Experimental Measurement Lab: What is an acoustical fabric?

In Diffuse Reflections 220421, we described the ARC's broad bandwidth impedance tube. In this post, we use the 160 mm square impedance tube to answer the question "*What is an acoustical fabric?"* Traditionally, an acoustic fabric was described as a material you could blow smoke through! In effect, this described a fabric that was acoustically transparent, so that the acoustical characteristic of the substrate would be maintained. But what if the acoustical design does not call for a preponderance of high-frequency absorption from a 1" (25 mm) or 2" (50 mm) fabric-wrapped panel? We now describe a method that uses the impedance tube with an anechoic termination to evaluate fabric transparency. These data reveal an effective use of densely woven or acrylic backed fabrics, which are less than 100% transparent and often preferred by architects and interior designers, to provide a more uniform absorption characteristic by reducing high-frequency absorption and increasing mid-low frequency absorption.

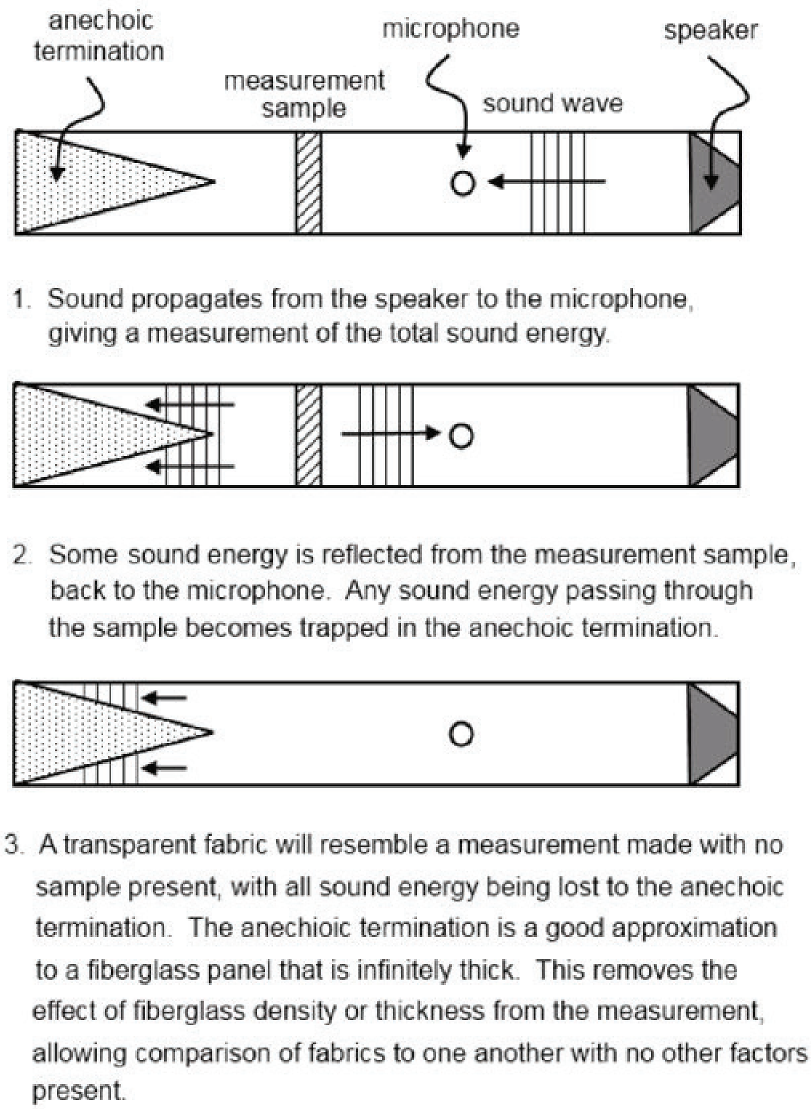

Figure 1. Simple explanation of the use of an anechoic termination.

In Figure 1, we describe how the use of an anechoic termination offers the opportunity to measure fabric transparency. A completely transparent fabric will appear to have complete absorption, so we can characterize the Transparency as an average of the absorption coefficient at 250, 500, 1000, and 2000 Hz, the NRC.

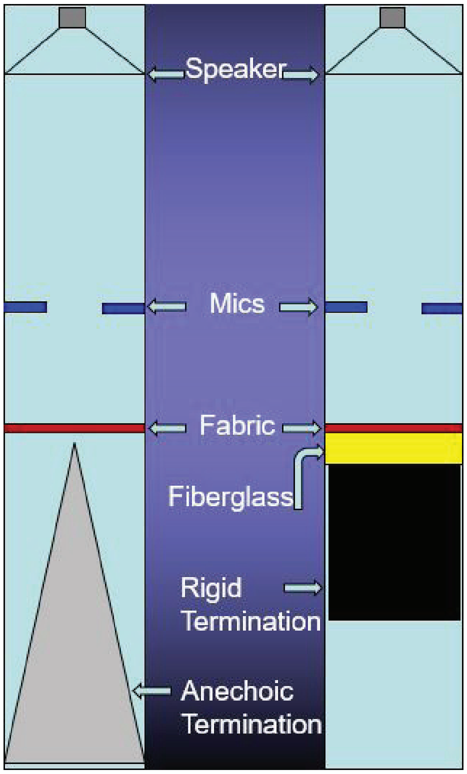

Figure 2. Impedance tube setup, using an anechoic and rigid termination.

We then attach the fabric to a 2” 6 pcf fiberglass sample (or any other porous substrate), using a rigid termination, and compare the absorption with and without the fabric applied, as shown in Figure 2. Following the Transparency test and applied fabric test, we can evaluate the fabric transparency and panel absorption, shown in Figure 3. The upper graph illustrates the Transparency, with 1 being 100% transparent. The lower graph shows a comparison between the fiberglass substrate and the fabric-covered panel, along with the NRC.

In Figure 4, we compare the absorption coefficient of 78 2” fabric-covered panels, with fabrics having Transparencies ranging from 95% to less than 50%. The anechoic termination Transparency is listed at the top of each panel. Again, the Transparency is the NRC of a fabric measure *in front of an anechoic termination.* The absorption coefficients of the 2” fiberglass panel is shown as a solid line. Each panel illustrates the absorption coefficient of several fabrics with a given Transparency, in effect illustrating the standard deviation from the mean. For example, the 85% Transparency panel in the first row, upper right, compares 12 fabrics with a Transparency of 85%. As expected, the 29 fabric panels wrapped with a Transparency of 95% do not affect the absorption of the fiberglass substrate, as shown in the left panel in the top row. A clear trend can be seen. As the Transparency of the fabric decreases, the high-frequency absorption decreases and the mid-low frequency absorption increases due to the diaphragmatic resonance of the less transparent fabric. Now, if the acoustical design requires the absorption response of the substrate, then a highly transparent fabric is a desirable choice. However, if a more uniform absorption characteristic is desired, one might choose a backed fabric or dense weave with a 75% Transparency. Or, if high-frequency attenuation and increased low-frequency absorption is desired, then a low-transparency backed fabric would be an excellent choice.

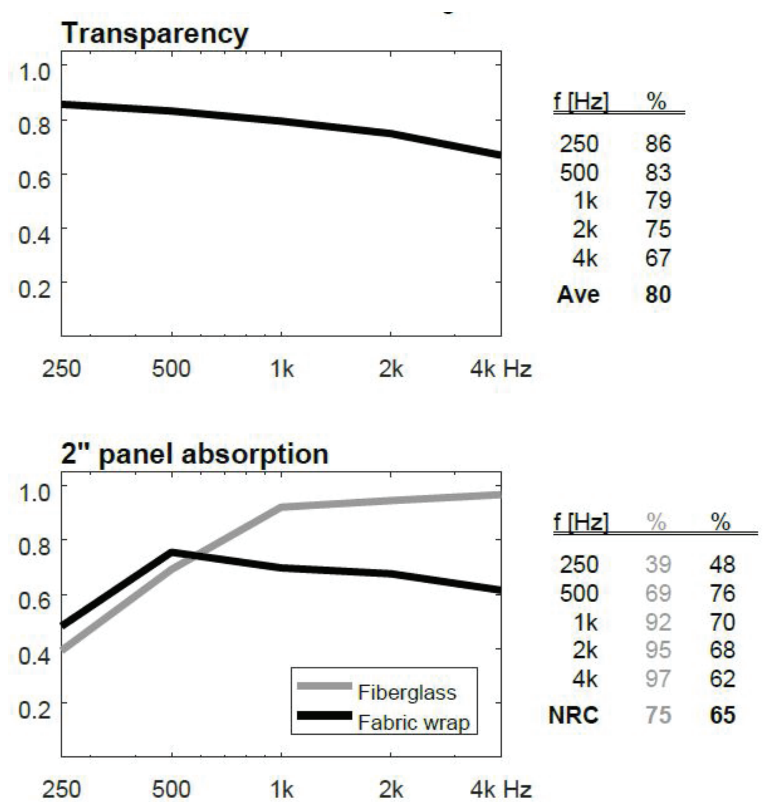

Figure 3. Comparison of a fabric’s Transparency and its effect on the absorption coefficient of a wrapped and unwrapped absorptive panel.

The data suggest that the thesis of this research, which suggested that one can use the Transparency of the applied fabric to modify the absorption of the porous absorptive substrate to meet the requirements of a project, has been proven.

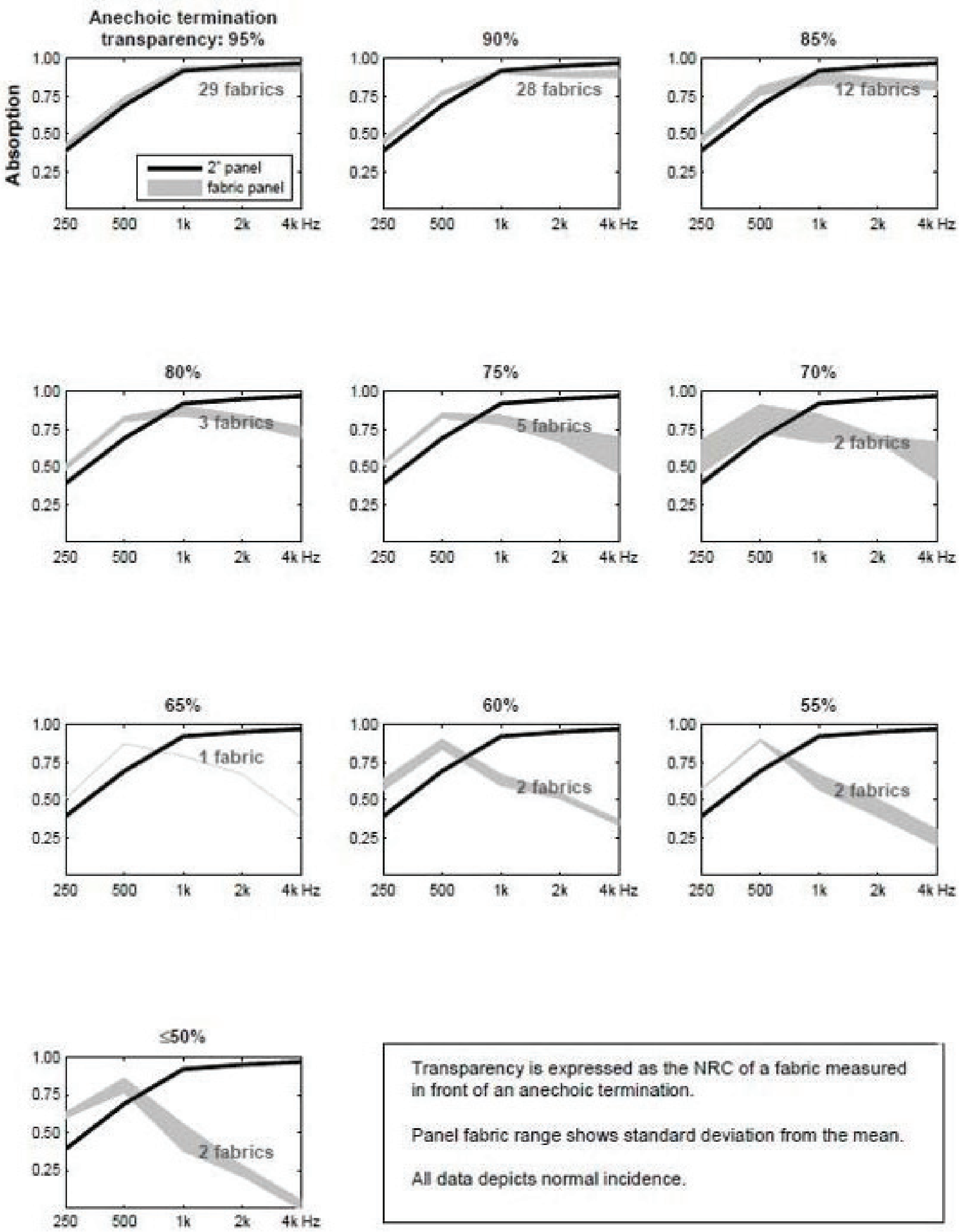

Figure 4. Comparison of panel absorption with 78 fabrics of varying transparencies.

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