# REPORT

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|---|---|---|
| Auftrag-Nr.:<br>*Contract no.* | 2446/2022/2 - BBA | 17.08.2022<br>STE/ESK |
| Auftraggeber:<br>*Customer* | REGUPOL BSW GmbH<br>Am Hilgenacker 24<br>DE-57319 Bad Berleburg | |
| Auftragsgegenstand:<br>*Subject* | Issue of a detailed report of test of the standardized impact sound pressure level $L_n$ of a walk-on flat roof in the test stand in accordance with ÖNORM (Austrian standard) EN ISO 10140-3:2015 with evaluation in accordance with ÖNORM EN ISO 717-2:2013 | |
| Auftragsdatum:<br>*Date of contract* | 11 April 2022 (email) | |
| Probeneingangsdatum:<br>*Date of sample delivery* | 20 January 2022 | |
| Leistungsdatum/<br>Leistungszeitraum:<br>*Date/Period of service* | April 2022 – August 2022 | |
| Geltungsdauer:<br>*Period of validity* | -- | |
| Textseiten:<br>*Pages* | 13 | |
| Beilagen:<br>*Enclosures* | 1 (1 page) | |

# 1. Subject:

With the e-mail dated 11 April 2022, the company REGUPOL BSW GmbH commissioned Holzforschung Austria with the issue of a detailed report of an acoustics test in a test stand of a walk-on flat roof (from order 1281/2022) in accordance with ÖNORM EN ISO 10140-3:2015 and evaluation in accordance with
ÖNORM EN ISO 717-2:2013.

# 2. Taking measurements

## 2.1. Measurement procedure for the standardized impact sound pressure level norm $L_n$

The impact sound pressure measurements were represented as in Table 1, in accordance with ÖNORM EN ISO 10140-3:2015 and ÖNORM EN ISO 10140-1:2016 using Sinus Soundbook MK2_8L measurement equipment (Inv. No. 4400) and the expander (Inv. No. 4403).

Table 1: Overview of the impact sound pressure measurements taken

| Date | Measurement no. | Flat roof | Short name |
|---|---|---|---|
| 26 January 2022 | M10.1 | REGUPOL sound and drain 22 under concrete tiles on pedestals | DA_A4 |

The impact acoustic excitation was generated using the standardized tapping machine Slim from the company Ntek (Inv. No. 4492).

The sound pressure levels received were measured using ½" G.R.A.S. 40AE condenser microphones (Inv. Nos. 4432–4436). with G.R.A.S. type 26AK preamplifier (Inv. Nos. 4442–4446).

The noise levels per hammer position are recorded in the receiving room with five discrete microphone positions per measurement cycle. One measurement consists of six measurement cycles, whereby the sound pressure levels in the receiving room are averaged from 30 microphone positions. The averaging time for each measuring cycle is 20 seconds.

The entire measurement chain is traceably calibrated to national standards. Before the measurement, a check was performed with the Svantek SV 30A test sound source (Inv. No. 4422); after the measurement the measurement chain was checked once again. The results of the measurements were evaluated in accordance with ÖNORM EN ISO 717-2:2013.

The **background noise level** was determined. The receiving room level was partially corrected in accordance with Section 4.3 of ÖNORM EN ISO 10140-4:2010. The correction is performed automatically by the Sinus Soundbook MK2_8L measuring system, if necessary. The frequency bands in which a correction was carried out can be found in the respective test report, where the corrected measurement values are marked with (*).

The **reverberation time** was determined using the integrated impulse response method. 3 speaker positions were used for this, each with five discrete microphone positions and 4 level drops per position. The results were averaged arithmetically.

To ensure a high repeatability **of the measurement in the low frequency range** (50 Hz – 80 Hz), larger room dimensions than those given are required. The recommendations according to Annex A of ÖNORM EN ISO 10140-4:2010 for measurements in the frequency range below 100 Hz are not fully complied with. For information purposes, the measured values from these frequency bands are nevertheless specified or evaluated in the measurement protocols.

## 2.2. Test stand

The measurements were carried out in the M-test stand of the Akustik Center Austria. The test stand was erected in accordance with the requirements for test stands specified in ÖNORM EN ISO 10140-1:2016 and ÖNORM EN ISO 10140-5:2014, without any indirect sound paths. The essential requirements as well as the properties of the M-test stand are listed in Table 2.

Table 2: Requirements for sound test stands and existing conditions of the test stand in the Akustik Center Austria (ACA):

| Criterion | | Requirement | ACA test stand M |
|---|---|---|---|
| Volume Receiving room / transmitting room | | > 50 m³ | 54 m³ / 60 m³ |
| Volume difference between the test rooms | | min. 10% | 11% |
| Test port | Wall | approx. 10 m² | 10.8 m² |
| | Ceiling | 10 m² – 20 m² | 20 m² |
| | Window | 1.875 m² | 1.875 m² |
| | Door | no requirements | Standard opening 1.7 m² |
| | | -- | variable test port |
| Recesses | | to be avoided | no recesses |
| Reduced test port | | to be avoided | full test port |

The test rooms are 2 rectangular rooms, equipped with the necessary absorbers and diffusers (for a reverberation time of approx. 1.5 s over the complete structural acoustic frequency range and to guarantee a sound field that is as diffuse as possible). The transmitting room consists of a wooden construction made of cross-laminated timber with a deeply coordinated facing formwork on the inside. The receiving room was built from 200 mm reinforced concrete, also with a deeply coordinated interior facing formwork. Both rooms are decoupled from the hall floor via appropriately dimensioned elastic intermediate layers in order to prevent interference signals from outside.

## 3. Item to be tested

In the section below, the test samples examined are described. Information on the structural components and their designations were provided by the customer and checked by the inspector. Technical details that were not checked by HFA employees (e.g. certain manufacturer details or details according to the customer) are marked with an asterisk *.

The choice of test samples (PK) was selected by the customer.

| | |
|---|---|
| Manufacturer | REGUPOL BSW GmbH |
| Date of delivery: | 20 January 2022 |
| Sample delivery numbers: | 1281/22_LENO Cross-laminated timber<br>incl. material for roof construction |

## 3.1. REGUPOL sound and drain 22 under concrete tiles on pedestals (DA_A4)

### 3.1.1. Construction (from the sending room to the receiving room) and surface density:

| | | |
|---|---|---|
| 40.0 | mm | Concrete tiles (500 × 500) mm² |
| 160.0 | mm | Buzon DPH-5-PH5 |
| 15.0 | mm | REGUPOL sound and drain 22 (250 × 250) mm² |
| 40.0 | mm | Concrete tiles (400 × 400) mm², distance = 100 mm, with stone chippings in gaps |
| 2.5 | mm | bitumen sealing |
| 100.0 | mm | EPS thermal insulation |
| 200.0 | mm | LENO cross-laminated timber ceiling, m' = 86.6 kg/m² |
| **557.5** | **mm** | **Total thickness** |
| **286.9** | **kg/m²** | **surface density** |

### 3.1.2. Materials used and installation:

Concrete tiles (500 × 500) mm²:

| | |
|---|---|
| Material | Concrete tiles |
| Type | no information |
| Manufacturer | no information |
| Dimensions (W × H × D) | (500 × 500 × 40) mm³ |
| surface density | 113.1 kg/m² |
| Mounting and fastening | The concrete tiles were laid butt to butt on the pedestals (Buzon DPH-5-PH5). |

Buzon DPH-5-PH5:

| | |
|---|---|
| Material | Copolymer polypropylene (CPP) pedestals |
| Type | DPH 5-PH5 |
| Manufacturer | Buzon Pedestal International s.a. |
| Measurements | Diameter top: 155 mm<br>Diameter bottom: 200 mm<br>Height: 160 mm |
| Mass | 0.667 kg |
| Centre distance | 500 mm |
| Mounting and fastening | The pedestals (Buzon DPH-5-PH5) were set to a height of 160 mm and placed centrally on the REGUPOL sound and drain 22 pads. |

REGUPOL sound and drain 22:

| | |
|---|---|
| Material | Impact sound insulation elastomer membrane made of polyurethane-bonded rubber fibres, profiled on the underside, laminated with geotextile on the upper side |
| Type | REGUPOL sound and drain 22 |
| Manufacturer | REGUPOL BSW GmbH |
| Dimensions (W × H × D) | (250 × 250 × 15) mm³ |
| surface density | 6.5 kg/m² |
| Centre distance | 500 mm |
| dynamic stiffness s′* | ≤ 21 MN/m³ |
| Compressibility cp* | ≤ 2 mm |
| Mounting and fastening | The square impact sound pads were placed centrally on the concrete tiles. |

Concrete tiles (400 × 400) mm²:

| | |
|---|---|
| Material | Concrete tiles |
| Type | no information |
| Manufacturer | no information |
| Dimensions (W × H × D) | (400 × 400 × 40) mm³ |
| surface density | 89.7 kg/m² |
| Centre distance | 500 mm |
| Mounting and fastening | The concrete tiles were laid evenly on the bitumen sealing at a spacing of 100 mm. |

Stone chippings in gaps between concrete tiles:

| | |
|---|---|
| Material | Paving chippings |
| Type | High-grade crushed stone 2–4 mm |
| Manufacturer | no information |
| Height of pile | 40 mm |
| Density | 1478.4 kg/m³ |
| Mounting and fastening | The paving chippings were loosely poured into the spaces between the concrete walkway tiles (400 × 400) mm². |

Bitumen sealing:

| | |
|---|---|
| Material | Crack-bridging, self-adhesive bitumen sealing membrane |
| Type | webertec 913 (cold self-adhesive membrane) |
| Manufacturer | Saint-Gobain Weber Terranova GmbH |
| Dimensions (W × L) | (1000 × 15000) mm² |
| Thickness | 2.5 mm |
| surface density | 1.75 kg/m² |
| Mounting and fastening | The self-adhesive bitumen sealing was cold-bonded directly to the EPS thermal insulation. |

EPS thermal insulation:

| | |
|---|---|
| Material | Thermal insulation boards made of extruded polystyrene (EPS) |
| Type | No information |
| Manufacturer | Karl Bachl GmbH & Co KG |
| Dimensions (W × H × D) | (500 × 1000 × 100) mm³ |
| surface density | 1.9 kg/m² |
| dynamic stiffness s'* | No information |
| Mounting and fastening | The EPS thermal insulation boards were laid without gaps on the cross-laminated timber ceiling. |

LENO Cross-laminated timber ceiling:

| | |
|---|---|
| Material | 4-piece cross laminated timber ceiling made of 5 layers of spruce wood |
| Type | LENO Cross-laminated timber |
| Manufacturer | ZÜBLIN Timber GmbH |
| Dimensions (W × H × D) | (1310 × 4230 × 200) mm³ (4-piece) |
| surface density | 86.6 kg/m² |
| Mounting and fastening | The 4 elements were laid in longitudinal direction. The connection between the elements was made using folding boards on the side of the sending room, which were screwed alternately on the left and right at a distance of 250 mm. |

## 3.2. Installation conditions of the tested constructions in the ceiling frame

The test frame is a reinforced L-shaped concrete frame with internal dimensions 4270 mm × 5280 mm. The test port is 3970 mm × 4980 mm and has the same dimensions as the receiving room, therefore there are no niches in the receiving room. The maximum installation depth in the test frame is 400 mm (see Fig. 1).

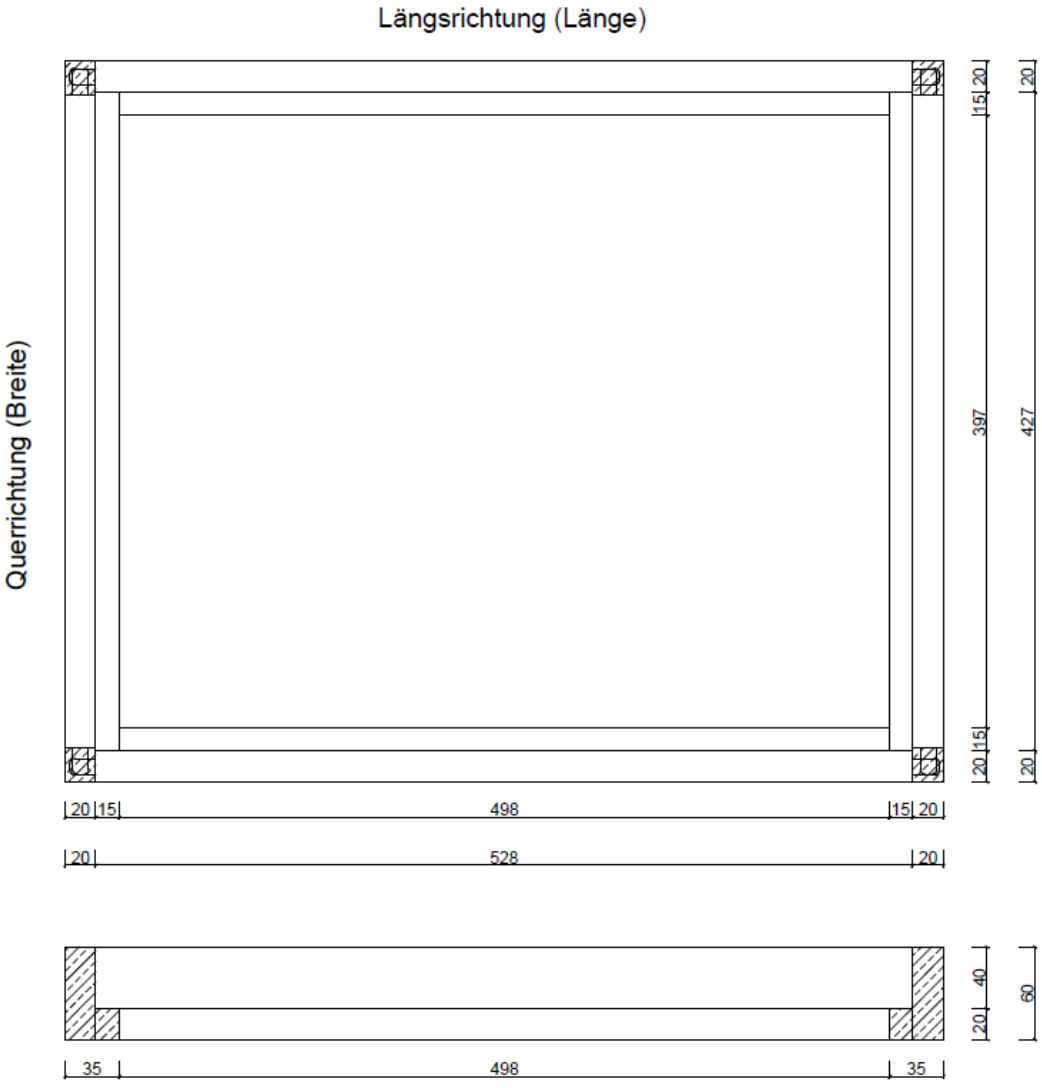



Fig. 1: Ceiling frame

For the assembly, the cross laminated timber elements were first installed in the test frame. The thermal insulation boards were then laid butt to butt on the cross laminated timber roof. The cold self-adhesive membrane was then applied and the concrete tiles (400 × 400) mm² were laid. (Fig. 2). The spaces in between were filled with stone chippings. The concrete tiles were followed by the terrace structure consisting of REGUPOL sound and drain 22, pedestals and concrete tiles. (Fig. 3).

The roof structure was decoupled from the test frame at the bottom with a elastomeric bearing. The lateral decoupling to the frame was carried out by means of impact noise insulation (TDPT 20, Saint-Gobain Rigips Austria GmbH) over the entire installation depth in order to avoid creating structure-borne sound bridges. The test frame was then placed on the test stand. Since the roof structure protruded above the test frame height, mineral wool (Isover TW-KF) was placed in the edge area to the sending room wall.
Lowered partitions in the sending room (made of Rigips Duo'Tech DLI 25 boards) prevent further possible sound bridges. The circumferential gap between the concrete tiles and the partitions was then closed with impact noise insulation (TDPT 20, Saint-Gobain Rigips Austria GmbH) (Fig. 4). The sealing of the structure towards the test frame was carried out on the receiving room side by means of window putty (Ilbruck OS201).

The assembly of the accessible flat roof was carried out by employees of REGUPOL BSW GmbH. The test was carried out by employees of Holzforschung Austria.


Fig. 2: Laying the concrete tiles (400 × 400) mm² on the cold self-adhesive membrane.

Fig. 3: The walk-on flat roof structure was decoupled from the test frame by means of impact noise insulation (TDPT 20, Saint-Gobain Rigips Austria GmbH).

Fig. 4: Gap closed with impact noise insulation (TDPT 20, Saint-Gobain Rigips Austria GmbH) between the concrete tiles (500 × 500) mm² and the partitions.

# 4. Results

## 4.1. Evaluated standardized impact sound pressure level $L_{n,w}$

The standardized impact sound pressure level $L_n$, represented by frequency in enclosure 1 was determined by averaging several measurements from various microphone positions in accordance with ÖNORM EN ISO 10140-3:2015. The evaluation was conducted in third-octave bands, in accordance with ÖNORM EN ISO 717-2:2013, and resulted in the following evaluated standardized impact sound pressure $L_{n,w}$ and the corresponding spectrum adaptive values $C_I$.

The evaluated standardized impact sound pressure $L_{n,w}$ is also given for information purposes in 1/10 dB including measurement uncertainty in accordance with ÖNORM EN ISO 12999-1:2015.

### 1. REGUPOL sound and drain 22 under concrete tiles on pedestals (DA_A4)

$$L_{n,w} (C_I) = 41 (-1) \text{ dB}$$

| | |
|---|---|
| $L_{n,w}$ in 1/10 dB including measurement uncertainty | $L_{n,w}$ = 40.5 dB ± 1.5 dB |
| Test report number | HFA_2446_22_M10.1 |

HOLZFORSCHUNG AUSTRIA

Dr Bernd Nusser
*Authorised signatory*

DI. Alexander Stenitzer
*Processor*

*This report was approved electronically in accordance with an internal HFA process by the designated authorized signatory, traceable and documented.*

1 enclosure:

Impact sound

1. Test report: HFA_2446_22_M10.1_en

Accreditation is given for the following procedures.
It is not permitted to use the included accreditation marks for one's own purposes.

| Accreditation marking | Type of accreditation | Process |
|---|---|---|
| Akkreditierung Austria 0055 ISO/IEC 17025 T | Testing | • ÖNORM EN ISO 10140-3:2015 |

The results and statements given in this document relate only to the tested materials as received, the present information and the state of the art at the time of investigation.

Publication in excerpts is only permitted with the written approval of Holzforschung Austria.

The conformity assessment of the results is subject to the shared-risk approach.

*In case of dispute the original German version prevails. This translation is for information purposes only.*

# Impact sound insulation according to ISO 10140-3

Laboratory measurement of sound insulation of building elements – Measurement of impact sound insulation

**Customer:**
REGUPOL BSW GmbH
Am Hilgenacker 24
DE-57319 Bad Berleburg

**Composition of the test item (from the transmitting to the receiving room):**
Details see in report: 2446/2022/2 - BBA

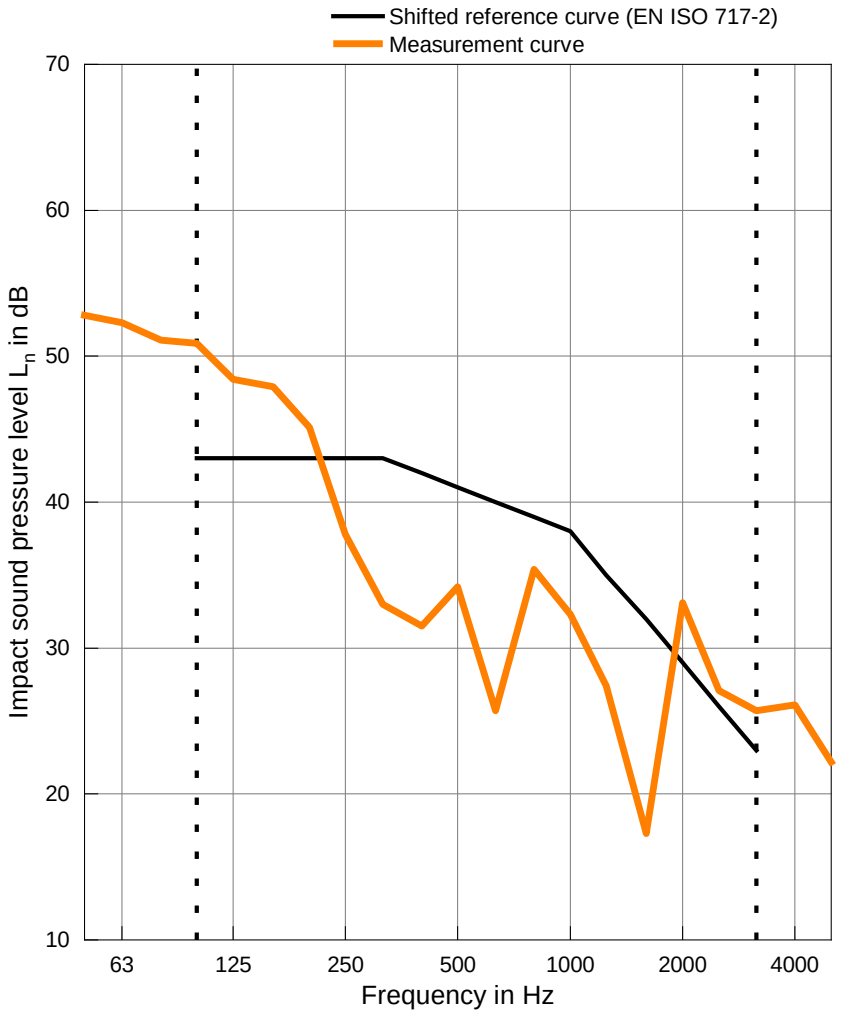
| | | |
|---|---|---|
| 40.0 | mm | Concrete tiles (500 × 500) mm² |
| 160.0 | mm | Buzon DPH-5-PH5 |
| 15.0 | mm | REGUPOL sound and drain 22 (250 × 250) mm² |
| 40.0 | mm | Concrete tiles (400 × 400) mm², distance = 100 mm, with stone chippings in gaps |
| 2.5 | mm | bitumen sealing |
| 100.0 | mm | EPS thermal insulation |
| 200.0 | mm | LENO CLT ceiling, m' = 86.6 kg/m² |
| 557.5 | mm | Total thickness |

**Illustration:** -

**Product name:**
REGUPOL sound and drain 22 under concrete tiles on pedestals
**Manufacturer:**
REGUPOL BSW GmbH

| | |
|---|---|
| Test date: | 26.01.2022 |
| Operator: | Johannes Reiter, Alexander Stenitzer |
| Installation by: | employees of REGUPOL BSW GmbH, assisted by employees of HFA |
| Area S of the tested element: | 19,8 m² |
| Surface-related mass: | 286,9 kg/m² |
| Temperature in test rooms: | 21,8 °C |
| Relative humidity in the test rooms: | 36,0 % |
| Static air pressure: | 1009,2 hPa |
| Volume of the receiving room: | 58,7 m³ |
| Volume of the transmitting room: | 56,4 m³ |
| Test sound: | Standardised tapping machine |
| Test code: | M10_DE_A4_ |

| Frequency in Hz | $L_n$ in dB |
|---|---|
| 50 | 52,8 |
| 63 | 52,3 |
| 80 | 51,1 |
| 100 | 50,9 |
| 125 | 48,4 |
| 160 | 47,9 |
| 200 | 45,1 |
| 250 | 37,8 |
| 315 | 33,0 |
| 400 | 31,5 |
| 500 | 34,2 |
| 630 | 25,7 |
| 800 | 35,4 |
| 1000 | 32,3 |
| 1250 | 27,4 |
| 1600 | 17,3 |
| 2000 | 33,1 |
| 2500 | 27,1 |
| 3150 | 25,7 |
| 4000 | 26,1 |
| 5000 | 22,2 |




* in these frequency ranges a correction was carried out due to the small difference to the background noise level (< 6 dB)

Rating in accordance with EN ISO 717-2 (in third octave bands)
**$L_{n,w}$ ($C_I$) = 41 (-1) dB** $C_{I,50\text{-}2500}$ = 3 dB

Test report number: HFA_2446_22_M10.1_en
Holzforschung Austria

Date: August 02, 2022
DI Alexander Stenitzer
Processor

*This test report was approved electronically in accordance with an internal HFA process by the designated authorized signatory, traceable and documented.*