Sound Advice from an Old Firestop Guy – Part 1

How STC is Determined

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I remember my first visit to an acoustics laboratory. It was a beautiful summer day at Riverbank Acoustical Labs in Geneva, IL, and my engineering manager sent me to run a test to obtain an STC value for our putty pads. It was an exciting new adventure for a young engineer. At this point in my career, I had barely witnessed a fire test, let alone an STC test. I literally didn't know what an STC was, and while it was easy to figure out that STC stood for Sound Transmission Class, it didn't take me long to discover I really didn't know the first thing about sound transmission. The one comforting fact concerning my ignorance - I was not alone.

As an engineer, I've learned to ask many questions to understand problems so they can be solved. For instance, how does this number generated from testing a single 16 square inch outlet box with a putty pad in a 64 square foot wall tell me anything about the performance of my product, when my product is literally applied to 0.2% of the surface area of the wall? I was left scratching my head, but hey, at the end of the 7-minute-long test, we had a number. And with that number, we were competitive. And even better still, I didn't smell like I had been to a bonfire as I flew back home that evening.

In my opinion, it is safe to say that STC is one of the most misunderstood and, possibly, the most misapplied performance value in construction today. In firestopping, we have a similar problem with ASTM E84 testing. Many people mistake the ASTM E84 performance for a fire-resistance value. If I have been asked once, I have been asked 1000 times if fire-rated plywood can be used in place of gypsum wallboard, well you know, since it is fire-rated. And the answer is, of course, no. ASTM E84 is a flame spread test and has nothing to do with compartmentation or fire resistance. Similar to STC, ASTM E84 provides us with a single unitless number called Flame Spread Index, or FSI. FSI tells us how quickly fire spreads on a surface, not through a barrier.

Did you know there is no such thing as an STC test? It's true. It took a lot of reading and digging into the facts of the matter to understand this. STC is a strange concept to someone like me who is used to performance measurements in incremental numbers with units that are easily understood, like hours, minutes, or degrees Fahrenheit. Instead, STC offers us a number. That's all, just a number. No units. No clear understanding of what that number means. Just a number. To understand STC a bit better, we will break it down into the functions that are used to develop the single number rating we call STC.

Obtaining an STC value requires following a multi-step process. The first step in the process is to run an ASTM E90 test to obtain a group of data called Sound Transmission Loss (STL). This test is performed with a double chamber, and the test article is the shared barrier between the two chambers. One side of the double chamber is called the source room, and the other side is called the receiving room. These rooms are constructed so there is virtually no loss in sound energy, so the test specimen is isolated as the only path for sound transmission to occur. In the source room, a pink noise signal is generated and delivered at a prescribed decibel level. Because this sound originates a distance away from the test article and travels through air before impacting the test article, the impact of this sound energy is called an airborne sound. This is as opposed to impact sound, which is generated by a direct impact on the surface of the test article, such as a footstep or a chair dragging on the floor. Those sounds require a different testing program altogether. The airborne sound waves make their way to the test article, where they then permeate the test article and continue to travel through the air in the receiving room until a microphone records them.

The volume level of the sound is recorded in decibels in both the source and the receiving room at 16 different frequency levels ranging from 125 Hz to 4000 Hz. The sound transmission loss data is calculated as the difference in decibels from the source side to the receiving side and this number is plotted on a chart at each frequency. A typical Sound Transmission Loss chart is shown in Figure 1. *(next page)*

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How STC is Determined *(continued)*

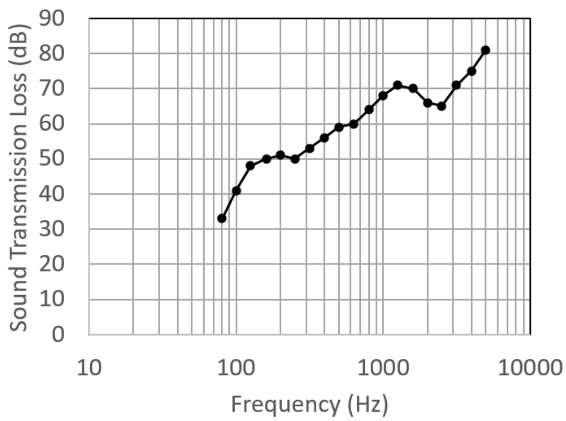

Figure 1 – Sound Transmission Loss Data

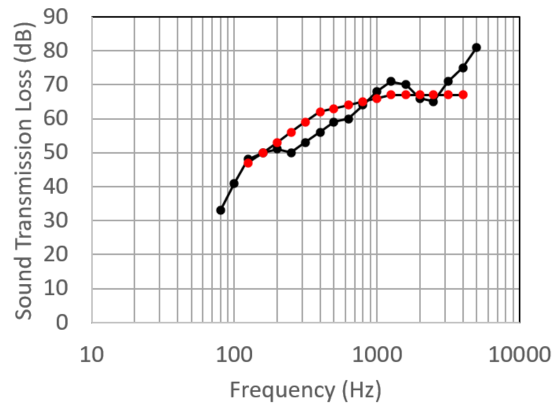

Figure 2 – Contour curve applied (Red Dots)

The first thing you will notice is that the horizontal axis grows in multiples of 10 Hz, and the vertical axis grows in increments of 10 decibels. This is because frequency measured in Hz grows logarithmically, compared to amplitude measured in decibels which grows incrementally. This is because the range of frequencies tested covers 5 octaves, and a single octave covers a range of doubled frequency. For example, the first octave tested is 125 Hz to 250 Hz. Each successive octave grows by doubling, so the next 4 octaves go from 250 Hz to 500 Hz, then to 1000 Hz, then to 2000 Hz, and ending at 4000 Hz. Because the frequency across successive octaves doubles every time, they grow at a much faster rate than the decibel level, so you have to use a logarithmic chart to show the relationship.

Once this STL data is charted, ASTM E413 Standard Classification for Rating Sound Insulation is applied as the next step of the process to determine the STC value. ASTM E413 includes a standard contour called the Contour for Calculation of Single-Number Ratings and this contour is applied to the Sound Transmission Loss data. The contour curve is always the same curve, no matter where it appears vertically on the chart. It moves as a unit until it meets the curve fitting requirements of ASTM E413 and is then plotted as shown in Figure 2.

As already stated, the contour line from ASTM E413 is moved into position until it meets the curve-fitting criteria. The curve fitting criteria are defined in terms of a measurement called "deficiencies," and a deficiency is simply the difference in decibels at each frequency from the contour curve and any STL data that lies below the contour curve. STL data above the curve do not count as deficiencies. For example, at the 250 Hz frequency mark in Figure 2 above, the STL data curve falls 6 dB below the contour, which counts as 6 deficiencies. At 1250 Hz, the STL value is about 3 dB above the contour curve and this counts as zero deficiencies. For the curve to be positioned correctly, it must meet two criteria. First, the total count of all deficiencies must not exceed 32 dB. Second, the maximum number of deficiencies at any frequency must not exceed 8dB. Once these criteria are met, the curve is positioned in its final location, and the STC can then be determined as shown in Figure 3 below:

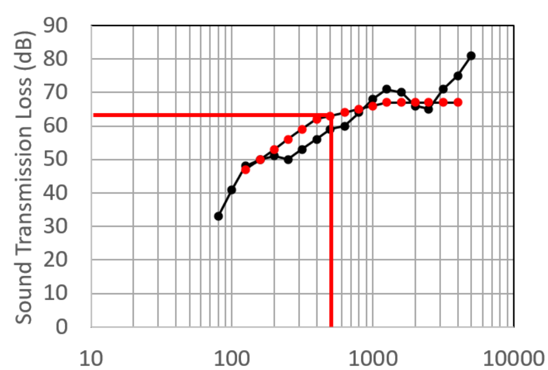

Figure 3 – Determining STC

How STC is Determined *(continued)*

Once the contour is settled, meeting the fitting criteria, the STC is determined by identifying the Sound Transmission Loss level on the contour curve at 500 Hz. If you look at Figure 3, it shows a vertical line drawn in red at 500 Hz. Where it crosses the contour curve, you then draw a horizontal line to the left axis. In the case of this test, the STC value is determined to be 63.

Now that we understand how STC is determined, we have a better understanding of what STC is. But I would argue that we are scratching the surface, and now we know enough to be dangerous. Some may be inclined to believe that STC correlates to the reduction of sound levels across a barrier, or in other words, if you have a wall with a tested STC value of 63, an 80 dB sound on one side would register as a 17 dB sound on the other side. Here is the problem with that. While an STC value does give you an idea of sound transmission loss expectations across a range of frequencies, because it is isolated to a single number rating, it is now independent of the frequency. If you look again at Figure 1 and see the entire STL data curve, you will notice at the lower frequencies there is less sound transmission loss than at higher frequencies. The STL at 125 Hz is about 49 dB, and on the other end of the spectrum, at 4000 Hz, the STL is about 75 dB. You can look at the STC number as sort of an average STL, but if the source of the 80 dB signal is 125 Hz, your 63 STC wall will filter out the sound and register about 31 dB on the opposite side. Whereas, if the 80 dB source signal is 4000 Hz, you can expect to hear a sound level of 5 dB at 4000 Hz on the other side. But in general, since noise is not typically singled out as an individual frequency, you can expect the effect would register to a person somewhere around 17 dB on average. That is still very impressive because, with a noise level equivalent to a vacuum cleaner on one side, the sound that makes it through to the other side would register somewhere between the volume level of a ticking watch to the sound of leaves rustling or a whisper.