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AIRBORNE SOUND TRANSMISSION LOSS

TIMBERCRETE PTY LTD

100 mm "ANCIENT STONE" BRICK

REPORT NUMBER: **4546**

PREPARED FOR:
Timbercrete Pty Ltd
2628 Bells Line of Road
Bilpin NSW 2758

Attention: Mr Peter Collier
Telephone: 4567 1149

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Report Status	**Prepared by:** Alex Li	**Approved by:** Stephen Gauld
Final		

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1.0 INTRODUCTION

Day Design was commissioned by Timbercrete Pty Ltd to measure the airborne sound transmission loss of their 100 mm "Ancient Stone" brick wall, in the twin reverberation rooms at the National Acoustic Laboratories in accordance with Australian Standard AS 1191-2002: *"Acoustics – Method for Laboratory Measurement of Airborne Sound Insulation of Building Elements"*.

The test specimen was rated in accordance with AS/NZS ISO 717.1:2004 *"Acoustics – Rating of Sound Insulation in buildings and of building elements"*.

2.0 INSTRUMENTATION

Measurements and analysis were made with instrumentation as follows in Table 2.1:

Table 2.1 Instrumentation

Description	Serial No.
Brüel and Kjær "Pulse" Data Acquisition System type 3560-C	2359059
Brüel and Kjær Cathode Follower type 2639	1356526
Brüel and Kjær Cathode Follower type 2660	1337994
Brüel and Kjær Microphone type 4144	439142
Brüel and Kjær Microphone type 4179	2245154
Brüel and Kjær Sound Level Calibrator type 4231	2095415
Yamaha Professional Sound Sources type S500 (2x units)	1068 & 1069
Murray 100 Watt Amplifier type MA534	15
Vaisala Digital Barometer type PTB201AD	R3330001
Testo Temperature/Humidity Logger, type 177-H1	00886924

All acoustic instrument systems have been laboratory calibrated using instrumentation traceable to Australian National Standards and certified within the last two years thus conforming to Australian Standards. The acoustic measurement system was also calibrated prior to and after the noise level measurements. Calibration drift was found to be less than 0.5 dB during the measurements. No adjustments for instrument drift during the measurement period were warranted.

3.0 ACOUSTIC TEST LABORATORY

Location:	National Acoustic Laboratories 126 Greville Street, Chatswood, NSW.
Room Construction:	The twin Reverberation Rooms were used for the acoustical measurements with the test specimen installed in the aperture. The rooms are of concrete and masonry construction, each having an internal volume of approximately 200 cubic metres. The floors are pentagonally shaped and the ceilings are inclined so that no two surfaces are parallel. The rooms are vibration and sound isolated from the enclosing building, being floated on steel springs and rubber dampers below the concrete floor. Large panels of 19 mm thick plywood, heavily coated with an epoxy resin are suspended inside the test room in random orientation to aid in the diffusion of the sound field.
Room Surface Area:	231 m^2
Atmospheric Conditions:	The relative humidity inside the reverberation room throughout the testing was between the ranges of 65 to 75 %. The temperature was between the ranges of 20 to 25 ^oC.
Test Wall:	The test wall consisted of: - 440 mm (L) x 240 mm (H) x 100 mm (D) Timbercrete "Ancient Stone" bricks (approximate density 1000 kg/m^3) constructed in the 10 m^2 aperture between the reverberation rooms.
Date of Masonry Wall Construction:	Tuesday 15th February, 2011
Date of Test:	Monday 21st February, 2011

4.0 MEASUREMENT PROCEDURE

Before testing commenced, the reverberation room temperature, relative humidity and barometric air pressure were noted. The measurement microphones were acoustically calibrated and the acoustical noise floor of the room checked.

All reverberation rooms have small space variations of the sound field distribution and time variations in sound field decay (of reverberation time) during the measurement period. The gathering of meaningful results therefore requires multiple measurements to determine the extent of these variations. The testing procedure uses 48 sets of data to determine the spread of results around the estimate of the mean, each set containing 18 measurements of one-third octave reverberation times.

The two reverberation rooms are identified as the Reverberation Room and the Diffuse Field Room; the Reverberation Room being the room where noise is generated, and the Diffuse Field Room is the room on the other side of the test specimen measuring the transmitted noise levels.

The suite of data is divided into two sets of 24 measurements. The first set consists of sound pressure level measurements in the Reverberation Room and Diffuse Field Room measured simultaneously as noise is generated in the Reverberation Room and is transmitted into the Diffuse Field Room. Sound pressure levels are measured at 12 different locations in each of the two rooms to obtain a spatial average of the sound pressure levels in the rooms. Measurements of sound transmission loss were carried out in accordance to AS 1191-2002: *"Acoustics – Method for Laboratory Measurements of Airborne Sound Insulation of Building Elements"*.

The second set of measurements is of the reverberation times in the Diffuse Field Room, which determines the absorption characteristics of the Diffuse Field Room. The measurements consist of a spatial average of six different combinations of two loudspeakers and three microphone positions, and four measurements taken at each combination for a time average to obtain an estimate of the reverberation time precision.

This space-time measurement data was computer processed on a pre-configured Excel spreadsheet to obtain a final average and standard deviation for the test specimen results. The calculations provide sound absorption coefficients and precision level of the measurements to a 95% confidence level.

4.1 Reverberation Time (T_{60})

The reverberation time, T_{60}, is the time it takes for a noise source to decay by 60 dB. A "live" room, such as a reverberation room, which consist of only hard surfaces will typically have a long reverberation time. A "dead" room, such as an anechoic chamber, which consist of highly absorptive surfaces, will have a much shorter reverberation time.

Measurement of the reverberation time in the Receiving Room allows us to adjust the measured sound reduction to account for the sound energy absorption by the room.

4.2 Equivalent Absorption Area (A)

The equivalent absorption area, *A*, of the receiving room is obtained from the measured reverberation time, *T*, at each one-third octave centre frequency by use of the following equation:

$$A = \frac{0.16V}{T}$$

where V = volume of receiving room (m^3)

T = space-averaged reverberation time of receiving room (seconds)

4.3 Sound Reduction Index (R)

The Sound Reduction Index, R, is the ratio of the incident sound power to the transmitted sound power through a building element. It is expressed as:

$$R = \frac{W_1}{W_2}$$

where W_1 = sound power incident on the element under test (watts)

W_2 = sound power transmitted through and radiated by the element under test (watts)

However, as sound powers cannot be measured directly, the Sound Reduction Index has been redefined in AS 1191-2002 in terms of sound pressure levels. The Sound Reduction Index is derived from the following equation:

$$R = L_{p1} - L_{p2} + 10\log(S/A)$$

where L_{p1} = average sound pressure level in the source room (dB)

L_{p2} = average sound pressure level in the receiving room (dB)

S = area of building element specimen under test (m^2)

A = equivalent absorption area in receiving room (m^2)

4.4 Weighted Sound Reduction Index (R_w) & Correction Factor (C_{tr})

The weighted sound reduction index (R_w) as described in Australian Standard AS/NZS ISO 717.1:2004 provides an acoustic rating for the sound insulation of walls and partitions subject to airborne sounds having a spectrum similar to that of the human voice, which is typically of a mid-to-high frequency character.

Sound insulation varies with frequency and is dependent on the type of material and construction. However, the R_w provides a convenient method of rating sound insulation using a single number. The higher the R_w rating the better the sound insulation provided by the partition.

The R_w rating is determined by comparing the measured sound reduction indices against a set of reference values between one-third-octave band centre frequency range of 100 Hz to 3150 Hz, as specified in AS/NSZ ISO 717.1:2004.

The reference data is then amplitude shifted in 1 dB increments across the spectrum until the sum of the unfavourable deviations is as large as possible without exceeding 32 dB. (The unfavourable deviation is the difference between the measured data and the reference data where the measured data is less than the reference data).

The spectrum adaptation terms C and C_{tr} are applied to the sound reduction index to account for the different spectra of noise sources that the specimen can be exposed to. The adaptation term C is used for sources such as children playing and highway road traffic noise, which have a wide energy distribution in their noise spectra. The adaptation term C_{tr} is used for noise sources such as aircraft noise (at long distance), slow railway traffic, and disco music, which has a high concentration of energy in the low frequency range of the measurement spectrum.

5.0 TEST SPECIMEN DESCRIPTION AND RESULTS

A single skin 100 mm masonry wall consisting of Timbercrete "Ancient Stone" bricks was constructed in the 10 m^2 aperture between the two reverberation rooms at the National Acoustic Laboratories. The "Ancient Stone" brick has a rough finish on one side and a smooth finish on the other side of the brick. The rough side is typically used as the external face of the wall, and the wall was constructed with the rough side facing the Reverberation Room (source room).

Figure 1. Construction of Timbercrete "Ancient Stone" brick wall in the aperture

Figure 2. Rough finish of "Ancient Stone" brick

Figure 3. Smooth finish of "Ancient Stone" brick

The wall was left to cure for 6 days after construction, to allow the mortar to set before testing. The Timbercrete "Ancient Stone" brick wall achieved a weighted sound reduction index of R_w ($C;C_{tr}$) = 41 (-1;-3).

Sound reduction indices (rounded to the nearest integer) are tabulated for each one-third-octave band tested, and presented in Table 1.

Table 1 Measured Sound Reduction Index

1/3 Octave Band Centre Frequency (Hz)	Sound Reduction Index (dB)	
	1/3 Octave	1/1 Octave
100	37	
125	28	31
160	33	
200	32	
250	31	33
315	36	
400	35	
500	32	34
630	35	
800	42	
1000	44	45
1250	47	
1600	49	
2000	52	51
2500	54	
3150	57	
4000	60	61
5000	63	
R_w ($C;C_{tr}$)	**41 (-1;-3)**	

Test measurements and calculations were conducted by the undersigned.

Alex Li, BE (Mech) Hons

Consulting Acoustical Engineer

for and on behalf of Day Design Pty Ltd.

AAAC MEMBERSHIP

Day Design Pty Ltd is a member company of the Association of Australian Acoustical Consultants, and the work herein reported has been performed in accordance with the terms of membership.

Attachments:

- Test Certificate 4546 – Timbercrete 100 mm "Ancient Stone" Brick Wall

DAY DESIGN	TIMBERCRETE WALL SOUND TRANSMISSION LOSS TEST CERTIFICATE	Test 4546

Client:

Timbercrete Pty Ltd

Test Specimen:

100 mm "Ancient Stone" Veneer Brick

440 mm (L) x 240 mm (H) x 100 mm (D) per brick
Approximate density 1000 kg/m^3

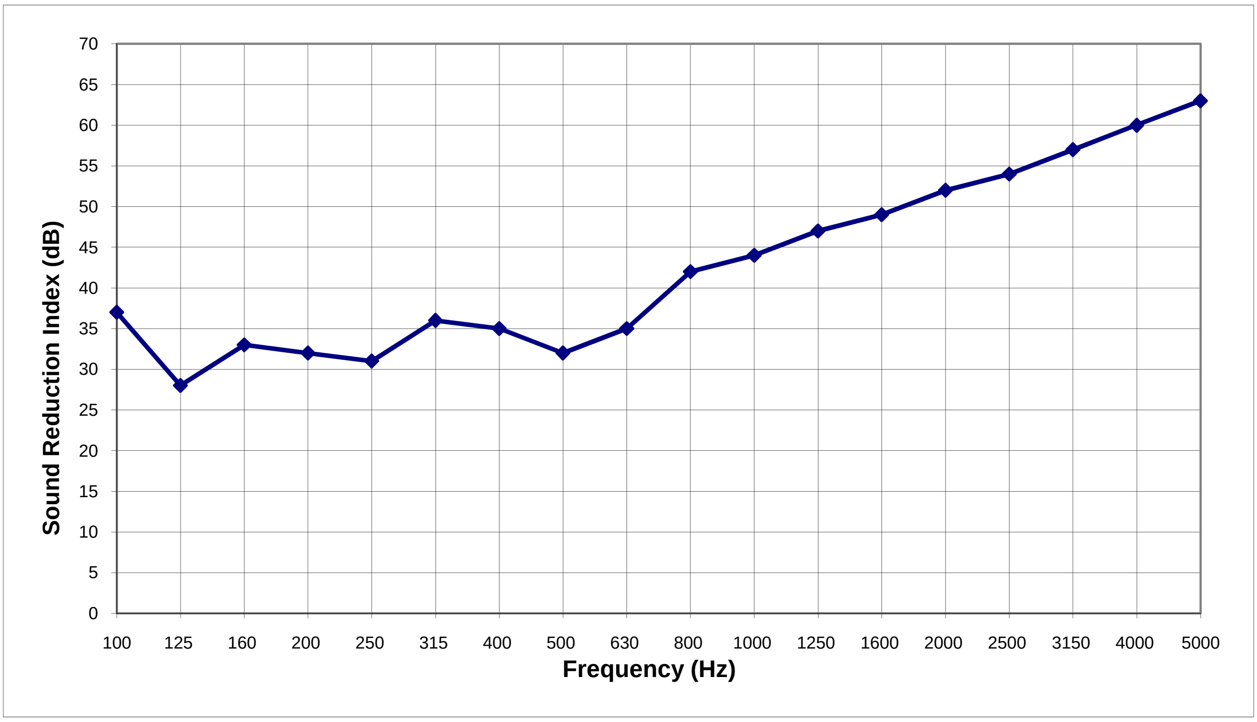
Frequency - Hz	Sound Reduction Index - dB 1/3 Octave	Sound Reduction Index - dB 1/1 Octave
100	37	
125	28	31
160	33	
200	32	
250	31	33
315	36	
400	35	
500	32	34
630	35	
800	42	
1000	44	45
1250	47	
1600	49	
2000	52	51
2500	54	
3150	57	
4000	60	61
5000	63	
R_w (C;C_{tr})	**41 (-1 ; -3)**	

Australian Standards:
Measured according to AS 1191-2002
Rated to AS/NZS ISO 717.1:2004

Test Specimen Dimensions:
3434 mm (H) x 2888 mm (W)

Test Location:
Twin Reverberation Rooms
National Acoustic Laboratories
126 Greville Street, Chatswood NSW

Instrumentation:
- Brüel and Kjær Two Channel Pulse Analyser (assembly 2825, 7521, 2 x 3015)
- Brüel and Kjær Cathode Follower type 2639
- Brüel and Kjær Cathode Follower type 2660
- Brüel and Kjær Microphone type 4144
- Brüel and Kjær Microphone type 4179
- Brüel and Kjær Sound Level Calibrator type 4231
- Yamaha Professional Sound Sources type S500



Date of Test: Monday, 21 February 2011
Project Number: 4546

Test Engineer: **Alex Li, BE(Mech) Hons**
For and on behalf of Day Design Pty Ltd