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2022-07-21
M104146/61 Version 1 RFD/STY

Fabric
“LAMINA”
Manufacturer Gabriel A/S

Determination of the airflow resistance
according to DIN EN ISO 9053-1

Test Report No. M104146/61

Client:	Gabriel A/S Hjulmagervej 55 9000 Aalborg DENMARK
Consultant:	Dipl.-Ing. (FH) Dominik Reif
Report date:	2022-07-21
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and the test equipment

1 Task

On behalf of Gabriel A/S, 9000 Aalborg, Denmark, the airflow resistance of the fabric type "LAMINA" with and without lamination was to be determined according to DIN EN ISO 9053-1 [1].

2 Basis

This test report is based on the following documents:

- [1] DIN EN ISO 9053-1: Acoustics – Determination of airflow resistance – Part 1: Static airflow method (ISO 9053-1:2018); German version EN ISO 9053-1:2018. March 2019
- [2] DIN EN ISO 5084: Textiles – Determination of thickness of textiles and textile products (ISO 5084:1996); German version EN ISO 5084:1996. October 1996

3 Test objects

3.1 General

The tested fabric is described in the following Table 1 (without lamination) as well as in Table 2 (with lamination). The indicated characteristic values were determined by the testing laboratory on the basis of a sample delivered by the manufacturer. For each fabric three samples were tested. Each measured sample had the dimensions of 210 mm x 297 mm.

The thickness of the test objects was determined by the testing laboratory according to DIN EN ISO 5084 [2]. Testing was done at three positions of the samples at pressure of 1.00 kPa and with a presser-foot of 2000 mm².

3.2 LAMINA – without lamination

Table 1. Test object “LAMINA” – without lamination.

Test object (manufacturer's information)	Sample	Area specific mass m'' [g/m ²]	Thickness t [mm]
Fabric: “LAMINA” – without lamination Design: 2560 Colour number: 66243 - blue Composition: 58 % PES REC / 42 % PES	01	146	0.60
	02	146	0.59
	03	145	0.60
Mean		146	0.60

3.3 LAMINA – with lamination

Table 2. Test object “LAMINA” – with lamination.

Test object (manufacturer's information)	Sample	Area specific mass m'' [g/m ²]	Thickness t [mm]
Fabric: “LAMINA” – with lamination Design: F03-2559 Colour number: 60329 – light grey Composition: 58 % PES REC / 42 % PES	01	316	1.99
	02	311	2.00
	03	315	2.05
Mean		314	2.01

4 Execution of measurements

The airflow resistance was determined according to DIN EN ISO 9053-1 [1].

The test method, the test facility, and the test equipment used are described in Appendix B.

5 Measurement results

5.1 General

The measurement results are shown in diagrams and tables in the test certificates in Appendix A of this report.

5.2 LAMINA – without lamination

The measurement results are also shown in the following Table 3.

Table 3. Specific airflow resistance.

Test object / Fabric type "LAMINA" – without lamination	Specific airflow resistance R_s / (Pa s / m)	Appendix A, page
Sample 1/3 (no. 15060/1)	127	1
Sample 2/3 (no. 15060/2)	132	2
Sample 3/3 (no. 15060/3)	142	3

For the three tested samples a mean specific airflow resistance of

$$R_s = 134 \text{ Pa} \cdot \text{s/m}$$

was determined.

5.3 LAMINA – with lamination

The measurement results are also shown in the following Table 4.

Table 4. Specific airflow resistance.

Test object / Fabric type “LAMINA” – with lamination	Specific airflow resistance R_s / (Pa s / m)	Appendix A, page
Sample 1/3 (no. 15061/1)	208	4
Sample 2/3 (no. 15061/2)	210	5
Sample 3/3 (no. 15061/3)	200	6

For the three tested samples a mean specific airflow resistance of

$$R_s = 206 \text{ Pa} \cdot \text{s/m}$$

was determined.

6 Remarks

The test results exclusively relate to the investigated subjects and conditions described.

Dipl.-Ing. (FH) Dominik Reif
(Project Manager)

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Testing laboratory accredited by DAkkS according to DIN EN ISO/IEC 17025:2018.
The accreditation is valid only for the scope listed in the annex of the accreditation certificate.

EN ISO 9053-1
Determination of airflow resistance

Client: Gabriel A/S
Hjulmagervej 55
DK-9000 Aalborg
Denmark

Project number: M104146

Sample number: 15060/1

Test object: Design 2560 LAMINA
Colour No.: 66243 - Blue
Material: 58 % PES REC / 42 % PES

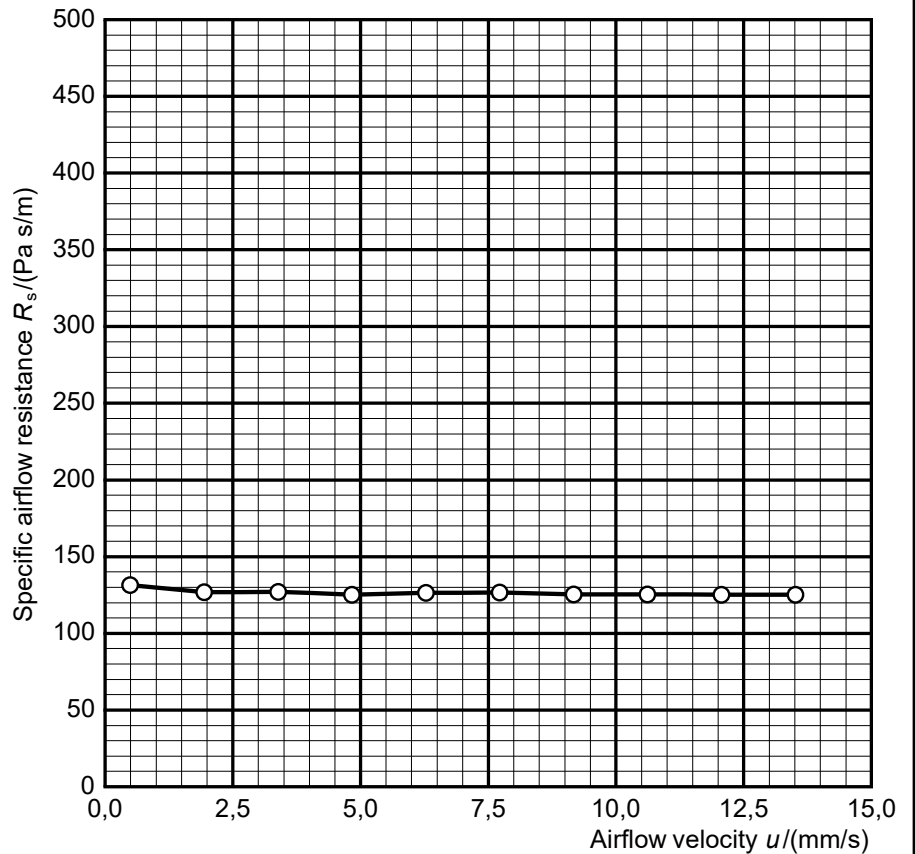
Diameter: 100 mm
Thickness: 0.6 mm
Area-specific mass: 146 g/m²

Barometric pressure:
 $B = 95,9 \text{ kPa}$

Temperature:
 $\theta = 25,2 \text{ °C}$

Relative humidity:
 $r. h. = 40,0 \text{ %}$

$u/$ (mm/s)	$R_s/$ (Pa s/m)
0.49	131
1.94	127
3.39	127
4.83	125
6.28	126
7.73	127
9.17	125
10.62	125
12.06	125
13.51	125



Specific airflow resistance $R_s(0.5 \text{ mm/s}) = 127 \text{ Pa s/m}$

Laboratory: Planegg
Responsible: Reif
Date: 2022-07-12

EN ISO 9053-1
Determination of airflow resistance

Client: Gabriel A/S
Hjulmagervej 55
DK-9000 Aalborg
Denmark

Project number: M104146

Sample number: 15060/2

Test object: Design 2560 LAMINA
Colour No.: 66243 - Blue
Material: 58 % PES REC / 42 % PES

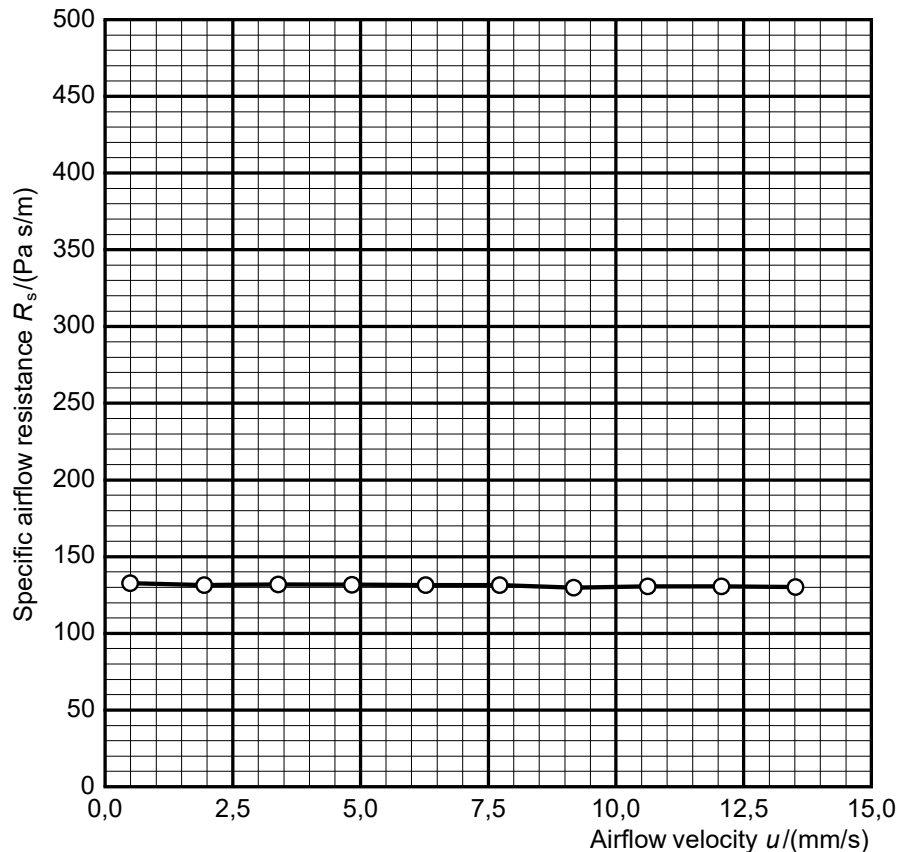
Diameter: 100 mm
Thickness: 0.59 mm
Area-specific mass: 146 g/m²

Barometric pressure:
 $B = 95,9 \text{ kPa}$

Temperature:
 $\theta = 25,2 \text{ }^\circ\text{C}$

Relative humidity:
 $r. h. = 40,0 \%$

$u/$ (mm/s)	$R_s/$ (Pa s/m)
0.49	133
1.94	131
3.39	132
4.83	132
6.27	131
7.72	131
9.17	130
10.62	131
12.06	131
13.51	130



Specific airflow resistance $R_s(0.5 \text{ mm/s}) = 132 \text{ Pa s/m}$

Laboratory: Planegg
Responsible: Reif
Date: 2022-07-12

EN ISO 9053-1
Determination of airflow resistance

Client: Gabriel A/S
Hjulmagervej 55
DK-9000 Aalborg
Denmark

Project number: M104146

Sample number: 15060/3

Test object: Design 2560 LAMINA
Colour No.: 66243 - Blue
Material: 58 % PES REC / 42 % PES

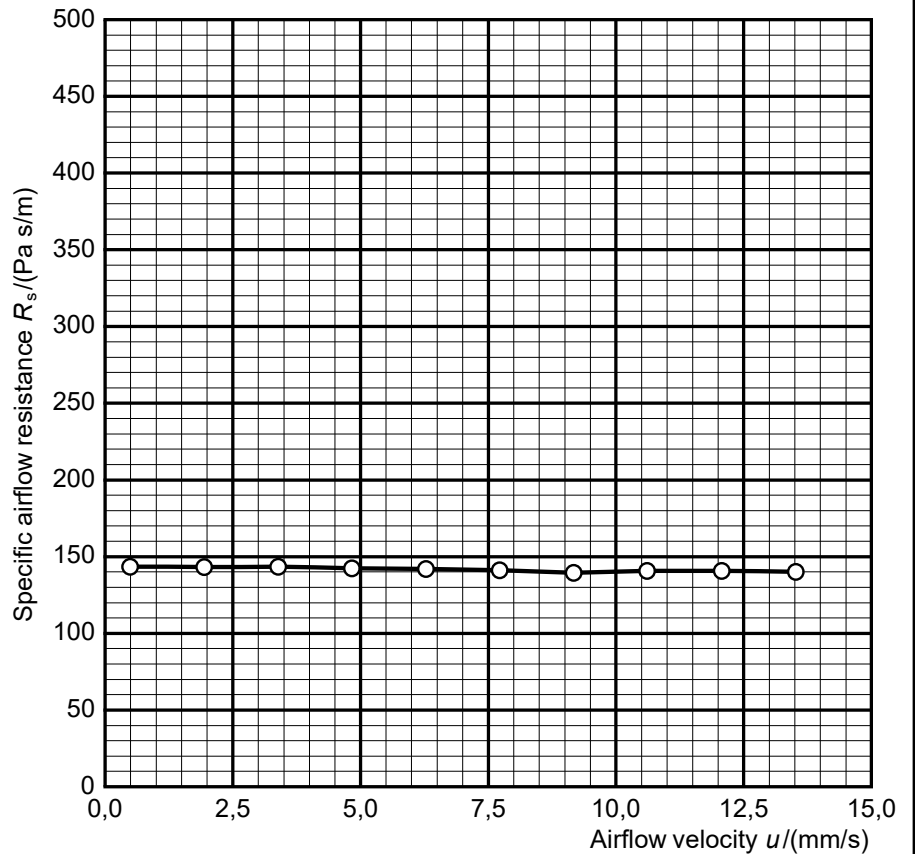
Diameter: 100 mm
Thickness: 0.6 mm
Area-specific mass: 145 g/m²

Barometric pressure:
 $B = 95,9$ kPa

Temperature:
 $\theta = 25,3$ °C

Relative humidity:
 $r. h. = 40,0$ %

$u/$ (mm/s)	$R_s/$ (Pa s/m)
0.49	143
1.94	143
3.39	143
4.83	142
6.28	142
7.72	141
9.17	139
10.61	141
12.07	141
13.52	140



Specific airflow resistance $R_s(0.5$ mm/s) = 142 Pa s/m

Laboratory: Planegg
Responsible: Reif
Date: 2022-07-12

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EN ISO 9053-1
Determination of airflow resistance

Client: Gabriel A/S
Hjulmagervej 55
DK-9000 Aalborg
Denmark

Project number: M104146

Sample number: 15061/1

Test object: Design F03-2559 LAMINA
Colour No.: 60329 - Light Grey
Material: 58 % PES REC / 42 % PES

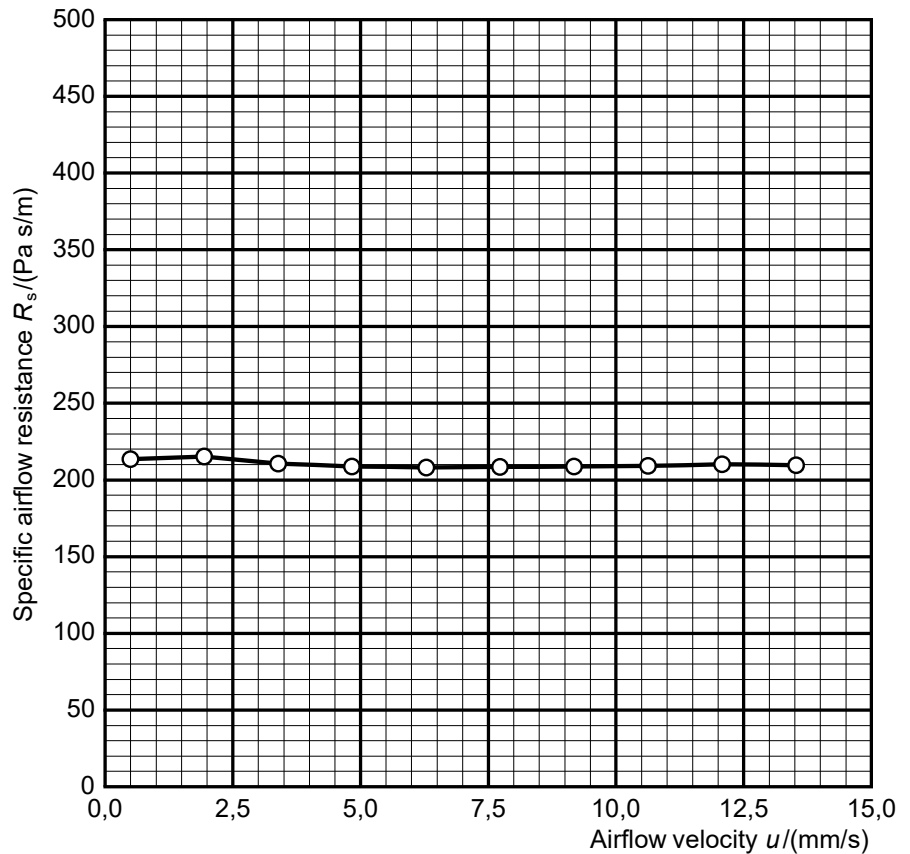
Diameter: 100 mm
Thickness: 1.99 mm
Area-specific mass: 316 g/m²

Barometric pressure:
 $B = 95,9 \text{ kPa}$

Temperature:
 $\theta = 25,5 \text{ }^\circ\text{C}$

Relative humidity:
 $r. h. = 40,0 \text{ \%}$

$u/$ (mm/s)	$R_s/$ (Pa s/m)
0.50	214
1.94	215
3.39	210
4.83	209
6.28	208
7.73	209
9.18	209
10.63	209
12.08	210
13.53	209



Specific airflow resistance $R_s(0.5 \text{ mm/s}) = 208 \text{ Pa s/m}$

Laboratory: Planegg
Responsible: Reif
Date: 2022-07-12

EN ISO 9053-1
Determination of airflow resistance

Client: Gabriel A/S
Hjulmagervej 55
DK-9000 Aalborg
Denmark

Project number: M104146

Sample number: 15061/2

Test object: Design F03-2559 LAMINA
Colour No.: 60329 - Light Grey
Material: 58 % PES REC / 42 % PES

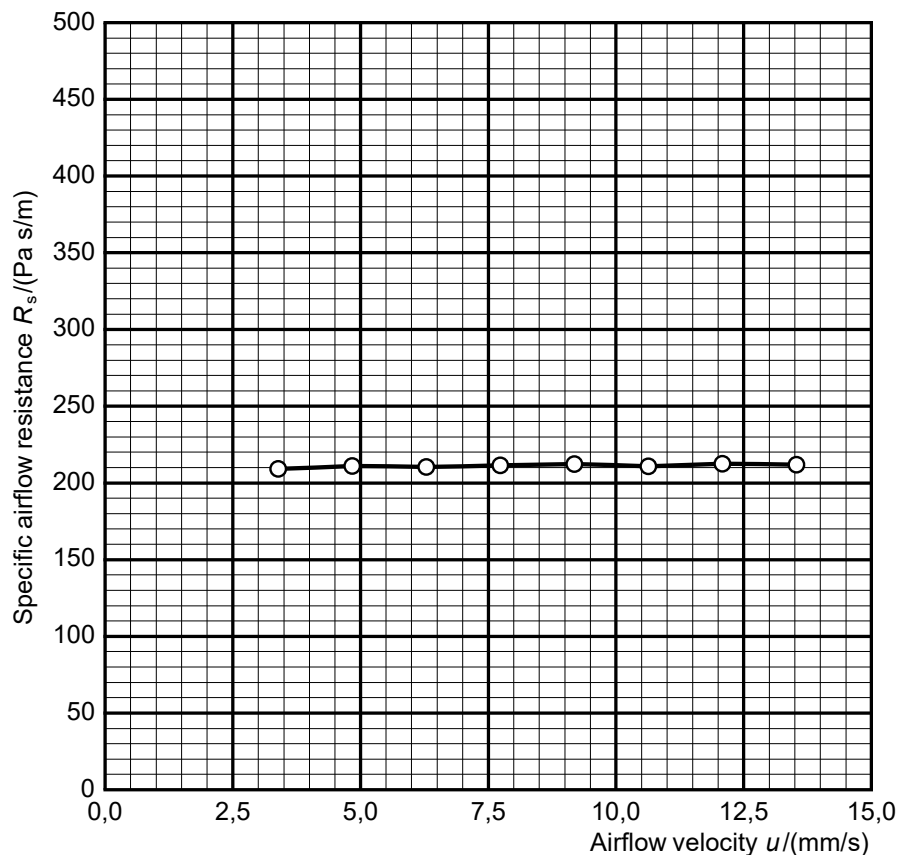
Diameter: 100 mm
Thickness: 2.0 mm
Area-specific mass: 311 g/m²

Barometric pressure:
 $B = 95,9$ kPa

Temperature:
 $\theta = 25,6$ °C

Relative humidity:
 $r. h. = 40,0$ %

$u/$ (mm/s)	$R_s/$ (Pa s/m)
3.39	209
4.84	211
6.29	210
7.74	211
9.18	212
10.63	211
12.08	212
13.53	212



Specific airflow resistance $R_s(0.5 \text{ mm/s}) = 210 \text{ Pa s/m}$

Laboratory: Planegg
Responsible: Reif
Date: 2022-07-12

EN ISO 9053-1
Determination of airflow resistance

Client: Gabriel A/S
Hjulmagervej 55
DK-9000 Aalborg
Denmark

Project number: M104146

Sample number: 15061/3

Test object: Design F03-2559 LAMINA
Colour No.: 60329 - Light Grey
Material: 58 % PES REC / 42 % PES

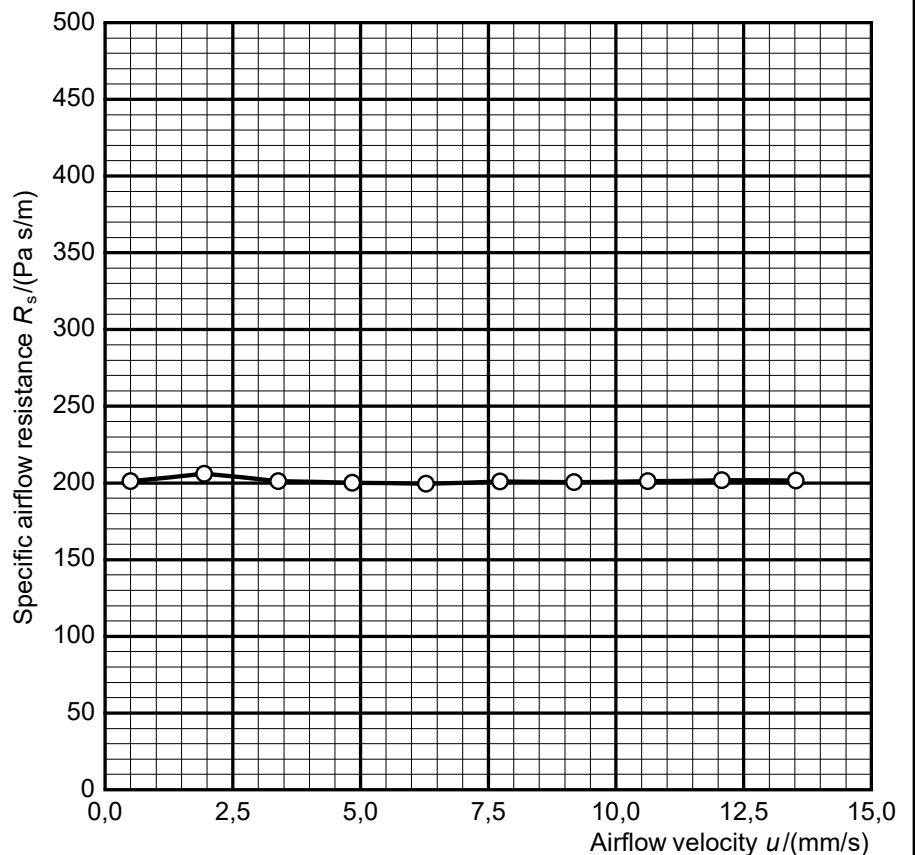
Diameter: 100 mm
Thickness: 2.05 mm
Area-specific mass: 315 g/m²

Barometric pressure:
 $B = 96,0$ kPa

Temperature:
 $\theta = 25,7$ °C

Relative humidity:
 $r. h. = 40,0$ %

$u/$ (mm/s)	$R_s/$ (Pa s/m)
0.50	201
1.94	206
3.39	201
4.84	200
6.28	199
7.73	201
9.18	200
10.62	201
12.07	202
13.52	201



Specific airflow resistance $R_s(0.5 \text{ mm/s}) = 200 \text{ Pa s/m}$

Laboratory: Planegg
Responsible: Reif
Date: 2022-07-12

Description of the test procedure for the determination of the airflow resistance

1 Measurand

The specific airflow resistance R_S of the test object was determined. For this purpose, the air pressure difference in front of as well as behind the test object was measured at different volumetric airflow rates. The specific airflow resistance $R_{S,i}$ for each volumetric airflow rate q_i determined was calculated using the following equation:

$$R_{S,i} = \frac{\Delta p_i \cdot A}{q_{v,i}}$$

With:

$R_{S,i}$ specific airflow resistance in Pa s/m

Δp_i air pressure difference across the test object with respect to the atmosphere in Pa

A cross-sectional area of the test object perpendicular to the direction of flow in m²

$q_{v,i}$ volumetric airflow rate passing through the test object in m³/s

u_i linear airflow velocity in m/s

In addition, the linear airflow velocity u_i was determined:

$$u_i = \frac{q_{v,i}}{A}$$

The indicated measurement result is the specific airflow resistance R_S , which is calculated for an airflow velocity of $u = 0.0005$ m/s by extrapolation with help of the linear regression.

2 Test procedure

The direct airflow method (static airflow method according to DIN EN ISO 9053-1 [1]) was applied. A steady unidirectional airflow with different airflow rates is pressed through the test object in the specimen holder. The resulting pressure drop between the two free faces of the test object is measured.

The specimen holder had a diameter of $D = 100$ mm.

3 Precision

For the test method DIN EN ISO 9053-1 [1] states a reproducibility of approx. 15 % for open porous foam materials. This information was determined on the basis of round robin tests.

4 List of test equipment

The test equipment used is listed in Table B.1.

Table B.1. Test equipment.

Name	Manufacturer	Type	Serial-No.
Measurement system airflow resistance	Müller-BBM	M89319-00	315003
Software for measurement and evaluation	Müller-BBM Acoustic Solution	m ars	Version 1.14.7256. 28813
Thickness gauge	Hans Schmidt & Co. GmbH	D-2000-C0913	2985
Digital measuring slide	Mitutoyo	CD-15PPR	07019377
Electronic balance	Kern	KB1200-2N	W1402353
Electronic balance	Kern	440-49N	WC0633572