Tucker "Responsive Bracing System" for Flat Back Double Basses - A New Bracing System for Flat Back Double Basses

---

Preamble

Double basses fall into two main families; roundback basses which have a carved back like violins and cellos; and flatback basses which have a thin braced back like viols and violas da gamba.

Flatback basses have a great sound, use less wood for construction, but the backs – on average 5-6mm thick - have little inherent strength without some form of bracing. Traditionally, such basses have been cross-braced; spruce beams of varying heights, widths and profiles are glued with grain at right angles to the grain of the back wood. This is relatively easy to achieve, and luthiers have been doing this for hundreds of years, so why is this a problem?

Simple answer: air-conditioning, central heating, and rapid air travel. Before WW1 the only humidity changes an instrument would undergo would be seasonal, slow and rarely extreme. An instrument built in one climate would usually stay in that climate, and if it did travel, it would be a slow move by road, rail or boat.

Nowadays, instruments are regularly moved from humid home to air-conditioned classroom, to car to concert hall, and even from summer to winter, in a very short length of time.

For a large instrument such as a double bass, the sheer width of the back means that in extremes of humidity there is a huge propensity for the wood to shrink or expand - up to several millimetres across the grain - and more often than not this results in cracks between the cross-braces (the horizontal bars restricting the ability of the back wood to move where they are glued), or the braces themselves becoming unglued (where the sheer force of expansion or contraction releases the original glue joint), or the back caves in horribly under the stress.

Typical old ladder-braced back, complete with shrinkage cracks and loose braces

Luthiers have attempted to deal with this inevitable lateral expansion or contraction by; gluing up braces only in very dry climate controlled rooms; forcing a slight convex arc in the back wood; using thick, wide cross-braces; by using various diagonal and X shaped bracing systems ... and by instructing players to use all sorts of humidification, from damp sponges inside the F holes to expensive room humidifiers to a regular squirt from a spray bottle!

Often, the alternate bracing systems used appear quite massive, and it has always seemed to me this approach is fighting a losing battle, as luthiers simply cannot practically control the climate in which a player may use the instrument, or stop the wood from expanding or contracting. And trying to humidify inside the bass only is, from a scientific point of view, a totally ineffective panacea. At the Oberlin Double Bass Workshop in 2016 my main project was to repair a cross-braced bass of mine that had suffered the indignity of a bad shrinkage crack opening the centre back joint, and loose cross-braces, following a brief winter spell outside the climate controlled showroom in New York. In Ohio, on the other hand, in mid summer, I was not able to control the humidity in the workshop, and I felt that there was no point replacing the braces with the same system. So after removing the existing braces and repairing the cracked back, I decided to try something else.

A new cross-braced top, with split centre seam and a loose lower brace end, caused by one week in a non humidified environment ... a dry New York winter.

I thought, instead of spreading the pressure from the soundpost *across* the back grain and providing structural stiffness with lateral braces, why not try to spread the load and the tension on the back from the strings, ALONG the grain of the back wood? I reasoned that a pair of vertically oriented back braces could easily provide the required resistance against the push of the sound post, but I was concerned about how such a system would affect lateral stiffness and maintain the flat back shape just as well as cross braces. I had previously seen laminated falcate (curved) bracing systems for acoustic guitar tops. It seemed that by laminating and curving the back braces, I could distribute the stiffness across a much large section of the back, and they could also be made thinner and lighter, and their lateral flexibility would be sufficient to allow them to move with the plate under extremes of humidity.

The new bracing idea supports along the grain, not across it.

Of course the soundpost would need to rest on something; ideally connecting the two curved braces, leaving room for adjustment, but not anything glued crossgrain, so a thickening of the soundpost area with similar wood, between and linking the braces, seemed possible and sensible. (Although a crazy idea of a cross-brace floating on TOP of the braces was and still is appealing, the practical application of this, so far, has deterred any further experimentation in this direction!)

As the curved braces - like inverted parentheses - diverge at the extremities, I was concerned that the wider lower bout might need some extra bracing to protect the lower part of the back from external impact and deformation. I came up with the idea of an inverted boomerang-shaped brace to "fill the hole" so to speak. I didn't think it necessary to install an upper boomerang, as the upper bout of most flatbacks has a stiffening bend in it. If however the upper bout is not bent, a brace might be necessary. Although I am very wary of cross-grain gluing, I am comfortable with the general repair approach of gluing edge-feathered reinforcing cleats and patches with grain at an angle to that of the back or top, to allow for some movement without stressing the glue joints; I use diamond shaped spruce cleats for this reason, with the grain oriented at 30 degrees to the grain of the plate.

I decided that all components of my bracing system should be consistent with these design rules. But as the apex of the boomerang would be cross-grain, breaking the rule; I decided to cut out any part of the brace at a greater angle than 45 degrees, creating a "flyover" but retaining the connection between the two arms.

So, to recap the design concept; stiff bracing along the back grain, leaving the edges free to vibrate; pressure load spread across as many grains as possible; NO component glue joints oriented more than 45 degrees to the back grain to minimize differential shrinkage problems. The bracing system must also be attached using conventional hide glue and removable without damage to the bass back.

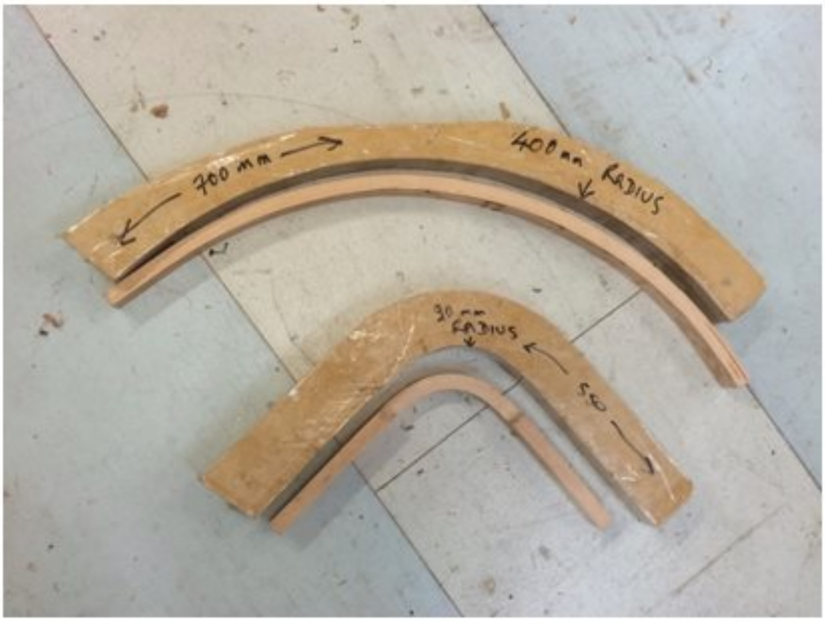
About the Materials Used:

Quarter cut spruce is a long-proven material for bracing on many kinds of instruments.

Modern laminating *epoxy resins* such as West System have been developed for, and proven in, applications such as aerospace and nautical engineering - far more harsh environments than the average musical instrument experiences.

An *epoxy/spruce composite* is stronger and stiffer than plain spruce in a vertical direction, reducing the necessary width, while the bent shape has some "give" allowing for lateral deformation of the braces to move with the grain of the back plate if required.

Making the Braces



The MDF molds and their respective laminated braces

I make a mold from 50mm MDF, 90mm wide, with an internal circular arc of radius one cubit (about 400mm), and length approximately 700mm, and cover it with packing tape as a glue release agent. Like a big thick "C".

A second mold is made with two arms approximately at right angles, joined by an approx *100mm* internal radius curved section **(This radius is easier to bend than the 90mm radius published in the original article)** , total length of this smaller mold is about 550mm. The exact shape is not so important. Parabolic is nice. Again, covered with packing tape.

On a table-saw, I cut 40mm x 3mm strips from quartered spruce, or cedar, long enough for each of the molds, and then I remove any rough surfaces. The strips are glued into the inside of the molds all at once, using West System epoxy and lots of clamps to keep the layers tightly together. I clamp from the middle outwards. I like to shuffle the order and orientation of the strips from the original unsawn plank for additional rigidity. Depending on the wood chosen and the thickness of the strips, it may be necessary to pre-bend the strips roughly on an iron before gluing. Thinner strips can be bent into the mold cold, but you need more of them. It is a sticky and smelly business. I make up two braces approximately 20mm wide, and the smaller boomerang brace, and leave to set overnight. (Titebond woodworking glue is also used successfully in wood laminating and appears to be suitable for this application if the components are well-prepared. I suspect both stiffness and weight of the resulting laminate may be a bit less, but this is probably not an issue. Titebond is not as good a gap filler as epoxy, so clamping technique is more critical)

When the glue has set properly hard, there is minimal spring-back. I clean off surplus glue and plane the faces completely flat. A jointer is useful for this.

I mark out the middle 100mm section of the boomerang - the bend that crosses the back grain by greater than 45 degrees - and cut out this "flyover" section on the bandsaw, about 10mm high. I sand this section neat and smooth and round the edges.

Placement of the braces:

Using a bridge blank, i measure and mark the bridge foot positions on the inside of the back. I mark out an area of soundpost adjustment about 10mm outwards from the extremity of the bridge foot, and and 40mm downwards.

I place the prepared, trimmed braces such that they are symmetrical and are as close together in the middle as possible, while remaining outside the marked adjustment area.

The ends of the braces work best approximately 60-80mm from the edge of the upper and lower bouts. The upper brace ends before the bend – if there is one – in the upper bout.

The boomerang brace is placed equidistant between the lower braces, again with the ends trimmed to the same distance from the edges as the other braces.

I try to have the three braces stiffen and support the back equally, sharing this function with the rib edges, so the braces end up dividing the back approximately in thirds between the C bouts, and thirds between the lower bout corners and the lower block. See the picture below for ideal placement.

Each of the three braces is then conventionally glued to the flat back using hide glue. There is no contamination whatsoever of the back plate with epoxy resin, and the bracing can be removed if desired without any damage to the back plate.

Shaping the braces:

Although these look a bit like curved bass-bars, they are performing a somewhat different function, on a flat surface. My "system", for want of repeatability, is to first shape the sides of the braces so that there is a nice pointed arch end to end, tall and thin. Then, I plane downwards from around a third of the way along the brace, aiming the plane at the edges of the plate.

Detail of brace layout showing the boomerang brace cut-out

The ends of the braces end up around 7-10mm tall. I even out the tops of the braces end to end in long swoops of the plane, leaving a flattish section in the middle. I trim the ends such that there are no straight lines aligned with the grain of the back. I sand the braces smooth, leaving some nice flat angles apparent. Same treatment for the boomerang brace.

Detail of brace shaping: ends can be finished in a variety of styles

The soundpost pad.

When the shaping of the braces is complete, I make a nicely shaped pad for the soundpost in the centre section between and touching both the braces, allowing an area for soundpost adjustment. I use the same type of wood as the back, to eliminate differential shrinkage, and align the grain very slightly off the grain of the back. I make the pad around the same thickness as the back, effectively doubling the back thickness at that point.

I clean up any glue blotches and install more angled-grain spruce diamond cleats as necessary to reinforce seams, and trim them to a feather edge.

The bracing system is now complete.

Conclusion

Now, if the back wood shrinks or expands, the braces can, in theory, move with it. If, like the top table, the back is glued on with a more dilute hide glue, then any extremes in wood movement should cause the seams to pop instead - which is a far better outcome than the braces ungluing, or cracks appearing.

The system has been installed in several basses to date, including one restoration, the backs remain stable and flat, and tonally the results are so far excellent; the backs become very "live" and vibrant while retaining the flatback "punch".

While it is too early to tell whether the problem of shrinkage cracks or rattling crossbars has been resolved, I believe it improves on previous bracing systems. I would love to hear from other people who wish to try this system.

This Article was first published in the Violin Society of America Journal "The Scroll" Volume 2, No 2, Fall 2017. This version of the article has several important amendments and additional observations.

To contact the author, email matthew@bresquebasses.com.au