Virtual Education Lab: What is a specular reflection?

As with many of the concepts in acoustics, the law of reflection originated in the field of optics, the branch of physics that studies the behavior, and properties of light. Fermat's principle states that "light travels between two points along the path that requires the least time, as compared to other nearby paths." From Fermat's principle, one can derive the law of reflection (the angle of incidence is equal to the angle of reflection) and the law of refraction (Snell's law).

While both transverse light and longitudinal sound are wave phenomena, the wavelength of sound is a million times larger than light and therefore, this difference places a condition on when an acoustic reflection is specularly directed, as shown in the virtual source schematic Figure 1.

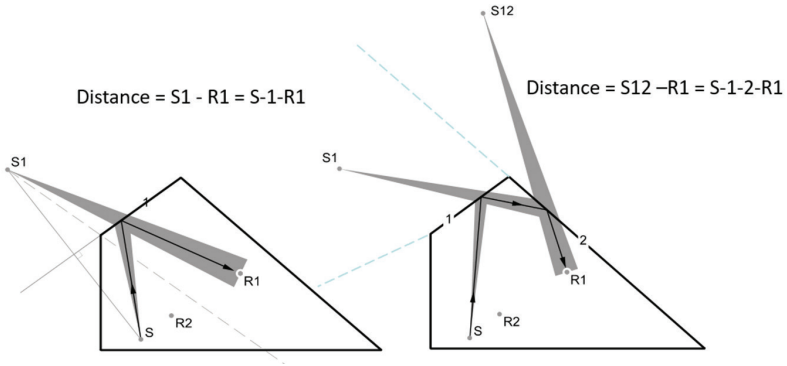

Figure 1. Geometrical acoustics first and second order reflections.

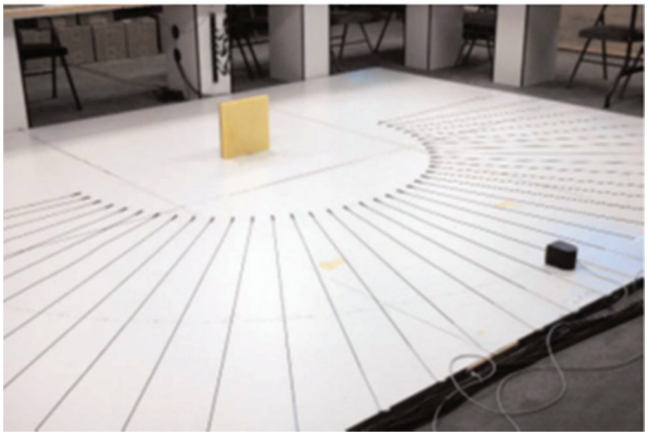

Figure 2. 12" reflective panel on the boundary plane Goniometer.

This condition can be determined by a measurement of the polar responses from a flat 12" reflective panel, using the Goniometer shown in Figure 2. The measured polar responses are shown in Figure 3 at octave band center frequencies from 500 Hz-16 kHz. The responses at 500 Hz and 1 kHz illustrate that when the wavelength is comparable to (0.9) or larger (0.4) than the panel size, the surface will act like a point source with uniform scattering. As the frequency is increased, the wavelength will progressively be less than the width of the panel and there will be a gradual sharpening of the polar response, with increasingly more of the scattered sound being directed in the specular direction. Therefore, it is clear that for a reflection to be specularly directed, the reflecting surface must be significantly larger than the wavelength. *The degree of specularity is determined by the ratio of panel size and incident wavelength.*

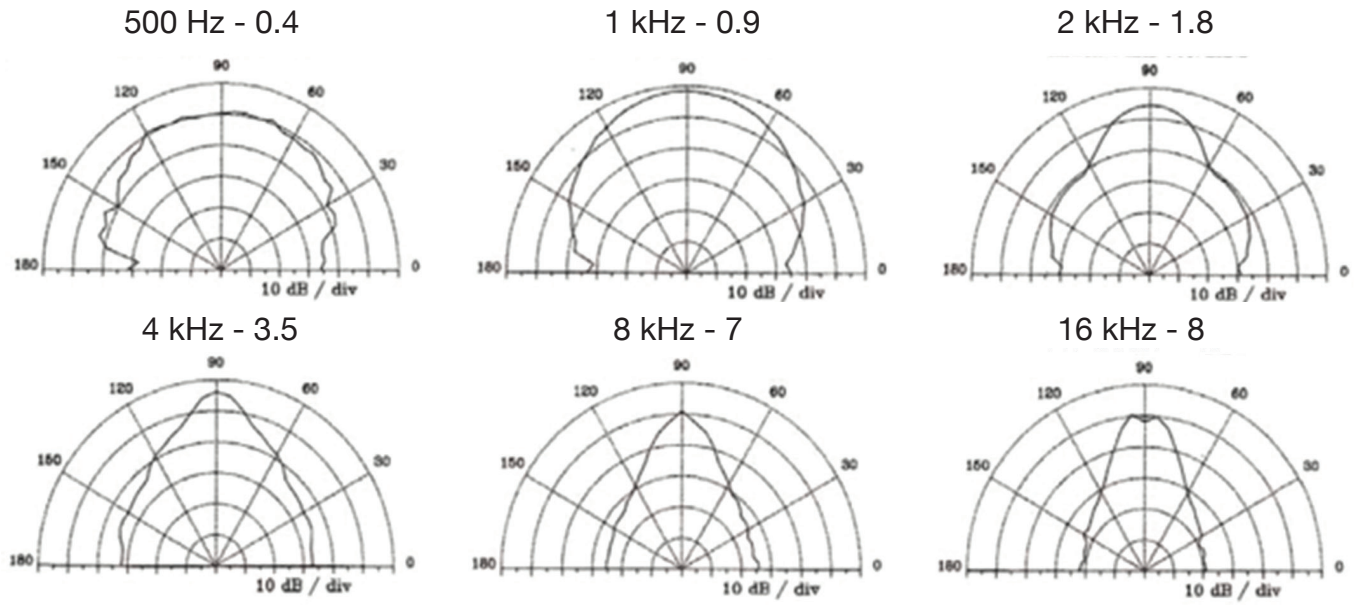

Figure 3. Polar responses for normal incidence at 6 octave band center frequencies with the respective values of the width of the panel divided by the incident wavelength.

In the next post, we will provide examples of the onset frequency for specularity for different ratios of panel width to incident wavelength.

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