Comment upon Figure 3.3, and the Associated Discussion, from "Wind Turbine Sound and Health Effects"

There have been well-argued and credible criticisms of the A/CanWEA health report. Of particular note are those provided by the Society for Wind Vigilance and by Wayne Gulden. This comment relates to the argument put forward on page 3-10 of the report that "there is no net force on the suspended system and it does not vibrate or resonate". The logical deduction of the statement is that the microphone and the ear do not work, that by extension musical instruments and loud-speakers do not produce sound waves and that when we are subject to loud music our chest is not really vibrating. Similarly, when we tell our undergraduate class that an opera singer can cause a crystal glass to vibrate to destruction we are lying to them and that the text-book illustrations are fake. There is of course a net force.

Linear Force from a Sound Wave

Consider a rectangular parallelepiped with area A perpendicular to the sound wave and depth c in the direction of the sound wave. The sound wave is:

$$P = P_0 \sin \omega t$$

The net force on the parallelepiped is then:

$$F = A\frac{dP}{dx}c = A\frac{1}{v}\frac{dP}{dt}c = \frac{Ac}{v}\omega P_0 \cos\omega t$$

Consider next a sound wave with a SPL of 60 dB and a frequency of 10 Hz. The pressure amplitude is given by:

$$SPL = 20\, log_{10}\left(\frac{P_0}{P_t}\right)$$

where P_t is the threshold-of-hearing pressure, 20 µPa. That is, P_0 = 0.02 Pa.

To simulate the chest, A = 0.15 m^2 and a = 0.2 m. The velocity of sound is 330 m/s and ω = 63 s^{-1}. Then:

$$F = 1 \times 10^{-4} \cos\omega t \;\; N$$

This is a small force but is not zero!

Bubble Mode

Note that the effect of the pressure variation shown in Figure 3.3 will be to excite the "bubble" mode of the cavity. The amplitude of the bubble oscillations will depend upon the elasticity of the cavity.

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