

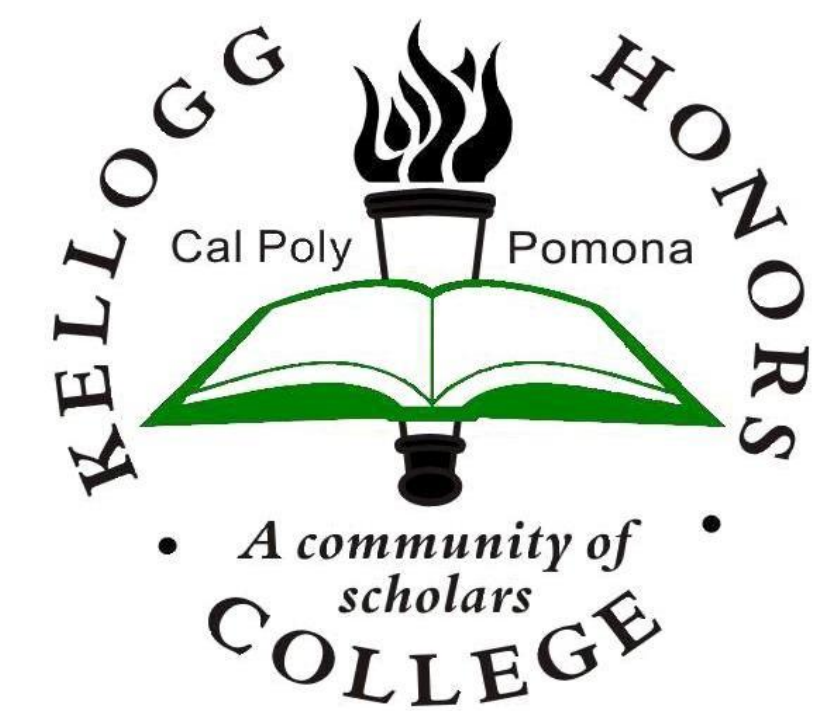
Sound Abatement and Noise Reduction in Acoustic Systems



Emily Cobb, Construction Engineering Technology

Mentor: Professor Hovel Babikian

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Abstract

Acoustics are an essential part of the interior finishes in a building. More often than not, we fail to realize the benefits and components that make up a suspended ceiling system or custom fabric sound panels that add to the overall experience one encounters in a hospital, movie theatre, school, or music auditorium. The use of High NRC (Noise Reduction Coefficient) ceiling tile provides benefits to many areas of the public sector and continues to provide the industry with new and innovative techniques and methods of developing sound abatement. In addition, fiberglass wall panels provide an equal amount of sound pollution at a low and effective cost. While ceilings and sound panels may seem like a small component of a building, they provide many solutions to reducing noise. By analyzing the various acoustical systems that are used in construction, one is able to discover the incredible advances in sound abatement practices.

Background

Acoustics are effective alleviators of unwanted noise and can be especially useful in specific areas including schools, hospitals, and music auditoriums. Acoustics can be defined as elements that decrease reverberation and noise. Two types of standard acoustics are wall panels and ceilings. There are two factors that can be largely considered when choosing the proper treatment to use in a room that needs acoustics. The low sound blocking CAC factor (Ceiling Attenuation Class) measures the performance of a ceiling that acts as a barrier to airborne sound transmission in small areas such as offices or classrooms. A CAC rating less than 25 does not provide any benefits while a ceiling system with a CAC of 35 or greater is considered very effective. The other factor is high sound absorption NRC (Noise Reduction Coefficient). This factor rates how much absorption an acoustic product provides. By considering both of the CAC and NRC ratings in a product, one will be able to provide the best acoustical benefits to a certain area.

Fiberglass is one of the most used insulating materials for sound panels because it has the highest NRC at the lowest expense. According to Alex Michaud in his article "Silence is Golden", "Acoustical wall panels use a sandwich construction with a variety of different inner absorptive options" (153-56). Michaud also explains that the perforated side of the panels typically face the noise source because it successfully absorbs sound (153-56). When compared to drywall, acoustical panels provide a better performance since they have an inner absorptive liner, are easy to clean, and do not absorb moisture. Depending on how much sound absorption is needed, different thicknesses and densities of the fiberglass insulation are made available. Different shapes and sizes of sound panels are also made to accommodate any irregular spaces. The final stage of assembling a sound panel includes covering it with a desired fabric and gluing or mounting it to a wall. Different types of fabric make wall panels appealing to the eye, while providing acoustical benefits.

Acoustical Ceiling Tile (ACT) is also a significant absorber of sound. Ceiling tile that is classified as high NRC provides extra absorption to school classrooms or hospital rooms. The Ceilings and Interior Systems Construction Association (CISCA) is a foundation that "exists to provide the acoustical ceiling and wall systems industry with a network of relevant opportunities for professionals to interact, grow and prosper through actionable education." In their article, "Acoustics in Healthcare Environments", CISCA asserts that non absorptive ceiling tile may create a privacy breach when sound is transmitted through the ceiling area (15). Ceiling tile with absorptive qualities would provide benefits to the vicinities where it is installed.

One area that contains an exceeding amount of noise pollution is the school classroom. The effects of a noisy classroom include speech problems, weakness in teacher's voices, and impediments to a student's learning ability. Speech problems are developed when acoustical features are not present and consequently causes a reverberation of the speaker's voice. When the teacher is talking, the individual words smear together when bounced off of the walls and ceilings and cause the students to not clearly understand. An additional area where sound creates problems is in hospitals. Interrupted sleep, privacy breaches, and slow recovery time are all factors that involve an abundance of noise. Sleep disruption, being one of the most common complaints in hospitals, is attributed to constant beeping machines, indistinct chatter, and loud patients. When the patients are not well-rested, the recovery process is slower, resulting in a longer stay at the hospital. If acoustical wall panels and a high NRC ceiling tile was being used in hospital rooms, they would provide quieter areas and less distractions that would aid in the healing process.

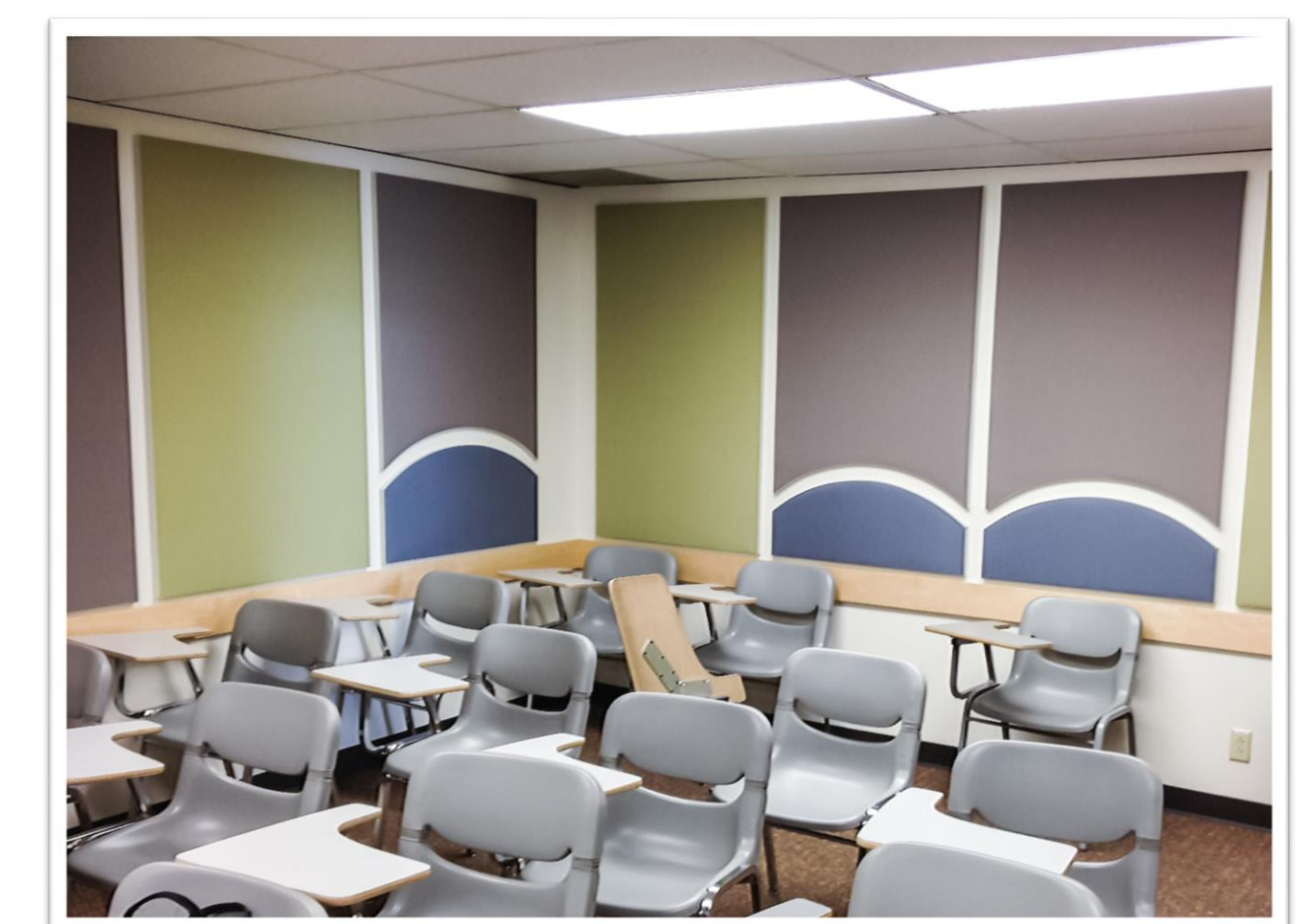


Figure 1. Acoustical sound panels in school classroom. Fabricmate.com

Reverberation Test

Reverberation tests are very useful in order to determine the effective acoustics of a room. For this process, I used a reverberation test provided by Armstrong, one of the leading ceiling and wall suppliers in the country. In running the test, I was measuring the reverberation in a 25' x 30' classroom and audio clips were available to hear the difference as shown in Figure 2. There are many factors that play a part in the acoustics including the wall type, floor type, and existing ceiling type (Figure 3). For this classroom, all of the walls were made out of 5/8" thick drywall, the floors were linoleum on concrete, and the ceiling was drywall. After plugging this information into the reverberation calculation (Figure 4), it was determined that the reverberation time exceeds the recommendation and more absorption should be considered in order to add to the benefit of the room.

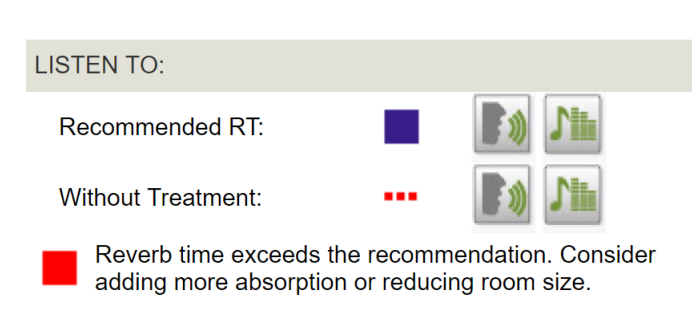


Figure 2. Audio test with or without reverberation treatment.

FREQUENCY:	125	250	500	1000	2000	4000
Recommended RT with proper treatment:			0.4-0.6	0.4-0.6	0.4-0.6	
Existing RT of the space:	0.63	1.4	2.18	2.69	2.03	1.51
SPACE SURFACES	PREDOMINANT MAT		SF	OTHER	TREATMENT	
Wall 1	Drywall (1/2" or 5/8")		225.0	-no-	-no-	
Wall 2	Drywall (1/2" or 5/8")		270.0	-no-	-no-	
Wall 3	Drywall (1/2" or 5/8")		225.0	-no-	-no-	
Wall 4	Drywall (1/2" or 5/8")		270.0	-no-	-no-	
Floor	Linoleum on concrete		750.0	-no-	-no-	
Ceiling	Drywall (1/2" or 5/8")		750.0	-no-	-no-	

Figure 3. Space Surfaces depicting Wall types and material.

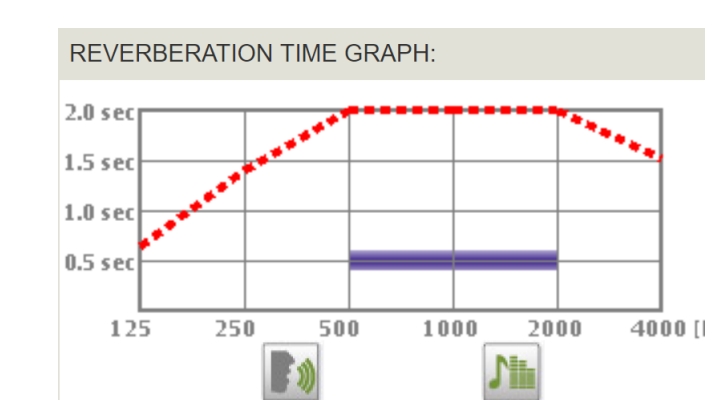


Figure 4. Reverberation Time graph with or without treatment.

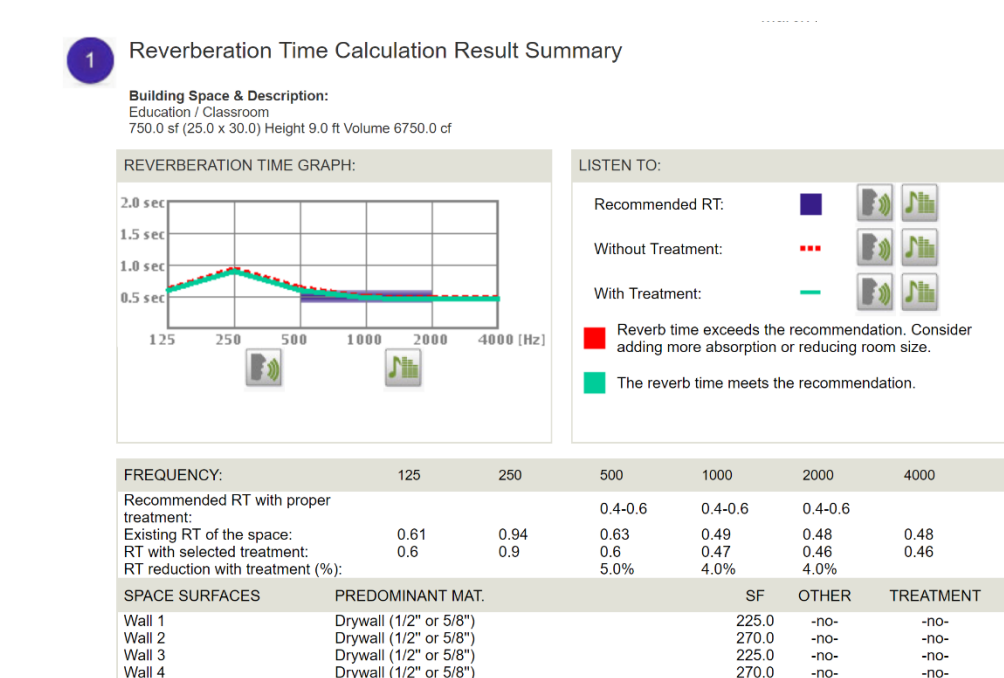


Figure 5. Full Reverberation test with solution.

Many differing recommendations could be made to reduce the reverberation in the room. The first component that was considered in the classroom was the occupants. I considered 20 students with desks. In addition, instead of drywall ceilings, I added an acoustical ceilings system with Armstrong Cortega tile. With the treatment, the reverb time met the recommended reverberation time (Figure 5).

Conclusion



Figure 6. Acoustical ceiling tile. Armstrong.com

The installation of sound panels and absorptive ceiling tile provides solutions to the many noise pollution problems. By looking at different problems in schools and hospitals, we can see how the installation of acoustics would be beneficial. When identifying the solutions that acoustics solve, hospitals and schools should be encouraged to add these components. Installing high NRC and CAC ceiling tile (Figure 6) and wall panels, schools would provide better educations to their students and hospitals would supply a healthier and quieter environment for their patients. By educating architects and engineers about the benefits of acoustical components, schools can provide better educations to their students (CISCA 3). The installation of these unique types of ceiling tile and sound panels would provide quiet and undisturbed areas in several educational institutions.

Sources

"Acoustics in Healthcare Environments." *Acoustical Interior Construction Magazine*. InformeDesign Research Desk, Oct. 2010. Web. 23 Feb. 2016. https://www.cisca.org/files/public/Acoustics%20in%20Schools_CISCA.pdf
 "Total Acoustics." Armstrong Ceiling Solutions. 2019. <https://www.armstrongceilings.com/content/dam/armstrongceilings/commercial/north-america/brochures/total-acoustics-brochure.pdf>
 Michaud, Alex. "Silence Is Golden." *Architectural Record* 202.3 (2014): 153-156. *Academic Search Premier*. Web. 25 Feb. 2016.