# The height of perfection

Double bass repairers know the value of raising the saddle to help the instrument's sound open up – but how much do you raise it by? **Felix Habel** reveals the formula that can give an exact measurement every time

xxxxx

Raised saddles are a very common sight on double basses and are sometimes recommended as a miracle cure for any kind of issue. 'Problems with your bass? Put on a raised saddle!' Consequently there are a lot of strange theories surrounding it, but raising the saddle can be very effective in cases where the instrument's bridge is creating excessive downward force. If your bass feels stiff, 'choked', or not free-sounding when playing, or if the E string seems unbalanced, it might indicate excessive load on the belly. One reason for this may be that the double bass strings have an excessively steep break angle at the bridge. Anything steeper than 148 degrees might need adjustment (although there may be many other factors as well).

The main question has always been: how high should we raise the saddle? Too low and we don't achieve the maximum improvement. Too high and we lose focus and strength. Some people suggest simple trial and error: just cut the saddle down gradually until you're happy with the result. I find this method impractical, as you can easily cut it down too far, and then have to start again with a new saddle. It's also very time-consuming, as you need to adjust the tailgut at each step. Another approach is to use an adjustable saddle, but this usually offers only a few steps to choose from, with no intermediate heights. It also requires you to remove the original saddle, and presents the same problem as the previous method regarding the tailgut adjustment.

LOWERING THE TUNING PITCH LED TO SOME REMARKABLE CHANGES IN THE INSTRUMENT'S BEHAVIOUR

Around 15 years ago I had an idea to overcome this, but I didn't manage to develop the whole calculation to determine the saddle height. The starting point was valid though: I tried lowering the tuning pitch, and experienced some remarkable changes in the behaviour of the instrument. (Somebody might object that the strings themselves behave differently when tuned down. In my opinion this is not an issue as they usually stay within a semitone.) I felt my intuition was right, but I got hopelessly stuck trying to calculate the exact height of the saddle.

The problem stayed at the back of my mind, but I only got back to it recently, when a customer came in with a bass that had a sound issue, most likely caused by excessive downforce from the bridge. We tried tuning it down, and eventually the instrument opened up. Since I wanted to satisfy the customer, I finally managed to work out a formula for the optimum saddle height.

The formula I came up with (**figure 1**) might look quite complex at first glance, but saving it into an Excel file makes it much simpler to use. The calculation basically considers the geometry of the strings on the tailpiece side of the bridge (**figure 2**).

$$X=\tan\left[\frac{\pi}{2}-\left(\frac{\pi}{2}-\arctan\frac{b+h_p-c}{d}+2\left(\frac{\pi}{2}-\arctan\left(\frac{F_1^2}{F_0^2}-\tan\left(\frac{\pi}{2}-\frac{A_0}{2}\right)\right)-\frac{A_0}{2}\right)\right)\right]*\left[\frac{b+h_p-c}{\tan\left(\frac{\pi}{2}-\left(\frac{\pi}{2}-\arctan\frac{b+h_p-c}{d}+2\left(\frac{\pi}{2}-\arctan\left(\frac{F_1^2}{F_0^2}-\tan\left(\frac{\pi}{2}-\frac{A_0}{2}\right)\right)-\frac{A_0}{2}\right)\right)\right)}-d\right]$$

**FIGURE 1** Formula for calculating the raised saddle height. This formula, and a ready-made table for the calculation, can be downloaded at the link below

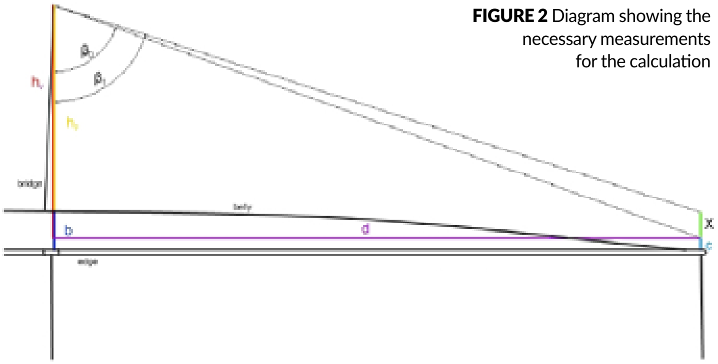


**FIGURE 2** Diagram showing the necessary measurements for the calculation

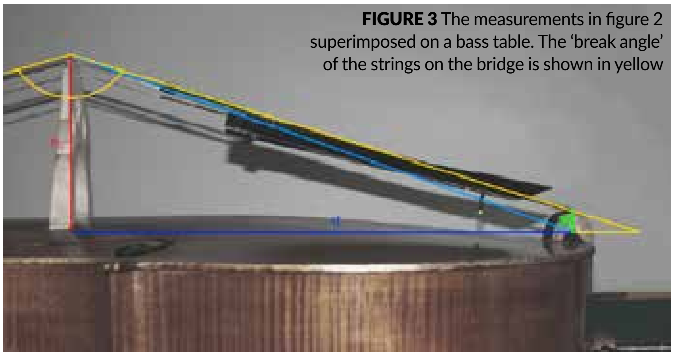

**FIGURE 3** The measurements in figure 2 superimposed on a bass table. The 'break angle' of the strings on the bridge is shown in yellow

With a few simple measurements from the instrument and some trigonometry, we are now able to calculate the exact height of the raised saddle. The first step is to determine the pitch at which the instrument works best ($F_1$). To do this you gradually tune down your instrument to a lower pitch and play the bass until you're sure where your instrument works best. Obviously there is a limit to this and it should be clear that you can't keep raising the saddle ad infinitum. Keep in mind that lowering the pitch one entire tone (392Hz) will result in a saddle 60.5mm high, on an average ¾-size upright bass, and with 21 per cent less downward force. A semitone would correspond to 32.7mm or 11 per cent. So we can reasonably move within a half-tone range, or most likely less. (If any major issues still persist on your instrument after this treatment, it may well need another kind of intervention, such as a stronger bass-bar or some other reinforcement of the front plate.)

Once we've found the pitch, we can calculate the downforce scaling factor: (lowered pitch)$^2$/(original pitch)$^2$. (Or $F_1^2/F_0^2$.) This enables us to calculate the new break angle of the strings, using a triangle of forces. As we could only change the string angle on the tailpiece side of the bridge, we should apply the whole difference between the old and the newly found string angle to that part.

To fill in our Excel file we still need to take some measurements from the bass: the break angle of the strings at the bridge ($A_0$); the height of the bridge (h); the elevation of the belly and the original saddle, minus the edge thickness (b); the elevation of the saddle (c); and the distance between the back surface of the bridge and the saddle (d). Don't worry about precision here: a couple of millimetres will not alter the result significantly.

| Measurement | Description | Units | Example value |
|---|---|---|---|
| $F_0$ | reference pitch | Hz | 440 |
| $F_1$ | pitch at which instrument works best | Hz | 425 |
| $A_0$ | string angle at bridge | degrees | 148 |
| h | bridge height | mm | 31 |
| b | belly elevation above edge | mm | 160 |
| c | saddle elevation above edge | mm | 10.5 |
| d | distance from back of the bridge to saddle | mm | 500 |
| | calculated downforce scale factor | | 0.93 |
| x | height of the raised saddle above original | mm | 19.9 |

But is it really so important to get the exact height of the raised saddle? When I worked on the customer's bass, I tried taking a short cut, and made a drawing to determine the optimum saddle height instead of working on the formula. I ended up with a saddle some 4mm higher compared to the result of the calculation. When I finally succeeded in developing the formula, I decided not to cut the old raised saddle down, but to make a new one. I wanted to have a comparison, just in case. With the higher saddle the instrument showed some improvement but it seemed to have gained at one side and lost at the other. The result was not really satisfying and did not quite match what we established in the empirical way, by tuning down the instrument. As I put on the raised saddle resulting from the formula, the sound opened up completely! It was exactly the result that we expected from our testing. So I feel confident in saying the exact height is crucial to achieve the maximum improvement to the bass sound. ●

*The Excel file containing the formula can be downloaded here:* bit.ly/XXXXXX

CREDIT XXX