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Bauaufsichtlich anerkannte Stelle
für Prüfung, Überwachung und
Zertifizierung
Zulassung neuer Baustoffe, Bauteile
und Bauarten
Forschung, Entwicklung, Demonstration und Beratung auf den Gebieten
der Bauphysik

Institutsleitung
Univ.-Prof. Dr.-Ing. Gerd Hauser
Univ.-Prof. Dr.-Ing. Klaus Sedlbauer

Test Report P-BA 104e/2009

Sound Insulation of a Pre-Cast Concrete Element with various Screw Plugs for Tie Points according to DIN EN ISO 140-3:2005

Client:
PERI GmbH
Schalung und Gerüste
Rudolf-Diesel-Str.
D-8926 Weißenhorn

Stuttgart, July 2, 2009

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1. Place and date of measurements

The measurements were carried out in the test facilities of the Fraunhofer Institute for Building Physics in Stuttgart on July 21, 2008.

2. Test object

Pre-cast concrete element with two tie points (conical holes in pre-cast concrete element), (see Fig. 1), hole diameter 17, 5 mm (front) to 22 mm (behind).

Dimensions of the element:	L x H x W = 100 cm x 100 cm x 21 cm
Total weight of the element:	512 kg

The two tie points were sealed by various screw plugs of PERI GmbH. Three different screw plugs (MX 50 OF, MX 50 MF and MX 84 MF) of PERI GmbH were investigated (see Figures 2 to 7).

First the tie points were sealed only on one side then the openings were also sealed on the other side. The screw plugs were screwed by 10 Nm by means of a torque spanner.

Six variants were tested:

Variant 1: screw plug MX 50 OF, installed on one side
Variant 2: screw plug MX 50 OF, installed on both sides
Variant 3: screw plug MX 50 MF, installed on one side
Variant 4: screw plug MX 50 MF, installed on both sides
Variant 5: screw plug MX 84 MF, installed on one side
Variant 6: screw plug MX 84 MF, installed on both sides

In addition, both tie points were closed soundproof with mineral filler, and the sound reduction index of this construction (corresponds to a element without tie points) was determined as reference value.

3. Sampling procedure

Delivery:	on July 17, 2008 by a forwarding company.
Installation in the test facility:	on July 21, 2008 by a handicraft enterprise.

4. Test procedure

The measurements were carried out in a test facility for windows, panels and small building elements according to DIN EN ISO 140-1: 2005. The test object was partly installed in the window opening and sealed by Terostat (adhesive) all around. The residual opening was sealed by a double-leaf construction of particle boards and mineral wool boards with high sound-insulating properties, and sealed towards the flanks and test specimen by Terostat adhesive. The weighted sound reduction index of the construction with high sound insulation was $R_w > 63$ dB. The measurement was performed according to DIN EN ISO 140-3: 2005.

The calculation of the weighted sound reduction index and of the spectrum adaptation terms was performed according to DIN EN ISO 717-1: 2006. The test signal was pink noise, filtered by 1/3 octave filters. The spatial averaging of the sound pressure level in the test rooms occurred by moving the microphones along inclined circular paths. The sound reduction index was determined by the following equation:

$$R = L_1 - L_2 + 10 \lg (S/A) \text{ dB}$$

With:

- R = sound reduction index
- L_1 = sound pressure level in the source room
- L_2 = sound pressure level in the receiving room
- A = equivalent absorption surface area in the receiving room, determined by measuring the reverberation time
- S = test surface area (total surface area of test object).

5. Test set-up and test conditions

Dimensions of the test rooms:	
Source room (L x W x H):	5.74 m x 3.75 m x 3.11 m; V = 67 m³
Receiving room (L x W x H):	4.85 m x 3.74 m x 3.11 m; V = 57 m³
Test opening (B x H):	1.25 m x 1.50 m; S = 1.875 m²
Air temperature:	22 °C
Relative air humidity:	45 %.
Measurement equipment:	
Microphones:	B & K 4190
Pre-amplifiers:	B & K 2639
Analyzer:	Norsonic 840/1
Amplifier :	Klein & Hummel AK 120
Loudspeaker:	Lanny MLS 82.

6. Measurement results

The measured sound reduction index of the various variants is presented in figures 8 to 14 in tables and diagrams in dependence of the frequency.
The weighted sound reduction index and the spectrum adaptation terms amount to:

Variant 1 (screw plug MX 50 OF, on one side)
R_w (C; C_{tr}; $C_{100\text{-}5000}$; $C_{tr,\ 100\text{-}5000}$) = 59 (-1; -5; 0; -5) dB.

Variant 2 (screw plug MX 50 OF, on both sides)
R_w (C; C_{tr}; $C_{100\text{-}5000}$; $C_{tr,\ 100\text{-}5000}$) = 59 (-1; -5; 0; -5) dB.

Variant 3 (screw plug MX 50 MF, on one side)
R_w (C; C_{tr}; $C_{100\text{-}5000}$; $C_{tr,\ 100\text{-}5000}$) = 59 (-1; -5; 0; -5) dB.

Variant 4 (screw plug MX 50 MF, on both sides)
R_w (C; C_{tr}; $C_{100\text{-}5000}$; $C_{tr,\ 100\text{-}5000}$) = 59 (-1; -5; 0; -5) dB.

Variant 5 (screw plug MX 84 MF, on one side)
R_w (C; C_{tr}; $C_{100\text{-}5000}$; $C_{tr,\ 100\text{-}5000}$) = 59 (-1; -5; 0; -5) dB.

Variant 6 (screw plug MX 84 MF, on both sides)
R_w (C; C_{tr}; $C_{100\text{-}5000}$; $C_{tr,\ 100\text{-}5000}$) = 59 (-1; -5; 0; -5) dB.

Reference:
Tie points soundproof closed:
R_w (C; C_{tr}; $C_{100\text{-}5000}$; $C_{tr,\ 100\text{-}5000}$) = 59 (-1; -5; 0; -5) dB.

The central result of the measurement is, that while closing the tie points with the tested screw plugs compared with a pre-cast concrete element without tie points no noticeable reduction of the sound insulation takes place. This is valid with one as well as with two-side installation of the screw plugs.

The test was performed in a test laboratory of IBP accredited according to DIN EN ISO/IEC 17025 by DAP under no. DAP-PL-3743.26. Test procedure and program of the measurements comply with the principles of the working committee of the test centers officially recognized by the building supervisory authority in accordance with the regulations of DIBt and NABau, sub-committee NA 005-55-76 AA.

This test report consists of 4 pages of text and 14 figures. The above-mentioned measurement results exclusively refer to the tested specimen. Any publication of extracts is subject to the written authorization of the Fraunhofer Institute for Building Physics.

Stuttgart, July 2, 2009
SMu/Hy

Responsible engineer:

Dipl.-Ing. (FH) S. Müller

FRAUNHOFER GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG e.V. 1
Fraunhofer Institut Bauphysik
amtlich anerkannte Prüfstelle

Head of the test laboratory:

Dr. rer. nat. L. Weber

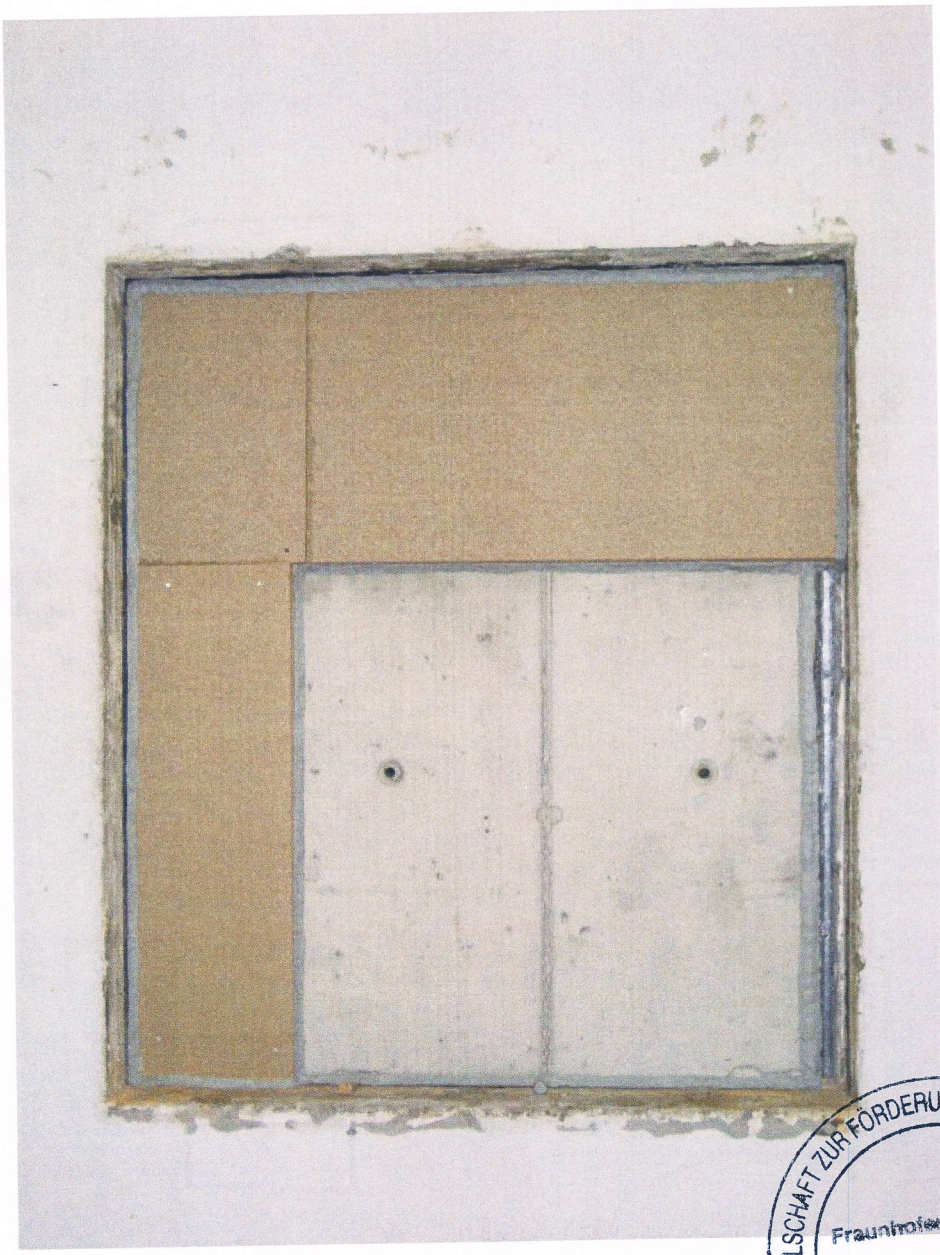


Fig. 1 pre-cast concrete element (100 cm x 100 cm x 21 cm) with two tie points installed in the test facility

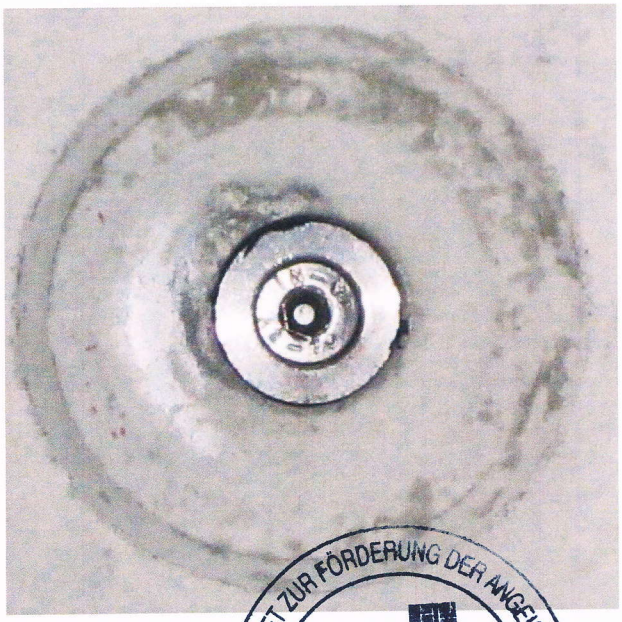


Fig. 2 pictures of the screw plug MX 50 OF (variants 1 and 2).

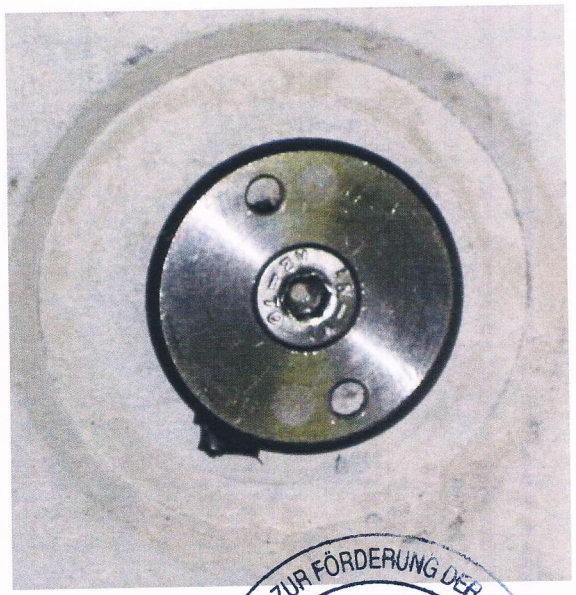


Fig. 3 pictures of the screw plug MX 50 MF (variants 3 and 4).

Fig. 4 pictures of the screw plug MX 84 MF (variants 5 and 6).

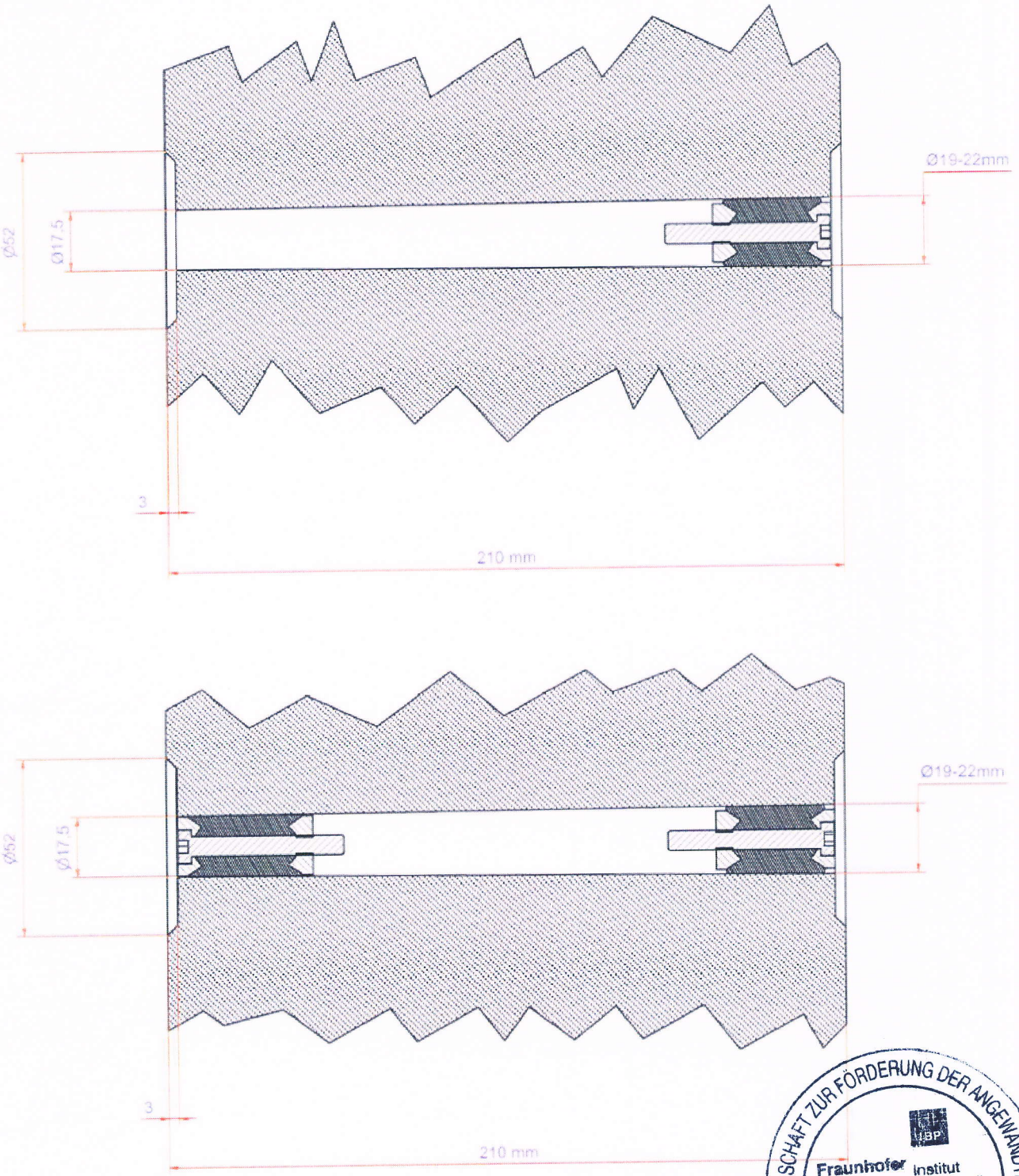


Fig. 5 screw plug MX 50 OF in one tie point
above: installation on one side
below: installation on two sides

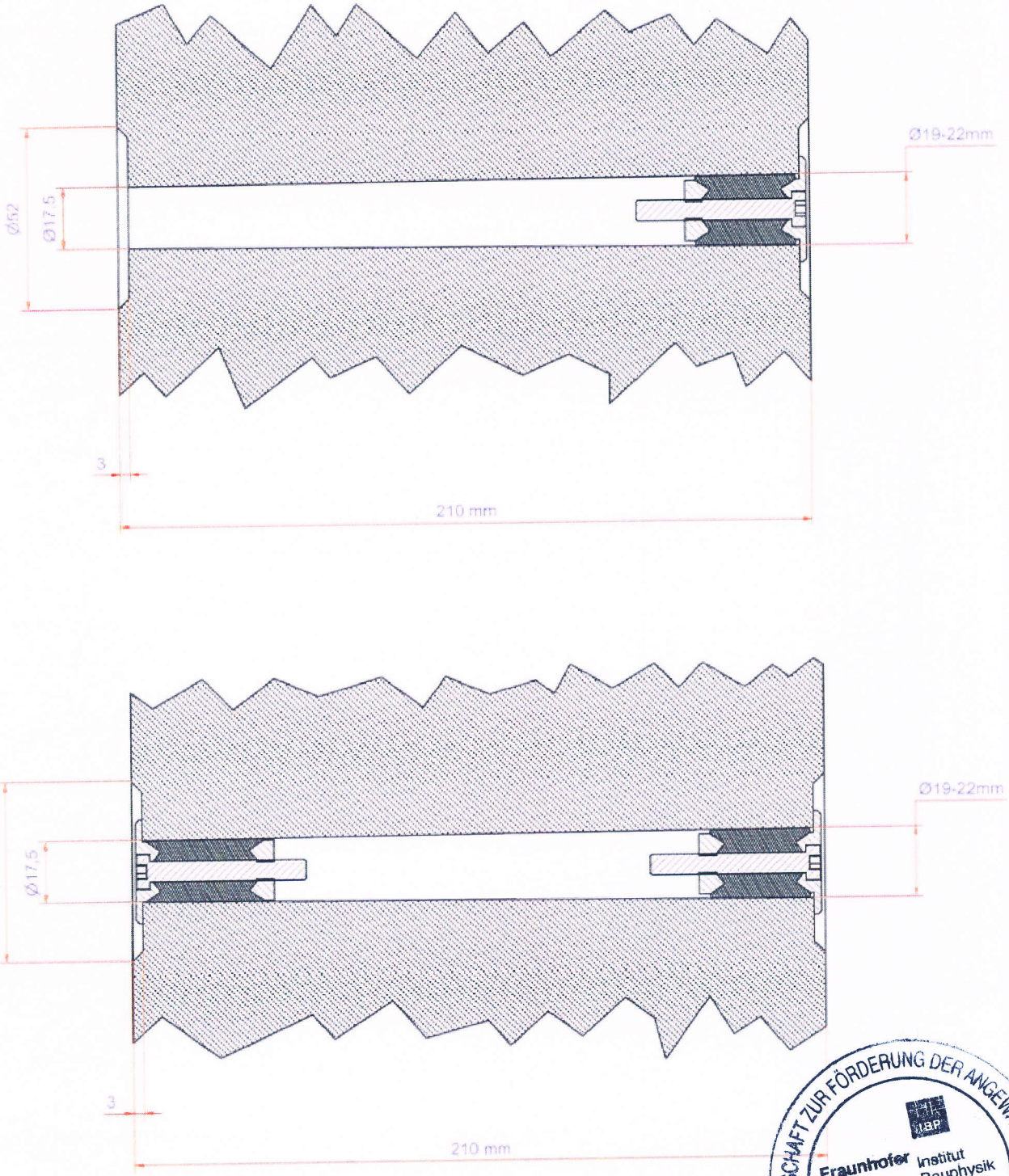
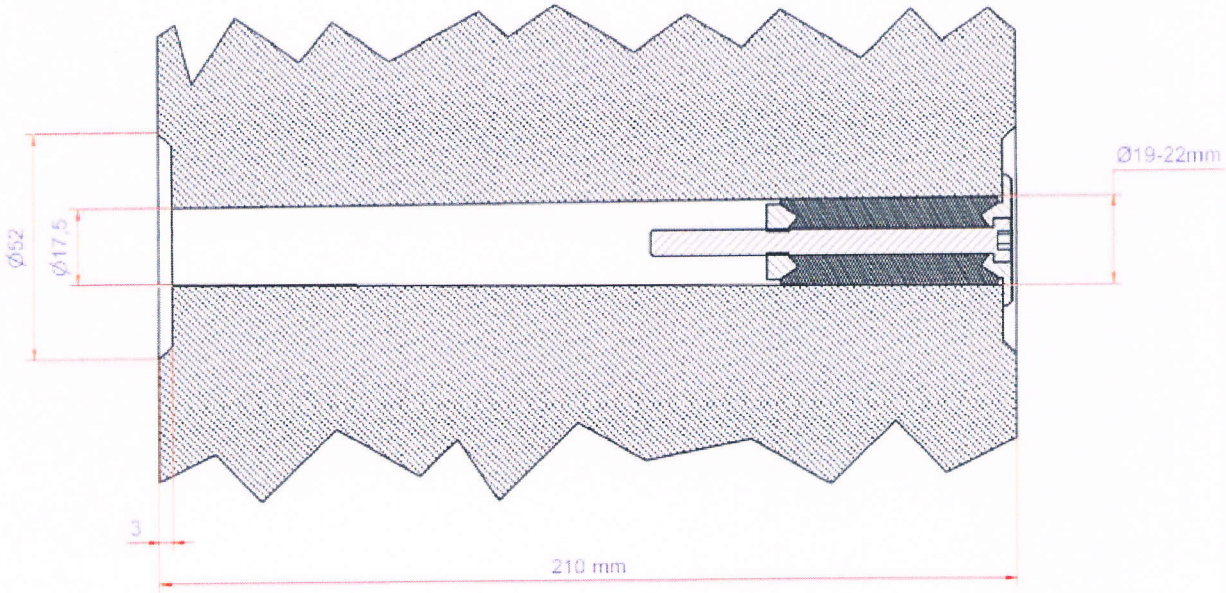


Fig. 6 screw plug MX 50 MF in one tie point
above: installation on one side
below: installation on two sides



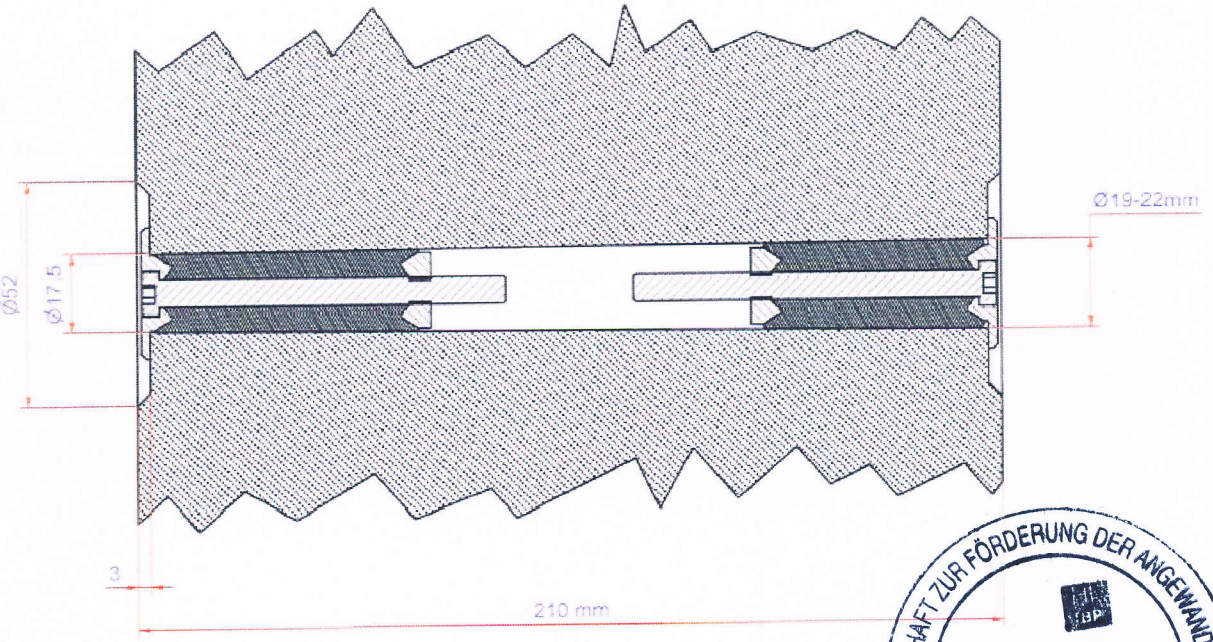


Fig. 7 screw plug MX 84 MF in one tie point
above: installation on one side
below: installation on two sides

Sound insulation according to DIN EN ISO 140-03: 2005

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Figure 8

Test object:

Pre-cast concrete element with two tie points (conical holes in pre-cast concrete element), (see Fig. 1), hole diameter 17, 5 mm (front) to 22 mm (behind).
Dimensions of the element: L x H x W = 100 cm x 100 cm x 21 cm
Total weight of the element: 512 kg

The two tie points were sealed by various screw plugs of PERI GmbH. Three different screw plugs (MX 50 OF, MX 50 MF and MX 84 MF) of PERI GmbH were investigated (see Figures 2 to 7).
First the tie points were sealed only on one side then the openings were also sealed on the other side. The screw plugs were screwed by 10 Nm by means of a torque spanner.

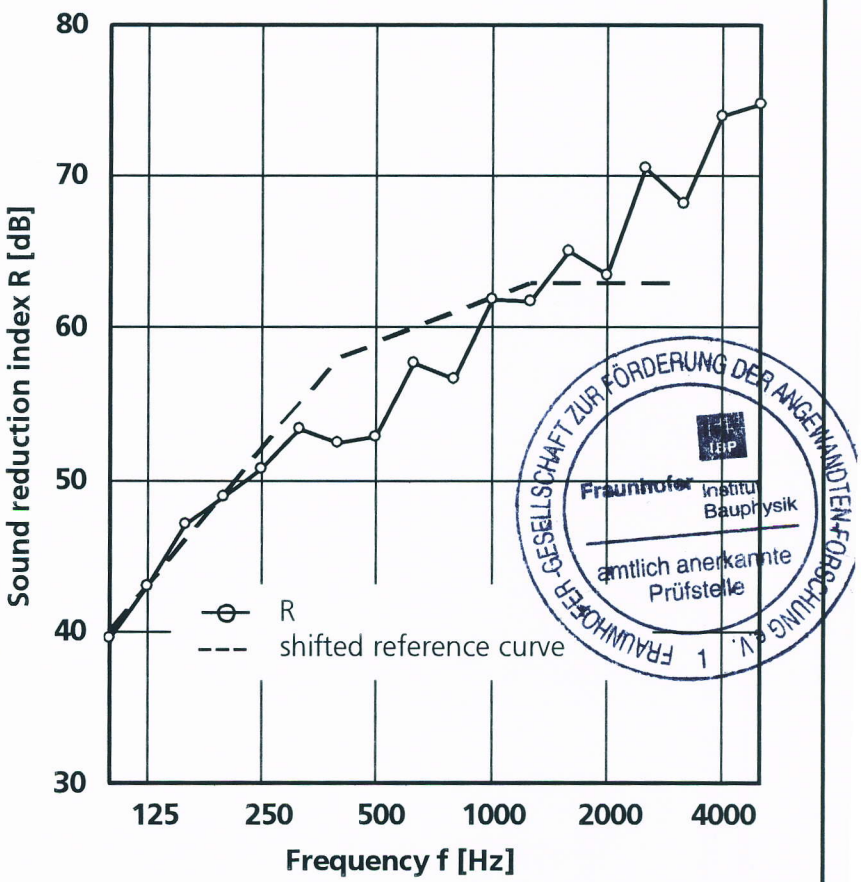
Additional description and technical data see page 2 of the test report P-BA 104e/2009, as well as figures 1, 2 and 5.

Variant 1: screw plug MX 50 OF, installed on one side

Test facility: test facility for windows, panels and small building elements P4
Room volume: V_S = 67 m³
V_E = 57 m³
Maximum insulation of the test facility: $R'_{max,w}$ = 72 dB
Test surface area: 1.0 m²
Test acoustic noise: pink noise
Rel. humidity: 45 %
Temperature: 22 °C.
Date of testing: July 21, 2008

f [Hz]	R [dB]	
100	≥ 39,6	(40,5)
125	≥ 43,0	(41,8)
160	≥ 47,1	(44,8)
200	≥ 48,9	(47,3)
250	≥ 50,7	(51,5)
315	≥ 53,3	(56,8)
400	52,4	
500	52,8	
630	57,7	
800	56,6	
1000	61,9	
1250	61,8	
1600	65,1	
2000	63,4	
2500	70,5	
3150	68,2	
4000	74,0	
5000	74,7	

Symbol "≥" shows that the signal-to-noise ratio or the difference between limiting insertion loss and measured sound reduction index is smaller than or equal to 6 dB. For the second case limiting insertion loss is indicated in brackets.



Weighted sound reduction index and spectrum adaptation terms acc. to DIN EN ISO 717-1: 2006
R_w (C; C_{tr}; $C_{100-5000}$; $C_{tr,100-5000}$) = 59 (-1; -5; 0; -5) dB

Fraunhofer IBP

The test was performed in the test laboratories of the IBP testing center accredited according to DIN EN ISO/IEC 17025 by the DAP (German Accreditation System for Testing), no. DAP-PL-3743.26.

Stuttgart, July 02, 2009

Head of the test laboratory:

Sound insulation according to DIN EN ISO 140-03: 2005

Client: PERI GmbH
D-8926 Weißenhorn

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Figure 9

Test object:

Pre-cast concrete element with two tie points (conical holes in pre-cast concrete element), (see Fig. 1), hole diameter 17, 5 mm (front) to 22 mm (behind).
Dimensions of the element: L x H x W = 100 cm x 100 cm x 21 cm
Total weight of the element: 512 kg

The two tie points were sealed by various screw plugs of PERI GmbH. Three different screw plugs (MX 50 OF, MX 50 MF and MX 84 MF) of PERI GmbH were investigated (see Figures 2 to 7).
First the tie points were sealed only on one side then the openings were also sealed on the other side. The screw plugs were screwed by 10 Nm by means of a torque spanner.

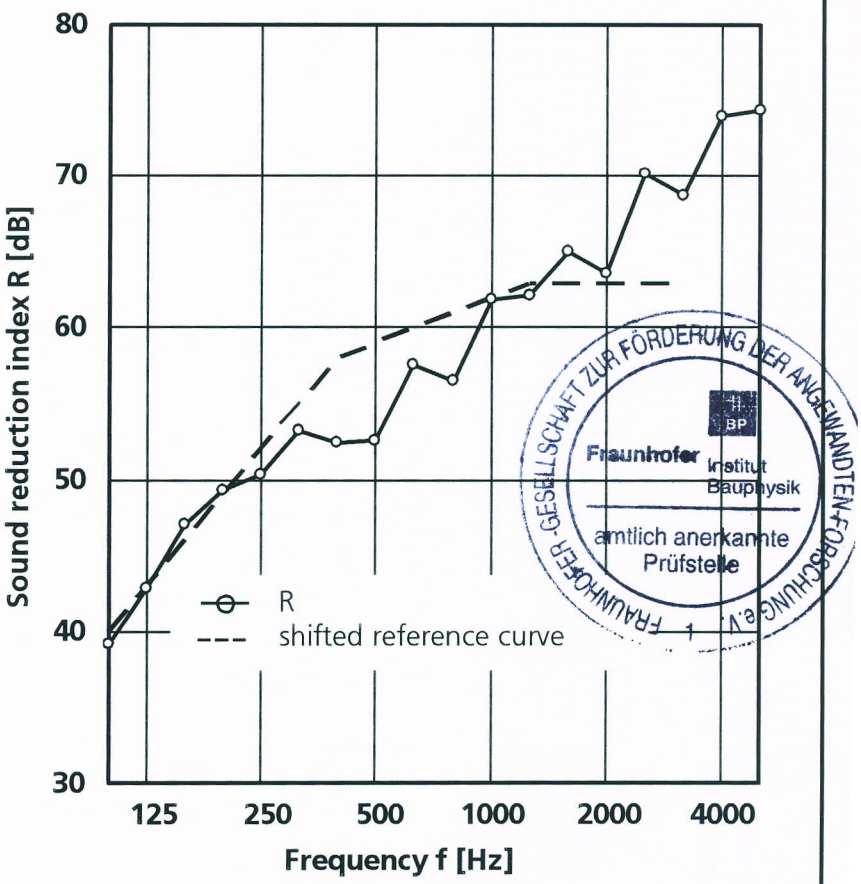
Additional description and technical data see page 2 of the test report P-BA 104e/2009, as well as figures 1, 2 and 5.

Variant 2: screw plug MX 50 OF, installed on both sides

Test facility: test facility for windows, panels and small building elements P4
Room volume: V_S = 67 m³
V_E = 57 m³
Maximum insulation of the test facility: $R'_{max,w}$ = 72 dB
Test surface area: 1.0 m²
Test acoustic noise: pink noise
Rel. humidity: 45 %
Temperature: 22 °C.
Date of testing: July 21, 2008

f [Hz]	R [dB]	
100	≥ 39,2	(40,5)
125	≥ 42,9	(41,8)
160	≥ 47,1	(44,8)
200	≥ 49,3	(47,3)
250	≥ 50,3	(51,5)
315	≥ 53,2	(56,8)
400	52,4	
500	52,6	
630	57,6	
800	56,5	
1000	61,9	
1250	62,1	
1600	65,1	
2000	63,6	
2500	70,2	
3150	68,7	
4000	74,0	
5000	74,4	

Symbol "≥" shows that the signal-to-noise ratio or the difference between limiting insertion loss and measured sound reduction index is smaller than or equal to 6 dB. For the second case limiting insertion loss is indicated in brackets.



Weighted sound reduction index and spectrum adaptation terms acc. to DIN EN ISO 717-1: 2006
R_w (C; C_{tr}; $C_{100-5000}$; $C_{tr,100-5000}$) = 59 (-1; -5; 0; -5) dB

Fraunhofer IBP

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Stuttgart, July 02, 2009

Head of the test laboratory:

Sound insulation according to DIN EN ISO 140-03: 2005

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Figure 10

Test object:

Pre-cast concrete element with two tie points (conical holes in pre-cast concrete element), (see Fig. 1), hole diameter 17, 5 mm (front) to 22 mm (behind).
Dimensions of the element: L x H x W = 100 cm x 100 cm x 21 cm
Total weight of the element: 512 kg

The two tie points were sealed by various screw plugs of PERI GmbH. Three different screw plugs (MX 50 OF, MX 50 MF and MX 84 MF) of PERI GmbH were investigated (see Figures 2 to 7).
First the tie points were sealed only on one side then the openings were also sealed on the other side. The screw plugs were screwed by 10 Nm by means of a torque spanner.

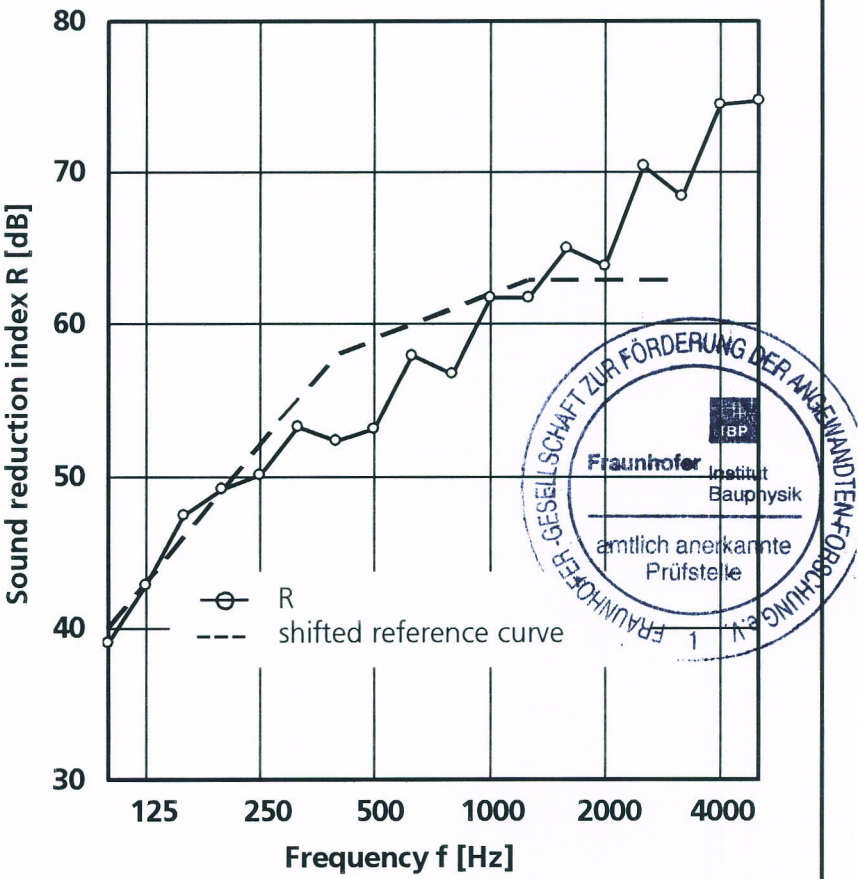
Additional description and technical data see page 2 of the test report P-BA 104e/2009, as well as figures 1, 3 and 6.

Variant 3: screw plug MX 50 MF, installed on one side

Test facility: test facility for windows, panels and small building elements P4
Room volume: V_S = 67 m³
V_E = 57 m³
Maximum insulation of the test facility: $R'_{max,w}$ = 72 dB
Test surface area: 1.0 m²
Test acoustic noise: pink noise
Rel. humidity: 45 %
Temperature: 22 °C.
Date of testing: July 21, 2008

f [Hz]	R [dB]
100	≥ 39,0 (40,5)
125	≥ 42,9 (41,8)
160	≥ 47,5 (44,8)
200	≥ 49,1 (47,3)
250	≥ 50,1 (51,5)
315	≥ 53,2 (56,8)
400	52,3
500	53,1
630	57,9
800	56,8
1000	61,7
1250	61,8
1600	65,1
2000	63,8
2500	70,4
3150	68,5
4000	≥ 74,5
5000	74,8

Symbol "≥" shows that the signal-to-noise ratio or the difference between limiting insertion loss and measured sound reduction index is smaller than or equal to 6 dB. For the second case limiting insertion loss is indicated in brackets.



Weighted sound reduction index and spectrum adaptation terms acc. to DIN EN ISO 717-1: 2006
R_w (C; C_{tr}; $C_{100-5000}$; $C_{tr,100-5000}$) = 59 (-1; -5; 0; -5) dB

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Stuttgart, July 02, 2009

Head of the test laboratory:

Sound insulation according to DIN EN ISO 140-03: 2005

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Figure 11

Test object:

Pre-cast concrete element with two tie points (conical holes in pre-cast concrete element), (see Fig. 1), hole diameter 17, 5 mm (front) to 22 mm (behind).
Dimensions of the element: L x H x W = 100 cm x 100 cm x 21 cm
Total weight of the element: 512 kg

The two tie points were sealed by various screw plugs of PERI GmbH. Three different screw plugs (MX 50 OF, MX 50 MF and MX 84 MF) of PERI GmbH were investigated (see Figures 2 to 7).
First the tie points were sealed only on one side then the openings were also sealed on the other side. The screw plugs were screwed by 10 Nm by means of a torque spanner.

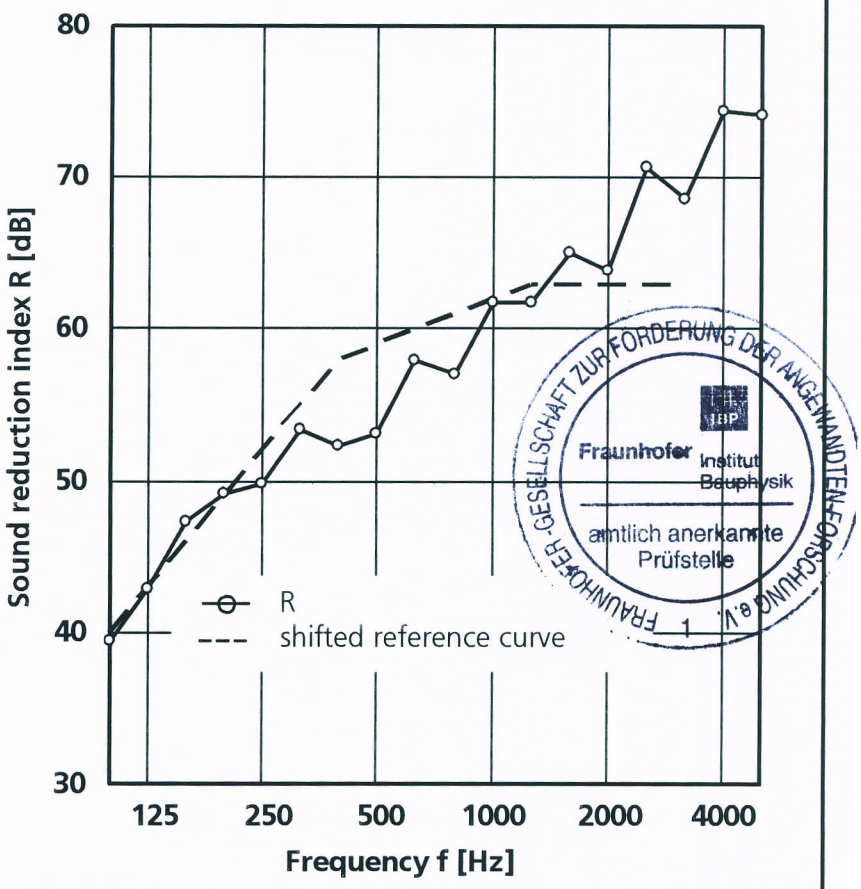
Additional description and technical data see page 2 of the test report P-BA 104e/2009, as well as figures 1, 3 and 6.

Variant 4: screw plug MX 50 MF, installed on both sides

Test facility: test facility for windows, panels and small building elements P4
Room volume: V_S = 67 m³
V_E = 57 m³
Maximum insulation of the test facility: $R'_{max,w}$ = 72 dB
Test surface area: 1.0 m²
Test acoustic noise: pink noise
Rel. humidity: 45 %
Temperature: 22 °C.
Date of testing: July 21, 2008

f [Hz]	R [dB]
100	≥ 39,4 (40,5)
125	≥ 42,8 (41,8)
160	≥ 47,3 (44,8)
200	≥ 49,1 (47,3)
250	≥ 49,8 (51,5)
315	≥ 53,3 (56,8)
400	52,3
500	53,1
630	57,9
800	57,0
1000	61,8
1250	61,8
1600	65,1
2000	63,8
2500	70,7
3150	68,6
4000	≥ 74,4
5000	74,1

Symbol "≥" shows that the signal-to-noise ratio or the difference between limiting insertion loss and measured sound reduction index is smaller than or equal to 6 dB. For the second case limiting insertion loss is indicated in brackets.



Weighted sound reduction index and spectrum adaptation terms acc. to DIN EN ISO 717-1: 2006
R_w (C; C_{tr}; $C_{100-5000}$; $C_{tr,100-5000}$) = 59 (-1; -5; 0; -5) dB

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Stuttgart, July 02, 2009

Head of the test laboratory:

Sound insulation according to DIN EN ISO 140-03: 2005

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Figure 12

Test object:

Pre-cast concrete element with two tie points (conical holes in pre-cast concrete element), (see Fig. 1), hole diameter 17, 5 mm (front) to 22 mm (behind).
Dimensions of the element: L x H x W = 100 cm x 100 cm x 21 cm
Total weight of the element: 512 kg

The two tie points were sealed by various screw plugs of PERI GmbH. Three different screw plugs (MX 50 OF, MX 50 MF and MX 84 MF) of PERI GmbH were investigated (see Figures 2 to 7).
First the tie points were sealed only on one side then the openings were also sealed on the other side. The screw plugs were screwed by 10 Nm by means of a torque spanner.

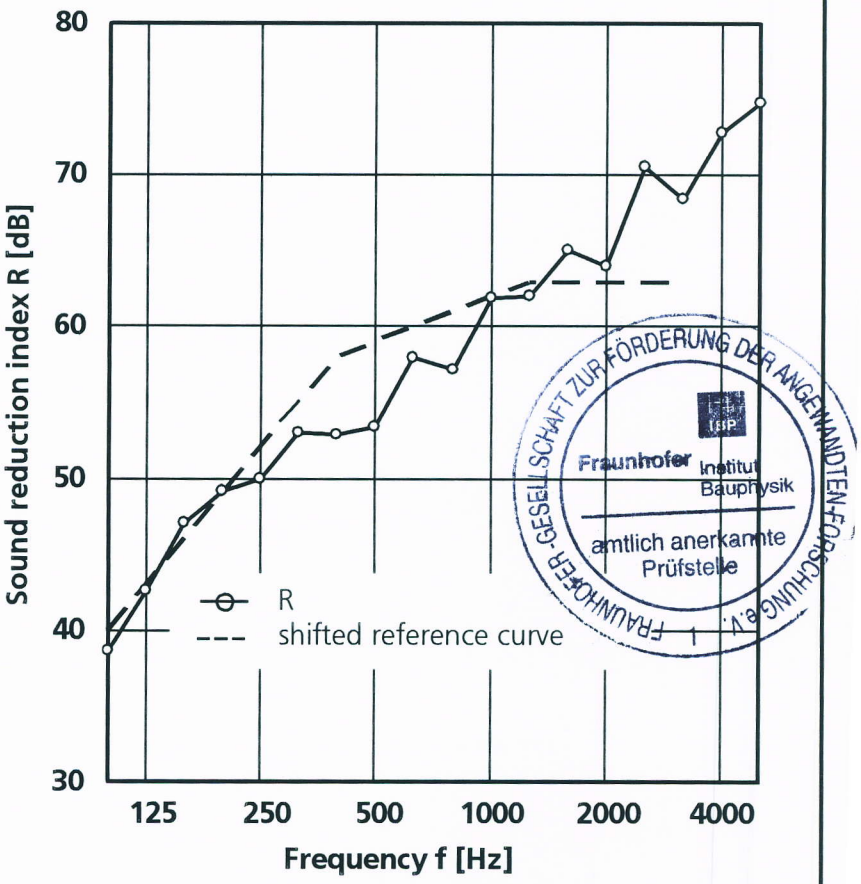
Additional description and technical data see page 2 of the test report P-BA 104e/2009, as well as figures 1, 4 and 7.

Variant 5: screw plug MX 84 MF, installed on one side

Test facility: test facility for windows, panels and small building elements P4
Room volume: V_S = 67 m³
V_E = 57 m³
Maximum insulation of the test facility: $R'_{max,w}$ = 72 dB
Test surface area: 1.0 m²
Test acoustic noise: pink noise
Rel. humidity: 45 %
Temperature: 22 °C.
Date of testing: July 21, 2008

f [Hz]	R [dB]	
100	≥ 38,7	(40,5)
125	≥ 42,6	(41,8)
160	≥ 47,0	(44,8)
200	≥ 49,1	(47,3)
250	≥ 50,0	(51,5)
315	≥ 53,0	(56,8)
400	52,8	
500	53,3	
630	57,9	
800	57,2	
1000	61,9	
1250	62,0	
1600	65,1	
2000	64,0	
2500	70,5	
3150	68,5	
4000	72,8	
5000	74,8	

Symbol "≥" shows that the signal-to-noise ratio or the difference between limiting insertion loss and measured sound reduction index is smaller than or equal to 6 dB. For the second case limiting insertion loss is indicated in brackets.



Weighted sound reduction index and spectrum adaptation terms acc. to DIN EN ISO 717-1: 2006
R_w (C; C_{tr}; $C_{100-5000}$; $C_{tr,100-5000}$) = 59 (-1; -5; 0; -5) dB

Fraunhofer IBP

The test was performed in the test laboratories of the IBP testing center accredited according to DIN EN ISO/IEC 17025 by the DAP (German Accreditation System for Testing), no. DAP-PL-3743.26.

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P-BA 104e/2009

Figure 13

Test object:

Pre-cast concrete element with two tie points (conical holes in pre-cast concrete element), (see Fig. 1), hole diameter 17, 5 mm (front) to 22 mm (behind).
Dimensions of the element: L x H x W = 100 cm x 100 cm x 21 cm
Total weight of the element: 512 kg

The two tie points were sealed by various screw plugs of PERI GmbH. Three different screw plugs (MX 50 OF, MX 50 MF and MX 84 MF) of PERI GmbH were investigated (see Figures 2 to 7).
First the tie points were sealed only on one side then the openings were also sealed on the other side. The screw plugs were screwed by 10 Nm by means of a torque spanner.

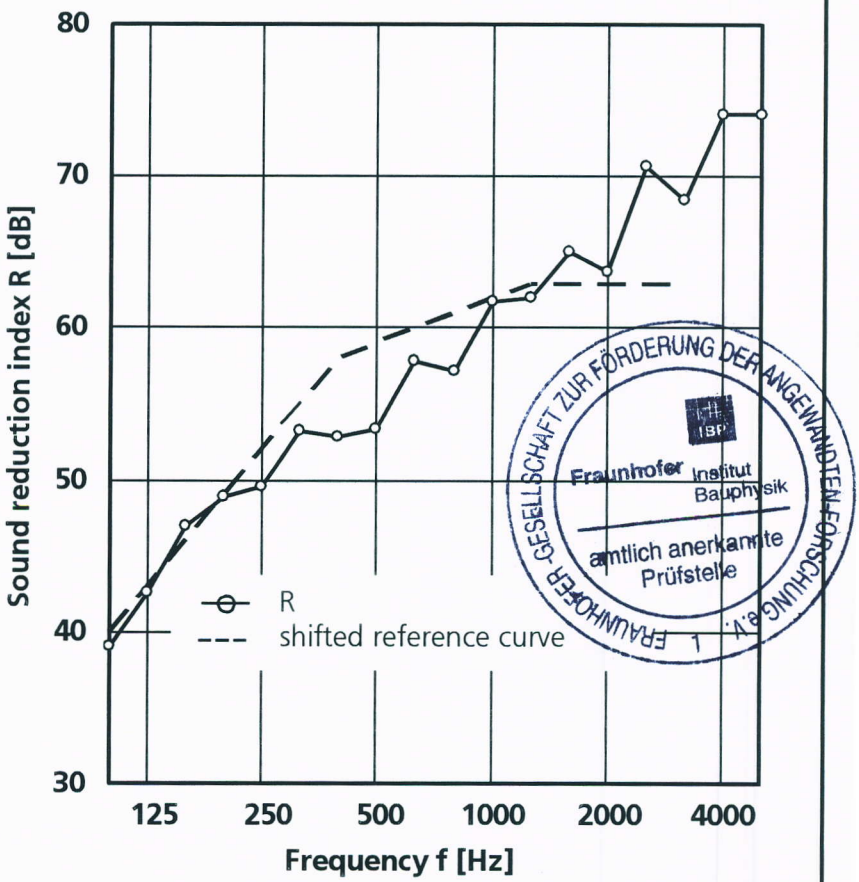
Additional description and technical data see page 2 of the test report P-BA 104e/2009, as well as figures 1, 4 and 7.

Variant 6: screw plug MX 84 MF, installed on both sides

Test facility: test facility for windows, panels and small building elements P4
Room volume: V_S = 67 m³
V_E = 57 m³
Maximum insulation of the test facility: $R'_{max,w}$ = 72 dB
Test surface area: 1.0 m²
Test acoustic noise: pink noise
Rel. humidity: 45 %
Temperature: 22 °C.
Date of testing: July 21, 2008

f [Hz]	R [dB]	
100	≥ 39,0	(40,5)
125	≥ 42,6	(41,8)
160	≥ 46,9	(44,8)
200	≥ 48,9	(47,3)
250	≥ 49,6	(51,5)
315	≥ 53,2	(56,8)
400	52,8	
500	53,3	
630	57,8	
800	57,1	
1000	61,8	
1250	62,0	
1600	65,1	
2000	63,7	
2500	70,7	
3150	68,5	
4000	≥ 74,1	
5000	74,1	

Symbol "≥" shows that the signal-to-noise ratio or the difference between limiting insertion loss and measured sound reduction index is smaller than or equal to 6 dB. For the second case limiting insertion loss is indicated in brackets.



Weighted sound reduction index and spectrum adaptation terms acc. to DIN EN ISO 717-1: 2006
R_w (C; C_{tr}; $C_{100-5000}$; $C_{tr,100-5000}$) = 59 (-1; -5; 0; -5) dB

Fraunhofer IBP

The test was performed in the test laboratories of the IBP testing center accredited according to DIN EN ISO/IEC 17025 by the DAP (German Accreditation System for Testing), no. DAP-PL-3743.26.

Stuttgart, July 02, 2009

Head of the test laboratory:

Sound insulation according to DIN EN ISO 140-03: 2005

Client: PERI GmbH
D-8926 Weißenhorn

P-BA 104e/2009
Figure 14

Test object:

Pre-cast concrete element with two tie points (conical holes in pre-cast concrete element), (see Fig. 1), hole diameter 17, 5 mm (front) to 22 mm (behind).
Dimensions of the element: L x H x W = 100 cm x 100 cm x 21 cm
Total weight of the element: 512 kg

The two tie points were sealed by various screw plugs of PERI GmbH. Three different screw plugs (MX 50 OF, MX 50 MF and MX 84 MF) of PERI GmbH were investigated (see Figures 2 to 7).
First the tie points were sealed only on one side then the openings were also sealed on the other side. The screw plugs were screwed by 10 Nm by means of a torque spanner.

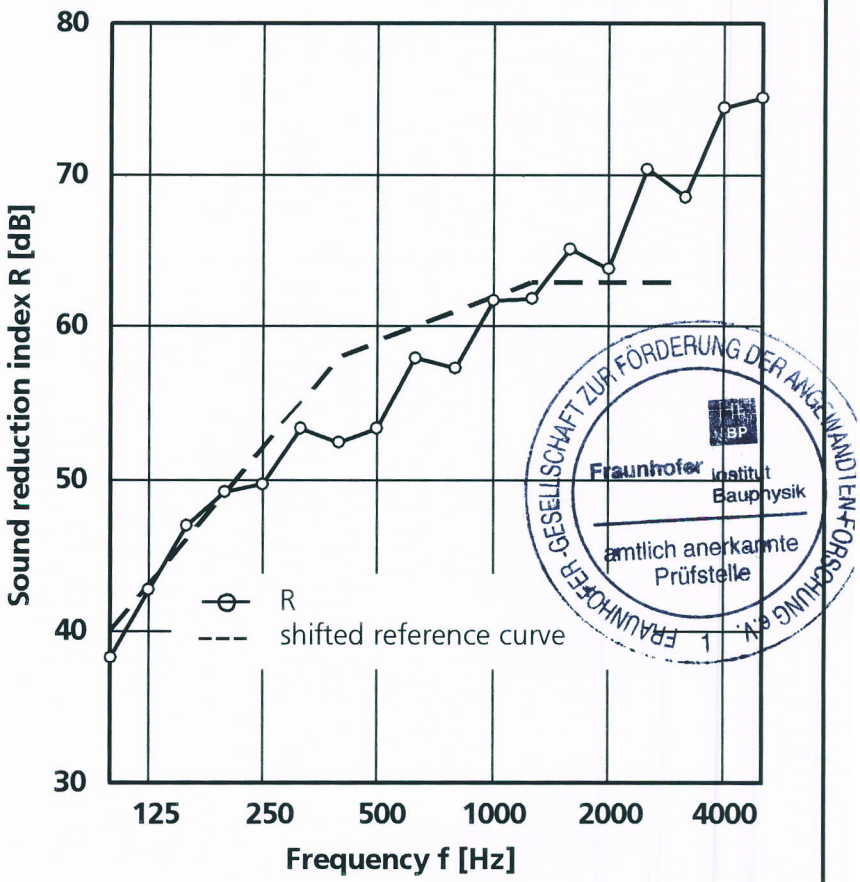
Additional description and technical data see page 2 of the test report P-BA 104e/2009, as well as figure 1.

Reference: tie points with mineral filler soundproof closed.

Test facility: test facility for windows, panels and small building elements P4
Room volume: V_S = 67 m³
V_E = 57 m³
Maximum insulation of the test facility: $R'_{max,w}$ = 72 dB
Test surface area: 1.0 m²
Test acoustic noise: pink noise
Rel. humidity: 45 %
Temperature: 22 °C.
Date of testing: July 21, 2008

f [Hz]	R [dB]
100	≥ 38,3 (40,5)
125	≥ 42,7 (41,8)
160	≥ 46,9 (44,8)
200	≥ 49,2 (47,3)
250	≥ 49,7 (51,5)
315	≥ 53,3 (56,8)
400	52,5
500	53,3
630	58,0
800	57,3
1000	61,8
1250	61,9
1600	65,2
2000	63,9
2500	70,4
3150	68,6
4000	≥ 74,5
5000	75,1

Symbol "≥" shows that the signal-to-noise ratio or the difference between limiting insertion loss and measured sound reduction index is smaller than or equal to 6 dB. For the second case limiting insertion loss is indicated in brackets.



Weighted sound reduction index and spectrum adaptation terms acc. to DIN EN ISO 717-1: 2006
R_w (C; C_{tr}; $C_{100\text{-}5000}$; $C_{tr,100\text{-}5000}$) = 59 (-1; -5; 0; -5) dB

Fraunhofer IBP

The test was performed in the test laboratories of the IBP testing center accredited according to DIN EN ISO/IEC 17025 by the DAP (German Accreditation System for Testing), no. DAP-PL-3743.26.

Stuttgart, July 02, 2009

Head of the test laboratory: