# DELTA Test Report

TEST Reg. no. 100

## Measurement of sound absorption coefficient for Fraster Brix

## Performed for Fraster ApS

DANAK 100/2463
Project no.: 118-36014
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2 annexes

21 January 2019

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Title
Measurement of sound absorption coefficient for Fraster Brix

| Journal no. | Project no. | Our ref. | Date of test |
|---|---|---|---|
| DANAK 100/2463 | 118-36014 | RSHS/CB/jes | 11-12-2018 |

Client
Fraster ApS
Linåvej 9a-b
4600 Silkeborg
Denmark

Client ref.
Trine Neve


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: 10.5 mm Fraster felt Brix
Thickness: 10.5 mm
Mounting depth: 0 mm

The product was 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 $\alpha_w$ and the absorption class according to EN ISO 11654:1997.

Descriptions of reverberation room and test procedure are found in Annex 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

Claus Backalarz
Senior Specialist, Acoustics

## 1. Introduction

At the request of Fraster ApS measurements of the sound absorption coefficient in a reverberation room were carried out for felt rug.

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

| | |
|---|---|
| Product: | Fraster felt Brix |
| Thickness: | 10 mm |
| Modul size: | 2900 mm x 3800 mm |

## 3. Mounting in the laboratory

The product was placed on a concrete floor.

Mounting depth: 10 mm (type A mounting).

The perimeter of the product was not covered with a frame due to the height of the product.

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

Photo of the test specimen in the laboratory can be seen in Annex 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 Annex 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 | 2017-07-18 | 2019-07-18 |
| 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 | 2019-11-19 |
| Microphone Preamplifier | B&K 2619 | 464T | 2018-01-03 | 2019-01-03 |
| Microphone Power Supply | B&K 2807 | 722L | 2018-07-20 | 2020-07-20 |
| Sensor for Temperature and Humidity | EBRO EBI 20-TH1 | 1618L | 2017-12-08 | 2019-12-08 |
| Acoustic calibrator | B&K 4231 | 1158L | 2018-11-19 | 2019-05-19 |

## 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.] | Reverbera-tion Time $T_2$ [sec.] |
|---|---|---|
| 100 | 7.12 | 6.66 |
| 125 | 7.50 | 7.51 |
| 160 | 7.84 | 7.70 |
| 200 | 7.49 | 6.79 |
| 250 | 7.15 | 6.16 |
| 315 | 7.29 | 5.60 |
| 400 | 7.26 | 4.36 |
| 500 | 6.77 | 3.29 |
| 630 | 6.54 | 3.37 |
| 800 | 5.94 | 3.41 |
| 1000 | 5.38 | 3.31 |
| 1250 | 5.10 | 3.04 |
| 1600 | 4.68 | 2.81 |
| 2000 | 4.16 | 2.48 |
| 2500 | 3.73 | 2.21 |
| 3150 | 2.90 | 1.80 |
| 4000 | 2.34 | 1.49 |
| 5000 | 1.95 | 1.24 |

Temperature and relative humidity in the reverberation room during measurements:

Room without test specimen: 16.2 °C, 55% RH. Date of test: 11 December 2018.
Room with test specimen: 16.2 °C, 54% RH. Date of test: 11 December 2018.

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 | ±0.15 |
| 250 | ±0.10 |
| 500 | ±0.05 |
| 1000 | ±0.10 |
| 2000 | ±0.10 |
| 4000 | ±0.10 |

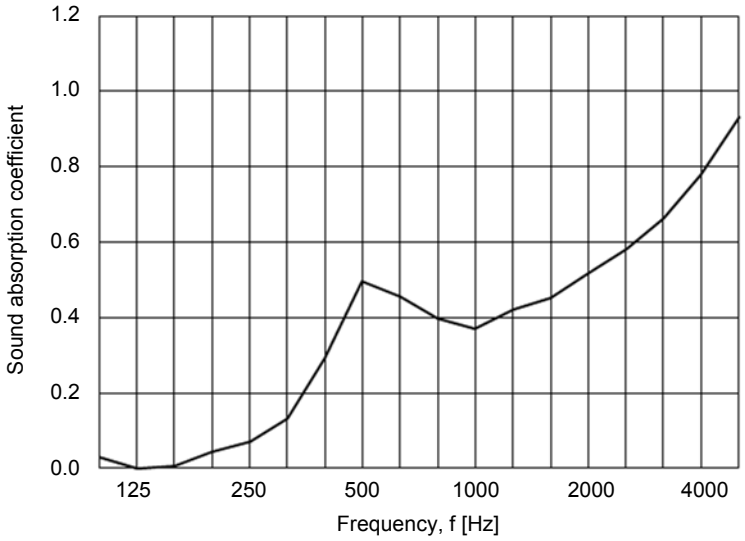
# Laboratory measurement of sound absorption coefficient according to EN ISO 354:2003

Client: Fraster ApS, Linåvej 9a-b, 4600 Silkeborg, Denmark
Date of test: 11 December 2018

Test specimen: Fraster felt Brix
Thickness: 10 mm
Module size: 2900 mm x 3800 mm
Mounting depth: 10 mm (Type A mounting)

Test area: 11.0 m²
Room volume: 215 m³
Room surface: 305 m²

| Frequency f [Hz] | $\alpha_s$ |
|---|---|
| 100 | 0.03 |
| 125 | 0.00 |
| 160 | 0.01 |
| 200 | 0.04 |
| 250 | 0.07 |
| 315 | 0.13 |
| 400 | 0.29 |
| 500 | 0.50 |
| 630 | 0.46 |
| 800 | 0.40 |
| 1000 | 0.37 |
| 1250 | 0.42 |
| 1600 | 0.45 |
| 2000 | 0.52 |
| 2500 | 0.58 |
| 3150 | 0.66 |
| 4000 | 0.78 |
| 5000 | 0.93 |

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Claus Backalarz, Acoustics

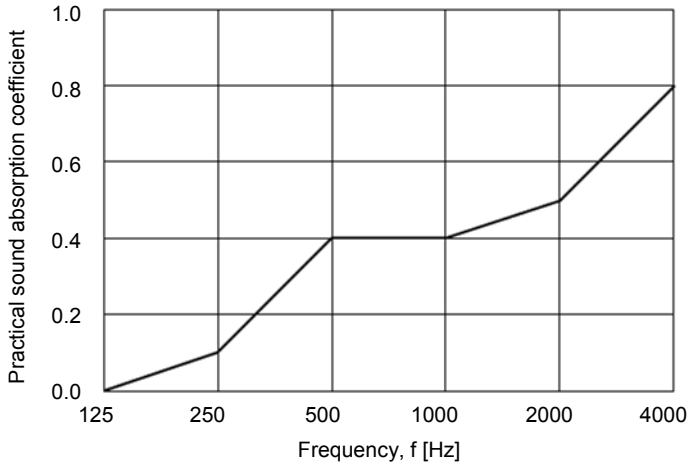
# Laboratory measurement of sound absorption coefficient according to EN ISO 354:2003

Client: Fraster ApS, Linåvej 9a-b, 4600 Silkeborg, Denmark
Date of test: 11 December 2018

Test specimen: Fraster felt Brix
Thickness: 10 mm
Module size: 2900 mm x 3800 mm
Mounting depth: 10 mm (Type A mounting)

Test area: 10.2 m²
Room volume: 215 m³
Room surface: 305 m²

| Frequency f [Hz] | $\alpha_p$ |
|---|---|
| 125 | 0.00 |
| 250 | 0.10 |
| 500 | 0.40 |
| 1000 | 0.40 |
| 2000 | 0.50 |
| 4000 | 0.80 |




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

$\alpha_w = 0.40(H)$ Absorption class D

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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 $\alpha_s$ 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 [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.

# Photo of specimen in the laboratory

Fraster Brix mounted in the laboratory.
The cords underneath the test sample were removed during the testing, and the sample was laying flat at the concrete floor.