ACOUSTICS AND LIGHT-WEIGHT ROOF STRUCTURES

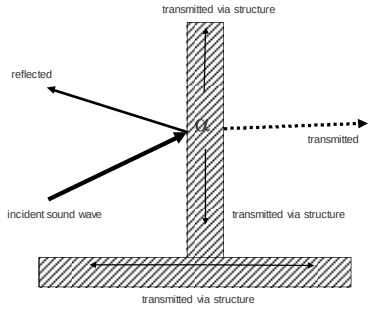
LSAA CONFERENCE 2011

HYATT REGENCY PERTH CASE STUDY

Alistair Bavage – Marshall Day Acoustics

MARSHALL DAY Acoustics

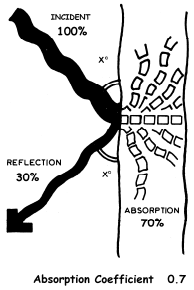
Sound Propagation



Distribution of energy when a sound wave is incident on the boundary of a room

MARSHALL DAY Acoustics

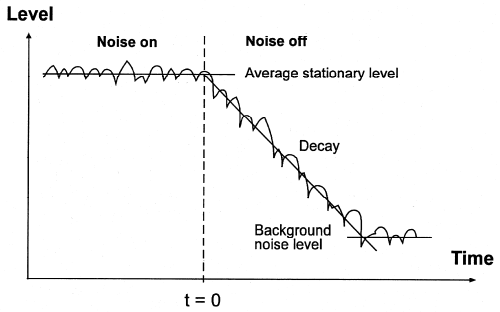
Sound Absorption



- When sound is incident on a surface, some of the sound is reflected and some is absorbed within the material
- 70% absorption = 0.7 absorption coefficient
- NOT good sound insulation
- Absorbed sound dissipated as heat or transmitted

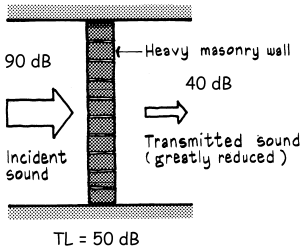
MARSHALL DAY Acoustics

Reverberation Time



MARSHALL DAY Acoustics

Sound Transmission Loss



- Transmission Loss is a measure of the energy loss through a material
- Gives an indication of the sound insulation value of the material
- Normally quoted in R_w (weighted sound reduction index) or STC (Sound Transmission Class)

MARSHALL DAY Acoustics

Other acoustic considerations

- Rain noise generation
- Background or ambient noise levels

MARSHALL DAY Acoustics

6

Case Study - Hyatt Regency Perth

- Existing light-weight polycarbonate roof structure
- Existing roof has reached the end of its life
- Some maintenance issues such as water leakage
- Alternatives to be investigated

MARSHALL DAY Acoustics

7

Hyatt Regency Perth

MARSHALL DAY Acoustics

8

Hyatt Regency Perth

MARSHALL DAY Acoustics

9

Hyatt Regency Perth

MARSHALL DAY Acoustics

10

Hyatt Regency Perth

MARSHALL DAY Acoustics

11

Hyatt Regency Perth

MARSHALL DAY Acoustics

12

Hyatt Regency Perth

MARSHALL DAY Acoustics

13

Hyatt Regency Perth

MARSHALL DAY Acoustics

14

Acoustic Design Issues

- Rain noise
- Noise break-in from external sources such as roof-mounted plant and aircraft
- Reverberation

Client happy with status-quo. What is the impact of alternative materials which may be cheaper and lighter?

MARSHALL DAY Acoustics

15

Existing conditions

- Measurements in August 2010
- Noise level on Balconies adjacent to roof plant 57-62dBA
- Noise level on lower levels away from plant 62dBA. Dominated by noise from fountain
- Existing roof noise reduction approx.15-20dB
- Reverberation time 2.0-2.5s.
- Rain could not be measured but not considered a major concern currently (Perth in drought).

MARSHALL DAY Acoustics

16

Material Options - Lexan

- 4.5mm thick Lexan (single skin polycarbonate)
- Equivalent to existing
- Predictions indicated TL performance of 17-22dB at mid frequencies.
- Absorption co-efficient 0.3
- Panels are relatively flexible
- Issues with maintenance, life span and leakage

MARSHALL DAY Acoustics

17

Material Options - Danpalon

- 16mm thick Danpalon panels (6 layers to form cellular core structure)
- Predictions indicated TL performance of 10-15dB at mid frequencies.
- Absorption co-efficient 0.3
- Panels are relatively hard and stiff
- Issues with joining and shaping of panels

MARSHALL DAY Acoustics

18

Material Options - ETFE

- ETFE (Ethylene Tetrafluoroethylene)
- Panels constructed from light-weight thin film with surface mass approximately 1kg/m^2
- Roof constructed from a number of single layers or double layer pneumatic panels (pillows)
- Predictions indicated TL performance of 7-10dB at mid frequencies.

MARSHALL DAY Acoustics

19

Material Options - ETFE

- Absorption co-efficient 0.15 at mid-high frequencies and 0.5-0.6 at mid-high frequencies
- Majority of incident sound transmitted therefore absorption co-efficients may be understated
- Panel surfaces are relatively hard and stiff when inflated
- Major advantages in terms of weight, span, shapes, longevity and maintenance.

MARSHALL DAY Acoustics

20

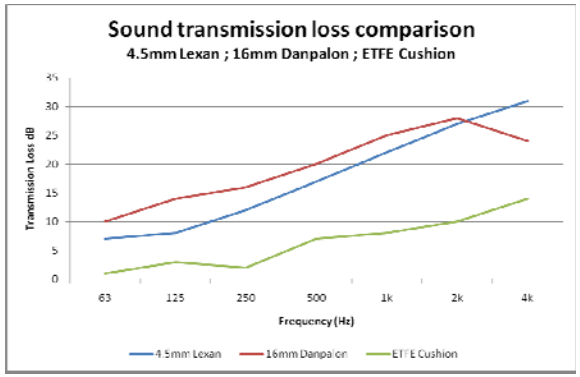
Sound Insulation

- Plant noise levels not anticipated to increase significantly with Lexan and Danpalon options
- 10dB increase possible with ETFE but plant noise could be addressed through localised treatments
- Increased noise levels not expected to have a significant impact given the influence of the fountain on existing ambient levels
- Noise level in guest rooms not expected to change for all options

MARSHALL DAY Acoustics

21

Sound Insulation



MARSHALL DAY Acoustics

22

Sound absorption - Reverberation

- Reverberation times not anticipated to change significantly with Lexan and Danpalon options
- Reverberation times may reduce marginally with ETFE
- RT primarily driven by volume therefore significant changes not anticipated for all options
- Limited opportunities to add absorption elsewhere within the space

MARSHALL DAY Acoustics

23

Rain Noise

- Rain noise currently not considered intrusive
- Lexan flexible and likely to maintain status-quo
- Danpalon and ETFE hard surfaces. Increased rain noise generation anticipated
- Rain noise suppression systems can be applied to EFTE system. Further investigation required. May be retro-fitted if required.

MARSHALL DAY Acoustics

24

Rain Noise

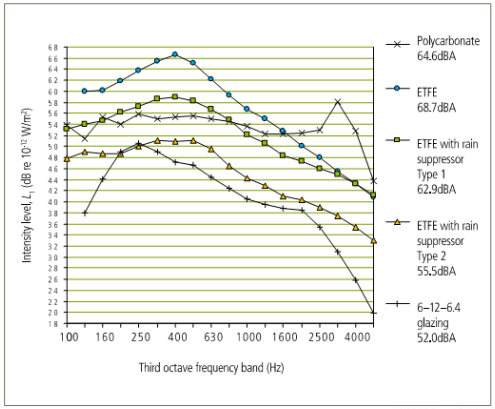
Test numbers	Construction details
L904-023	• 25mm thick polycarbonate sheet (Brett Martin - Marlon st longlife Fivewall) • 3.4kg/m² • 1.5m x 1.25m • Test element angle was 30°
L904-024	• 6-12-6.4 glazing (6 mm toughened glass, 12 mm air space, and 6.4 mm laminate glass) • 30.5 kg/m² • 1.5m x 1.25m • Test element angle was 30° • Artificial rainfall fell upon the side with the 6mm toughened glass
L904-025	• ETFE Pillow: 150 micron layer taped to a 50 micron layer, air gap (200 mm cushion dip), 150 micron layer. • Air pressure: 180Pa • 2.23m x 1.6m • Test element angle was 30°
L904-026	• ETFE Pillow: 150 micron layer taped to a 50 micron layer, air gap (200 mm cushion dip), 150 micron layer. • Air pressure: 180Pa • 2.23m x 1.6m • Texlon rain suppressor Type 1 (Patent No. GB2387395A - Vector Special Projects Ltd) • Test element angle was 30°
L904-027	• ETFE Pillow: 150 micron layer taped to a 50 micron layer, air gap (200 mm cushion dip), 150 micron layer. • Air pressure: 180Pa • Texlon rain suppressor Type 2 (Patent No. GB2387395A - Vector Special Projects Ltd) • Test element angle was 30°

Extract from BRE test report No. 220312

MARSHALL DAY Acoustics

25

Rain Noise



Source: BRE : Rain noise from glazed and lightweight roofing IP 2/06

MARSHALL DAY Acoustics

26

Summary

- Noise break-in from plant likely to be comparable to existing with Lexan and Danpalon. ETFE may require localised treatment to roof plant
- Rain noise likely to increase with ETFE. Current levels can be maintained with a rain suppressor
- Reverberation times unlikely to change significantly due to influence of room volume

MARSHALL DAY Acoustics

27

Final Point

- The acoustic environment can be significantly compromised where light-weight roof structures are specified. Materials must be carefully chosen and additional treatments incorporated above acoustically sensitive spaces.

MARSHALL DAY Acoustics

28