

## Silk strings vs. Gut and Synthetic strings

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A taut string has energy that is spent on: 1) vibrations of the string body, 2) overcoming the internal resistance of the string, 3) other losses associated with the design of the instrument (friction of the string on the surface of the nut, bridge, bending and vibration of the soundboard and other parts of the instrument), which we will not consider.

String vibrations (caused by plucking or friction of the bow) are associated with vibration of its surface. This, in turn, causes vibrations of the air with different frequencies, including the sound spectrum. The larger the diameter of the string, the larger the surface of its contact with the air, and the stronger the vibration of air waves (louder the sound). However, other qualities of the string besides its diameter also affect the quality of the sound. One of the most important qualities is the density of the string, that is, the ratio of its mass to volume. Steel strings have the highest density: a piece of steel string of a given length and diameter weighs significantly more than the same piece of string made of synthetic or natural fibers. Why is this so important? The fact is that most of the string's energy is spent on overcoming internal resistance. During string vibration, the fibers rub against each other, wasting energy on heat instead of amplifying the sound. In addition, another part of the energy is spent on stretching and contracting the fibers during vibration. This expenditure is greater, the more elastic the string.

Does this mean that steel strings are the best in all cases? No. It is precisely because of their high density that these strings produce a very high spectrum of accompanying frequencies, ignoring low harmonics. In other words, they do not sound as soft and warm as non-metallic ones.

However, let's get back to fiber strings. Their density can be increased in two ways: 1) firmly fasten the fibers together (for example, with glue), 2) choose fibers with a minimum degree of stretch. The first condition is met by strings made of natural fibers - gut and silk. They have intercellular spaces that absorb glue well. Synthetic fibers, on the contrary, have a monolithic structure that does not hold glue well. Therefore, when producing strings, synthetic fibers are held together only by a metal winding.

As for the second condition, natural silk strings come first, which are much less stretchable, and are also one and a half times stronger than gut strings. For example, a gut string with a diameter of 0.8 mm breaks under a tension of 8 kg, and a silk string - 12 kg. Therefore, *in most cases, strings made of natural silk are preferable* to gut strings. They have a higher density, and therefore sound brighter and louder.

NOTE: In cases where the requirements for volume and string tension are not so critical, and low harmonics are important (low bourdon strings in a hurdy-gurdy), the choice may be in favor of gut strings.