CSIRO ACOUSTIC MEASUREMENT REPORT

Commonwealth Scientific and Industrial Research Organisation, Infrastructure Technologies
Acoustics Testing Laboratory, Research Way, Clayton, Vic 3168 Australia

Report No:
AC348-03-1

Client: Woven Image Pty. Ltd.
37-39 Chard Road, Brookvale, NSW 2100 Australia

Measurement Type: Sound Absorption

AS ISO 354–2006 [R2016]: *Acoustics–Measurement of sound absorption in a reverberation room*
AS ISO 11654–2002 [R2016] (ISO 11654:1997): *Acoustics–Rating of sound absorption–Materials and systems*

Test Specimen

[Specimen area[5]: 3.600 x 2.700 m (9.720 m²)]

Name: Woven Image 'Fuji Hachi 9 x 12 ceiling tiles' tested mounted on proprietary hardware placed on the floor of the test chamber and with no perimeter enclosure.

Test Specimen Details[3]:

- Product designation: Woven Image 'Fuji Hachi 9 x 12 ceiling tiles'
- 'Fuji Hachi 9 x 12 ceiling tile' composition: 3 mm thick non-woven PET core (70% recycled) with a 1.3 mm thick 'Mura' (100% PET – 60% recycled) layer laminated to front and rear faces compressed to 4.6 mm (± 2 mm) and thermoformed into a dished profile resulting in a rounded rectangle absorber tile 1740 x 840 mm (± 3 mm) x 132 mm deep. Tile weight: 2570 g ea (meas); Area density (Tile only): 1740 gsm (nom).
- Supplied with proprietary mounting/installation kits comprising: - a] Mounting Rails (2.5 m long proprietary aluminium extrusions to be fixed to or suspended from the ceiling above), b] joiners to join mounting rails/segments together, c] Barrel kit mounts (made from ABS/stainless steel) to fix tiles to rails, d] mounting rail end caps, e] snap covers (cut to size to close-off the open mouth of the mounting rails).

Installation: (carried out by laboratory staff, as per manufacturer's instructions)

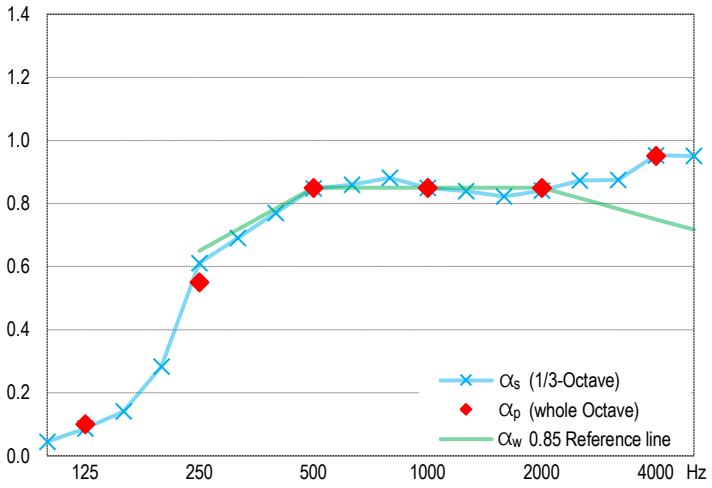
- The reverberation chamber was swept and vacuumed.
- Due to test-laboratory constraints, this product was tested upside-down on the floor of the test chamber in a manner acoustically equivalent to being suspended below the ceiling of a normal room.
- The specimen for testing consisted of mounting rails positioned in 3 parallel lines at 900 mm centres, with 2 tiles per line (2 Barrel kits per tile; 900 mm centres). End caps and snap covers were used to close-off the voids of the rails as per a field installation. Tiles installed to present concave dished face visible to the test chamber.
- The tiles mounted on the rails were placed on the floor of the test chamber, the rectangular 2 x 3 array of tiles was oriented at an angle of 11° from the walls of the chamber (not parallel, as per AS ISO 354 cl 6.2.1.2), and was notionally applying acoustic treatment to an area[5] of 3600 x 2700 mm.
- The specimen area of 9.72 m² is less than 10 – 12 m² required for compliance with AS ISO 354; partial rows, non-rectangular test specimen shape or cutting tiles deemed to be greater deviation from the requirements in AS ISO 354 and/or manufacturers' field installation recommendations.
- The perimeter edges of the test specimen were not enclosed[6].

Specimen as tested (image inverted to depict ceiling installation)

Left: Oblique view of the Woven Image 'Fuji Hachi 9 x 12 ceiling tile'; Right: Fuji Barrel kit mount

Measurement Details & Results

Freq	Absorption coefficients[5]			Reverberation times, T_{60} (sec)	
Hz	α_s	α_p	95% Conf (δ)	Empty room[4]	with Specimen
100	0.04		0.06	5.13	4.80
125	0.09	0.10	0.03	5.99	5.19
160	0.14		0.05	6.48	5.09
200	0.28		0.06	5.82	3.90
250	0.61	0.55	0.08	4.96	2.60
315	0.69		0.06	5.92	2.67
400	0.77		0.07	5.87	2.50
500	0.85	0.85	0.06	5.41	2.29
630	0.86		0.04	5.13	2.22
800	0.88		0.05	4.86	2.13
1000	0.85	0.85	0.04	4.78	2.16
1250	0.84		0.04	4.29	2.07
1600	0.82		0.04	3.77	1.96
2000	0.84	0.85	0.03	3.50	1.86
2500	0.87		0.04	3.22	1.75
3150	0.87		0.04	2.92	1.65
4000	0.95	0.95	0.04	2.44	1.44
5000	0.95		0.04	2.09	1.30



Performance Indices[1,2]

α_w = 0.85
SAA = 0.76
NRC = 0.80
Sound Absorption Class = B

The required 12 spatially independent decay curves came from ensemble averaging 10 successive decays with each of 3 different source loudspeaker positions, all sampled by 4 fixed microphones, using linear averaging.

Measurement Conditions	Empty room	with Test Specimen
Date of measurement:	6 Jun 2023	6 Jun 2023
Temperature & humidity:	18 °C, 71 % R.H.	18 °C, 68 % R.H.
Atmospheric pressure:	1008 mBar	1009 mBar

Notes, Deviations etc

1. Shape indicators (L, M, and H), if any, following the α_w index, indicate α_p values above the reference contour by ≥ 0.25 in the Low, Medium or High frequency ranges respectively; it is strongly recommended to use this single number rating in combination with the complete sound absorption coefficient curve.
2. SAA and NRC are defined in ASTM C423; laboratory requirements for which differ from AS ISO 354.
3. Physical characteristics of materials may be as per client or supplier's advice; not necessarily verified by CSIRO.
4. Empty room absorption area in the 250 Hz band did not comply with the requirements of AS ISO 354; a non-compliance unrelated to the product/material under test.
5. Absorption coefficients reported are based on 9.72 m² of room area being 'treated' with each tile notionally treating an area of 1800 x 900 mm.
6. At the request of the client, the perimeter of the test specimen was not enclosed – a deviation from the requirements of Annex B of AS ISO 354.

Issuing Authority

Signed: .....
John Watson
Date: 20 June 2023

Instrumentation

Real time analyser: • Brüel & Kjær PULSE LAN-XI type 3160-A-04/2
Microphones/preamps: • 4 microphones (4 x GRAS 46AQ) on GRAS preamps, in fixed positions as per AS ISO 354.
Noise source: • Room populated with three Norsonic NOR276 dodecahedron loudspeakers, driven in turn by a Norsonic NOR280 power amplifier.
Calibration: • Analyser: September 2021 (NATA cal)

Laboratory Construction

Reverb room: • 300 mm thick concrete (closed off from the adjoining room by a Sandwich Panel/plaster-board composite wall) • parallelepiped with dimensional proportions 1:1.3:1.6 for distribution of room modes • approx. 202 m³ total room volume
Diffusers: • approx. 215 m² surface area excluding diffusers • 20 stationary diffusers, approx. 40 m² total surface area
Absorption area: • in accordance with AS ISO 354, unless noted otherwise