How to build

a laminated Glass Bow

INDEX

Design

Probably there are at least as many ideas on how the perfect bow should look, as there are bowyers around that build them. Besides that, it also depends a lot on what the bow will be used for.

But there are a number of significant parameters, that help to boost or damp certain characteristics of the bow. To discuss all the different possibilities how to design a bow would be way to much for this book. Besides that, designing a bow has a lot to do with experience made along the way and we can't get them just by reading a book. But still, I will try to explain a few of the most important parameters of a good design.

Bow Profile

The bow profile describes the form of the bow when it's unstrung. Together with the width and the thickness of the limbs, it's responsible for the characteristics of the bow during the draw and the release of the arrow.

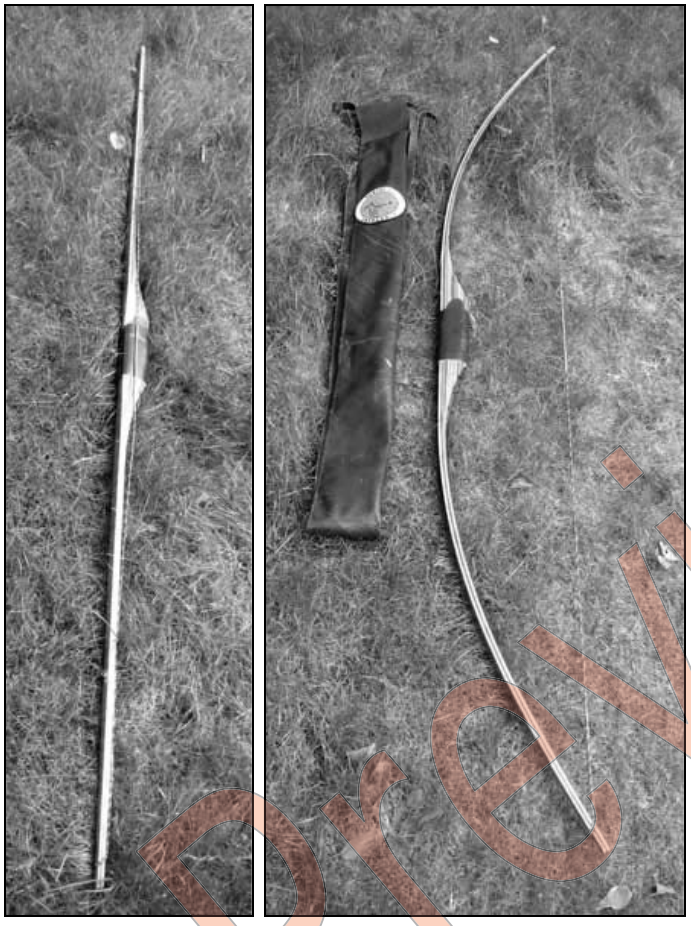
The Straight Longbow (Hill Style Bow)

The straight longbow is the simplest bow form and has some advantages, that make it the perfect starting bow. On one hand the straight longbow does have a very smooth draw , because the preload of the limbs is not as big as it would be in a reflex, a deflex/reflex or a recurve bow.

On the other hand these bows are of a well tempered nature and less sensitive to an improper shooting style.

This is due to the fact that even glass laminated bows take a little set after they are glued up. So if a bow is glued up in a straight form it will have a slightly deflexed profile after being shot in. This will make the bow less sensitive to a sloppy release (I will explain this further in the section about the deflex/reflex profile on page 11 + 12).

But this doesn't mean that this type of bow is only for the beginners. The great Howard Hill was a confessed fan of the straight longbow, why this type of bow is often called Hill style bow.



Picture 3: A classic Hill style longbow

On top of that the straight profile has the great advantage, especially for self builders, that the form for glueing up the bow is easy to build. No need to cut any curves and radiuses, that makes it much less complicated compared to a form for a deflex/reflex or a recurve bow.

It's also a lot easier to fit the riser piece to the form. Instead of sanding the riser piece until it fits perfectly, just cut it on a circular saw and it fits.

Bow Grip

The grip is probably the most underestimated part of a bow. A lot of people forget that it's the link between the archer and the bow and that it's abloutely critical for good and constant shooting. On the one hand the bow should lie absolutely stable in the hand of the archer, but on the other hand the grip should also be loose and not to tense.

To get good results and make quick progress it is very important that the hand of the archer holds the bow always exactly at the same place and in the same way.

Locator Grip

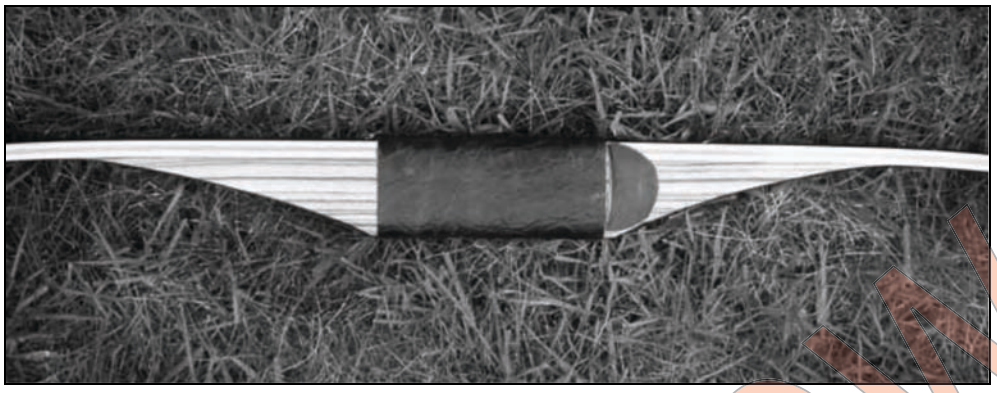
This grip has underneath the shelf a more ore less pronounced recessed grip and helps to guide the hand of the archer always in the same position.

Picture 10: Locator grip of a deflex/reflex longbow

The locator grip is probably the grip form that is used most commonly on longbows, because it helps a lot to always getting the same grip.

The straight Grip

This grip form is still used a lot on Hill style longbows. But contrary to the locator grip it requires an active and concious positioning of the bow hand. Novices or less skilled archers may face some problems to get constant results with a bow with a straigth grip.



Picture 11: A straigth grip of a Hill style bow

With a straigth grip it's much more difficult to place the bow hand always at the same place.

Pistol Grip

The deep cut pistol grip is mostly used on recurve bows. It allows the archer to get a good grip of the bow and supports a streched wrist of the bow hand.

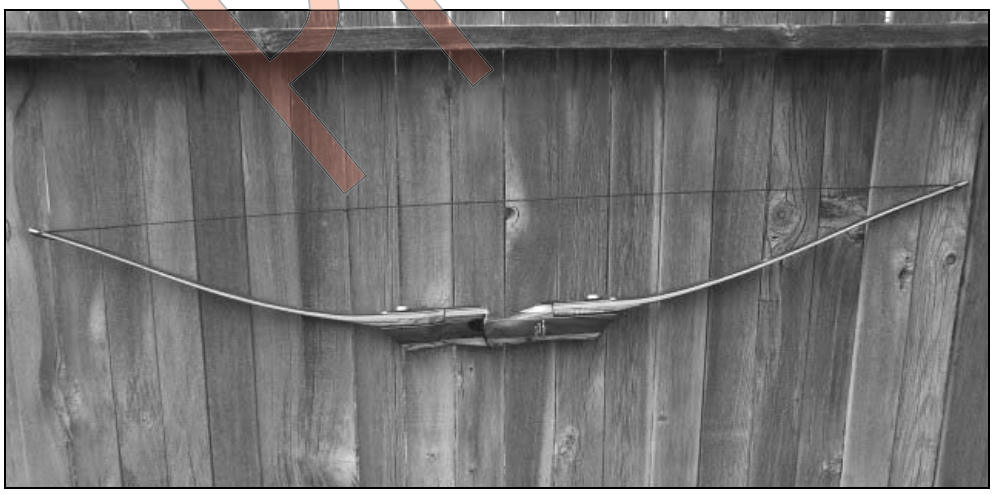
Picture 12: The pistol grip of a recurve supports a streched wrist of the bow hand

The alongated wrist allows the archer to hold the bow only with the thumb and the index. This helps to prevent unintentional canting of the bow. At the same time the bow arm and the bow hand are pointed straight onto the target, wich helps a lot if one is an instinctive shooter.

Reverse Grip

The reverse grip (or forward riser) is built forward on the back of the bow. The limbs are set back a little and therefore it helps to stabilize the bow in the same way like the deflex/reflex design does. The reverse grip is commonly used on recurve bows.

Picture 13: The reverse grips sets back the limbs and helps to stabilize the bow during the draw



Picture 14: The same principle can also be used on a longbow

What draw lenght ?

The required draw length is 27 inches. I will build the bow, so that it can be drawn up to 29 inches without stacking. To make sure that the lenght of the working limbs don't get to short I will reduce the length of the riser piece to 17 inches (instead of 18). By doing that the lenght of the working limb is only ½ inch shorter that it would be with a bow length of 66 inches.

What kind of wood ?

For the limbs I will use hard maple as core laminations and cocobolo veneers under clear glass.

For the riser I will use cocobolo with some stripes of carelian birch. For the riser overlay I will use the same woods. Since cocbolo is a very dense and heavy wood the riser will have more mass and therefore give the bow more stability and reduce handshock.

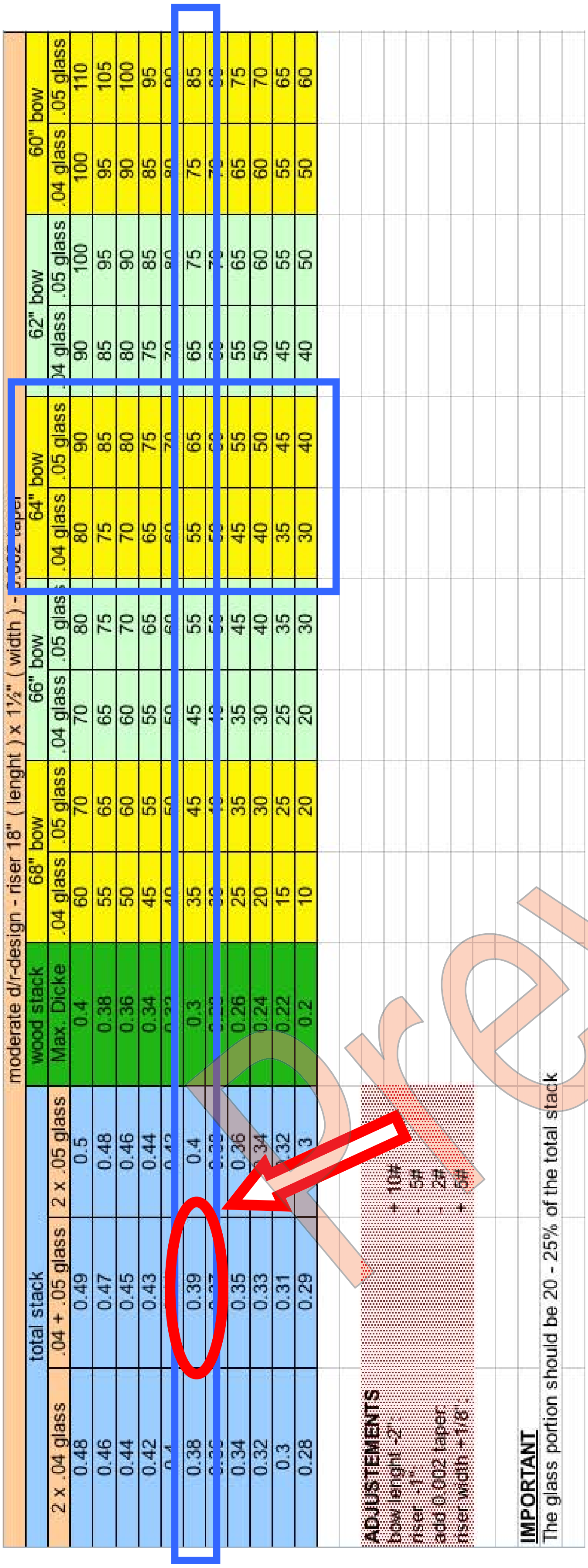
Now that we have defined the dimensions and the profile of the bow we can start to evaluate the thickness of the lams with the table on the next page. First we select the column with the bow lenght (64 inches) and mark the row with the desired draw weight (45 lbs). To compensate the stronger taper and the shorter riser piece we add approx. 7 lbs (see ADJUSTEMENTS underneath the chart). Finally we add another 10 lbs to make sure we have enough room for a correct tillering. So we end up with a theoretical draw weight of 62 lbs. In the according row (55/65 lbs) we can see that we need a stack thickness of 0.38 – 0.40 inches.

With a stack thickness of 0.39 inches, that equals a draw weigth of 60 lbs, we are very close to our theoretical draw weight of 62 lbs and we should be able to hit the target weight of 45@28.

As you can see at the bottom of the chart, the glass should make up 20 – 25% of the stack. With 0.04 glass we are at 20% and with 0.05 glass we are at 25%. With one 0.04 glass and one 0.05 we would exactly hit the middle, but for reasons of simplicity we choose 0.05 glass for the back and the belly.

Now we can calculate the thickness of the lams: 0.39 – (2 x 0.05) = 0.29 inches (total wood thickness).

For the limbs we use two core lams, two veneers and two unidirectional glass lams. By doing so we can split the total taper on the two core lams.



moderate d/r-design - riser 18" (lenght) x 1½" (width) - 0.002 taper													
total stack			wood stack	68" bow		66" bow		64" bow		62" bow		60" bow	
2 x .04 glass	.04 + .05 glass	2 x .05 glass	Max. Dicke	.04 glass	.05 glass	.04 glass	.05 glass	.04 glass	.05 glass	.04 glass	.05 glass	.04 glass	.05 glass
0.48	0.49	0.5	0.4	60	70	70	80	80	90	90	100	100	110
0.46	0.47	0.48	0.38	55	65	65	75	75	85	85	95	95	105
0.44	0.45	0.46	0.36	50	60	60	70	70	80	80	90	90	100
0.42	0.43	0.44	0.34	45	55	55	65	65	75	75	85	85	95
0.4	0.41	0.42	0.32	40	50	50	60	60	70	70	80	80	90
0.38	0.39	0.4	0.3	35	45	45	55	55	65	65	75	75	85
0.36	0.37	0.38	0.28	30	40	40	50	50	60	60	70	70	80
0.34	0.35	0.36	0.26	25	35	35	45	45	55	55	65	65	75
0.32	0.33	0.34	0.24	20	30	30	40	40	50	50	60	60	70
0.3	0.31	0.32	0.22	15	25	25	35	35	45	45	55	55	65
0.28	0.29	0.3	0.2	10	20	20	30	30	40	40	50	50	60

ADJUSTEMENTS

bow lenght -2":	+ 10#
riser -1":	- 5#
add 0.002 taper:	- 2#
riser width +1/8":	+ 5#

IMPORTANT

The glass portion should be 20 - 25% of the total stack

Picture 16: Chart to figure out the stack thickness fo a mild deflex/reflex bow

Building the Form

Before we can start building bows we need to build a form for the glue up. In the appendix I have attached the drawings for the form of the recurve and the deflex/reflex longbow.

For this we get ourselves a wood core plywood board with the following dimensions: 78 x 15 x 1.5 inches. I do not recomend the use of MDF because it will not hold it's form, or in worst case even break.

After we have copied the form of the bow onto the board, we can start to cut it out on the band saw. The more accurate we cut the form, the less we have to sand until the form is nice and smooth. With a drum sander even out possible dings and nicks. Don't forget to check, that the drum is square.

Picture 20: With a drum sander we even out possible dings and nicks

It is important that the curves run smooth and even and that they have no dings. Since the bow will be a exact copy of the form it is clear that more precise we work here, the better the bow will look.

On top of the form we glue a strip of glass, or a metal band, to get a nice and clean surface.

Finally we draw a parallel line, 2 inches away from the outline. On this line we drill wholes with a diameter of ½ inch. In these whole we insert wooden or metal rods that stick out 2 inches on every side of the form. On these rods we'll attach the rubber bands during the glue up

Picture 21: The form is ready for the glue up and we can start to build the bow

Another possibility to cut out the form is the use of a pattern router bit instead of a drum sander. Before we can cut out the form we have to cut a template of the form. After we have sanded and cleaned the form of the template, we screw it on the form so that we can use it as a guide for the pattern bit. If the bit isn't long enough we have to clean the surface in two passes. Like this we get a nice and clean surface that is perfectly square.

Building the Riser

For the riser we use a block of cocobolo with the following dimensions 1.5 x 2 x 18 inches and two stripes of karelian birch that we are going to use for the accent stripes.

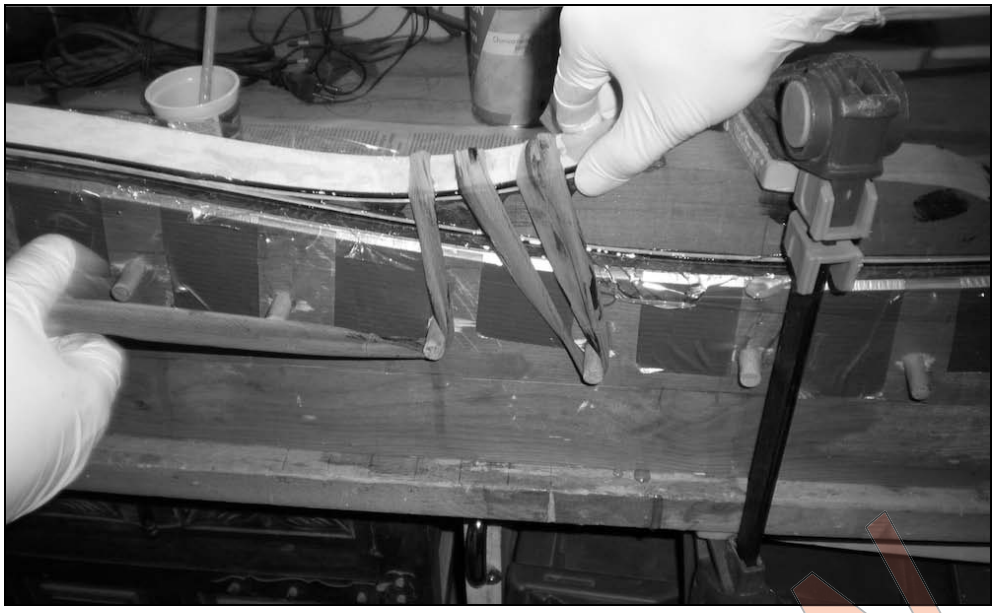
Since cocobolo is very heavy and dense, the riser will add stability and help to minimize handshock.

Because karelian birch is very brittle and porous I added it only as a decorative element in the riser block. By doing so the stability of the riser is not compromised.

Picture 22: The cocobolo riser block with the decorative accent stripes of karelian birch

After the glue has cured we draw the shape of the riser with a template onto the riser block. It is important that the radiuses of the fades run out in a continious curve that is not steep, otherwise we might run into some problems getting bad glue lines and glue joints. The fades of the template are about ¼ wide, this gives us enough room to sand the shape of the riser and the fades until eveything fits the form perfectly.

Now that the glass and the veneer of the bows back and the outer core lam are in the form, it's time to glue in the riser piece. With a clamp we assure that it stays in place while we're laminating the rest of the bow.

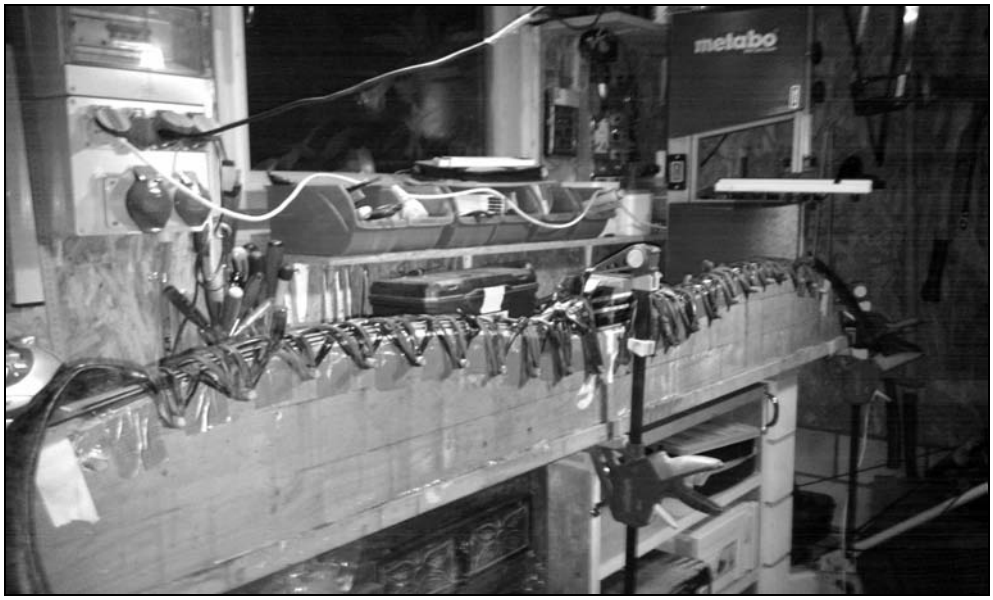


Picture 33: After fixing the riser piece in place with a c clamp we can start to laminate the rest of the bow. With rubber bands we press the lams into the form

Now we can laminate the two limbs one after the other. We proceed exactly the same way as before by applying epoxy to all glueing surfaces and laying the lams into the form.

After all the laminations and the glass are in the form we put a pressure strip on top of the whole stack. The pressure strip is 2 – 3mm thick and approx. half as wide as the lams. It helps to apply an even pressure on the whole width of the lams. With the rubber bands (bike tires cut in half lengthwise) we press the whole sandwich into the form. Begin to apply the rubber bands at the riser and work your way out to the tips.

This work is much easier if you have somebody that can hold the laminates in place, while you apply the rubber bands. Apply good pressure, but don't strain the rubber bands to much. It's better to apply a second, third and fourth band on top to get an even and good pressure over the whole length of the limbs.



Picture 34: The rubber bands are in place and apply a strong and even pressure, without damaging the lams or the glass or leaving pressure marks.

Now we can put the bow in the heatbox for curing. Smooth On needs tempering to get good glue joints with the best mechanical strength. I leave the bow for 6 hours at a temperature of 55°C in the box. Check the datasheet of the manufactor of the epoxy on how to cure it if you use another epoxy.

Picture 43: A chainsaw file has the perfect size for filing the temporary string grooves

We make the grooves about 1.5 – 2.0 mm deep and round the edges to protect the string from getting damaged.

Before we draw the bow for the first time, we check once again that the string don't jump out of the grooves. Then we carfully draw the bow for the first time.

Now we can check the tiller and how the limbs bend. Don't forget to have a look from the front and check if the limbs are well aligned or if they eventually twist to the side. The string should run perfectly above the centerline of the bow.

The limbs bend nice and evenly over the whole lenght, but towards the tips there is still some visible reflex left. Since the future owner plans to use the bow on tournaments in the longbow cathegory, we have to get rid of this reflex. By making the limbs narrower about 1 mm on the last 10 inches of the limbs we get them to bend more in that section.

After having drawn the bow a couple times, we check the draw weight with a bow scale. The draw weight is approx. 5 lbs above the target weight of 40 - 45@28. That is perfect and gives us some room to make the limbs a bit narrower towards the tips and for the fine adjustment of the tiller.

Picture 44: We draw the bow carefully for the first time and check the draw weight with a bow scale

Event though the limbs are tillered only roughly, we can see that the limbs bend nicely over the whole length and we can draw the bow up to 30 inches without stacking. The reason for this nice and smooth drawing lies in the deflex/reflex - profile of the bow. It also increases the preload of the string and therefore more energy is stored.

Tillering of the Bow

At the moment the draw weight is about 5 lbs above the target weight of 40 - 45@28 with a brace height of 7½ inches. We will lose a few pounds with the tillering and the final sanding and the bow will end up spot on the target weight.

Before we can start the fine tiller of the bow, we have to find out wich limb is the weaker one.

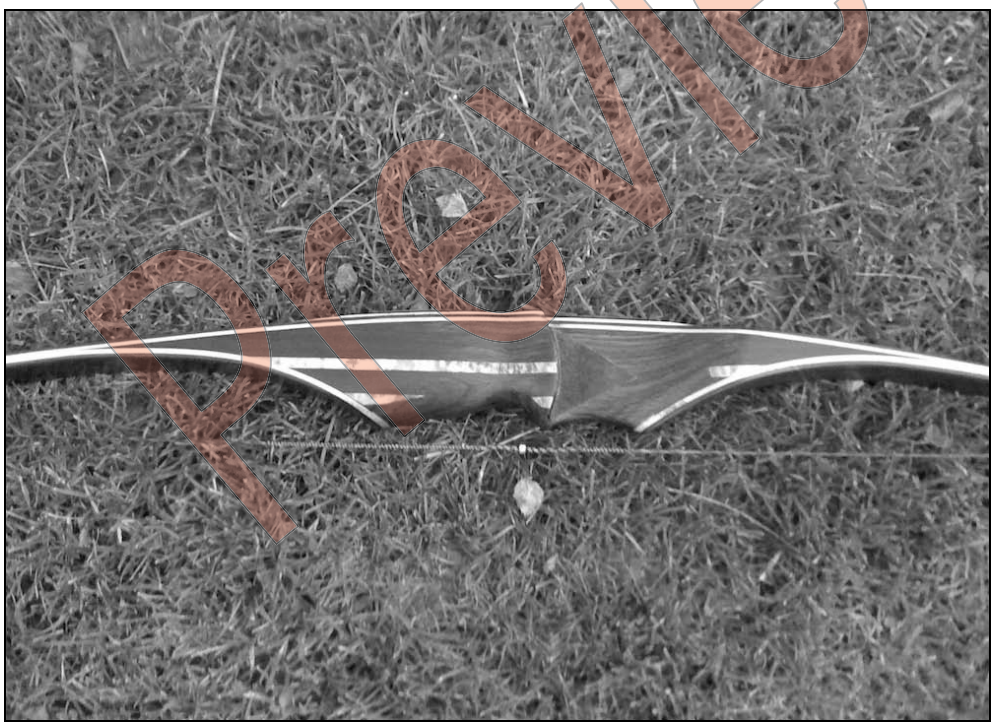
Picture 45: Checking the tiller

Picture 58: The finish is applyed and we let the bow dry in a dustfree environment

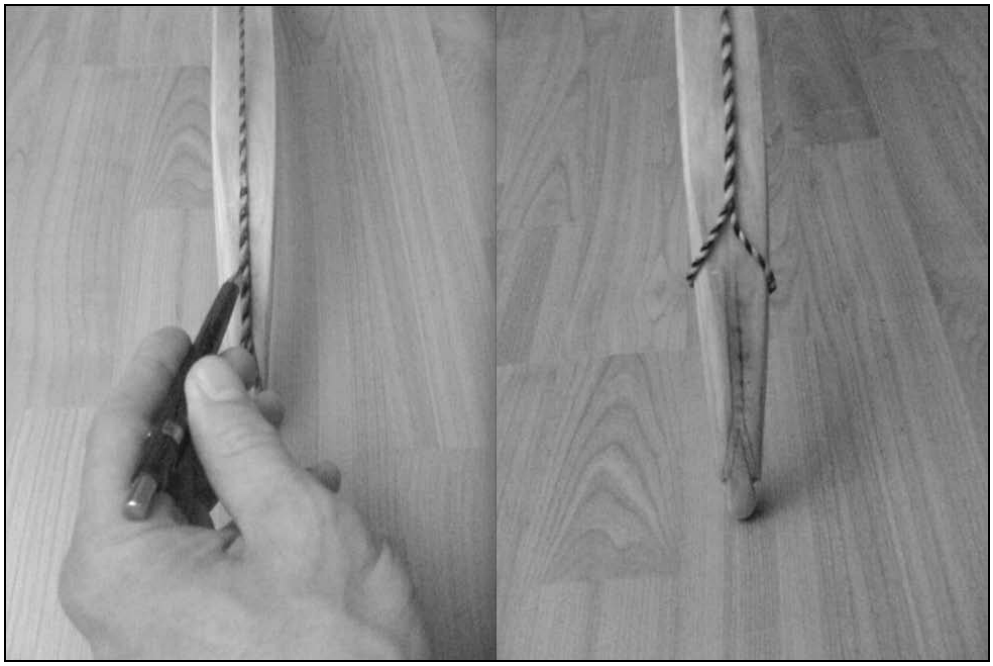
After the signature is on the bow we add another 2 – 3 coats in the same way as before. If the finish is to shiny, we can rub it off with a scotch brite flees and give it a nice satin look.

Picture 59: Signature and draw weight are written on the bottom limb

With an adhesive tape we put a hair rest on the shelf and the window.

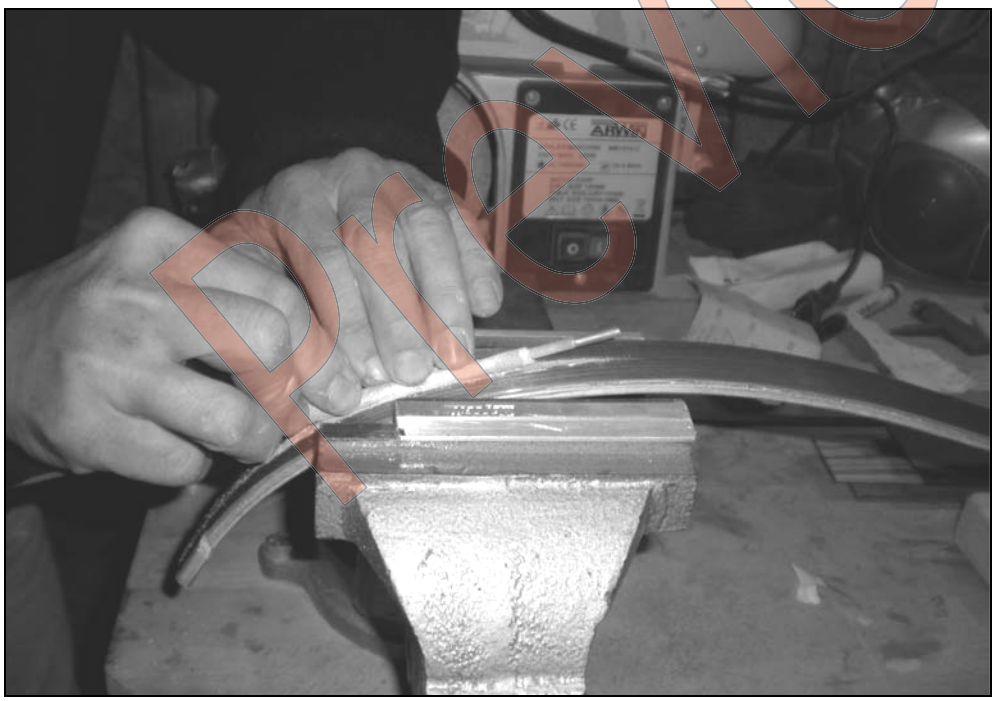


Picture 60: Cut the hair rest until it fits flawless into the shelf/arrow window



Picture 67: Marking the position of the guiding grooves on the belly of the limbs

With a chainsaw file we carefuly file in the grooves on the belly side where the string touches the limb. Make them about 1mm deep and assure that the grooves are straight and well centered.



Picture 68: With sanding paper we round off the edges of the string grooves