A Better Sound Environment for All

Shimane Prefectural Hamada high school

Introduction

Our daily lives are filled with various sounds. Creating a comfortable space includes managing the sound environment. The acoustic design of buildings greatly affects how we hear sounds, including noise control and speech clarity. The sound environment in places like homes and schools is an essential element of daily life. Especially, in classrooms, a good sound environment helps students concentrate and teachers teach effectively. This requires controlling noise from outside and reducing echo through sound absorption.

Investigating the Current Sound Environment in Classrooms

To improve speech clarity, both noise reduction and reverberation control are essential. According to the sound environment standards for school facilities set by the Architectural Institute of Japan in June 2020, the appropriate reverberation time for a general classroom is said to be 0.6 seconds.

In this study, I measure the reverberation time in my school classrooms and compare the results to the recommended standards. The reverberation time values in the table represent measurements taken at 500Hz and 1000Hz.

Degree of resonance	Room and Locations	Typical room sides	Reverberation time
Rooms suitable for moderate sounds	Regular classroom	200m³	0.6 s
	Music classroom	300m³	0.7s
	Special classrooms (science room, quilt room)		
	Principal's Office, Staff Room		
	library room		
Rooms suitable for short echoes	Music Practice Room(For brass band practice)	300m³	0.6s
	audiovisual room,Listening Classroom	300m³	0.4s

(The Sound Environment Standards for School Facilities by the Architectural Institute of Japan, 2020)

Experiment date : 2024.11.11

Research Method

I measured the reverberation time by clapping hands in the center of the classroom and using the app “Clap Reverb.” The app calculated the average reverberation time (in seconds) at 500Hz and 1000Hz after five claps. Measurements were taken three times.

The experiment was conducted in a standard classroom at Hamada High School. The classroom’s volume was approximately 192m³.

Regular classroom	500Hz	1000Hz
	1.14	1.11
	1.38	0.95
	1.32	1.32
Average	1.28	1.126666667

Results

The reverberation time was much longer than the standard value of 0.6 seconds (Architectural Institute of Japan, 2020). A space with a long reverberation time makes speech unclear, causing discomfort and reducing learning efficiency.

To create a quieter environment where students can focus better, it is important to absorb sound and shorten the reverberation time. Therefore, I decided to look for everyday materials that can be used as sound-absorbing materials.

Finding More Effective Sound-Absorbing Materials

Experiment Method

I built a wooden box measuring 30 cm in length, width, and height as a classroom model. Four types of sound-absorbing materials were tested: melamine sponge, water-absorbing sponge, design board, and design board with sealed holes.

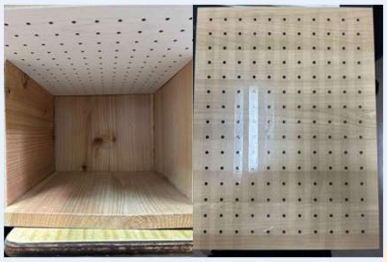
Each material was attached to the ceiling of the wooden box. Using the “Clap Reverb” app, I measured the reverberation time for each setup, following the same procedure as before. Measurements were taken three times for each material.

melamine sponge	500Hz	1000Hz	mass	volume	density
	0.72	0.8	22.9 g	30×30×2.5cm	0.01017777778
	0.34	0.5			
	0.42	0.66			
	0.4933333333	**0.6533333333**			

Water absorbing sponge	500Hz	1000Hz	mass	volume	density
	1.37	1.77	74.2 g	30×30×2.5cm	0.03297777778
	0.33	0.92			
	1.33	0.65			
	1.01	**1.113333333**			

The design board with holes	500Hz	1000Hz
	0.65	1.32
	0.42	0.55
	1.06	0.74
	0.71	**0.87**

The sealed design board	500Hz	1000Hz
	1.02	0.88
	1.2	1.07
	1.03	1.55
	1.083333333	**1.166666667**



Experimet date: 2024.11.14

Results

The standard reverberation time is 0.6 seconds (Architectural Institute of Japan, 2020). The melamine sponge had the closest result, with a difference of 0.11 seconds at 500 Hz and 0.05 seconds at 1000 Hz.

The second closest material was the design board with holes. Its difference was 0.11 seconds at 500 Hz and 0.27 seconds at 1000 Hz. The sealed design board had bigger differences: 0.48 seconds at 500 Hz and 0.57 seconds at 1000 Hz. The design board with holes was closer to the standard than the sealed one.

Photos of the wooden box, sound-absorbing materials, and the experiment would help explain better. The sealed design board had a longer reverberation time because more sound reflected. The board with holes had a shorter time because the sound could pass through.

Discussion and Future Outlook

I found that using materials with uneven surfaces that can absorb sound effectively reduces reverberation time more than flat surfaces alone.

However, I could not identify a clear relationship between reverberation time and a learning environment that promotes concentration. In the future, I plan to study how different reverberation times affect students’ concentration levels.

Reference

DAIKEN Corporation D. (2024). **How to Improve Students' Concentration! Start by Reevaluating the Classroom's Acoustic Environment.** DAIKEN - DAIKEN Corporation.
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