



# DELTA Test Report



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## Measurement of sound absorption coefficient for WoodUpp Akupanel, suspended 65 mm, with 45 mm mineral wool

### Performed for WoodUpp IVS

DANAK 100/2519

Project no.: 119-30824

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5 August 2019

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**Title**

Measurement of sound absorption coefficient for WoodUpp Akupanel, suspended 65 mm, with 45 mm mineral wool

**Journal no.**

DANAK 100/2519

**Project no.**

119-30824

**Our ref.**

RSHS/ERTH/ilk

**Date of test**

23-07-2019

**Client**

WoodUpp IVS  
Industrivej 53  
6760 Ribe  
Denmark

**Client ref.**

Troels Johansson

**Summary**

Laboratory measurements of sound absorption coefficient were carried out in a reverberation room according to the test method of EN ISO 354:2003.

Product: WoodUpp Akupanel  
Thickness: 20 mm  
Mounting depth: 65 mm

The panels were supported by 45 x 45 mm laths on the concrete floor of the reverberation room enclosed by a frame.

The test results per one-third octave and per octave are shown in tabular form and graphically on the graph sheets together with the weighted sound absorption coefficient  $\alpha_w$  and the absorption class according to EN ISO 11654:1997.

Descriptions of reverberation room and test procedure are found in Appendix 1.

**Remark**

The test results apply only to the objects tested.

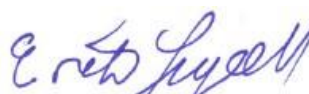
The measurements have been carried out by Rasmus Stahlfest Holck Skov.

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Rasmus Stahlfest Holck Skov  
Specialist, Acoustics



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Erik Thysell  
Senior Specialist, Acoustics

## 1. Introduction

At the request of WoodUpp IVS, measurements of the sound absorption coefficient in a reverberation room were carried out for a slat absorber mounted on a polyester felt.

## 2. Description of the test specimen based on the client's specifications

Product: WoodUpp Akupanel. Wooden slat panel mounted on a polyester felt, with 45 mm mineral wool.

Wood slat: MDF with veneer. Thickness: 11 mm; Width: 27 mm.

Air gap between wood slat: 13 mm.

Polyester felt: 9 mm porous polyester felt (density 20 kg/m<sup>3</sup>).

Total thickness of panel: 20 mm.

Mineral wool: 45 mm ISOVER 37 Basic batts (density 15 kg/m<sup>3</sup>).

The panels were supported by 45 x 45 mm laths with 600 mm ctc distance, with mineral wool between the laths.

## 3. Mounting in the laboratory

The panels were supported by 45 x 45 mm laths on the concrete floor of the reverberation room enclosed by a frame with the size 3.60 m × 3.00 m.

Mounting depth: 65 mm (Type E70 mounting).

The edges of the test specimen were enclosed by a 20 mm thick wooden frame.

All joints between the test specimen and the frame as well as between the frame and the concrete floor were sealed with tape.

The test specimen was placed so that no part of it was closer than 1 m to any edge of the boundary of the room.

Photo of specimen in the laboratory can be seen in Appendix 2.

## 4. Test method

The measurements were carried out according to the test method of EN ISO 354:2003: "Measurement of Sound Absorption in a Reverberation Room".

The sound absorption coefficient was calculated from the reverberation times measured with and without the test specimen.

The measurements were performed in Room 005, Building 355 at the Technical University of Denmark. Brief descriptions of the reverberation room and test procedure are found in Appendix 1.

## 5. Instrumentation

The following instruments were used for the test:

Instrument	Type	DELTA No.	Calibration	
			Last	Next
Sound Level Meter / Analyser	B&K 2270	1498L	2019-07-16	2021-07-16
Measuring Microphone	B&K 4144	1256L	2017-09-21	2019-09-21
Measuring Microphone	GRAS 40EN 1"	1616L	2017-09-21	2019-09-21
Microphone Preamplifier	B&K 2619	719L	2018-11-19	2020-11-19
Microphone Preamplifier	B&K 2619	464T	2018-01-03	2020-01-03
Microphone Power Supply	B&K 2807	722L	2018-07-20	2020-07-20
Microphone Power Supply	B&K 5935	1392L	2018-04-16	2020-04-16
Sensor for Temperature and Humidity	EBRO EBI 20-TH1	1618L	2017-12-08	2019-12-08
Acoustic calibrator	B&K 4231	1158L	2019-05-02	2019-11-02

## 6. Measurement conditions

The reverberation time was recorded in 6 microphone positions, each placed in the range 1.55 m to 2.85 m above the floor. The number of sound source positions was two.

The reverberation time  $T_1$  per third octave of the room without test specimen and the reverberation time  $T_2$  per third octave of the room with test specimen:

Frequency f [Hz]	Reverberation Time $T_1$ [sec.]	Reverberation Time $T_2$ [sec.]
100	7.07	4.80
125	7.61	4.73
160	8.10	4.16
200	7.54	3.26
250	6.84	2.69
315	6.97	2.48
400	6.97	2.29
500	6.42	2.13
630	6.44	2.13
800	5.80	2.12
1000	5.17	1.99
1250	5.05	2.06
1600	4.66	2.00
2000	4.23	2.00
2500	3.82	1.88
3150	3.14	1.71
4000	2.61	1.58
5000	2.24	1.49

Temperature and relative humidity in the reverberation room during measurements:

Room without test specimen: 22.0 °C, 62.8 % RH. Date of test: 23 July 2019

Room with test specimen: 22.1 °C, 69.6 % RH. Date of test: 23 July 2019

The correction of the absorption coefficient due to differences in temperature and relative humidity during measurements of  $T_1$  (the reverberation time of the empty room) and  $T_2$  (the reverberation time of the room with test specimen) was 0 at all frequencies.

## 7. Test results

The test result  $\alpha_s$  per one-third octave from 100 Hz to 5000 Hz is shown in tabular form and graphically on Graph Sheet 1.

The calculated, practical sound absorption coefficient  $\alpha_p$  per octave from 125 Hz to 4000 Hz is shown in tabular form and graphically on Graph Sheet 2 together with the weighted sound absorption coefficient  $\alpha_w$  as well as the absorption class. These values are calculated in accordance with EN ISO 11654:1997.

## 8. Measurement uncertainty

Measurement uncertainty (90 % confidence interval) estimated from a Nordic intercomparison (Nordtest Project No. 1023-92) for the practical absorption coefficient  $\alpha_p$  per octave:

Frequency [Hz]	Uncertainty
125	$\pm 0.15$
250	$\pm 0.10$
500	$\pm 0.05$
1000	$\pm 0.10$
2000	$\pm 0.10$
4000	$\pm 0.10$



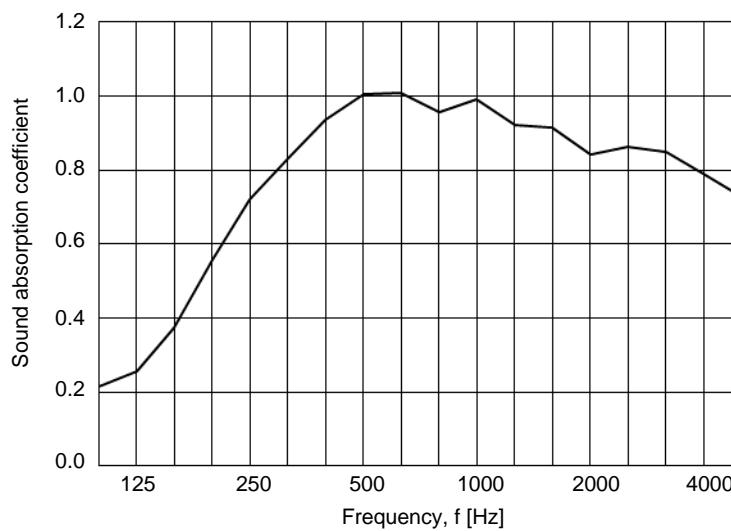
## Laboratory measurement of sound absorption coefficient according to EN ISO 354:2003

Client: WoodUpp IVS, Industrivej 53, 6760 Ribe, Denmark  
Date of test: 23 July 2019

Test specimen: WoodUpp Akupanel, with 45 mm mineral wool  
Mounting depth: 65 mm (Type E70 mounting)

Test area: 10.8 m<sup>2</sup>  
Room volume: 215 m<sup>3</sup>  
Room surface: 305 m<sup>2</sup>

Frequency f [Hz]	$\alpha_s$
100	0.21
125	0.26
160	0.37
200	0.56
250	0.72
315	0.83
400	0.94
500	1.00
630	1.01
800	0.95
1000	0.99
1250	0.92
1600	0.92
2000	0.84
2500	0.86
3150	0.85
4000	0.79
5000	0.73



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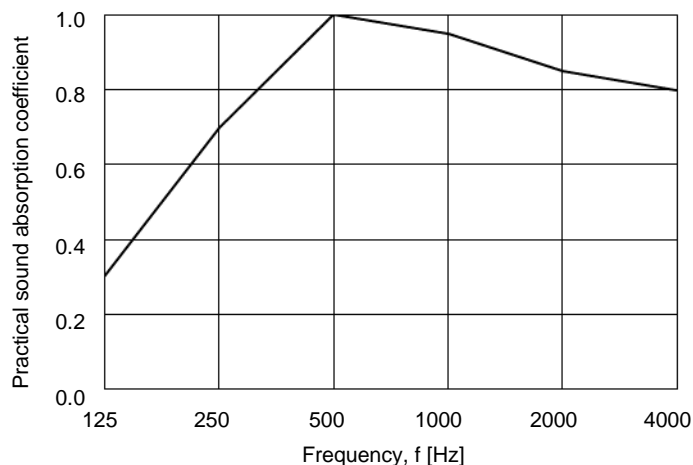
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Test area: 10.8 m<sup>2</sup>  
Room volume: 215 m<sup>3</sup>  
Room surface: 305 m<sup>2</sup>

Frequency f [Hz]	$\alpha_p$
125	0.30
250	0.70
500	1.00
1000	0.95
2000	0.85
4000	0.80



Practical sound absorption coefficient, weighted sound absorption coefficient, and absorption class according to EN ISO 11654:1997:

$\alpha_w = 0.90$

Absorption class A

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## Description of reverberation room

The measurements are performed in a reverberation room (Room 005, Building 355 at the Technical University of Denmark) with walls, ceiling, and floor of 300 mm in situ cast concrete. Length, width, and height of the room are 7.85 m, 6.25 m, and 4.95 m, respectively. The volume of the room is approx. 215 m<sup>3</sup>, and the total surface area is approx. 305 m<sup>2</sup>. Sound diffusion elements of concrete, of damped steel plate, and of acrylic sheets are placed in the room.

## Test procedure

Measurement of sound absorption according to EN ISO 354:2003 is carried out in a reverberation room. The reverberation time is measured with and without the test specimen, and the sound absorption coefficient is evaluated using Sabine's formula.

The test signal used is broad band pink noise emitted successively by two loudspeakers located in two opposite corners of the room. The reverberation time is measured in six microphone positions for each loudspeaker. For each microphone/loudspeaker position three repeated excitations are used. One-third octave filters (100-5000 Hz) are included in the receiving equipment.

The reverberation time is evaluated from the averaged slope of the decay curve over a range from 5 dB to 25 dB below the steady state level.

The sound absorption coefficient  $\alpha_s$  is calculated using the following formula:

$$\alpha_s = \frac{55.3 \cdot V}{c \cdot S} \cdot \left( \frac{1}{T_2} - \frac{1}{T_1} \right) - \frac{4V}{S} \cdot (m_2 - m_1)$$

where  $V$  = Volume of the empty reverberation room [m<sup>3</sup>]

$c$  = Velocity of sound in air [m/s]

$S$  = Area of the test specimen [m<sup>2</sup>]

$T_1$  = Reverberation time of the empty reverberation room [s]

$T_2$  = Reverberation time of the reverberation room after the test specimen has been introduced [s]

$m_1$  = Attenuation coefficients due to air absorption during measurement of  $T_1$  (m<sup>-1</sup>)

$m_2$  = Attenuation coefficients due to air absorption during measurement of  $T_2$  (m<sup>-1</sup>)

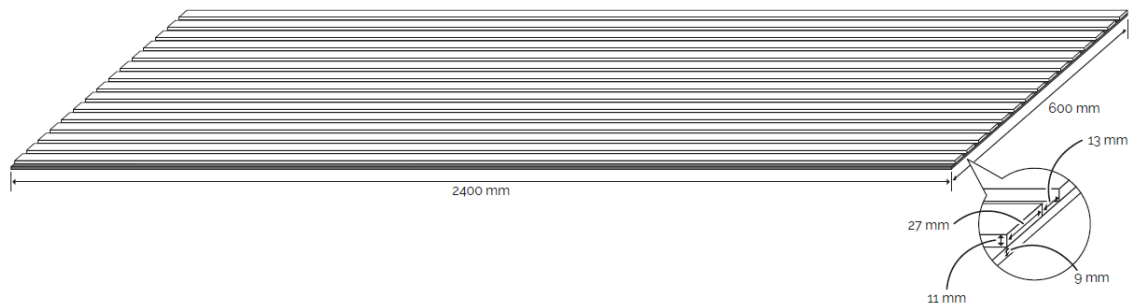
The attenuation coefficient of sound in air varies with relative humidity, temperature, and frequency. During a series of measurements of reverberation times  $T_1$  and  $T_2$ , the relative humidity and the temperature are held as constant as possible. A correction term as given in the formula above is applied. The correction is based on data from ISO 9613-1:1993.



### Photo of specimen in the laboratory



WoodUpp Akupanel mounted in the laboratory.



Sketch of WoodUpp Akupanel.