TECHNICAL REPORT

SOUND RESEARCH LABORATORIES LIMITED

Report Number	Date
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For

Onduline Building Products Ltd
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Project

The Laboratory determination of the Random incidence sound absorption coefficient and Airborne sound reduction index of an acoustic panel manufactured by Onduline Building Products Ltd.

Prepared by

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1. BRIEF OF COMMISSION

To undertake laboratory measurements to determine:-

a) The random incidence sound absorption coefficient in accordance with BS EN 20354:1993.

b) The airborne sound reduction index in accordance with the procedure detailed in BS 2750:Part 3:1980.

The tests to be carried out over the 1/3rd octave band frequency range 100Hz to 5000Hz to determine the sound absorption coefficient and 100Hz to 3150Hz to determine the airborne sound reduction index.

2. SUMMARY

Test in accordance with the brief have been undertaken in the reverberation rooms of SRL's Laboratory at Holbrook House, Sudbury, Suffolk.

From these measurements the required results have been derived and are presented in tabular form.

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J C SOPP
Laboratory Manager

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A SMALLS
Laboratory Engineer

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3. DETAILS OF MEASUREMENTS

3.1 Location

Sound Research Laboratories Ltd
Holbrook House
Little Waldingfield
Sudbury
Suffolk
CO10 OTH

3.2 Test Date 11th April 1996

3.3 Instrumentation and Apparatus Used

Make	Description	Type
E D I	Microphone Multiplexer Microphone Power Supply Unit	
Norwegian Electronics	Real Time Analyser	830
Olivetti	Computer	M290S
Epson	FX Printer	FX 100
Bruel & Kjaer	12mm Condenser Microphones Windshields Pre Amplifiers Microphone Calibrator	4166 UA0237 2639 4230
Larson Davis	12mm Condenser Microphone	2560
SRL	Power Amplifiers	
Celestion	Loudspeakers	100w
Solomat	Multimeter 226 R.H. Probe	MPM500e PT100

3.4 References

BS 2750:Part 3:1980 ISO 140/3	Laboratory measurements of airborne sound insulation in building elements
BS EN 20354:1993	Method for measurement of sound absorption in a reverberation room

3.5 Personnel Present

Mr T. Knell	Onduline Building Products Ltd
Mr R. Gibson	Onduline Building Products Ltd

4. DESCRIPTION OF TEST

4.1 Description of Sample

Random incidence sound absorption coefficient sample was constructed in the reverberation room.

Construction No 1 The lower corrugated sheets were laid on battens at 880mm centres. 95mm spacer timber was laid on the bottom sheets, the upper corrugated sheet was laid on the timber.

Construction No 2 For this construction the cavity was filled with 50mm Gypglas insulation.

The corrugations were blanked off with pre-formed foam strip for both constructions.

Airborne sound reduction sample was pre-assembled to fit into a 2000 x 1200mm test aperture. This was a double skin construction with 95mm spacer with no infill.

4.2 Sample Delivery date 11th April 1996

4.3 Test Procedures

The sample were located and tested in accordance with the relevant standard. The method and procedure is described more fully in Appendices 1 and 2.

5. RESULTS

The results of the measurements and subsequent analysis is given in Tables 1 and 2.

TABLE 1 RANDOM INCIDENCE SOUND ABSORPTION COEFFICIENT

Sample area: 13.21 sq. metres

Temperature: 13.8°C

Frequency Hz	Construction No 1 (Test 1)	Construction No 2 (Test 2)
100	0,07	0.70
125	0.26	0.66
160	0.43	0.58
200	0.25	0.30
250	0.25	0.25
315	0.25	0.23
400	0.24	0.25
500	0.20	0.23
630	0.19	0.21
800	0.22	0.22
1.0k	0.26	0.25
1.25k	0.29	0.31
1.6k	0.21	0.22
2.0k	0.12	0.12
2.5k	0.08	0.09
3.15k	0.10	0.12
4.0k	0.05	0.05
5.0k	0.05	0.09

Construction No 1 2 sheets of corrugated Onduline sheet with 95mm spacers.

Construction No 2 2 sheets of corrugated Onduline sheet with 50mm Gypglas infill in the 95mm cavity.

$f_0 = 84\sqrt{\frac{1}{d}\left(\frac{1}{m_1}+\frac{1}{m_2}\right)}$ d: épaisseur lame f_0 le + bas possible. f_0 : 200 à 250 Hz

$f_R = \frac{nc}{2d}$ f_R : le + grd possible. f_R = 3400 Hz

TABLE 2 **AIRBORNE SOUND REDUCTION INDEX dB**

Sample area: 2.4 sq metres

Frequency Hz	1/3 Octave	1/1 Octave
100	12.1	
125	10.1	11.4
160	12.5	
200	17.3	
250	20.7	19.3
315	21.0	
400	22.4	
500	26.4	25.1
630	29.3	
800	27.2	
1.0k	26.2	27.0
1.25k	27.8	
1.6k	32.1	
2.0k	36.6	35.1
2.5k	39.9	
3.15k	40.4	
Average Sound Reduction Index (100-3150Hx)		25.1
Weighted Average Sound Reduction Index R_w		28
Sound Tranmission Class (S.T.C.)		28

Construction No 3 2 sheets of corrugated Onduline sheet with 95mm spacer, no infill.

APPENDIX 1

Measurements of Random Incidence Sound Absorption Coefficients to BSEN 20354:1993/ISO 354:1985

The Laboratory determination of random incidence sound absorption coefficients is characterised by the corrected difference in decay rates in a reverberation room with and without the test sample installed.

The reverberation room is constructed from 215mm brick, which is internally plastered with a reinforced concrete roof and floor. The room has a volume of 300 cubic metres and is isolated by the use of resilient mountings and seals from the surrounding structure.

Using at least two loudspeakers, narrow band random noise is produced in the room using an electronic generator and power amplifier. When the amplification system is switched off the decay of sound at any chosen frequency is filtered and measured. This process is repeated for each of the microphone positions and the values arithmetically averaged to obtain a final value for each frequency.

The sample, which has an area between $11.3m^2$ and $13.6m^2$ is then laid on the floor of the reverberation room so that no part of it is closer than one metre from any edge of the boundaries. The whole procedure of measuring the decay rates is then repeated.

The Sound Absorption Coefficients are calculated from the difference in decay rates for each frequency according to the formula:

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

where

α_s	=	is the random incidence absorption coefficient
A		is the increase in absorption due to the introduction of the sample
S		is the area of the sample

The increase in absorption is further defined as:

$$A = \left(\frac{55.3V}{c}\right)\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

where

V	is the volume of the reverberation room
c	is the speed of sound
T_2	is the reverberation time In the room with sample installed
T_1	is the reverberation time in the empty room

It is occasionally found that the absorption coefficient derived in this manner reaches a value greater than unity. This is theoretically impossible by definition, and investigation has shown that this anomaly is due to diffraction of the impinging sound waves at the edges of the sample.

APPENDIX 2

Measurement of Sound Transmission in accordance with BS 2750:1980, ISO 140:1978

The Laboratory determination of airborne sound transmission is characterised by the difference in corrected sound pressure levels measured across the test sample installed between the reverberant rooms. The test is intended to be conducted under conditions which restrict the transmission of sound by paths other than that directly through the sample and where the source field is randomly incident on the sample.

The test sample is located and sealed in an aperture within the brick dividing wall between the two rectangular reverberant or acoustically "live" rooms, both of which are constructed from 215mm brick with reinforced concrete floors and roofs. The brick wall has dimensions of 4.8m wide x 3.1m high and 550mm nominal thickness and forms the whole of the common area between the two rooms. One of the rooms termed the receiving room has a volume of 300 cubic metres and is isolated by the use of resilient mountings and seals from the surrounding structure and the adjoining room, therefore ensuring good acoustic isolation. The adjoining source room has a volume of 60 cubic metres.

Using at least two loudspeakers, broad band white noise is produced in the source room from an electronic generator and power amplifier. The resulting sound pressure levels in both rooms are sampled, filtered into one third octave band widths, integrated and averaged by means of a Real Time Analyser using a spaced array of microphones. The value obtained at any particular frequency is known as the equivalent sound pressure level for either source or receiving rooms. The change in level across the test sample is termed the equivalent sound pressure level difference i.e.

$$D = L_1 - L_2$$

where

D is the equivalent Sound Pressure level difference in dB

L_1 is the equivalent Sound Pressure level in the source room in dB

L_2 is the equivalent Sound Pressure level difference in the receiving room in dB

The Sound Reduction Index (R) also known by the American terminology Sound Transmission Loss, is defined as the number of decibels by which sound energy randomly incident on the test sample, is reduced in transmitting through it and is given by the formula:

$$R = D + 10\log_{10} \frac{S}{A} \text{ ...... in decibels}$$

where

S is the area of the sample

A is the total absorption in the receiving room

both dimensions being in consistent units

The Sound Reduction Index is an expression of the laboratory sound transmission performance of a particular element or construction. It is a function of the mass, thickness, sealing method of mounting etc.and is independent of the overall area of the sample.

However, when a sample is installed on site and forms part of an enclosure of building, the sound insulation obtained will be dependent upon its surface area, the larger the area the greater the sound energy transmitted, as well as the absorption in the receiving area. In addition, the overall sound insulation of an enclosure is also determined by the sound transmission through other building elements, some of which may have an inferior performance to the sample. Because of this the potential Sound Reduction Index of a sample is not always fully realised in practice. A further consequence is that the Sound Reduction Index of a particular sample can only successfully be measured in a laboratory because only under such controlled conditions can the sound transmission path be limited to the sample under test.