Analysis 4

Acoustical Analysis of Interior Partitions- Breadth

Background

Good classroom acoustics are vital when the teaching and learning process relies strongly on verbal communication. Transmission of noise from one learning environment to another can hinder learning when speech communication from an instructor is difficult to understand. When concentration on speaking and listening can be removed teaching tends to be more effective. Good classroom acoustics can reduce repetition by instructors and reduce the number of questions by students. Classroom acoustics have an impact on typical students' ability to learn and especially on students with disabilities.

The American National Standards Institute has written the standard for Acoustical Performance in School Buildings. This standard defines acceptable Sound Transmission Class (STC), Impact Isolation Class, and Reverberation Time values for school buildings. Table 11 below includes STC values for three school spaces. STC, evaluated in this analysis, is a single number rating for sound transmission loss through construction assemblies. The goal of this analysis is to calculate the required STC & Transmission Loss values for four receiving spaces, compare the values to the existing wall assemblies, and make appropriate recommendations.

American National Standards Institute Acoustical Peformance Criteria for Schools(ANSI Standard S12.60)		
Receiving Space	**Adjacent Space**	**STC Required**
Classroom	Bathroom	53
Classroom	Mechanical Room	60
Classroom	Classroom	50

Table 11- ANSI STC Criteria for Schools

Resources

- Penn State Architectural Engineering Faculty
- Textbook: Architectural Acoustics by M. David Egan
- Acoustical Society of America: American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools-ANSI S12.60
- Textbook: Architectural Acoustics by Marshall Long
- National Concrete Masonry Association TEK Note 13-1A

Methods

- Determine Noise Criteria Values for Critical Receiving Space
- Determine Absorption Coefficients of Floor, Wall, Ceiling, & Materials
- Calculate the Following

  - Floor, Wall, & Ceiling Area of Critical Receiving Space
  - Total Acoustical Absorption of Critical Noise Receiving Space
  - Required Noise Reduction & Transmission Loss Values
- Compare Existing to Required Transmission Loss Values
- Compare ANSI S12.60 Required Sound Transmission Class Values to Existing Values
- Make Recommendations for Improvement If Necessary

Results

This analysis evaluated the Transmission Loss and Sound Transmission Class criteria for three different classroom spaces, all with different adjacent spaces. Adjacent bathroom, mechanical, and classroom spaces were chosen for analysis. Required Noise Reduction and Transmission Loss values were calculated using receiving room absorption values, transmitting room sound levels, and receiving room ambient sound levels.

Required Transmission Loss Values, calculated in decibels at 6 frequency bands, were determined for 4 classroom receiving spaces. The Transmission Loss values and the STC rating of the wall assemblies were then determined using tables in M. David Egan's Architectural Acoustics book. The calculated and existing values were then compared. The results of these calculations and comparisons can be seen in Tables 12-16 at the end of this section. The full length acoustical calculations can be found in the Appendix B of this report.

The expected outcome of this analysis was that the existing STC values of the partitions might be improved upon. The STC value of 52 for the spaces divided by only metal stud partitions fell just below the specified standard of 53 by ANSI S12.60. The ANSI Standard S12.60 of 53 is a minimum value for a classroom space. To improve on this rating, an additional layer of 5/8" gypsum wall board is recommended. This material addition will increase the STC Rating from 52 to 57. The cost of the material addition can be seen below in Table 12.

	Gypsum Board Cost		
Room	**Quantity**	**Unit Price ($/SF)**	**Total Cost ($)**
156	438	$0.89	$389.82
151	258	$0.89	$229.62
184	294	$0.89	$261.66
		Total Cost	**$881.10**

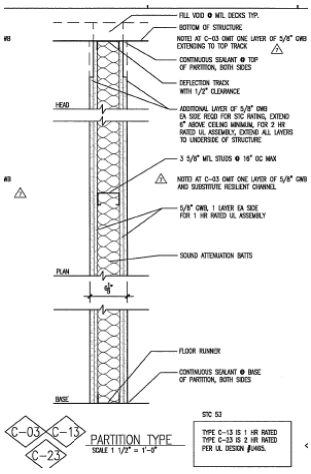
Table 12- Gypsum Board Material Cost

Currently, the partitions do not run entirely from floor to bottom of structure. Gypsum wall board is extended 6" above the acoustical ceiling panels. To further improve upon the room acoustics, the wall board could be extended to the bottom of the metal decking where the top track of the stud wall is attached.

Additionally, the acoustics of water flow through piping in the bathroom partition wall was checked. For 2" supply lines a value of 40 GPM was used to determine a water velocity of 4 ft/s. This value meets the maximum requirement for of 4 ft/s for 2" pipe specified in M. David Egan's Architectural Acoustics Text Book. This calculation can be seen below.

$$V = 0.4\,(Q/d^2) = 0.4\,[40\text{gpm} / (2")^2] = 4\ \text{ft/s} \leq 4\ \text{ft/s OK}$$

Partition Acoustics Results



- Interior partition for Receiving Classrooms 151,156, & 184.
- 3 5/8" Metal Stud Wall
- 2 Layers 5/8" Gypsum Wall Board Each Side
- 3" Sound Attenuation Batt in Cavity
- STC Rated 52

Receiving Classroom 156	Area (SF)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Ambient Classroom Noise (NC-30)		52	45	40	36	34	33
Required Transmission Loss (dB)		**29**	**30**	**33**	**37**	**34**	**29**
Existing Construction TL (STC-52)		**38**	**52**	**59**	**60**	**56**	**62**

ANSI Standard S12.60 STC	**53**
Existing Partition STC	**52**
STC Increase (1 Layer 5/8"GWB)	**5**
Improved STC Rating	**57**
STC+NC=82 ≥ 75 OK	

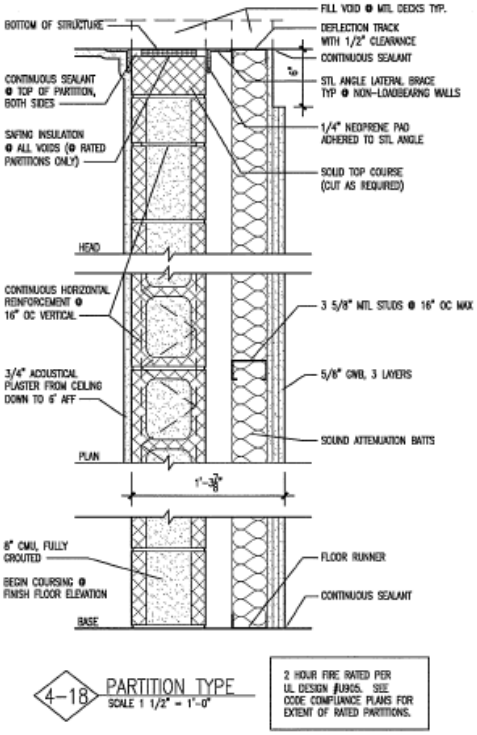
Table 13- Bathroom Space Transmitted to Tiered Lecture Space

Receiving Classroom 151	Area (SF)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Ambient Classroom Noise (NC-30)		52	45	40	36	34	33
Required Transmission Loss (dB)		**9**	**22**	**32**	**33**	**29**	**22**
Existing Construction TL (STC-52)		**38**	**52**	**59**	**60**	**56**	**62**
		ANSI Standard S12.60 STC					**50**
		Existing Partition STC					**52**
		STC Increase (1 Layer 5/8"GWB)					**5**
		Improved STC Rating					**57**
		STC+NC=82 ≥ 75 OK					

Table 14- Tiered Lecture Space Transmitted to a 44 Seat Classroom

Receiving Classroom 184	Area (SF)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Ambient Classroom Noise (NC-30)		52	45	40	36	34	33
Required Transmission Loss (dB)		**13**	**23**	**30**	**31**	**30**	**27**
Existing Construction TL (STC-52)		**38**	**52**	**59**	**60**	**56**	**62**
		ANSI Standard S12.60 STC					**50**
		Existing Partition STC					**52**
		STC Increase (1 Layer 5/8"GWB)					**5**
		Improved STC Rating					**57**
		STC+NC=82 ≥ 75 OK					

Table 15- Methods Laboratory Transmitted to a 44 Seat Classroom



- Interior Partition for Receiving Classroom 129
- 8” Reinforced, Fully Grouted CMU Wall
- 2” Air Space
- 3 5/8” Metal Stud Wall
- 3 Layers 5/8” Gypsum Wall Board
- 3” Sound Attenuation Batt in Cavity
- STC Rated 79

Receiving Classroom 129	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Classroom Noise (NC-30)	52	45	40	36	34	33
Required Transmission Loss (dB)	**29**	**35**	**39**	**42**	**43**	**42**
Equivalent STC Rating	**79**					
	ANSI Standard S12.60 STC					**60**
	Existing Partition STC					**79**
	STC+NC= ≥ 75 OK					

Table 16- Mechanical Equipment Room Transmitted to a 44 Seat Classroom

Conclusion

To ensure acoustically sound learning spaces, some of the analyzed partitions in the TETC building need to be slightly improved upon. The existing metal stud partitions fall slightly under the acceptable STC ratings in the America National Standards Institute specification for acoustical performance of learning spaces. For most sound transmissions, the partitions would likely be sufficient but additional layers of Gypsum Wall Board would make the learning spaces acoustically sound at wall times. The 8” CMU/Stud Wall partition was found to be far more

adequate than the ANSI specified standard. It can be concluded that designers often put too much emphasis on isolating noisy spaces such as mechanical rooms and not as much emphasis on other spaces. Sound isolation between two adjacent classrooms can be just as important for a good learning environment.