Technical Report
Acoustics of an Atrium with Lobby
Contents

1 Abstract

The simulation of the sound propagation within the Atrium shows the following:

- The biggest reduction in sound level and reverberation will occur with an absorbent shell wall
- The sound level and the reverberation can further be noticeably reduced with perforating the wood panels of the interior curtain wall

2 Atrium

2.1 Reverberation

The dominating measure to describe the general "feel" of a space is reverberation. There are additional measures for special spaces like speech transmission in auditoria or music

perception in concert halls. Reverberation is controlled by applying absorbent materials to the surfaces of a room. If the proportion between the volume and the surface area is big, then even making all surfaces absorbent will not reduce the reverberation below a certain value. We have calculated the reverberation in the atrium by simulation testing these options:

- Option A: Non-absorbent shell wall
- Option B: Absorbent shell wall
- Option C: As option B, with 2 microperforated polycarbonate sheets beneath the glass roof (distances 30 mm and 100 mm)
- Option D: As option B, with perforated wood panels on the interior curtain wall

- With the alterations of the built the sound absorption will be excellent even at low frequencies.

Statistical Absorption Coefficient					
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
0.60	0.80	0.85	0.90	0.95	0.89

Table 1 Absorption coefficient of the shell wall with the alterations. This absorption coefficient was used for the simulations

The resulting reverberation times are:

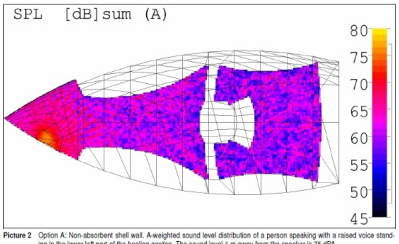
Reverberation Time in Seconds						
Option	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
A: non-absorbent shell wall	14.75	13.98	10.76	9.59	5.86	3.34
B: Absorbent shell wall	4.51	3.51	3.30	2.81	1.86	1.92
C: As B with microperforated sheets in beneath the glass roof	4.36	3.10	2.31	2.33	1.82	1.90
D: As B with a perforated wood panels on the interior curtain wall	4.15	2.15	1.81	1.54	1.49	1.59

Table 2 Reverberation times calculated by simulation.

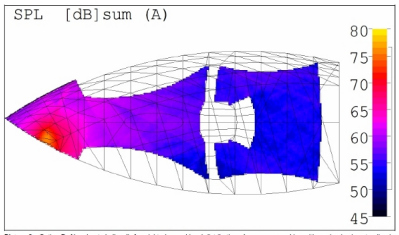
2.2 Sound Transmission

The sound transmitted within the atrium is also dependent on the properties of the surfaces. Surfaces near a speaker will enhance the sound level of a speaker and surfaces further away will guide sound by reflections to a listener.

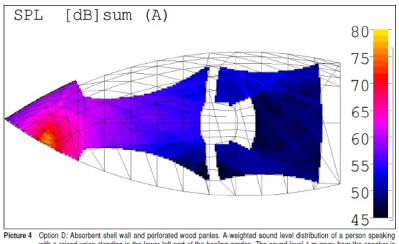
We have simulated a speaker standing in the south of the atrium speaking with a raised voice. Here again the already above mentioned options were tested. Since the results for some options differ only by a small margin from other options only the most striking options are depicted.



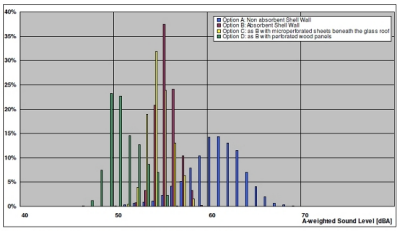
Picture 2 Option A: Non-absorbent shell wall. A-weighted sound level distribution of a person speaking with a raised voice standing in the lower left part of the healing garden. The sound level 1 m away from the speaker is 75 dBA.



Picture 3 Option B: Absorbent shell wall. A-weighted sound level distribution of a person speaking with a raised voice standing in the lower left part of the healing garden. The sound level 1 m away from the speaker is 75 dBA.



Picture 4 Option D: Absorbent shell wall and perforated wood panles. A-weighted sound level distribution of a person speaking with a raised voice standing in the lower left part of the healing garden. The sound level 1 m away from the speaker is



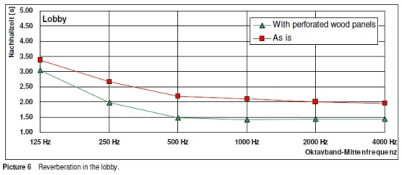
2.3 Focusing Effects

There will be no focusing in the atrium. The curvatures of the shell and pixel walls are bigger than the size of the atrium and no focusing can occur according to the reflection laws of curved mirrors.

There will be however some mirroring effects. As already mentioned above sound will be reflected mainly by the glass roof from the front part into the back part of the atrium. Also some whispering effects may occur along the pixel wall in the front part of the atrium. Depending whether a "pixel" is in the way due to its curvature sound is guided along the reflecting wall. But this effect can be neglected. It will only occur if the listener and the speaker will stand near the wall and only within the front part of the atrium where the pixel wall is freely accessible.

3 Lobby

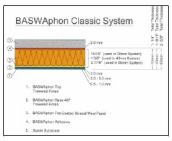
The ceiling of the lobby together with the reveal of the skylight and the wood panels of the facade need an absorbent treatment.



Picture 6 Reverberation in the lobby.

Possible measures are:

Ceiling and reveal skylight: BaswaPhon, a thin acoustically permeable, white plaster on a stiff mineral wool. The appearance will be like a plain gypsum. Pigments can be added to the plaster to add colour.



Perforated wood panels on the interior curtain wall: The panels could be perforated with an acoustic mat behind it.