

ACOUSTICS

DESCRIPTION

In the lighting design portion of this thesis, skylights were added to the large instrumental rehearsal room to include daylight as an integral part of the lighting system. This space is mainly functional, focused on the creation and perfection of instrumental music. Therefore, this space is very concerned with acoustics. It is important that both the conductor and the musicians can hear each part of the ensemble clearly. It is also important that the sound is allowed to blend within the space so that the gestalt characteristic of music develops. The reverberation time of a space is a key indicator to the acoustic performance of a space. The addition of skylights will affect the reverberation time of this space. The following analysis will show the impact of the addition of skylights in this space.

ANALYSIS

Reverberation times were calculated using Eyring's equation;

$$T_{60} = \frac{55.2 * V}{c * S * \ln(1 - \alpha_{sab})^{-1}}$$

$$\alpha_{ab} = \frac{\sum (S_i * \alpha_i)}{\sum S_i}$$

T_{60} = reverberation time

V = room volume

c = speed of sound

S = total surface area

α_{sab} = sabine absorption coefficient

Existing Condition

Curtains Drawn

$\Sigma S\alpha$ by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
2728.963	3689.974	4615.381	5798.484	5975.95	5871.286

ΣS 11518.37

α avg. by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
0.236923	0.320356	0.400697	0.503412	0.518819	0.509732

T60 by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1.084753	0.759512	0.572889	0.419022	0.400968	0.411491

α avg.	0.41499
T60 avg	0.547097

seconds

No Curtains

$\Sigma S\alpha$ by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
2613.363	2822.974	3199.281	3919.984	4213.05	4223.986

ΣS 11518.37

α avg. by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
0.226886	0.245084	0.277755	0.340324	0.365768	0.366717

T60 by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1.139833	1.043262	0.901418	0.705066	0.644162	0.642049

α avg.	0.303756
T60 avg	0.810133

seconds

These results show the range of reverberation times (T60) available in the rehearsal room with the use of the velour curtains. This range is in accordance with the desired acoustic properties for a professional rehearsal space. The ceiling in this space is a 2x2' grid and is filled with a checkerboard pattern of alternating panels of gypsum board and acoustic ceiling panels. The skylights will remove 576 sf of 2x2' grid area, and will be replaced with a skylight well and glazing which are considerably less absorptive than suspended ceiling panels. To accommodate for the addition of the skylights, all remaining 2x2' ceiling grid spaces will be filled with acoustic ceiling panels rather than gypsum board.

New Condition

Curtains Drawn

$\Sigma S\alpha$ by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
2952.007	3802.816	4714.982	5906.407	6076.027	5977.893

ΣS 12413.67

α avg. by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
0.237803	0.306341	0.379822	0.475799	0.489463	0.481557

T60 by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1.00224	0.74406	0.569669	0.421376	0.404822	0.414291

α avg.	0.395131
T60 avg	0.55715

No Curtains

$\Sigma S\alpha$ by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
2836.407	2935.816	3298.882	4027.907	4313.127	4330.593

ΣS 12413.67

α avg. by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
0.228491	0.236499	0.265746	0.324473	0.34745	0.348857

T60 by Frequency					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1.049158	1.00859	0.881056	0.693816	0.637572	0.634364

α avg.	0.291919
T60 avg	0.81143

CONCLUSION

This analysis shows that by compensating for the addition of skylights by using only acoustic ceiling panels in the remaining ceiling grid there is virtually no change in the acoustic performance of this space. The scattering effects of the skylight wells are hard to anticipate and have not been accounted for. Yet it can be assumed that any adverse effects of the splayed skylight wells will be less severe than if standard, straight wells were used.