CSIRO ACOUSTIC MEASUREMENT REPORT

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

Report No:
AC321-04-1

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: 3.600 x 3.000 m (10.800 m^2)]

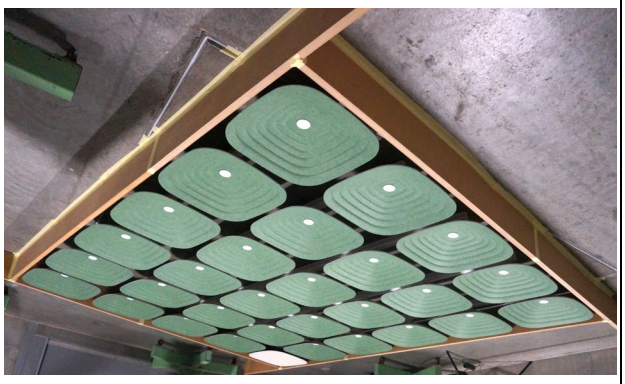
Name: Woven Image 'Fuji 6 x 6 ceiling tiles' fixed at 200 mm height, and tested with a full perimeter enclosure

Test Specimen Details[3]:

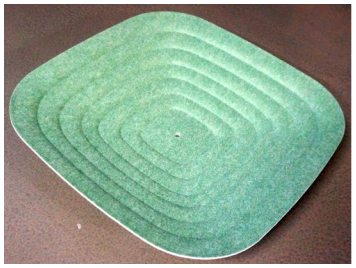
- Product designation: Woven Image 'Fuji 6 x 6 ceiling tile' (30 full tiles used in test)
- 'Fuji 6 x 6 ceiling tile' composition: 3 mm thick non-woven PET core (70% recycled) with a 1.3 mm thick 'Mura' (100% PET – 60% recycled) layer laminated to front and rear faces compressed to 4.6 mm (± 2 mm) and thermoformed into a dished profile resulting in a rounded square absorber tile 560 x 560 mm (± 3 mm) x 90 mm deep. Tile weight: 517 g ea (meas); Area density: 1740 gsm (nom).
- Supplied with 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] plastic mounts to suspend tiles from rails, d] mounting rail end caps, e] snap covers (to be cut to size and used to close-off the open mouth of the mounting rail).

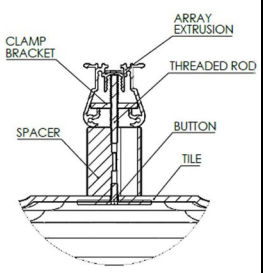
Installation: (carried out by laboratory staff, as per manufacturer's instructions)

- 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 5 parallel lines at 600 mm centres, with 6 tiles per line (1 plastic mount per tile). End caps and snap covers were used to close-off the voids of the rails. The rectangular 6 x 5 array of tiles was oriented at an angle of 10° 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 of 3600 x 3000 mm.
- Tiles were attached to the plastic mounts so as to present their concave dished face visible to the room, with the brim at a height of 200 mm from the surface of the room behind.
- The perimeter of the test specimen was enclosed by 32 mm thick MDF, 200 mm high installed to enclose the standard treatment area of the installed tile array. Gaps between the enclosure and the surrounding chamber floor and between adjacent enclosure members were sealed with tape.



Specimen as tested (image inverted to depict ceiling installation)

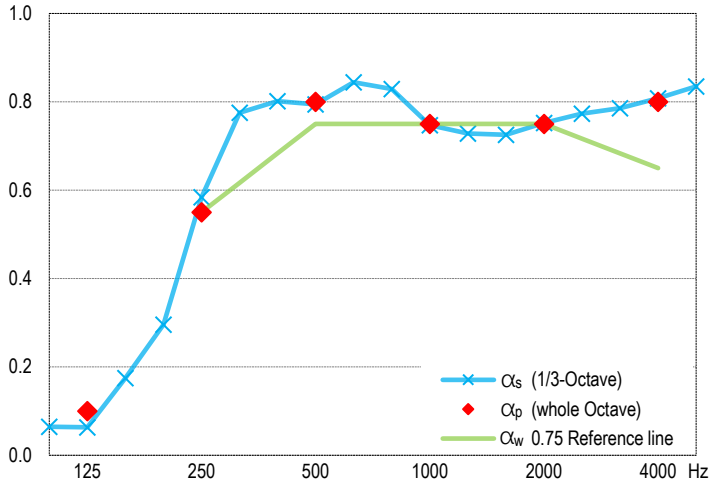




Left: Oblique view of the Woven Image 'Fuji 6 x 6 ceiling tile'; Right: Fuji plastic mount

Measurement Details & Results

Freq	Absorption coefficients			Reverberation times, T_{60} (sec)	
Hz	α_s	α_p	95% Conf (δ)	Empty room[4]	with Specimen
100	0.06		0.04	5.16	4.64
125	0.06	0.10	0.04	5.70	5.09
160	0.17		0.04	6.39	4.67
200	0.30		0.06	5.73	3.67
250	0.58	0.55	0.08	4.58	2.43
315	0.78		0.06	5.86	2.34
400	0.80		0.04	5.65	2.26
500	0.79	0.80	0.05	5.41	2.24
630	0.84		0.06	5.29	2.14
800	0.83		0.05	4.92	2.09
1000	0.75	0.75	0.04	4.82	2.20
1250	0.73		0.04	4.46	2.15
1600	0.73		0.04	4.07	2.06
2000	0.75	0.75	0.04	3.72	1.93
2500	0.77		0.03	3.37	1.81
3150	0.79		0.04	3.07	1.71
4000	0.81	0.80	0.05	2.54	1.51
5000	0.83		0.05	2.18	1.36



Performance Indices[1,2]

α_w = 0.75
SAA = 0.72
NRC = 0.70
Sound Absorption Class = C

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:	11 May 2022	11 May 2022
Temperature & humidity:	17 °C, 75 % R.H.	17 °C, 75 % R.H.
Atmospheric pressure:	1012 mBar	1012 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.

Issuing Authority

Signed: .....
John Watson
Date: 14 June 2022

Instrumentation

Real time analyser: • Brüel & Kjær PULSE LAN-XI type 3050-A-060
Microphones/preamps: • 4 microphones (1 x B&K 4134, 1 x B&K 4166, and 2 x GRAS 40AR) on B&K and 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 plaster-board wall) • parallelepiped with dimensional proportions 1:1.3:1.6 for distribution of room modes • approx. 202 m^3 total room volume • approx. 215 m^2 surface area excluding diffusers
Diffusers: • 20 stationary diffusers, approx. 40 m^2 total surface area
Absorption area: • in accordance with AS ISO 354, unless noted otherwise