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Mechanical Breadth

Introduction

For my second breadth study, I wanted to redesign the acoustical system in my music room to get acceptable reverberation times. I chose to do this because when I altered the lighting system in the 10' ceiling, I changed the existing system. For this study, I went to multiple manufactures websites looking at ceiling pyramids, wall panels, etc, and tried to design a system that was optimal for the multipurpose band room space.

Problem Statement

The major challenge of the acoustical study was trying to find a reverberation time that would be decent for all the different types of musical and singing activities that go on in the room. Since the range of activities varies so much, I chose to average the reverberation time between these activities and try to get a reverberation time that falls close to the average.

Design Criteria

For my acoustical study, design criteria were taken from my AE 458 note, the AE 458 handout packet, and the AE309 book by Egan. I went to manufactures websites to find absorption coefficients for ceiling pyramids and wall panels, but I used the absorption coefficients off of the charts in my books for the rest of the architectural materials.

Walter Nichols **Music Room T60 Calcs**

Surface	Material	Area (ft^2)	125 Hz α	250 Hz α	500 Hz α	1000 Hz α	2000 Hz α	4000 Hz α
10' Ceiling Below	Foam Pyramid 2" thick	512	0.07	0.25	0.6	0.94	0.97	1.08
Walls	Gypsum board -1 layer @ 5/8"	1742	0.55	0.14	0.08	0.04	0.12	0.11
	Painted Foam Panels 2" think	160	0.05	0.31	0.81	1.01	0.99	0.95
Windows	Heavy Glass	300	0.18	0.06	0.04	0.03	0.02	0.02
Doors	Steel Doors	48	0.05	0.1	0.1	0.1	0.07	0.02
Floor	Glazed Tile	1441	0.01	0.01	0.01	0.01	0.02	0.02
15' Ceiling	Plaster on Lath	1441	0.14	0.1	0.06	0.05	0.04	0.03

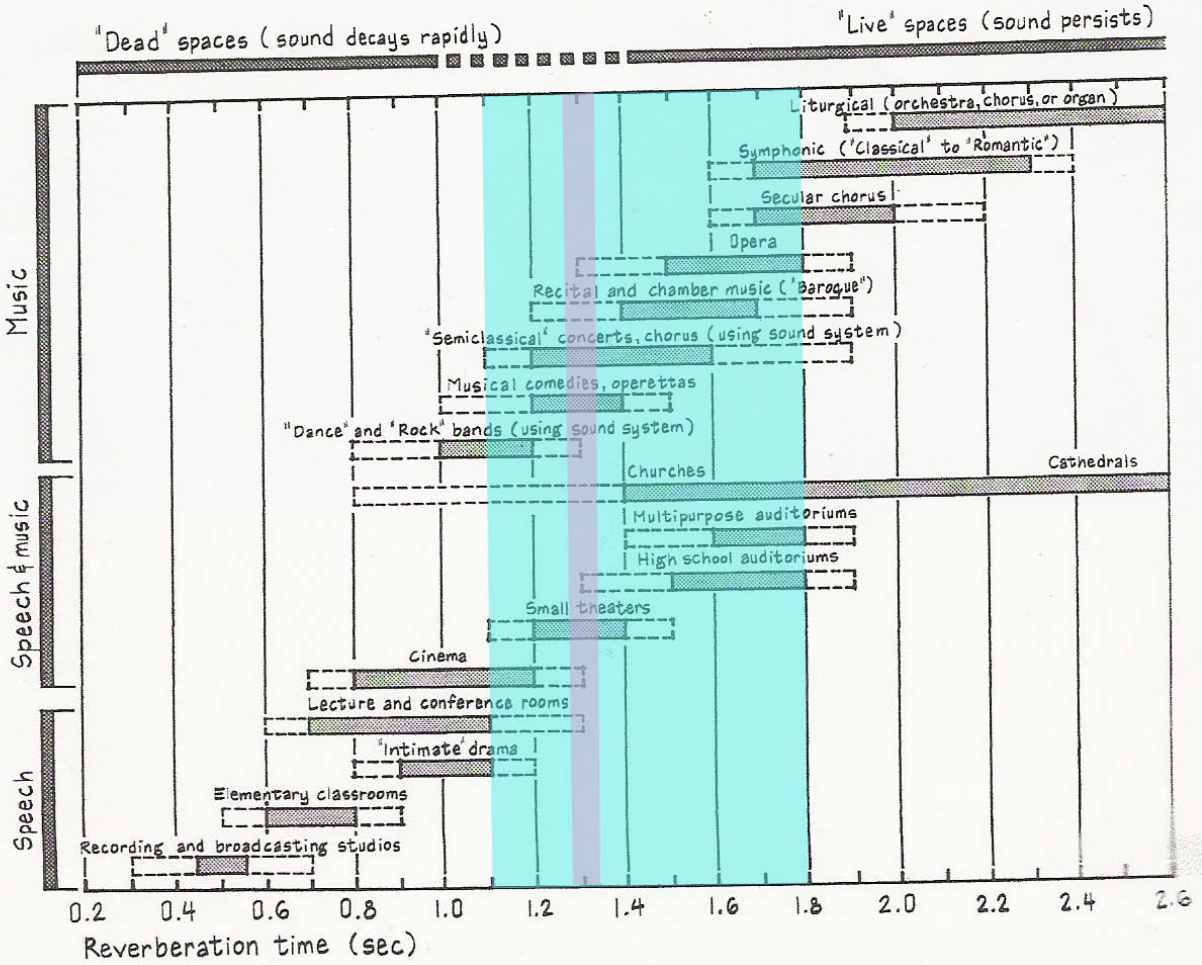
Surface	Material	Area (ft^2)	125 Hz Sα	250 Hz Sα	500 Hz Sα	1000 Hz Sα	2000 Hz Sα	4000 Hz Sα
10' Ceiling Below	Foam Pyramid 2" thick	512	35.84	128	307.2	481.28	496.64	552.96
Walls	Gypsum board -1 layer @ 5/8"	1742	958.1	243.88	139.36	69.68	209.04	191.62
	Painted Foam Panels 2" think	160	8	49.6	129.6	161.6	158.4	152
Windows	Heavy Glass	300	54	18	12	9	6	6
Doors	Steel Doors	48	2.4	4.8	4.8	4.8	3.36	0.96
Floor	Glazed Tile	1441	14.41	14.41	14.41	14.41	28.82	28.82
15' Ceiling	Plaster on Lath	1441	201.74	144.1	86.46	72.05	57.64	43.23
		ΣSα =	1274.49	602.79	693.83	812.82	959.9	975.59

Volume (ft^3) = 21615

T60=	0.847986	1.79291	1.55766	1.32963	1.1259	1.107791
Ave. T60=	1.293646					

OPTIMUM REVERBERATION TIME

The preferred ranges of reverberation time at mid-frequency (average of reverberation at 500 and 1000 Hz) for a variety of activities are given on the bar graph below. The ranges, based on the experience of normal-hearing listeners in completed spaces, are extended by dashed sections at the ends of the bars to indicate the extreme limits of acceptability. Satisfactory listening conditions can be achieved in auditoriums which have different reverberation times within the preferred range, provided other important acoustical needs are fulfilled. In general, large rooms should be nearer the upper end of the reverberation time ranges than smaller rooms of the same type (see Chap. 3). For example, liturgical organ music is composed for church- or cathedral-sized rooms; chamber music is intended for small rooms.



Note: Long reverberation times degrade speech perception of hearing-impaired persons far more than normal-hearing persons. For hearing-impaired and elderly listeners, reverberation times should be well below most of the values in the graph (e.g., < 0.5 s for satisfactory speech perception).

Reference

R. B. Newman, "Acoustics" in J. H. Callender (ed.), *Time-Saver Standards for Architectural Design Data*, McGraw-Hill, New York, 1974, p. 696.