The Relative Stiffness of Violin Tops and Backs

By John Schmidt, Laurinburg, NC, USA, January 7, 2014

It seems to me that a stiffer violin back should require a stiffer top. We know that there is a variation in the stiffness of tops of good old Cremonese violins. What we do not know is the relationship of the stiffness of the backs of each corresponding top. Since violin tops are glued on with weak glue, in anticipation of their later removal for service, we have data on tops. But since backs are usually glued on with firmer glue, not designed for removal, we do not have much data for famous violins.

But at least a few good modern violin makers keep data on their violins, the following data analysis might be very useful. Namely, gather mode 5 frequency data and mass for tops and corresponding backs. In addition, make an estimate of the quality of the sound. Four categories should be sufficient – excellent, very good, average, poor. Or soloist, orchestra professional, advancing student, and poor.

Whether or not "stiffness" is the correct term, "ktop" is defined here by

ktop = (mass_top * (M5topfrequency)^2)/10,000,000

kback = (mass_back * (M5backfrequency)^2)/10,000,000

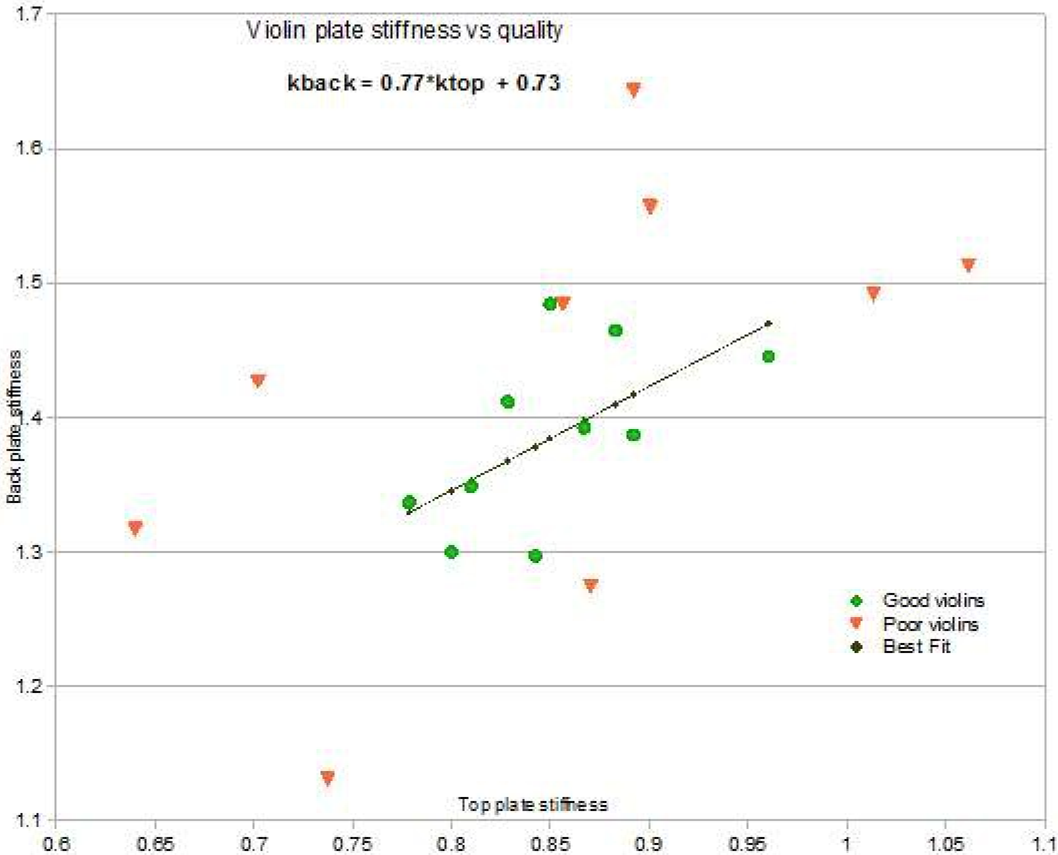
The quantity mass*freq^2 can be derived from the harmonic oscillator equation

$$\omega = \sqrt{\frac{k}{m}} = \frac{2\pi}{T}.$$

So that k of a harmonic oscillator is analagous to ktop and kback. K is the stiffness of a spring and by analogy, ktop is related to the "stiffness" of the top. I am taking quite a jump here. No formal derivation will be given. The plates vibrate and are harmonic oscillators. I leave it to theoreticians to show the link, if they feel compelled. Galileo may have guessed that a large ball and a small one fall at the same rate, and then he tried it out. Years later, Newton provided the theory of gravity. For violin making, it is more important to know what the actual result is, and how to achieve it, than knowing the theory behind it.

So, you have the mass and frequencies of M5 for both plates. Now plot the ktop vs kback data points. Look for patterns. Here is the current plot, as of January 7, 2014. The green dots are for good violins. They appear to be clustered. The red triangles are poor violins. These points are spread out, not clustered. The line of best fit for the green dots is

kback = 0.77 * ktop + 0.73



Stiffness Factor is Probably Only Part of the Picture

Just my guess, but I think the stiffness relationship of top and back is not important for frequencies above about 600 Hz. So, if the hypothesis about stiffness of top and back is found to be important, then we can probably say

- All "good" violins must have the proper stiffness relationship. Well, they must be in the range of acceptable values.
- Some violins will have plates within the range, and will have good characteristics up to 600 Hz, but fall short in tone and power above 600 Hz.
- Violins outside of the range will NOT be good.

So, this stiffness relationship is a minimum for a good violin. A violin may be in the right region on the stiffness graph, but other things may prevent it being a good violin.