Ref no: T1702-2

LABORATORY MEASUREMENT OF AIRBORNE SOUND INSULATION OF PIR ROOF PANELS (According to ISO 10140-2)

AUCKLAND UNISERVICES LIMITED
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THE UNIVERSITY OF AUCKLAND

Report prepared for:
Conqueror International Ltd
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Date: 26 July 2016

Report prepared by:
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Acoustics Testing Service
The University of Auckland

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Mr. Gian Schmid.

Dr. Michael Kingan

T1702-2

Acoustics Testing Service

Sound reduction index, R, in accordance with ISO 10140-2
Laboratory measurements of airborne sound insulation of building elements

Description and identification of the test specimen and test arrangement:
Date of test: 1-Feb-17

Airborne sound insulation of Roof panels
Client: Conqueror International Ltd.

Test Wall : Conqueror 75mm (110mm overall to top of ribs) *PIR Roof Panels* comprising: 75mm - 110mm *PIR* sandwiched between 0.4mm - 0.6mm pre-painted *Zincalume* coated steel

Panel Joint Sealant: *Selleys No More Gaps*

Test Wall Perimeter Sealant: *GIB Soundseal*

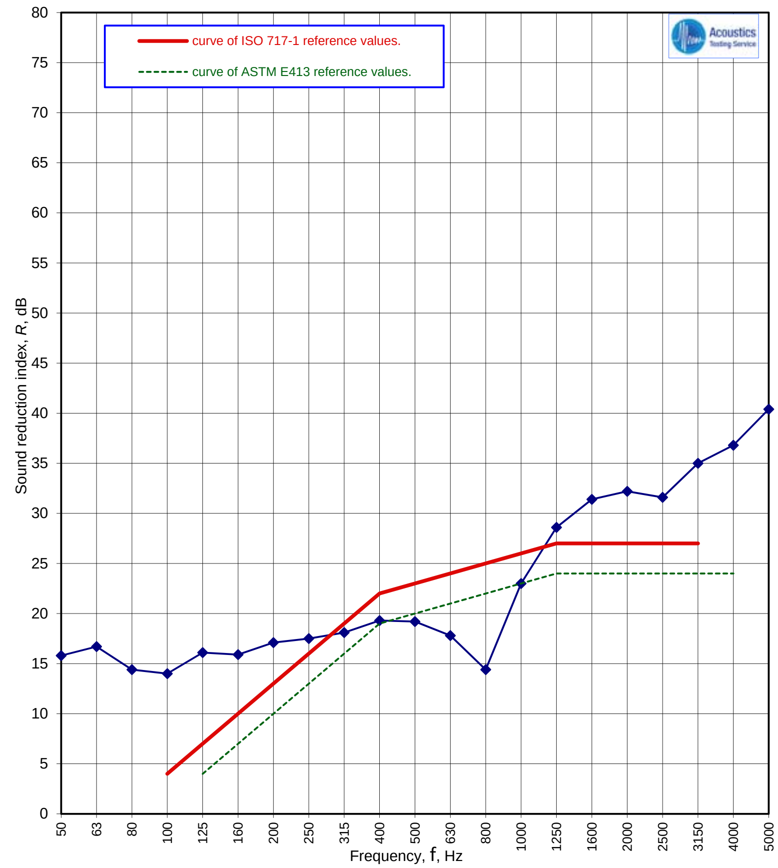
Source chamber: Chamber C, Receiving chamber: Chamber A . Test specimen installed by client.

Computer files: T1702-2.CMG Emmited noise: T1702-2.CMG: ID.1 Received noise: T1702-2.CMG: ID.0 Reverberation time: T1702-2.CMG: ID.66

Area *S* of test specimen:	11.95 m^2
Mass per unit area:	11.21 kg/m^2
Air temp in the test rooms:	21 ^oC
Air humidity in test rooms:	57 %
Source room volume:	202 m^3
Receiving room volume:	202 m^3

Frequency *f* Hz	*R* One-third octave dB
50	15.8
63	16.7
80	14.4
100	**14.0**
125	**16.1**
160	**15.9**
200	**17.1**
250	**17.5**
315	**18.1**
400	**19.3**
500	**19.2**
630	**17.8**
800	**14.4**
1000	**23.0**
1250	**28.6**
1600	**31.4**
2000	**32.2**
2500	**31.6**
3150	**35.0**
4000	**36.8**
5000	40.4

Notes:1. #N/A = Value not available.
2. **Bold** values are used to calculate STC and R_w.
3. Words in ***Blue Italic*** in the description are manufacturers brand names.



Rating according to ISO 717-1

***R**$_w$* **(*C* ;*C*$_{tr}$) = 23 (-1 ; -3) dB**

Rating according to ASTM E413 -87

$C_{50\text{-}3150}$ = -1 dB $C_{tr,\ 50\text{-}3150}$ = -4 dB
$C_{50\text{-}5000}$ = 0 dB $C_{tr,\ 50\text{-}5000}$ = -4 dB
$C_{100\text{-}5000}$ = 0 dB $C_{tr,100\text{-}5000}$ = -3 dB

Sound Transmission Class = 20 dB

Evaluation based on laboratory measurement results obtained by an engineering method.

No. of test report: **T1702-2**
Name of test institute: University of Auckland Acoustics Testing Service.
Date: *Wednesday, 1 March 2017*
Signature:

ANNEX A.

PHOTOS AND DETAILS OF THE TEST SPECIMEN

Figure 1: Section view showing PIR core

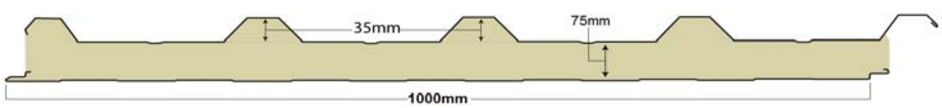


Figure 2: Section view showing dimensions

Figure 3: Interior side of roof panels in test rooms

Figure 4: Exterior side of the roof panels showing corrugations

ANNEX B.

ADDITIONAL INFORMATION ABOUT EQUIPMENT USED

	EQUIPMENT	TYPE / SERIAL No.
INSTRUMENTATION	CHAMBER C SOURCE ROOM	
	1/2" Microphone	4165 / 1622303
	Preamplifier	2619 / 9459549
	Rotating Boom	3923 / 936497
	CHAMBER A RECEIVING ROOM	
	1/2" Microphone	4190 / 2150379
	Preamplifier	2619 / 945952
	Rotating Boom	3923 / 936496
	Calibration of the above equipment was conducted by Electroacoustic Calibration Services (ECS), an IANZ registered laboratory.	
	BOTH ROOMS	
	Calibrator	4231 / 2241899
	Analyzer	01dB Stell / 01381

ANNEX C.

SUMMARY OF THE MEASUREMENT OF AIRBORNE SOUND INSULATION OF BUILDING ELEMENTS

INSTALLATION OF TEST SAMPLE

The wall under test is installed in the opening between two reverberation chambers – chambers C and A for a wall, chambers A and B for a floor. These chambers are vibration isolated from each other which results in a structural discontinuity at the middle of the test opening. This gap is covered over by a collar, which seals the gap and provides for ease of fixing of samples. The wall sample is constructed by the client following the techniques normally used in practice for that type of wall or floor/ceiling, and is sealed into the test opening with perimeter seals of acoustic sealant. For ease of removal, the surfaces of the test opening are covered with an adhesive, heavy fabric tape prior to the construction of the building element.

METHOD

The measured transmission loss values are obtained in accordance with the recommendations of ISO standard 10140-2:2010(E) "Laboratory measurement of sound insulation of building elements- Part 2: Measurement of airborne sound insulation"

Essentially the transmission loss of a building element is measured by generating sound on one side of the building element (the source chamber) and measuring how much sound is transmitted into the receiving chamber. In the source chamber pink noise is radiated from a loudspeaker. Time and space averaged sound pressure levels in both the source and receiving chambers are measured by using a rotating boom microphone, and the average sound pressure levels are obtained by sampling the sound pressure levels as the boom rotates through one cycle (taking 64 seconds). This is repeated for a different loudspeaker position in the source chamber.

Measurements of the background noise levels in the receiving chamber are also made. Then, should it prove necessary, the transmitted noise levels are corrected for the influence of background noise as prescribed in the standard.
The sound absorption of the receiving chamber is also determined by measuring the reverberation times (ISO-354:2003(E) "Measurement of Sound Absorption in a Reverberation Room").

RESULTS

The third octave band sound reduction indices R are presented in both table and graph formats. Sometimes a highly reflective test sample means that the lower frequency sound pressure levels cannot be reliably measured; this is indicated by #N/A in the table of results. Additionally, if the specimen is highly insulating, sometimes the background noise affects the measurements, resulting in only an upper threshold being found; this is indicated by a > sign preceding the tabulated results.

Single figure ratings are also presented. The weighted sound reduction index Rw, determined according to ISO 717-1, is presented along with spectrum adaptation terms Ctr and C. Rw is determined by fitting a reference curve to the third octave band sound reduction indices R from 100Hz to 3150Hz, and gives a single figure rating of the sound reduction through the building element (higher is better). The spectrum adaptation terms are added to Rw and are used to take into account the characteristics of particular sound spectra. C is used for living activity noise, children playing, railway traffic at medium and high speed, highway (>80km/h) road traffic, and jet aircraft at short distances. Ctr is used for lower frequency noise such as urban road traffic, low speed railway traffic, aircraft at large distances, pop music, and factories which emit low to medium frequency noise. C and Ctr without further subscripts are applied to a frequency range of 100Hz to 3150Hz. Other spectrum adaptation terms are provided with enlarged frequency ranges (if measured), e.g. Ctr,50-5000 is applied to urban traffic noise with a frequency range of 50Hz to 5000Hz. For light timber constructions Ctr will be negative, indicating the poor sound insulation abilities of such constructions at low frequencies.

The sound transmission class (STC) determined according ASTM E413 is also presented. This is determined by fitting a reference curve to the third octave band sound reduction indices R from 125Hz to 4000Hz, but in a slightly different way to ISO 717-2. The sound transmission class gives a single figure rating of the sound reduction through the building element so that higher is better.

ANNEX D.

DESCRIPTION OF THE REVERBERATION CHAMBERS AT THE UNIVERSITY OF AUCKLAND

There are three large interconnected reverberation chambers at the Acoustics Research Centre, two at ground level (Chambers C and A) and the third (Chamber B) below A.

All three reverberation chambers may be described as hexagonal prisms; each has 6 vertical sided walls, perpendicular to the floor. The roofs of chamber A and C are plane, but inclined at 12 degrees from horizontal. Chamber B has a plane, horizontal roof which is the floor of chamber A above it. The floor of chamber B is also horizontal, but has two angled sections at its North West and south east ends. The centre section is horizontal because a floor jack is installed there. The floor jack may be raised hydraulically to the ceiling of chamber B, the centre of which consists of a floor plug between the two chambers. This plug may be disconnected from chamber A and lowered down into chamber B, leaving a 3.2 m x 3.2 m opening between the two chambers. This allows for the measurement of airborne and impact insulation of floor and roof elements.

The wall of chamber C adjacent to chamber A is left open, and the corresponding wall of chamber A consists of a pair of iron doors that are clamped against the chamber. The clamps may be removed and the iron doors pulled back, leaving the entire wall area (4.6 m wide x 2.74 m high) between the chambers open. This allows for the measurement of airborne sound insulation of wall elements.

Chamber A has a rotating vane diffuser in a central position with an area (both sides) of about 53 m^2. It has the shape of two cones with their bases joined, with the two opposite quadrants of one cone open and the complementary quadrants in the other cone open. Chamber C has a similar rotating vane diffuser but it is smaller, having a total area of about 27 m^2.

In addition, up to ten static diffusers may be employed if needed. These are constructed of two laminated layers of dense Formica, of dimensions 1m x 1m. The Formica elements are riveted to a frame constructed of aluminium T section. Four aluminium arms may be bolted onto the frame to allow the diffusers to be mounted as desired.
Currently four of these are used in chamber C, and three are used in chamber B.

The volumes and surface areas of the reverberation chambers are as follows:

	VOLUME (m^3)	SURFACE AREA (m^2)
Chamber A	202 ± 3	203.6 ± 0.9
Chamber B	153 ± 2	173 ± 1
Chamber C	209 ± 4	214 ± 0.9

The three Reverberation Chambers are linked by heavy steel doors and a removable Standard Industrial Floor Section which is removed and repositioned by a hydraulic hoist. The three chambers are vibration isolated from one another so that sound can only pass from one to the other via the intervening Test Wall or Test Floor/Ceiling Section.