DELTA Test Report

DANAK
TEST Reg. no. 100

Measurement of Sound Absorption Coefficient for Gyptone Sixto 11 mm, Suspended 100 mm with 75 mm Mineral Wool

Client: Gyproc A/S

AV 1180/06
DANAK 100/991
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10 May 2006

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Title
Measurement of Sound Absorption Coefficient for Gyptone Sixto 11 mm, Suspended 100 mm with 75 mm Mineral Wool

Journal no.	**Project no.**	**Our ref.**	**Date of test**
AV 1180/06 DANAK 100/991	A580213	DH/JV/lm	26 April 2006

Client
Gyproc A/S
Hareskovvej 12
4400 Kalundborg

Client ref.
Kim Byberg

Summary

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

Product: Gyptone Sixto 11 mm, suspended 100 mm with 75 mm mineral wool (13 kg/m^3)
Thickness: 13 mm
Mounting depth: 100 mm

The tiles were placed on the concrete floor of the reverberation room.

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 α_w and the absorption class according to EN ISO 11654:1997.

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

Remark

The test results apply only to the objects tested.

DELTA, 10 May 2006

Dan Hoffmeyer
Acoustics

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Head of Department, Acoustics

1. Introduction

At the request of Gyproc A/S measurements of the sound absorption coefficient in a reverberation room were carried out for a ceiling product.

2. Description of the Test Specimen Based on the Client's Specifications

Product:	Gyptone Sixto 11 mm, suspended 100 mm with 75 mm mineral wool (13 kg/m^3)
Thickness:	13 mm
Module size:	600 mm × 600 mm

3. Mounting in the Laboratory

The tiles were placed as a plane on a concrete floor in a frame with the size 3.00 m × 3.60 m.

Mounting depth: 100 mm (Type E-100 mounting).

The mineral wool was placed just behind the tiles.

Both the air gap and the edges of the test specimen were enclosed by a 22 mm 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.

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 the Appendix.

5. Instrumentation

The following instruments were used for the test:

Instrument	Type	A&V No.
Real-Time Frequency Analyser	B&K 2144	1025L
Measuring Microphone	B&K 4144	859L
Measuring Microphone	B&K 4144	1256L
Microphone Preamplifier	B&K 2619	853L
Microphone Preamplifier	B&K 2619	857L
Microphone Power Supply	B&K 2807	722L
Sensor for Temperature and Humidity	Elpro Ecolog TH1	1216L

The instruments used have been tested according to procedures approved by the Danish accreditation scheme DANAK.

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 per octave of the room without test specimen:

Frequency f [Hz]	Reverberation time T_1 [sec]
125	7.9
250	7.9
500	6.8
1000	5.7
2000	4.5
4000	2.7

Temperature and relative humidity in the reverberation room during measurements:

Room without test specimen: 18.3°C, 59% RH. Date of test: 24 April 2006
Room with test specimen: 18.7°C, 63% RH. Date of test: 26 April 2006

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 0.01 at 2500 Hz, 0.02 at 3150 Hz, 0.03 at 4000 Hz, 0.05 at 5000 Hz, and 0 at all other frequencies.

7. Test Results

The test result α_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 α_p per octave from 125 Hz to 4000 Hz is shown on Graph Sheet 2 together with the weighted sound absorption coefficient α_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 α_p per octave:

Frequency [Hz]	Uncertainty
125	±0.15
250	±0.10
500	±0.05
1000	±0.10
2000	±0.10
4000	±0.10

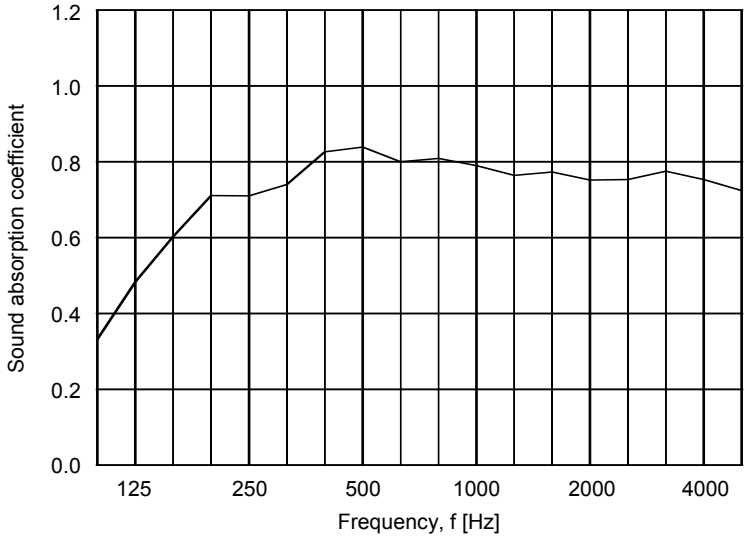
Laboratory Measurement of Sound Absorption Coefficient according to EN ISO 354:2003

Client: Gyproc A/S, Hareskovvej 12, 4400 Kalundborg
Date of test: 26 April 2006

Test specimen: Gyptone Sixto 11 mm, suspended 100 mm with 75 mm mineral wool (13 kg/m^3)
Thickness: 13 mm
Module size: 600 mm × 600 mm
Mounting depth: 100 mm (Type E-100 mounting)

Test area: 10.8 m²
Room volume: 215 m³
Room surface: 305 m²

Frequency f [Hz]	α_s
100	0.33
125	0.48
160	0.60
200	0.71
250	0.71
315	0.74
400	0.83
500	0.84
630	0.80
800	0.81
1000	0.79
1250	0.76
1600	0.77
2000	0.75
2500	0.75
3150	0.77
4000	0.75
5000	0.72



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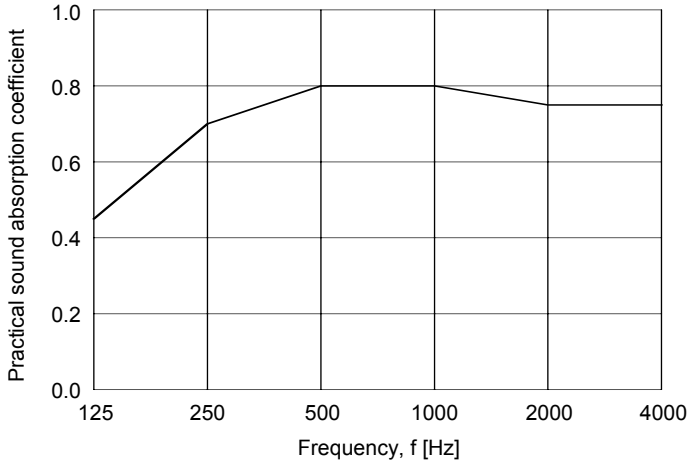
Laboratory Measurement of Sound Absorption Coefficient according to EN ISO 354:2003

Client: Gyproc A/S, Hareskovvej 12, 4400 Kalundborg
Date of test: 26 April 2006

Test specimen: Gyptone Sixto 11 mm, suspended 100 mm with 75 mm mineral wool (13 kg/m^3)
Thickness: 13 mm
Module size: 600 mm × 600 mm
Mounting depth: 100 mm (Type E-100 mounting)

Test area: 10.8 m²
Room volume: 215 m³
Room surface: 305 m²

Frequency f [Hz]	α_p
125	0.45
250	0.70
500	0.80
1000	0.80
2000	0.75
4000	0.75



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

$\alpha_w = 0.80$ Absorption class: B

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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 m³, and the total surface area is approx. 305 m². 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 α_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 [m³]

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

S = Area of the test specimen [m²]

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^{-1})

m_2 = Attenuation coefficients due to air absorption during measurement of T_2 (m^{-1})

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.