Impact Flutter Testing Article

IMPACT FLUTTER TESTING

DON'T USE SAILCLOTH WITHOUT IT!!

By:

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Background:

When I started my sailmaking career at ***Hard Sails*** in the mid sixties, testing sailcloth was non-existent. The "Old Timers" evaluated the cloth by feeling it's "Hand". If it felt good, we used it. Being a graduate engineer, this "testing" method seemed pretty variable and unreliable, to say the least! Convinced we needed a more scientific method of quantifying cloth selection, I designed and built a cloth testing machine that would measure the elongation on 2-inch wide cloth strips at varying loads. I cut cloth strips 2-inches wide by 16-inches long on the fill threadline (across the panel at 90-degrees to the edge), 10-degrees off threadline strip, 30-degrees off threadline strip, and the bias (at 45-degrees off threadline). As I gathered data, and began to compare the these tests results with the observed shapes in the sails we made, it became apparent that different batches of the same cloth from the same cloth manufacturer resulted in different shapes as the fabrics distorted, especially on One Design sails like my Star mains.

As my sails got used up, even more discrepancy in shape became apparent. Testing strips cut from my "blown out" sails revealed extreme changes in the fabric's

original strength with use. Obviously, testing strips of new fabric was not sufficient to judge the fabric's ability to maintain the designed sail shape with extended use, especially in heavy air. Testing strips from blown out sails, or hanging samples outside to flutter in the prevailing breeze produced data that was not repeatable, and, more importantly, was too late to avoid using a fabric with poor durability.

When I began ***Haarstick Sailmakers*** in 1970, it was time to go back to the drawing board. How to duplicate the same beating that cloth takes on the boat as it slams shrouds in a tack, or flogs when luffing before the start? The **Impact Flutter** machine that I built consisted of a large wheel with posts for the 4 strips as per above, which spun these strips at 30 mph into a table edge. With a cut off timer, it was now possible to beat every fabric tested for exactly the same amount of time, and compare the resulting tests with the new strip tests.

As data was collected on the various fabrics we were using, it became very obvious that there was even more variability between various batches of the same cloth after Impact Flutter testing, and it was not possible to judge the merits of any fabric without first measuring the Impact Flutter test results. After all these years, the Impact Flutter test is still the required procedure for accepting any Dacron woven or high tech laminate fabric at ***Haarstick Sailmakers***. As the cloth manufacturers still do not do Impact Flutter testing as a standard procedure, we pretest a yard sample before the cloth is even shipped to us, as the reject rate is too high to test after the cloth has arrived.

The time and expense of performing our Impact Flutter test for virtually every batch of Dacron and laminates before we purchase it, is not trivial, and the cloth manufacturers are not going to adopt any procedure as time consuming as this, just for one customer.

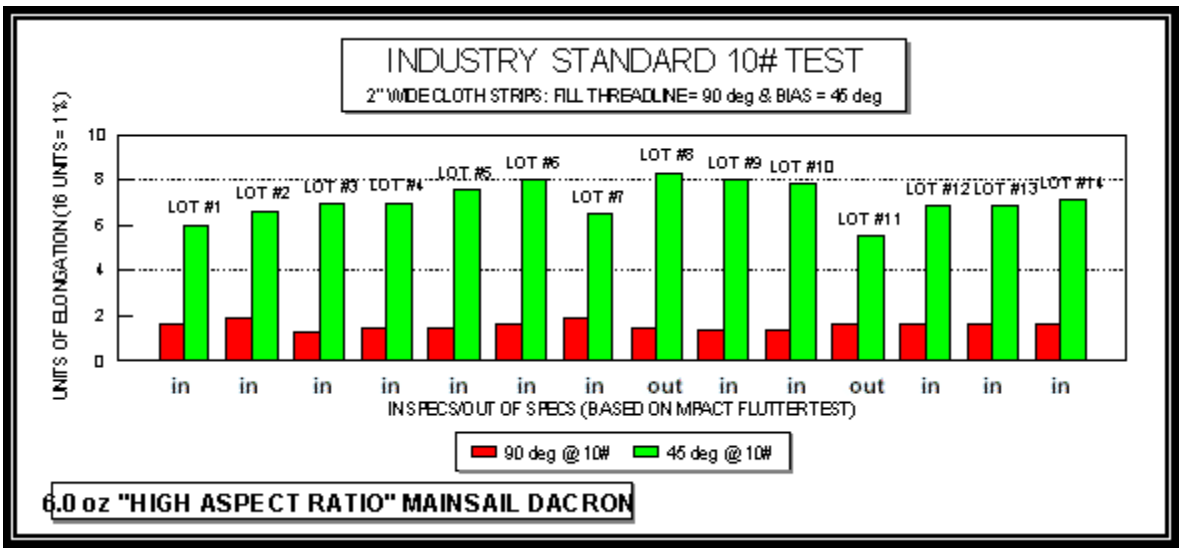
Beyond the costs, there are differing opinions on the value of Impact Flutter testing. Frankly, there is probably no in-house test that will fully duplicate the conditions that sails encounter on the boat. The Ultraviolet exposure, the flogging against the shrouds on every tack, the impact of the spreader tip, or the lifeline stanchion, the repeated creasing of the cloth when stuffed into the bag, and/or when stepped on, or slept on, all these events affect cloth in an adverse manner. Also, the velocity of the wind dramatically affects the degree of abuse. Any sail that is used in 20 knots and up will suffer loss of shape far faster than another that sees only light air. Many others feel that there is simply not enough variation between batches of the same cloth to warrant such an expense. Still others have moved away from any testing, as they purchase only what is needed to cut the sail orders on hand, carrying no left over inventory. If you have to purchase whatever cloth is available to meet your cutting deliveries, testing would obviously have much less importance.

However, after all these years of testing, I believe the Impact Flutter test is absolutely vital to qualifying cloth before purchase**. I KNOW THERE IS A BIG DIFFERENCE** between batches of the "same" cloth from the same manufacturer.

Buying "Blind" by not testing is crazy, if you believe in the quality of your product. The stretch properties of the cloth you purchase are the most important single element in the final quality and durability of your sail. You simply can't make a quality, high performance, durable sail from a poor batch of cloth!

Test Data:

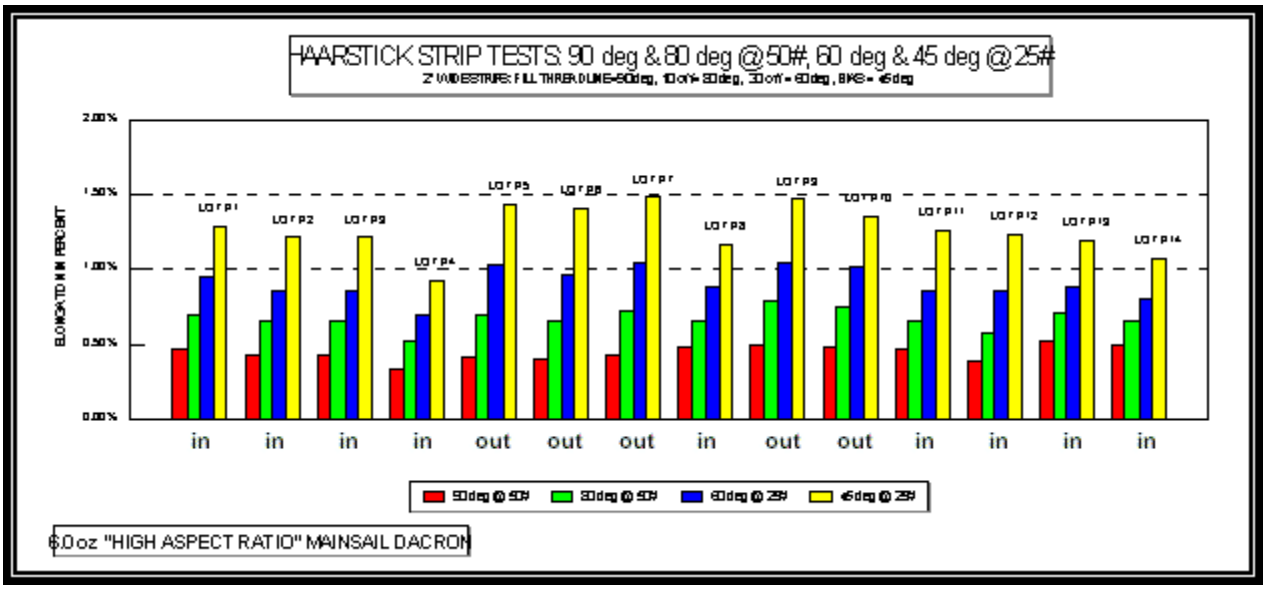
To illustrate the importance our Impact Flutter test makes in selecting the best cloth, let's look at test data we have recorded over a period of three years for twelve different lots of a 6.0 oz "High Aspect Ratio" Dacron commonly used in mainsails: **Chart #1** shows the manufactures “INDUSTRY STANDARD 10# TEST” data. These tests record the elongation of the "Fill" (which is 90-degrees to the cloth edge), and the "Bias" (which is 45-degrees to the cloth edge) at a 10-pound load on a 2-inch wide by 16-inch long strip of cloth. To demonstrate how this graph is used to choose cloth, let's assume we want cloth with a Bias stretch range of between 6 and 8. This selection criterion would eliminate 2 out of the 14 lots tested (lots #8, 11).



(**Chart #1** – Industry Standard 10# Test). Click Here to Enlarge

Now let's look at **Chart #2**: the next set of test data for these same pieces of cloth, labeled "HAARSTICK STRIP TESTS". The first thing to notice is that there isn't much similarity between the two graphs. The Haarstick Strip Test chart not only shows that more cloth strips are tested, but records these elongations (in %'s) at much higher loads than the Industry Standard test. These higher loads are necessary for two

reasons: The 10-pound load is nowhere near the actual load (per 2-inch strip) encountered in most sails using this weight of cloth, and, thus, data taken at this low load can not give any indication what the cloth will do at the higher sailing loads. Also, a 10-pound load is so small that mishandling the strip while loading it into the tester can alter the results. Increasing the recording load up to 50 pounds, reduces the effect of any handling errors while loading the strip on the test machine, and gives stretch data that is related to the actual load range of the sail.



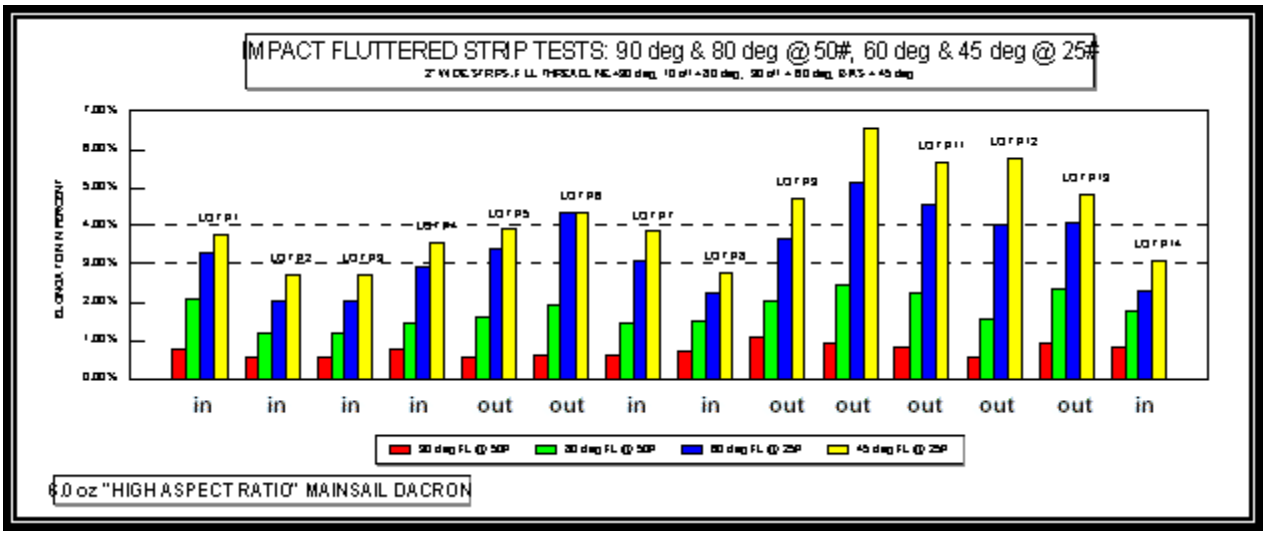
(**Chart #2** – Haarstick New Strip Tests). Click Here to Enlarge

Chart # 2 has two strips tested at the 50-pound load. The Fill strip, similar to the standard test is cut at 90-degrees to the panel edge. The additional 80-degree strip data, cut at a 10-degree bias angle, is very important. To predict what kind of distortion will occur in the leech area of the sail, we must know the relationship between the stretch on the 90-degree strip and the 80-degree strip. The two Bias strips are tested at half the threadline load, or in this case at 25-pounds. These two bias tests are necessary to predict not only the effects of distortion on the depth of the sail, but also on the movement of the draft fore and aft in the sail.

If we use this test data to select cloth, let's assume the cloth is “In Spec” if the bias (45 deg.) stretch is less than 1.25% elongation at the 25-pound test load. At this higher load, we get similar, but slightly different results: Lots: 5, 6, 7, 9, 10, are now “OUT”.

However, it is our “IMPACT FLUTTER STRIP TEST” (**Chart # 3**) as shown that will override all the selections made above. Look closely at this graph and you will quickly notice that it bears little similarity to the previous **Chart #2**. The Impact Flutter

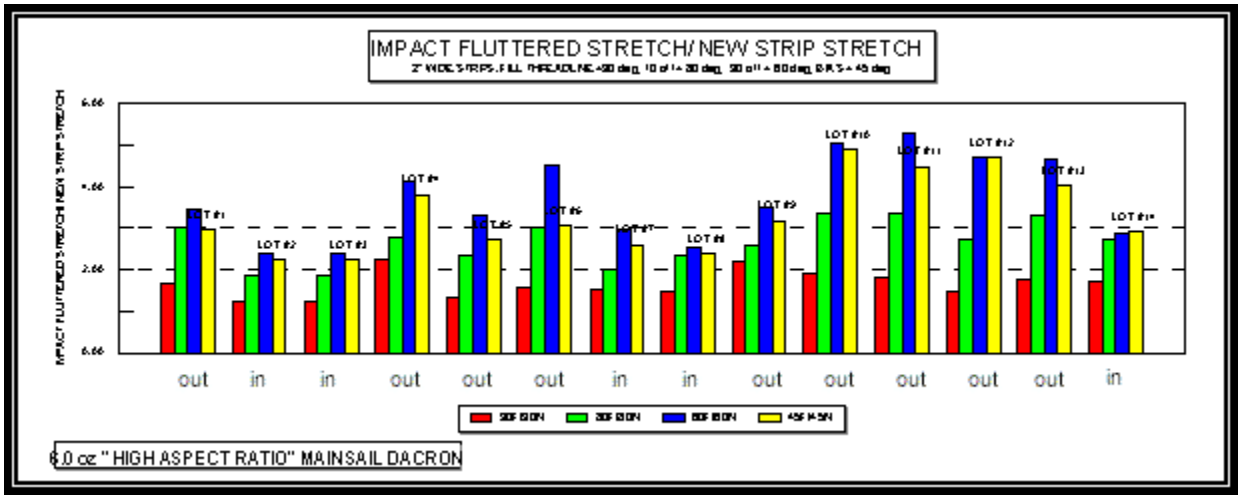
test rejects 7 Lots of cloth, almost 50% of the total lot's tested, 5, 6, 9, 10, 11, 12, 13. Four Lot's were out earlier, 5, 6, 9, 10, but now Lot's 11, 12, and 13 are also out. AND Lot 7 is now back "IN"



(**Chart #3** – Haarstick impact Fluttered Strip Tests). Click Here to Enlarge

The Impact Flutter tests show that initial tests on unused cloth are not reliable! The lower stretch samples do not always stay lower stretch after they have been fluttered. The finish in these samples may not be properly impregnated into the weave of the cloth, and the initial stretch properties just don't last. While this sample may look good when "new", it will rapidly loose strength, as the cloth is used on the boat.

How well each piece of cloth retains its original strength after severe use is the most important criteria for selecting the most durable cloth. It is more important than the comparisons of the new, or unused cloth properties. The more change occurs with use, the less durable the cloth. **Chart #4** shows the relative increase in stretch for each lot after Impact Flutter. This is where the finish and tightness of the weave really become the key ingredients of a superior batch of cloth. There is **ABSOLUTELY NO WAY TO DETERMINE THIS WITHOUT AN IMPACT FLUTTER TEST!! WITHOUT USING THE IMPACT FLUTTER TEST, WE WOULD HAVE PURCHASED THE WRONG CLOTH!!!** There is no way two identical designed and cut sails would look the same after one year of use. You don't have to be a One Design sailor to appreciate the importance of eliminating BAD CLOTH from your new sail!



(**Chart #4** – Impact Fluttered Stretch/New Strip Stretch). Click Here to Enlarge

FINAL COUNT OF "IN SPEC" LOTS TESTED: 2, 3, 7, 8, AND 14 = 5 LOTS OUT OF 14 TESTED. 9 LOTS ARE OUT. **ONLY 36% OF THE LOTS TESTED WERE FINALLY ACCEPTED.**

Summary:

This acceptance procedure is what makes ***Haarstick Sailmakers*** different from all other sailmakers. While others talk about their quality, none of them test cloth the way we do. Our quest to produce the finest sails, built only from the best cloth is what defines us. Buying cloth without this kind of testing is simply unacceptable at ***Haarstick Sailmakers***!

Making the cloth at the same time as the sail is built, is equally impossible for me to understand. How do you easily reject a bad lamination after the sail is built?? The importance of the cloth in the final performance and durability of the sail cannot be underestimated. All efforts must be spent to avoid using defective cloth, if you are really serious about the quality of your product. This approach may not have the "sizzle" of some of the new “molding” techniques, but I wouldn't have it any other way.