If r, the mechanical resistance, is very small, Formula 1 may be written

$$\tau = \frac{1}{\frac{n^2}{n_0^2} - 1} \qquad (2)$$

where n_0 is the natural frequency of the machine upon the elastic pad,

$$n_0 = \frac{1}{2\pi}\sqrt{\frac{1}{mc}}.$$

In most cases of design of resilient machine mounting the effect of frictional resistance is small, and Equation 2 may be used. In such cases it is only necessary to know the natural frequency of the elastic pad or platform used under the desired loading and the transmissibility for any vibrational frequency of the machine may be obtained. However, this formula gives the theoretical maximum insulation which may be obtained and should be used with a liberal factor of safety. (A factor of 2 is common practice when the ratio is converted to decibels.)

If the pad is to be of any value in the prevention of solid-borne vibrations, the value of τ' must be considerably smaller than unity. If the fundamental frequency of vibration generated by the machine happens to coincide with the natural frequency of the mass of the machine resting on the elastic pad, a condition of resonance will be established, and the machine will exert a greater force upon the foundation than it would if the pad were completely removed. It is necessary, therefore, that the elastic support be sufficiently compliant, and the mass of the machine

TABLE 2. COMPLIANCE AND RESISTANCE DATA FOR TYPICAL SPECIMENS OF FLEXIBLE MATERIALS[a]

The compliances and resistances given in the table are for specimens 1 in. thick and 1 sq cm in cross-section

MATERIAL	DESCRIPTION OF MATERIAL	APPROXIMATE UPPER SAFE LOADING IN POUNDS PER SQUARE INCH	COMPLIANCE c IN CENTIMETERS PER DYNE	RESISTANCE r IN ABSOLUTE UNITS
Corkboard	1.10 lb per board foot	12	0.25×10^{-6}	0.15×10^{5}
Corkboard	0.70 lb per board foot	8	0.50×10^{-6}	0.25×10^{5}
Fiber Board	1.35 lb per board foot	4 to 6	0.60×10^{-6}	0.50×10^{5}
Fiber Board	Carpet lining	10	0.40×10^{-6}	.....
Fiber Board	Insulating board	12	0.18×10^{-6}	.....
Fiber Board	Insulating board	15	0.16×10^{-6}	.....
Fiber Board	Insulating board	15	0.12×10^{-6}	.....
Anti-Vibro-Block	.....	5	0.60×10^{-6}	1.5×10^{5}
Sponge Rubber	25 lb per cubic foot	1 to 3	3.0×10^{-6}	.....
Soft India Rubber	55 lb per cubic foot	3 to 6	1.2×10^{-6}	.....

[a] From *Architectural Acoustics*, by V. O. Knudsen, p. 278.

sufficiently heavy, that the natural frequency of the mass m upon its elastic support will be low in comparison with the frequencies which are generated by the machine. Thus, if the principal vibrations in the machine be of the order of 100 vibrations per second, the natural frequency of the machine mounted on its elastic support should not exceed about 50 vibrations per second, and for best results preferably 20.

When the forced frequency is low, it is frequently impossible to insulate for the fundamental forced frequency due to connecting pipe work and other relevant factors. In cases of this kind an effective installation of sound insulation may be obtained with a mounting which functions far above the fundamental forced frequency. For example, a compressor operating at 500 rpm has a forced frequency of 8.3 vibrations per second. By designing a mounting having a natural frequency of 20 to 25 vibrations per second, it is possible to isolate practically all of the noise.

The elastic support under the machine acts as a low-pass filter which passes all frequencies below about two times the natural frequency of the machine mounted on its elastic support, but prevents all frequencies above about $\sqrt{\frac{mc}{\pi}}$ from reaching the solid structure of the building. The principal influence of the internal mechanical resistance r is to limit the vibration at the resonant frequency.

If the values of c and r for a flexible material be known, it is possible to calculate, by means of Equation 1, the amount of insulation that will be obtained from the use of this material as a flexible support for a piece of equipment having a mass m. For the routine calculations in practice, r may be neglected with only a slight sacrifice of accuracy. Table 2 gives the values of c and r for a number of commonly used flexible materials.

Example 1. A machine weighing 1000 lb has a base area of 20 sq ft. Assume that the principal vibration of the machine has a frequency of 100 cycles per second (most machinery vibrations are less than 150 vibrations per second, and the assumed frequency of 100 is quite representative of typical machines). Suppose that a 1-in. slab of corkboard weighing 1.10 lb per board foot be placed between the machine and the floor. The loading on the cork will then be only 50 lb per square foot, or slightly more than ⅓ lb per square inch. (It is assumed that the compliance c in centimeters per dyne for a specimen 1 in. thick and 1 sq cm in cross-section is 0.25×10^{-6} and the resistance r in mechanical ohms is 0.15×10^{5}.)

The *transmissibility* is calculated in the following manner:

Mass of machine in grams $= 1000 \times 454 = 4.54 \times 10^{5}$.

Area of base in square centimeters $= 20 \times 144 \times 2.54 \times 2.54 = 1.86 \times 10^{4}$.

Therefore, the compliance of the entire support, 1 in. thick and 20 sq ft in cross-section, is $0.25 \times 10^{-6} \times \frac{1}{1.86 \times 10^{4}} = 0.134 \times 10^{-10}$ cm per dyne.

$$n_0 = \frac{1}{2\pi}\sqrt{\frac{1}{4.54 \times 10^{5} \times 0.134 \times 10^{-10}}} = 64.5 \text{ cps}$$

by Equation 2:

$$\tau = \frac{1}{\frac{100^2}{64.5^2} - 1} = \frac{1}{1.41} = 0.71.$$

Consequently it will be seen that the transmissibility is not far below unity and that the support is not satisfactory for insulating 100 or fewer vibrations per second.