity and good recovery characteristics will guarantee longterm performance of the fabrics. So you can see, the quality of coating is paramount to ensure the high performance of cloth over time.

CLOTH FOR THE RIBS

Bearing all that in mind, it is generally accepted that medium-soft crunchy-feel cloth with a certain degree of elasticity and good recovery is the best material for your wing. The ribs however are a different matter and here opinion is divided.

One school of thought believes that the cloth for the ribs should be as rigid as possible – with no stretch whatsoever. Other manufacturers use the same cloth for ribs and external surfaces.

SO WHO'S RIGHT?

At first look it seems logical that rigid cloth must be better for the ribs, because whatever shape is designed, cut and sewn into the profile should remain the same. The problem is that all the different types of rigid cloth have quite bad recovery characteristics. They tend to quickly distort under excessive load and do not regain their original shape.

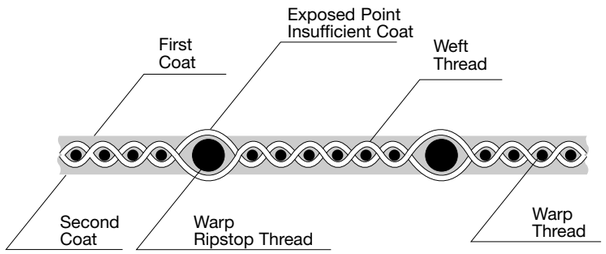
The process is accelerated when the cloth is crushed, crumbled, fluttered and shaken, generating an endless number of little coating cracks. The result is the wing's profile deviates from the designed profile.

Another argument against rigid cloth is that the designed rib profile is only defined where the rib is stitched between the panels. Any other cross-section in the wing will reveal a profile quite different to the projected profile – the result of inflated surfaces with a variable cross-section across the span. This means in any given cross-section across the wingspan there are different profiles or rib sections, and they definitely differ from the actual rib stitched in.

With stiff cloth, the designer only has control over the profile he stitches into the actual rib. The performance of the glider in general then comes down to trimming by the design team – a process of trial and error guided by experience.

So there you have it. A lot of work goes into making the cloth that makes a paraglider: take care of it and it will take care of you. XC

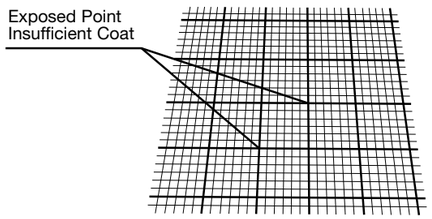
Cross Section of Ripstop Cloth



POROSTY TESTING

Check the porosity of your old glider the old-fashioned way – by squeezing moisture through the cloth by pressing a wet finger to the cloth surface – and you will notice that the moisture bubbles first on the cross-section of the thicker threads of ripstop construction while the rest of the surface is still airtight. This is because the thin layer of coating that the cloth has does not fully cover the thicker cross-section of ripstop junctions and these points give in first. This is why, over time, plain weave cloth with the same coating would probably give better porosity results for a longer time.

Ripstop Weave Cloth



A CLOTH GLOSSARY

Acrylic
Synthetic coating applied to some paraglider cloth

Bias
The diagonal direction in fabric

Calendaring
A finishing process used on cloth where fabric is folded in half and passed under rollers at high temperatures and pressures.

Cracking
Where the coating on a fabric cracks at the edges

Coating
A polymer coating applied to fabric to make it airtight

Denier
A unit of measurement – a single strand of silk is one denier

Elasticity
How far cloth stretches and how well it comes back to its original shape

Filament
A single thread

Grey Goods
Woven cloth before finishing

Nylon 6.6
Versatile commercial nylon known for its strength

Permeability
A measure of how airtight cloth is

Polyurethane
Synthetic coating applied to some paraglider cloth

Rib
The cloth between cells, commonly stiffer than the rest of the cloth in a paraglider

Ripstop nylon
Lightweight nylon fabric with interwoven reinforcement threads in a crosshatch pattern

Silicon
Synthetic coating applied to some paraglider cloth

Warp
Lengthwise thread in the fabric, through which the weft is woven

Weft
Horizontal thread in the fabric, that weaves through the warp

White breaks
White lines on the cloth that mark the cracked edges of coating