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TEST REPORT No : 2781-2467

DATE OF ISSUE : 6 October 2016

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BS EN ISO 354:2003
ACOUSTICS – MEASUREMENT OF SOUND ABSORPTION IN A
REVERBERATION ROOM

CLIENT: Edmund Bell & Co. Ltd
Unit E1A Kingsway Business Park
John Boyd Dunlop Drive
Kingsway
Rochdale
OL16 4NG

JOB NUMBER: ACOUS/02781

MANUFACTURER: Client

MODEL: Enigma – 6974/6975 DIM-OUT Fabric

TYPE: Type G-100 Mounting

DATE RECEIVED: 17 August 2016

DATE OF TEST: 14 September 2016

Signed:.....

D Wong-McSweeney
Laboratory Manager

Approved:.....

D J M^cCaul
Technical Manager

1 **TEST SAMPLES**

1.1 **Description of Test Samples**

Test Reference: **2781-2467**

Sample Reference: Enigma – 6974/6975 DIM-OUT Fabric

Sample Description: A timber rail was installed 3.0 m above the ground on the wall of the Reverberation Room and its outer face was 100 mm from the wall. The sample, as supplied by the client, was 7.0 m × 3.0 m. It was gathered using the draw strings of the heading tape to a width of 3.5 m as specified by the client. The curtain was mounted on the timber rail so that it hung just to the ground. The curtain was affixed to the timber rail at regular intervals of between 100 and 150 mm creating approximately eleven folds at the base. The mass per unit area below was calculated using the total mass ÷ mounted area.

Sample area, unfolded: 7000 × 3000 mm

Sample area, mounted: 3500 × 3000 mm

Thickness: 0.50 mm

Mass per unit area: 0.67 kg/m²



2 DESCRIPTION OF TEST PROCEDURE

2.1 Description of Test Facility

The tests were carried out in the large reverberation room at the University of Salford. The room has been designed with hard surfaces and non-parallel walls to give long empty room reverberation times with uniform decays. It has the shape of a truncated wedge. In addition 11 plywood panels, each panel 1.22m × 2.44m, were hung in the room to improve the diffusivity of the sound field. The test sample was placed in the centre of the floor. The excitation signal comprised wide band random noise played into the room via a loudspeaker system mounted in a cabinet facing a corner. The sound was monitored at each of 6 microphone positions. The room is 7.4m long × ~6.6m wide × 4.5m high with a volume of 220m³ and a total surface area of 224m². The volume of the room permits a maximum sample size of 12.79m² to be tested, in accordance with Clause 6.2.1.1 in BS EN ISO 354: 2003, "Acoustics - Measurement of sound absorption in a reverberation room".

2.2 Test Procedure

The procedure followed that detailed in BS EN ISO 354. Measurements were made on the rate of decay of sound in the test chamber with and without the sample in place. The frequency range from 100Hz to 5000Hz was covered in one-third octave bands. An average reverberation time was taken from five decays at each of six microphone positions for each of two loudspeaker positions (i.e. 60 decays per third octave band). The decays were produced by exciting the room with amplified wide band random noise and stopping the excitation once the chamber became saturated. The time taken for the sound to decay by a given amount is measured and extrapolated to give the reverberation time. In practice this was determined by sampling the decaying sound field on a one-third octave band frequency analyser and storing the spectrum in a computer every 32 milliseconds. The reverberation time was obtained from the arithmetically averaged decays at each frequency. The measurements with and without the sample in the room were carried out consecutively to avoid significant changes in relative humidity and temperature that influence air absorption at higher frequencies.

2.3 Calculation

The random incidence sound absorption coefficients were determined from the measured data by means of the equations below:

$$\alpha_s = \frac{A_T}{S}$$

Where

α_s is the absorption coefficient of the sample

S is the area covered by the test specimen (m²)

A_T is the equivalent sound absorption area of the test specimen (m²)

$$A_T = A_2 - A_1 = 55.3V \left(\frac{1}{c_2 T_2} - \frac{1}{c_1 T_1} \right) - 4V(m_2 - m_1)$$

A_1 is the equivalent sound absorption area of the empty reverberation room (m²).

A_2 is the equivalent sound absorption area of the room reverberation containing the test specimen (m²).

V is the volume, in cubic metres, of the empty reverberation room:

c_1 is the propagation speed of sound at air temperature t_1 ;

c_2 is the propagation speed of sound at air temperature t_2 ;

T_1 is the mean reverberation times of the empty reverberation room in each frequency band (sec).

T_2 is the mean reverberation times of the reverberation room containing the test specimen in each frequency band (sec)

m_1 is the power attenuation, in reciprocal metres, using the climatic conditions that have been presented in the empty reverberation room.

m_2 is the power attenuation, in reciprocal metres, using the climatic conditions that have been presented in the reverberation room containing the test specimen.

The single-number rating, α_w , has been calculated in accordance with BS EN ISO 11654:1997.

(No correction is applied for the absorption of the surface covered by the test sample)

3 **EQUIPMENT**

	Departmental Record No
Norwegian Electronics 1/3 octave band real time analyser type 850 with in-built random noise generator	RTA3-07 to 12
Quad 510 power amplifier	PA7
2 × broadband loudspeakers (receiving room)	LS3-LS4
4 × Brüel & Kjær random incidence condenser microphone type 4166 in the receiving room	M8, M9 M18, M19
2 × G.R.A.S. random incidence condenser microphones type 40AP in the receiving room	M20, M31
Environmental sensor data logger, hygrometers and barometer	HL1, HG1, HG2, SP04
Toshiba TECRA R850 119 laptop computer and related peripheral equipment (network switch, printer, monitor etc.)	RTA3-00
Yamaha GQ1031BII graphic equalizer	GEQ1

4 RESULTS

The random incidence sound absorption coefficients are given in the table(s) overleaf.

Reverberant room volume	220 m ²		
Sample size	Unfolded: 7000 × 3000 mm Mounted: 3500 × 3000 mm		
Sample thickness	0.42 mm		
		Sample out	Sample in
Temperature [°C ± 0.3]	21.7	22.1	
Rel. humidity [% ± 3.0]	69.1	70.6	
Atm. Pressure [kPa ± 0.14]	100.8	100.7	

The results here presented relate only to the items tested and described in this report.

BS EN ISO 354:2003

Acoustics - Measurement of absorption in a reverberation room

Client: **Edmund Bell &Co. Ltd**
 Unit E1A Kingsway Business Park, John Boyd Dunlop Drive,
 Kingsway, Rochdale, OL16 4NG

Product Identification: Enigma - 6974/6975 DIM-OUT Fabric

Description of Sample: Curtain

Room Volume: 220 m³ **Location:** Acoustic Transmission Suite

Sample Size: 10.50 m² **Test Room:** Large reverberation Room

Sample Thickness: 0.5 mm **Condition:** Clean

Sample Out		Sample In	
Temperature	21.7 °C	Temperature	22.1 °C
Relative Humidity	69.1 %	Relative Humidity	70.6 %
Static Pressure	100.8 kPa	Static Pressure	100.7 kPa

Random Incidence Sound Absorption Coefficient

Frequency [Hz]	T_1 [s]	T_2 [s]	α_S
100	3.44	3.04	0.13
125	3.58	3.34	0.07
160	3.49	2.93	0.19
200	3.50	2.71	0.29
250	4.03	2.73	0.40
315	4.14	2.50	0.53
400	4.19	2.08	0.81
500	4.35	2.05	0.87
630	4.41	2.06	0.87
800	4.37	2.06	0.86
1000	4.30	2.10	0.82
1250	3.97	2.03	0.81
1600	3.78	2.00	0.79
2000	3.54	1.92	0.80
2500	3.24	1.85	0.78
3150	2.93	1.75	0.78
4000	2.51	1.62	0.74
5000	2.07	1.42	0.76

Test reference: 2781-2467

Date: 14 September 2016

University of Salford, School of Computing Science & Engineering

BS EN ISO 354:2003
Acoustics - Measurement of absorption in a reverberation room

Client: **Edmund Bell &Co. Ltd**
 Unit E1A Kingsway Business Park, John Boyd Dunlop Drive,
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Product Identification: Enigma - 6974/6975 DIM-OUT Fabric

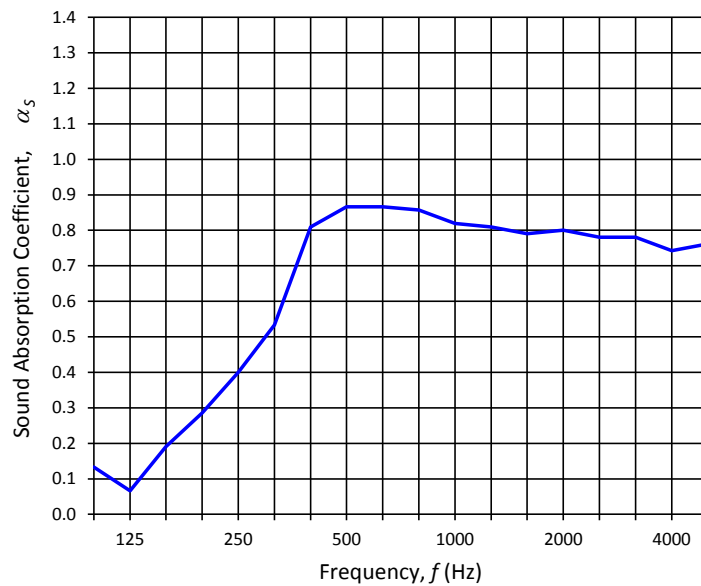
Description of Sample: Curtain

Room Volume: 220 m³ Location: Acoustic Transmission Suite
 Sample Size: 10.50 m² Test Room Large reverberation Room
 Sample Thickness: 0.5 mm Condition: Clean

Sample Out		Sample In	
Temperature	21.7 °C	Temperature	22.1 °C
Relative Humidity	69.1 %	Relative Humidity	70.6 %
Static Pressure	100.8 kPa	Static Pressure	100.7 kPa

Random Incidence Sound Absorption Coefficient

Frequency [Hz]	α_s
100	0.13
125	0.07
160	0.19
200	0.29
250	0.40
315	0.53
400	0.81
500	0.87
630	0.87
800	0.86
1000	0.82
1250	0.81
1600	0.79
2000	0.80
2500	0.78
3150	0.78
4000	0.74
5000	0.76



Signed: 

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BS EN ISO 11654:1997
Acoustics - Sound absorbers for use in buildings

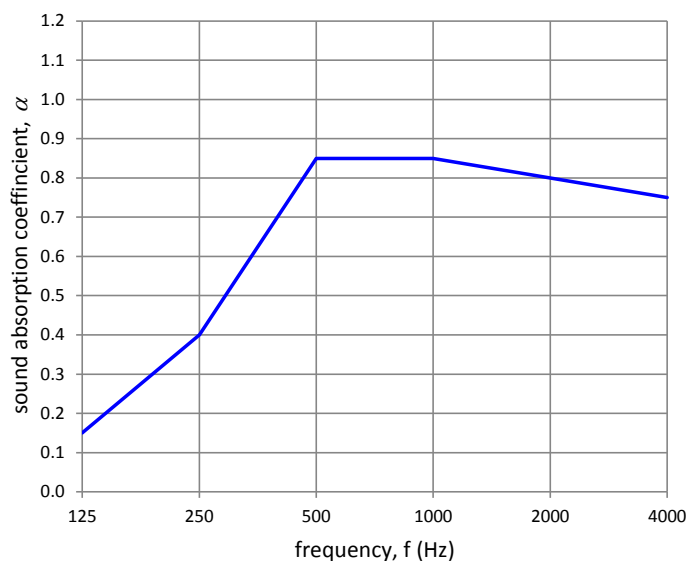
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 Unit E1A Kingsway Business Park, John Boyd Dunlop Drive,
 Kingsway, Rochdale, OL16 4NG
Product Identification: Enigma - 6974/6975 DIM-OUT Fabric
Description of Sample: Curtain

Room Volume: 220 m³ Location: Acoustic Transmission Suite
 Sample Size: 10.50 m² Test Room Large reverberation Room
 Sample Thickness: 0.5 mm Condition: Clean


Sample Out Temperature 21.7 °C
 Relative Humidity 69.1 %
 Static Pressure 100.8 kPa
Sample In Temperature 22.1 °C
 Relative Humidity 70.6 %
 Static Pressure 100.7 kPa

Random Incidence Sound Absorption Coefficient

Frequency [Hz]	α_{pi}
125	0.15
250	0.40
500	0.85
1000	0.85
2000	0.80
4000	0.75



$\alpha_w = 0.70$
Classification: C

Signed: 

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