Note the negative sign between the reactance, X and the susceptance, B formulae. Note also that the units of Z, R and X are kg/sec. The units of Y, G and B are therefore sec/kg.

For a given mode, n of a vibrating string on a guitar, which has a quasi-free end support located, say at x = L, which is now mechanically connected to other portion(s) of the guitar, then it can be shown that the transverse velocity of the quasi-free end support, located at x = L, for the mode, n of the vibrating string is given by:

$$u_{ny}(x = L, t) = \alpha G_n F_{ny}(t)$$

where $F_{ny}(t)$ is the vertical component of the force acting on the quasi-free end support located at x = L, associated with the vibrational mode, n. The dimensionless parameter, α is a constant of proportionality, and G_n is the conductance associated with that mode, n.

In general, it is very difficult to *apriori* reliably predict, in a "first-principles" manner, what the conductance, G_n, the transverse velocity $u_{ny}(x=L,t)$ and transverse force, $F_{ny}(t)$ will be for a given vibrational mode, n for an actual guitar, be it an acoustic or and electric guitar. These things will depend on the details of the design and construction of the guitar, the totality of the materials used to build it - different kinds of wood, how they are oriented, various types of glue(s), the finishes used on the surfaces of the guitar, etc. It is easier, and more reliable to experimentally measure e.g. $u_{ny}(x=L,t)$ and $F_{ny}(t)$, and then compute G_n (assuming α is known).

The decay time constant, $\tau_n^{support}$ associated with energy loss through a quasi-free end support physically attached to other portions of the guitar, for a given mode of vibration, *n* is given by:

$$\tau_n^{support} = \frac{1}{8 m_{string} f_n^2 G_n}$$

If the conductance, G_n of the quasi-free end support is large for the vibrational mode, n of the string, then the decay time, $\tau_n^{support}$ is short for this mode. Note that this decay time varies inversely as f_n^2, i.e. it has quite a strong frequency dependence, compared, e.g. to viscous air damping of the vibrating string.

Magnetic Damping Effects of Vibrating Strings on Electric Guitars

The pickups on electric guitars have permanent magnets which magnetize the strings of the guitar. The material used for electric guitar strings therefore must be magnetically permeable - typically steel, stainless steel on the three higher, small-gauge plain strings, and steel or stainless steel core wrapped with either steel or stainless steel, or pure nickel or a nickel alloy on the three lower, larger gauge wound strings.

Interestingly enough, the magnetic field of the pole piece of the pickup induces a *magnetic quadrupole field* (i.e. a linear {N-S} + {S-N} configuration) in the magnetically permeable strings of an electric guitar! As shown in the figure below, there are *two* South poles induced in the string in proximity to the North pole of the rod magnet. Due to the magnetic permeability (μ) properties of the electric guitar string, the string becomes a *magnetic flux tube*, *confining* the (majority of) magnetic field lines *inside* the string, thus connecting each South pole to its companion North pole, one at each end of the string!