Defining the Acoustic Requirements for a Building and Community

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Cities throughout the United States have building codes that typically include acoustical requirements. These code mandates are specified in terms of ASTM standards. The most common standards used in building codes are Sound Transmission Class (STC) and Impact Insulation Class (IIC). On the surface, it seems as if there are only a few standards that need to be understood to meet acoustical building requirements. If there is not a complete understanding of the full spectrum of the ASTM standards that address such aspects as field vs. lab standards, community noise standards, methods of quantifying and qualifying absorption and RT60, etc., then there is not a full understanding of the goals of the building design. This article gives an overview of the ASTM building acoustical requirements that not only help the engineer to attain building code but also manage a client's expectations.

In a home, whether it is a single- or multi-family residence, such acoustic aspects as the intensity of audible footfall from the floor above, the clarity of speech from a TV through the wall, or many other potential disturbances, are necessary elements of the building design. Adherence to and communication of the ASTM standards for the building environment are also critical for client satisfaction from the architect to the builder to the homeowner, since the process adjusts expectations in accordance with the budget for the project. The many ASTM standards provide tools for the acoustical/noise engineer to quantify the acoustic environment of a building as part of the design through all its stages of construction to its completion. When there is a renovation, it is ASTM testing that helps offer insight into the quality of the existing construction. It is a deeper understanding of these ASTM standards from lab to field that allows the engineer to provide a better building and community environment.

Building Environment, Codes and ASTM

An understanding of the standards and how they allow the acoustic environment of a building to be quantified is facilitated by a discussion of STC, which is a relevant measure used to quantify sound separation across a partition. STC is a measurement of an assembly's ability to attenuate or reduce airborne sound transmission. When an actual field test is performed, these measures are referred to as FSTC (field sound transmission class).

Sound Transmission Class Defined By ASTM

STC is the rating that identifies the ability of an object to block sound. Specifically, STC is a single-number rating calculated in accordance with ASTM classification by using values of sound transmission loss.

How STC Relates to Building Environment. Generally, STC ratings can be interpreted as follows:

- 25 – Normal speech can be understood quite clearly
- 30 – Loud speech can be understood fairly well
- 35 – Loud speech is audible but not intelligible
- 45 – Loud speech is very faint
- 50 – Loud speech is not audible, but amplified sound will be audible
- 60 – Minimum requirement for amplified sound

Examples of Codes that mandate STC are:

- CA: Article 4 – Noise Insulation Standards: 1092 (2) – STC of 50
- NYC: Article 9 – Noise Control in Multiple Dwellings: Section 27-769 (a) Acoustical isolation of dwelling units – STC of 50

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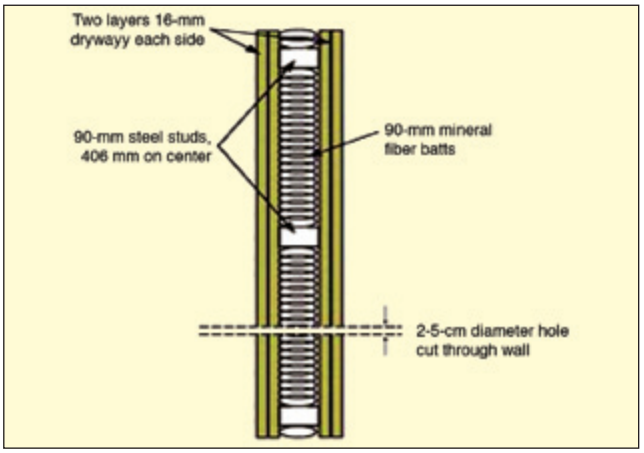

Figure 1. Configuration of test wall with 2.5 cm diameter hole.

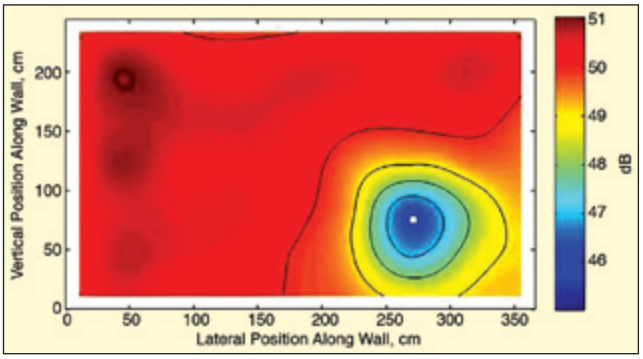

Figure 2. FSCC results of test wall with 2.5 cm diameter hole.

- HUD (Table 1 shows a few STC and IIC specifications)

The commonly used ASTM codes for STC and FSTC are:

- E90-09 – Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- E336-14 – Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
- E413-10 – Classification for Rating Sound Insulation

Difference between STC and FSTC. This subject is best introduced by referring to a standard acoustics book such as one published in 1997 by David Harris:[1] *Airborne Sound Leaks, or Flanking, are the Most Insidious Problem in Resolving Sound Transmission*. Acoustic leakage can significantly degrade the performance of a partition. At this time for clarity of lab vs field results, one test from the extensive research done at the National Canada Research Council (CNRC) performed by Gover and Bradley[2] is presented. Figures 1 and 2 clearly show the results from when the lab tested a wall with a design STC of 56, with a 1-inch hole. This is an excellent example, since this is roughly equal to acoustically untreated back-to-back electric outlets.

Table 1. A few STC and IIC specifications.

Partition Function Between Dwellings		Luxury Grade I		Average Grade II		Minimum Grade III	
APT. A above	APT. B	STC	IIC	STC	IIC	STC	IIC
Bedroom	Bedroom	55	55	52	52	48	48
Living Room	Bedroom	57	60	54	57	50	53
Kitchen	Bedroom	58	65	55	62	52	58
Family Room	Bedroom	60	65	56	62	52	58

As shown in Figure 2, the wall FSTC at a distance from the hole was 51, but near the hole the wall had an FSTC of 41. This is the difference between not hearing talking and hearing talking through a wall. This reference to the extensive research at CNRC testing is provided here to demonstrate the importance of having an innate understanding of the ASTM lab versus field standard and the acoustic aspects that cause the difference between the two. This difference in the results between the STC and FSTC emphasizes the importance of correct installation and also the importance of designing to the FSTC over the STC for noise-sensitive clients or applications.

Acoustically treating all seams, openings, etc. in walls and ceiling/floor configurations demonstrates the vital importance of construction administration of an acoustics installation. This even includes light fixtures in a ceiling, such as a recessed light. Referring to the information provided above, it becomes apparent that if the acoustics installation is not tested for the proper seal, then there remains a possibility that despite the correct configuration, the system will not meet code.

Decay Time as Defined by ASTM

One ASTM standard for determining decay time in a room is E 2235-04: Standard Test Method for Determination of Decay Rates for Use in Sound Insulation Test Methods. On the surface, this standard seems straightforward. While it is, by becoming a member of ASTM and attending the biannual meetings, discussions help engineers to share and clarify field data variations.

Office Design Through The Eyes Of ASTM

It is always important to review the several standards that give guidance to a design. An example is that of office design, where at minimum, the following standards should be taken into account in the design:

- E1110-06(2011) – Guide for Classification for Determination of Articulation Class
- E1130-08 – Test Method for Objective Measurement of Speech Privacy in Open Plan Spaces Using Articulation index
- E1179-13 – Specification for Sound Sources Used for Testing Open Office Components and Systems

Other Important ASTM Standards

- E477-13 – Test Method for Laboratory Measurements of Acoustical and Air Flow Performance of Duct Liner Materials and Prefabricated Silencers.
- E557-12 – Guide for Architectural Design and Installation Practices for Sound Insulation between Spaces Separated by Operable Partitions
- E596-96(2009) – Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures
- E756-05(2010) – Test Method for Measuring Vibration-Damping Properties of Materials
- E966-10 – Field Measurements of Airborne Sound Attenuation of Building Façades and Façade Elements

Discussion and Conclusions

This article gives a broad overview of important ASTM tests that form the foundations of building environment standards. These standards will evolve over time to accommodate the information shared by ASTM members to provide a better standard. An involvement in ASTM helps to understand standards evolution.

Acknowledgements

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References

1. David Harris, *Noise Control Manual for Residential Buildings*, McGraw Hill, 1997.
2. B.N. Gover and J.S. Bradley, "Detection of Localized Sound Leaks of 'Hot Spots' and their Effects on Architectural Speech Privacy (Speech Security)," *NRC-CNRC Publication.*

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