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Report 110410071502

Measurement of sound absorption coefficient in a reverberation room

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This document contains 9 pages including this page and 6 pages annex.

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1 Subject

Subject of the present report is the determination of the spectral sound absorption coefficient of fabrics in a reverberation room in the sense of EN ISO 354 [1]. Additionally, the spectral rating of the sound absorption coefficient was carried out according to EN ISO 11654 [2].

2 Fundamentals

This report is based on the following documents:

- [1] EN ISO 354: Acoustics - Measurement of sound absorption in a reverberation room (ISO 354:2003); December 2003
- [2] EN ISO 11654: Acoustics - Sound absorbers for use in buildings - Rating of sound absorption (ISO 11654:1997); July 1997

3 Measurements

3.1 Measurement procedure

The determination of the spectral sound absorption coefficient in the reverberation room was carried out on the basis of the measuring procedure described in [1]. Thereby, the specimens are positioned in the reverberation room as defined in section 3.2. The average spectral sound absorption coefficient α_S of the specimen is yielded by dividing the equivalent sound absorbing area A of the specimen by its surface area S to:

$$\alpha_S = \frac{A}{S} \quad (3.1)$$

The equivalent sound absorbing area A is determined by applying Sabine's Law to the volume of the reverberation room V and the reverberation time T :

$$A = 0,163 \frac{V}{T} \quad (3.2)$$

To yield the sound absorbing properties of the specimen, it is required to measure the reverberation time T of the reverberation room without specimen as well as with specimen. If necessary, any climatic changes occurring in the reverberation room have to be corrected.

The determination of the reverberation time is carried out by repeated measurement of the early decay curve of the sound pressure level at not less than three microphones within the reverberation room after turning off the excitation signal of a dodecahedron loudspeaker box (pink noise) at not less than two source positions.

3.2 Specimens

The measurements were carried out at six specimens of fabric (see Table 3.1). To determine the spectral sound absorption coefficient acc. to [1], setup type G at an average distance to the wall of 150 mm, the fabrics were suspended over the whole measurement surface (see Figure 3.1). To prevent the sound propagating laterally to the specimens, the specimens were framed at all sides (width x thickness: 150 mm x 18 mm, spruce wood) and sealed by tape (see Figure 3.2).

Table 3.1: Overview of the investigated specimens

| Specimen | Installation | Length in m | Width in m | Surface in m ² |
|----------|----------------------|----------------|---------------|------------------------------|
| Bedra | suspended and plain | 3,84 | 2,96 | 11,4 |
| Bedra | suspended with tucks | 3,84 | 2,96 | 11,4 |
| Belene | suspended and plain | 4,29 | 2,68 | 11,5 |
| Belene | suspended with tucks | 4,29 | 2,68 | 11,5 |
| Salina | suspended and plain | 4,29 | 2,68 | 11,5 |
| Salina | suspended with tucks | 4,29 | 2,68 | 11,5 |



Figure 3.1: Measurement setup for determining the spectral sound absorption coefficient in the reverberation room



Figure 3.2: Measurement setup for determining the spectral sound absorption coefficient in the reverberation room; all-round frame with sealing tape

3.3 Measuring instruments

The measurements of the sound absorption coefficient were carried out by means of the following measuring instruments:

- 1 x 4-channel data acquisition HARMONIE™ quadro PLUS, Sinus Messtechnik GmbH
- 1 x analysis software SAMURAI™ v 2.0, Sinus Messtechnik GmbH
- 3 x condenser microphone, type M 360, class 1, Microtech Gefell GmbH
- 1 x sound level calibrator, type 4230, class 1, Brüel & Kjær
- 1 x dodecahedron loudspeaker box with amplifier

3.4 Measurement results

The spectral sound absorption coefficient α_s of the investigated specimens (acc. to Table 3.1) is displayed in Table 3.2 and Figure 3.3.

Table 3.2: Spectral sound absorption coefficient of investigated specimens (third octave spectrum)

| Frequency in Hz | Bedra | | Belene | | Salina | |
|--------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | plain | with tucks | plain | with tucks | plain | with tucks |
| 100 | 0,05 | 0,09 | 0,05 | 0,08 | 0,05 | 0,07 |
| 125 | 0,05 | 0,08 | 0,06 | 0,11 | 0,06 | 0,09 |
| 160 | 0,09 | 0,18 | 0,05 | 0,20 | 0,08 | 0,14 |
| 200 | 0,15 | 0,24 | 0,14 | 0,26 | 0,12 | 0,20 |
| 250 | 0,27 | 0,38 | 0,29 | 0,46 | 0,22 | 0,34 |
| 315 | 0,48 | 0,61 | 0,45 | 0,69 | 0,38 | 0,53 |
| 400 | 0,61 | 0,80 | 0,64 | 0,83 | 0,52 | 0,62 |
| 500 | 0,69 | 0,85 | 0,72 | 0,87 | 0,61 | 0,70 |
| 630 | 0,73 | 0,89 | 0,76 | 0,89 | 0,67 | 0,75 |
| 800 | 0,73 | 0,86 | 0,76 | 0,88 | 0,69 | 0,74 |
| 1000 | 0,62 | 0,84 | 0,68 | 0,88 | 0,58 | 0,74 |
| 1250 | 0,56 | 0,84 | 0,57 | 0,91 | 0,44 | 0,76 |
| 1600 | 0,63 | 0,85 | 0,65 | 0,92 | 0,50 | 0,79 |
| 2000 | 0,65 | 0,85 | 0,66 | 0,90 | 0,57 | 0,79 |
| 2500 | 0,63 | 0,85 | 0,64 | 0,88 | 0,53 | 0,78 |
| 3150 | 0,65 | 0,84 | 0,67 | 0,89 | 0,58 | 0,78 |
| 4000 | 0,64 | 0,77 | 0,69 | 0,88 | 0,59 | 0,81 |
| 5000 | 0,44 | 0,56 | 0,58 | 0,88 | 0,54 | 0,68 |
| Rating | 0,60 | 0,70 | 0,60 | 0,75 | 0,55 | 0,65 |

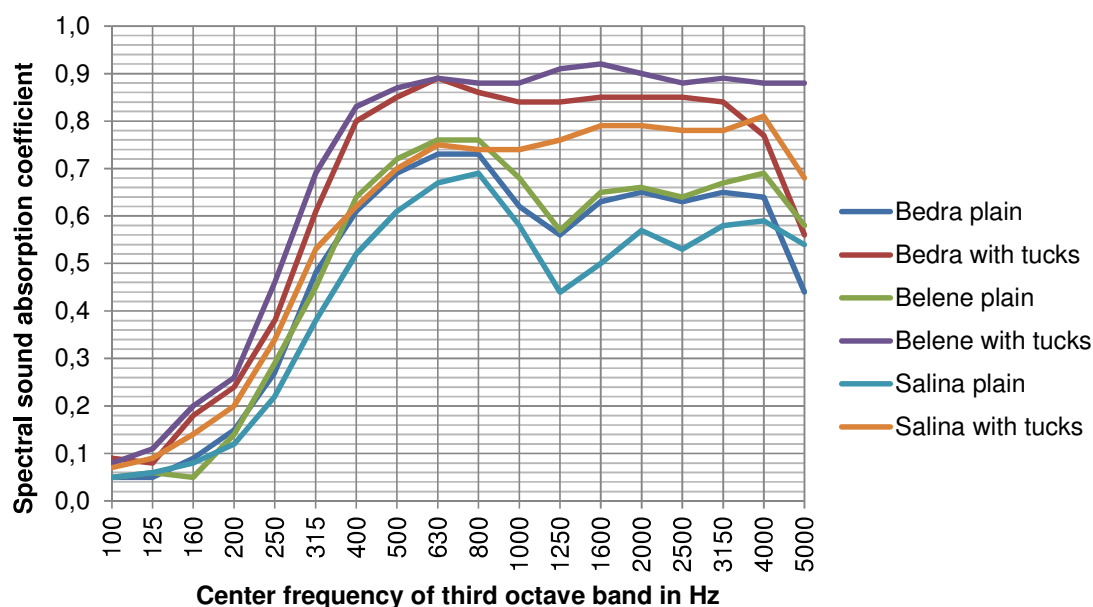


Figure 3.3: Spectral sound absorption coefficient of investigated specimens (third octave spectrum) acc. to Table 3.2

It can be recognized that the spectral sound absorption coefficient of the suspended specimens with tucks is always higher than the sound absorption coefficient of the specimens suspended and plain. Figure 3.4 shows the direct comparison of the rated sound absorption coefficient of the investigated specimens.

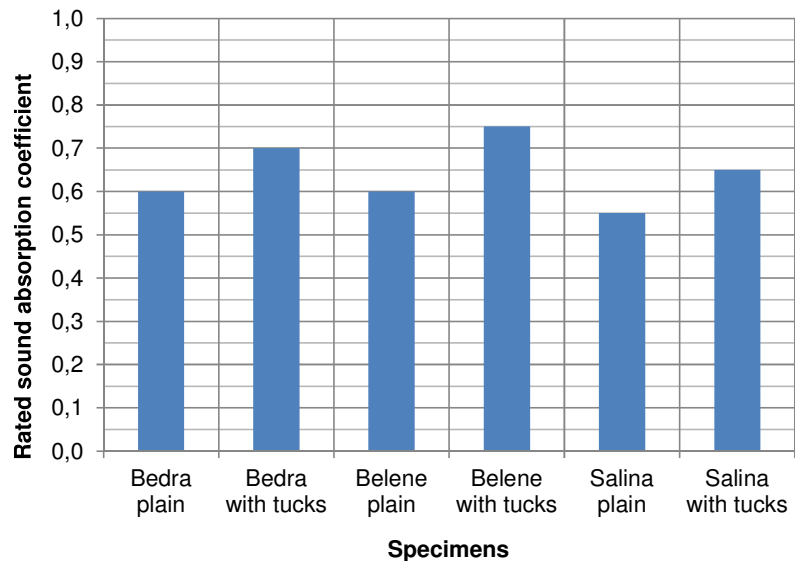


Figure 3.4: Rated sound absorption coefficient of investigated specimens acc. to Table 3.2

4 Summary

The measurements showed that the spectral sound absorption coefficient of the suspended specimens with tucks is always higher than the sound absorption coefficient of the specimens suspended and plain.

5 Annex

- Measurement setup for determining the spectral sound absorption coefficient in the reverberation room
- Measurement protocol A 01-1E:sound absorption coefficient „Bedra“ suspended and plain
- Measurement protocol A 01-2E:sound absorption coefficient „Bedra“ suspended with tucks
- Measurement protocol A 02-1E:sound absorption coefficient „Belene“ suspended and plain
- Measurement protocol A 02-2E:sound absorption coefficient „Belene“ suspended with tucks
- Measurement protocol A 03-1E:sound absorption coefficient „Salina“ suspended and plain
- Measurement protocol A 03-2E:sound absorption coefficient „Salina“ suspended with tucks



Figure 5.1: Measurement setup for determining the spectral sound absorption coefficient in the reverberation room at the specimen „Bedra“ suspended and plain



Figure 5.2: Measurement setup for determining the spectral sound absorption coefficient in the reverberation room at the specimen „Bedra“ suspended with tucks

Sound absorption coefficient in the sense*) of EN ISO 354

Measurement of sound absorption in a reverberation room

A 01-1 E

Test subject:

Name: "Bedra"
 Description: fabric suspended, plain
 Manufacturer: Vescom BV, NL-5750 AV Deume
 Client: Textile Lab, NL 7556 RC Hengelo (ov)



Measurement conditions:

Standard: EN ISO 354: Measurement of sound absorption in a reverberation room
 Method: method with noise turned off, measurement of five early decay curves at three / four microphone positions / source positions and averaging of determined reverberation times
 Volume of reverberation room V : 195 m³ (angular cuboidal room with dimensions of ca. 7,2 m x 6,0 m x 4,5 m)
 Surface of reverberation room S_T : 205 m² (without consideration of 12 diffusors with dimensions of ca. 1,5 m x 1,0 m)
 Temperature: 18 °C
 Relative humidity: 49 %
 Date of measurement: 23.11.2011

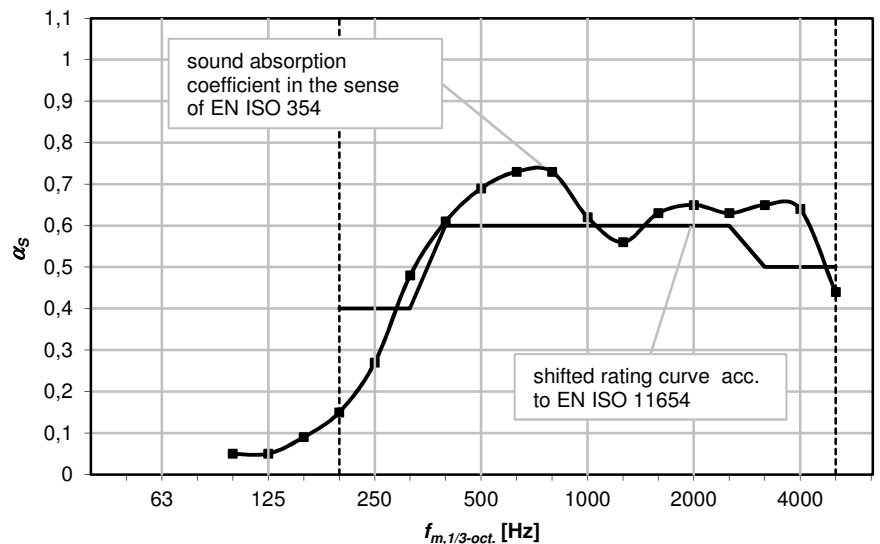
Specimen:

Surface of specimen S : 11,4 m² (length x width: 3,84 m x 2,96 m)
 Measurement setup: acc. to EN ISO 345, annex B5: setup type G-150: mean distance to wall = 150 mm, specimen suspended over whole measurement surface, 150 mm frame all-round, spruce wood $D = 18$ mm, sealed by tape

***) Diviation to standard, annex B.5 type G, on demand: measured at mean distance to wall of 150 mm only, setup G-100 was not investigated**

Results:

| $f_{m,1/3-oct.} / f_{m,oct.}$ | $\alpha_{S,1/3-oct.}$ | $\alpha_{S,oct.}$ |
|-------------------------------|-----------------------|-------------------|
| 50 | --- | --- |
| 63 | --- | --- |
| 80 | --- | --- |
| 100 | 0,05 | 0,05 |
| 125 | 0,05 | |
| 160 | 0,09 | 0,30 |
| 200 | 0,15 | |
| 250 | 0,27 | |
| 315 | 0,48 | 0,70 |
| 400 | 0,61 | |
| 500 | 0,69 | 0,65 |
| 630 | 0,73 | |
| 800 | 0,73 | 0,65 |
| 1000 | 0,62 | |
| 1250 | 0,56 | 0,65 |
| 1600 | 0,63 | |
| 2000 | 0,65 | 0,60 |
| 2500 | 0,63 | |
| 3150 | 0,65 | 0,60 |
| 4000 | 0,64 | |
| 5000 | 0,44 | --- |



center frequency of 1/3-octave band / octave band $f_{m,1/3-oct.} / f_{m,oct.}$ in Hz
 sound absorption coefficient of each 1/3-octave band / octave band $\alpha_{1/3-oct.} / \alpha_{oct.}$

Single value: Rated sound absorption coefficient $\alpha_{S,w} = 0,60$

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Sound absorption coefficient in the sense*) of EN ISO 354

Measurement of sound absorption in a reverberation room

A 01-2 E

Test subject:

Name: "Bedra"
 Description: fabric suspended with tucks (2:1)
 Manufacturer: Vescom BV, NL-5750 AV Deume
 Client: Textile Lab, NL 7556 RC Hengelo (ov)



Measurement conditions:

Standard: EN ISO 354: Measurement of sound absorption in a reverberation room
 Method: method with noise turned off, measurement of five early decay curves at three / four microphone positions / source positions and averaging of determined reverberation times
 Volume of reverberation room V : 195 m³ (angular cuboidal room with dimensions of ca. 7,2 m x 6,0 m x 4,5 m)
 Surface of reverberation room S_r : 205 m² (without consideration of 12 diffusors with dimensions of ca. 1,5 m x 1,0 m)
 Temperature: 18 °C
 Relative humidity: 49 %
 Date of measurement: 23.11.2011

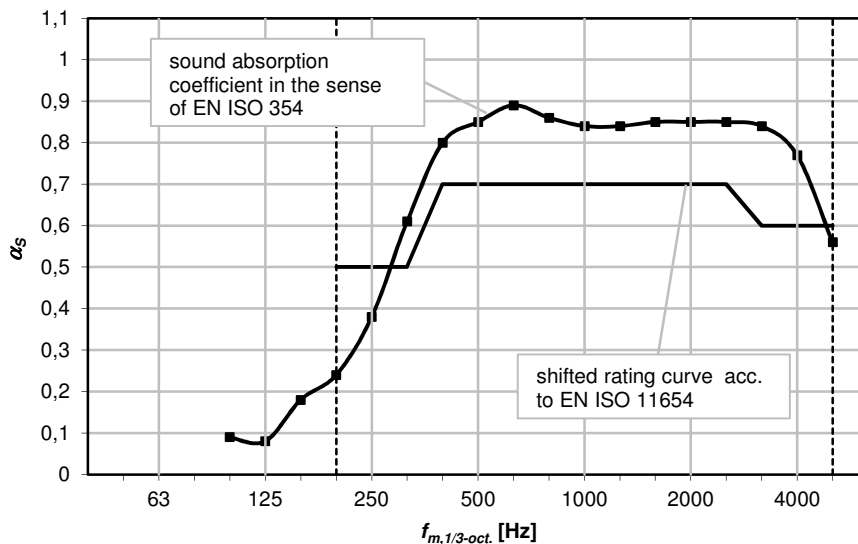
Specimen:

Surface of specimen S : 11,4 m² (length x width: 3,84 m x 2,96 m)
 Measurement setup: acc. to EN ISO 345, annex B5: setup type G-150: mean distance to wall = 150 mm, specimen suspended over whole measurement surface, 150 mm frame all-round, spruce wood $D = 18$ mm, sealed by tape

***) Diviation to standard, annex B.5 type G, on demand: measured at mean distance to wall of 150 mm only, setup G-100 was not investigated**

Results:

| $f_{m,1/3-oct.} / f_{m,oct.}$ | $\alpha_{S,1/3-oct.}$ | $\alpha_{S,oct.}$ |
|-------------------------------|-----------------------|-------------------|
| 50 | --- | --- |
| 63 | --- | --- |
| 80 | --- | --- |
| 100 | 0,09 | 0,10 |
| 125 | 0,08 | |
| 160 | 0,18 | 0,40 |
| 200 | 0,24 | |
| 250 | 0,38 | |
| 315 | 0,61 | 0,85 |
| 400 | 0,80 | |
| 500 | 0,85 | 0,85 |
| 630 | 0,89 | |
| 800 | 0,86 | 0,85 |
| 1000 | 0,84 | |
| 1250 | 0,84 | 0,85 |
| 1600 | 0,85 | |
| 2000 | 0,85 | 0,85 |
| 2500 | 0,85 | |
| 3150 | 0,84 | 0,70 |
| 4000 | 0,77 | |
| 5000 | 0,56 | |



center frequency of 1/3-octave band / octave band $f_{m,1/3-oct.} / f_{m,oct.}$ in Hz
 sound absorption coefficient of each 1/3-octave band / octave band $\alpha_{1/3-oct.} / \alpha_{oct.}$

Single value: Rated sound absorption coefficient $\alpha_{S,w} = 0,70$

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