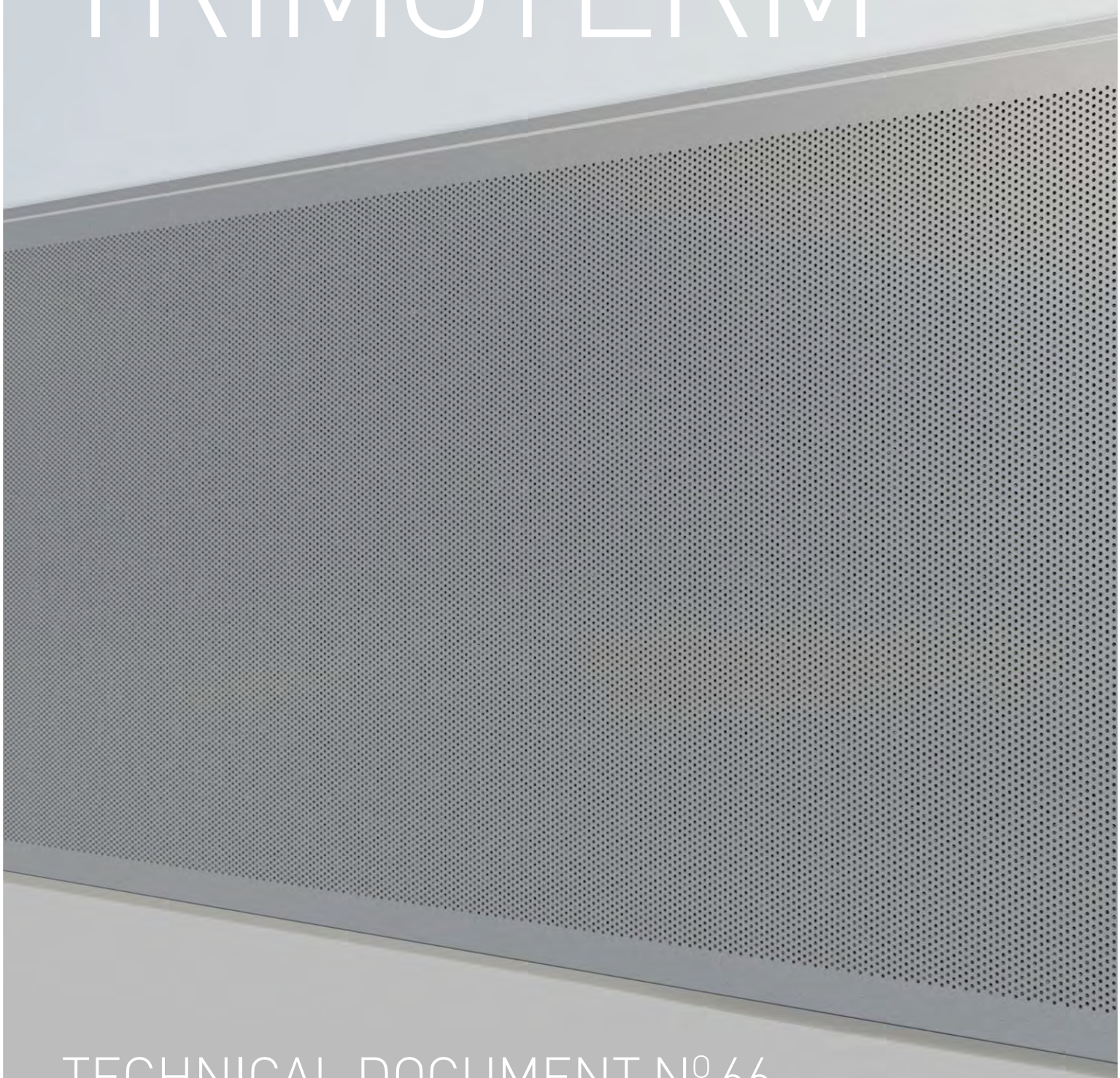
TRIMO

TRIMOTERM



TECHNICAL DOCUMENT Nº 66

SOUND INSULATION AND ABSORPTION OF TRIMO ELEMENTS

CONTENT

ACOUSTICS

GENERAL INFORMATION

Sound definition

In physics sound is defined as longitudinal waves, which means that particles of a substance in which the sound spreads (gases, liquids, solids) vibrate in the direction of wave travelling. It holds true for longitudinal waves that thickening (contraction) and dilution (decompression) appear in the substance. Contraction appears where particles of the substance come closer and decompression where particles of the substance travel away.
The main characteristics of the sound are frequency and amplitude. A frequency unit is hertz (Hz = the number of cycles per second). A human ear can detect sound through sound pressure measured in Pa. The lowest change in pressure detected by the human ear is 2x10-5 and the highest is 20 Pa. Since the scale is huge, a logarithm is used for its expression where relations can be described by a relative low number. A dB unit is used for sound pressure in a logarithmic scale. Decibél (abbreviation dB) is a unit without any dimension expressing a relation between acceptable quantity and fixed reference.

Since dB's are in logarithms this fact shall be considered in calculations. E.g. when adding these two it is necessary to convert each in an arithmetic figure / number, add and logarithm it again.

If there are two sound sources Lp1 = 40 dB and Lp2 = 45 dB this can be converted and added:
104.0 + 104.5 = 10000 + 31622 = 41622
log (41622) = 46.2 dB

SOUND TRANSFER, SOUND INSULATION AND SOUND ABSORPTION

With respect to the appearance of sound disturbance sound travels over the walls and mezzanine structures in a building in two ways:

- Noise travelling through the air,
- Noise that spreads over structural elements and is called impact sound.

The so-called airborne sound is discussed when the sound source emits sound into a room where the source is located. As a result sound generates waves of partition walls in a room and thus the emission of sound to the neighbouring rooms.

Impact sound is discussed when a building structure is excited by walking, moving of furniture etc. where waves of bordering partition walls of a room are excited and these then emit sound to the neighbouring rooms.

Sound insulation is of vital importance for health and well-being of people. It is especially important in house building and in facilities for special use. In recent years strict requirements also apply to the industrial constructions due to intensified regulations concerning employers and the environment.

It is relevant that one distinguishes sound insulation from sound absorption. The functions of sound insulation and sound absorption are closely related and each expresses a different aspect of sound technical characteristics:

- Sound insulation (R) gives information about the difference between sound that travels to the element and the sound that pushes from an element
- Sound absorption (α) gives information about a share of emitted sound depending on sound received

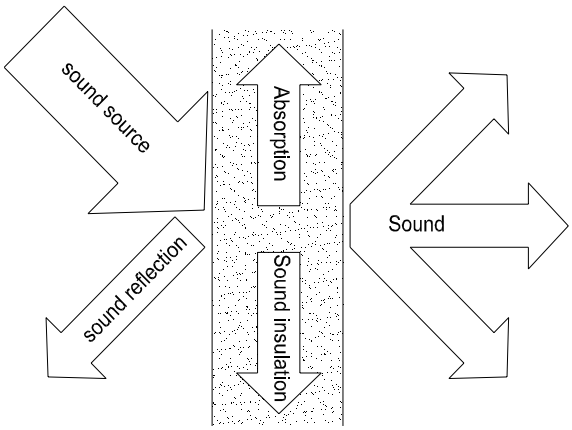
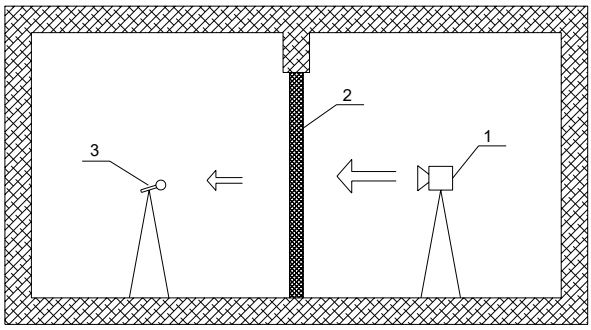


Fig. 1: Sound contact with a wall

In this relation, separate test methods are used for testing of elements:

- Test of sound insulation in compliance with EN ISO 140-3:1997 (Fig. 2)
- Test of sound absorption in an echo chamber in compliance with EN 20354:1998 (Fig. 3)

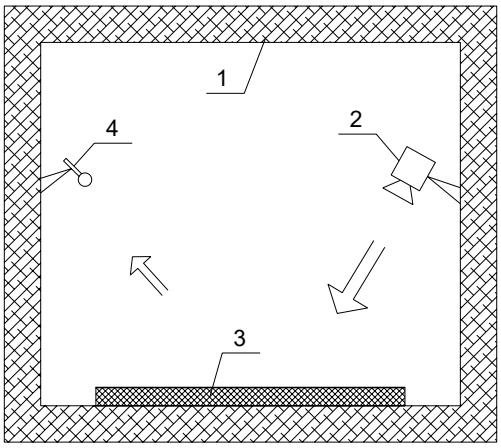


1- Sound source

2- Test piece

3- Sound meter

Fig. 2: Test procedure for definition of sound insulation in compliance with EN ISO 140-3:1997



1 – Echo chamber

2 – Sound source

3 – Test piece

4 – Sound insulation meter

Fig. 3: Testing equipment – measuring of sound absorption in compliance with EN 20354:1998

OTHER TERMS (Rw, Rw´, dLα, dB, dBA,...)

Decibel dB, dBA

Decibél (abbreviation dB) is a unit without any dimension and it is used for expressing a relation between a changeable quantity and fixed reference. dBA is the unit used for weighted measurements with the factor.

Sound insulation Rw

The so-called evaluated minimal value of sound insulation before sound in the air of partition walls and mezzanine structures defined by Rw (measured in a laboratory) or the value Rw' (measured in the facility) is used in practice instead of the sound insulation R.

The value Rw is supplemented by the following data C and Ctr.
The sum of Rw + C stands for sound insulation for high frequencies in dBA. These are:

- Daily activities (talking, music, TV,...)
- Railway traffic at medium and high speed
- Motorway traffic or traffic on local roads
- A distant plane
- High frequency noise from factories

The sum of Rw + Ctr strands for sound insulation for low frequencies in dBA. These are:

- Railway traffic at low speed
- Traffic in towns
- Disco music
- Low frequency noise from factories

E.g. Rw = 46 (-3;-8) dB) where C = -3 and Ctr = -8 dB.

Measured and estimated sound absorption – dLα

Absorption (dLα) for the measured panel sample laid in an echo chamber is defined on the basis of the formula:

$$dL\alpha = -10.\log\left(1 - \frac{\sum_1^{18} asi.10^{0,1Li}}{\sum_1^{18} 10^{0,1Li}}\right)$$

WHERE:

Li – are factors taking into account the frequency spectrum of road traffic under consideration of the correction in accordance with the correction curve A αsi – are co-efficients of sound absorption in third frequency band established by measurements

TRIMOTERM ACOUSTIC PANELS AND PARTICULARITIES

Sound insulation of Trimoterm panels

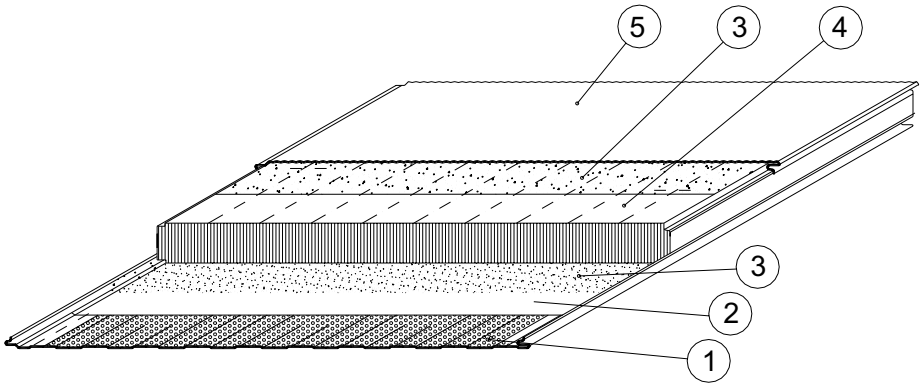
Characteristic co-efficients of sound insulation Rw for the type of construction with sandwich panels depend on fillers and thickness of panels/panel weight in the range from 20 dB to 35 dB. For panels with mineral wool it usually amounts to 30-35 dB. Multi-layer structures are needed in case of more demanding requirements, some them are presented in the following sections.

There are various penetrations, openings in walls, joints over which sound spreads differently as over a panel. Therefore architects / design engineers specialised in sound insulations consider in projects the actual situation and calculate total Rw. Deviations in practice or the fact that sound insulation is not equal to the calculated insulation are to be considered in these calculations and therefore the usually measured sound insulation Rw´ is slightly lower.

Properties of Trimoterm AC acoustic panels

In addition to the excellent fire-protection and thermal-insulation properties Trimoterm AC® acoustic sandwich panels have also good sound insulation and absorption. Primarily, acoustic panels are used for sound chambers, compound walls and under the mentioned construction-physical conditions also for partition or external walls and ceilings or roofs.

On the inner side Trimoterm acoustic panels have a perforated coating (1) that has been previously protected by polyester felt (2), load-bearing filler made of incombustible mineral wool (4) and profiled coating on the external side (5) – all elements are glued by adhesive (3). The installed protective felt has a double function: protection against the penetration of dust particles in the filler of the panel and protection against leaking of mineral wool particles.



1- Perforated profiled sheet metal
2- Polyester felt
3- Adhesive
4- Mineral wool
5- Profiled sheet metal

Fig. 4: Composition of a Trimoterm acoustic panel

Types of panel performance

- The following types of acoustic panels can be performed:
- Trimoterm FTV – ac
- Trimoterm FTV HL – ac
- Trimoterm FTV R – ac
- Trimoterm SNV –ac

Types of profiles / sheet metal thickness:

Outer shell of façade panels:

- m, s, v; sheet metal thickness t_n = 0.6 mm, (0.7 mm)

  Outer shell of a roof panel:

- TS; sheet metal thickness tn = 0.6 mm, (0.7 mm)

  Inside of façade / roof panels:

- s, v; sheet metal thickness t_n = 0.6 mm
- Profiled sheet metal, perforation RT Ø4 x 8 A_{pf} = 22%

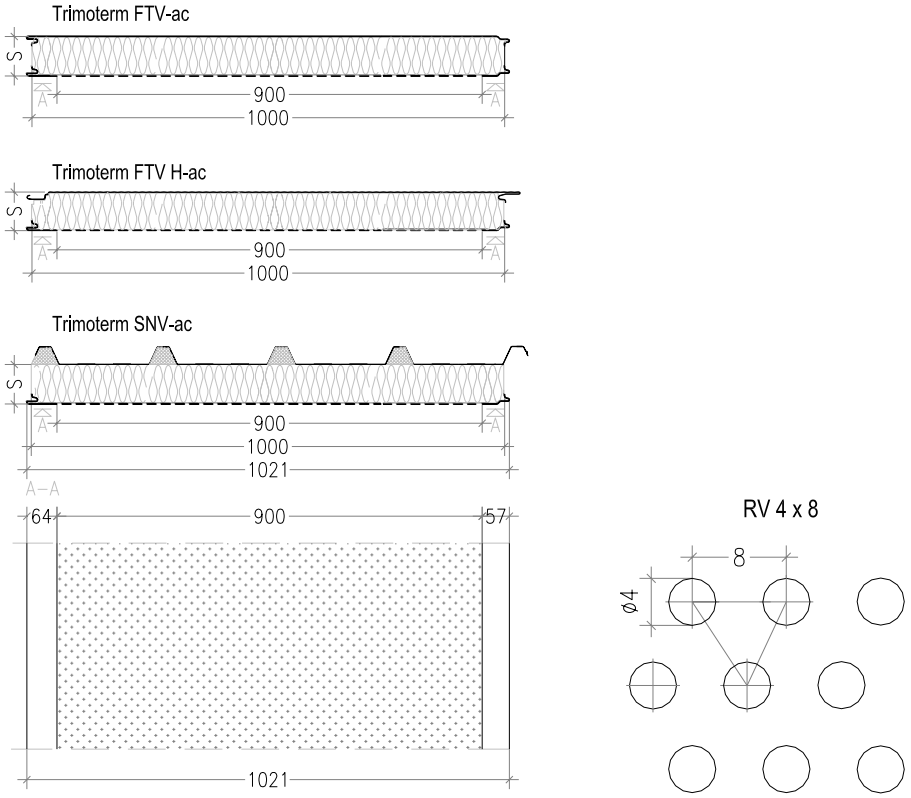


Fig. 5: Types of Trimoterm acoustic panels

Complete marking of an order (an example):

FTV 100 gs – ac* - 9006/9002** - 0.6 PVDF / 0.6 SP25

gs...profile smooth (externally), standard (internally)

9006...RAL external paint protection

9002...RAL internal paint protection

0.6 PVDF... sheet metal thickness and material of paint protection

0.6 SP25... sheet metal thickness and thickness of a paint protection layer

* ac- acoustic panel

*- internal perforated sheet metal is possible only in colour RAL 9002 and SP25 polyester paint protection

Acoustic properties of the Trimoterm AC panel

Sound insulation and sound absorption of a Trimoterm AC panel

Properties of sound insulation are valued by a test procedure in compliance with standard EN ISO 140-3, and properties of sound absorption in compliance with standard EN 20354.

- In accordance with the requirements of standards the co-efficients of sound absorption α_s are valued at prescribed widths of the third spectrum in a frequency spectrum 100 Hz to 5000 Hz.
- For simple evaluation and comparison the evaluated co-efficient of sound absorption α_w is calculated in compliance with the requirements of the standard.

f(Hz)	100	125	160	200	250	315
α_s	0.20	0.31	0.36	0.43	0.63	0.70
f(Hz)	400	500	630	800	1000	1250
α_s	0.83	0.86	0.90	0.87	0.91	0.92
f(Hz)	1600	2000	2500	3150	4000	5000
α_s	0.91	0.92	0.96	0.93	0.88	0.88

Table 1: The co-efficient of sound absorption α_s at different frequencies for the Trimoterm FTV 60 - ac acoustic panel.

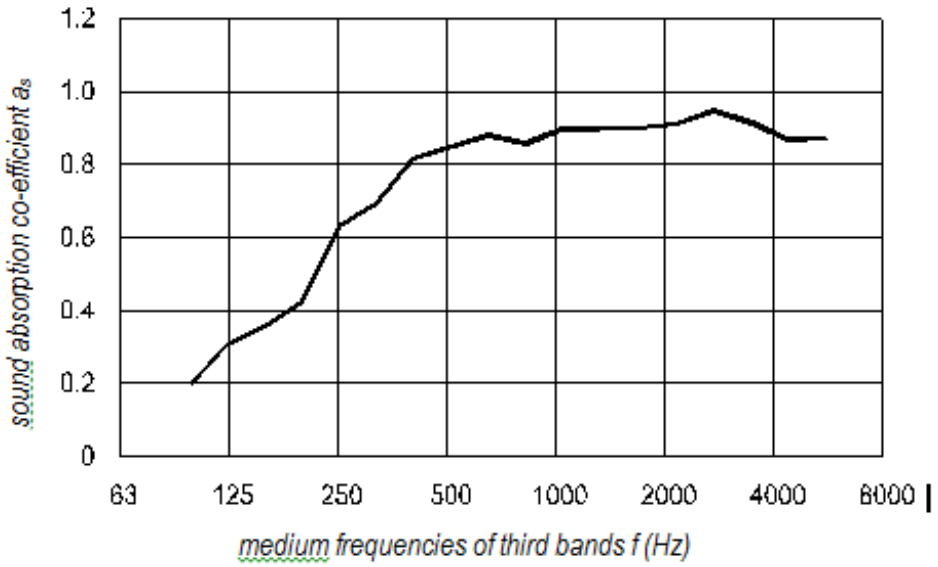


Fig. 6: The co-efficient of sound absorption as Trimoterm FTV 60 - ac.
(Test report No. P 526/ 05-510-2 - ZAG Ljubljana)

The evaluated co-efficient of sound absorption αw = 0.85

Sound insulation of a panel in compliance with standard SIST EN ISO 717 (evaluated in accordance with this standard) reaches 34 dB, sound absorption in compliance with standard EN 20354 reaches 8.3 dB. On the basis of technical-acoustic properties of large thickness types we declare that the panels of large thickness types (80 to 240 mm) reach the same or better results of sound insulation and sound absorption.

Particularities of acoustic panels

Combustibility

The response of Trimoterm AC panels to fire has been tested in compliance with standard SIST EN 13823. In compliance with standard SIST EN 13501-1 Trimoterm AC panels reach classification relating to response to fire B-s1,d0.

Fire resistance

Trimoterm panels have been tested in accordance with standards EN 14509:2006 and EN 1364-1. In accordance with standard EN 14509:2006 panels can be installed vertically and horizontally. Trimoterm AC acoustic panels have 22% perforation and incombustible core of A1 class.

In accordance with standard EN 12254-5:2009 tests with non-perforated sheet metal are valid also for panels with perforated sheet metal on the side of fire up to 40 % perforation and the core is declared as A2-s1, d0 or better.

Load-bearing capacity of acoustic panels

Tables of permissible distance for Trimoterm panels are not valid for Trimoterm AC acoustic panels. Due to the perforation and thus weakening of sheet metal the permissible distances are slightly shorter.

Trimo needs to make exact case calculation.

The following data are needed for the calculation of a distance:

- mathematical wind load (defined by the location and form of a building)
- colour of the outer shell of the panel (installation under special conditions)
- static system (single-pole, double-pole, multi-pole)
- panel thickness and profile type
- snow load (valid for roof panels)

Building physics

Because of perforated sheet metal on the inside acoustic panels have limited use on façades and roofs. The use is limited due to diffusion of steam and consequently due to the danger of appearance of increased humidity in the filler of the panel, mostly directly along the outer shell. It usually appears in winter when external temperatures are lower than the ambient temperatures.

External and internal climate conditions are important and these are:

- Air temperature
- Relative air humidity

Trimoterm acoustic panels cannot be used for external applications on heated facilities.

Exceptions:

- Non-heated facilities with the provided ventilation with air exchange of n > 2/h
- Non-heated facilities in climate conditions where winter temperatures do not drop below freezing point (te > 0 °C)
- Compound structures where thermal insulation is provided by other elements of a compound structure – panels can provide only sound insulation or absorption function.

RESULTS OF MEASUREMENTS OF PANEL SOUND INSULATION

TEST RESULTS OF SOUND INSULATION (Rw) FOR FTV PANELS

FTV panels in a thickness of 100 mm have been tested in compliance with standards EN ISO 140-3 and EN 20354. Sound insulation of a panel in compliance with standard EN ISO 140-3 reaches 32 dB.

Façade panel:

- FTV 60 Rw (C;Ctr) = 30 (-2;-3) dB,
- FTV 100 Rw (C;Ctr) = 32 (-1;-3) dB,

On the basis of technical –acoustic properties of large thickness types we declare that panels of large thickness types (100 to 240 mm) reach the same or better results of sound insulation.

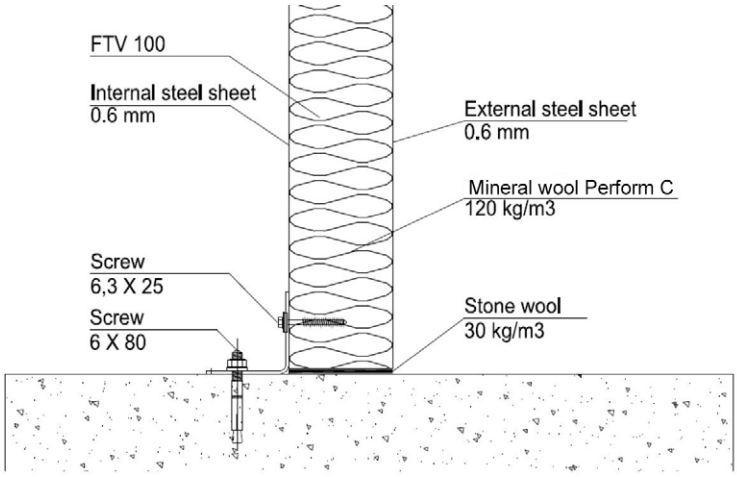
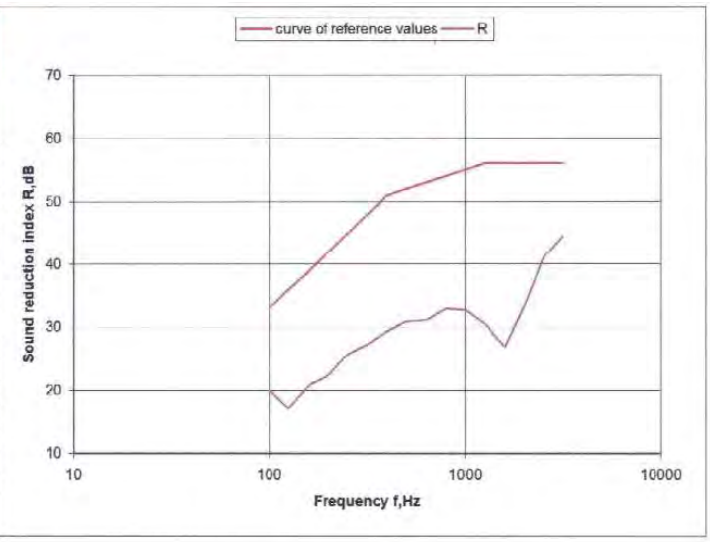


Diagram:

Frequency f Hz	R One-third octave dB
50	
63	
80	
100	20
125	17
160	21
200	22
250	26
315	27
400	29
500	31
630	31
800	33
1000	33
1250	30
1600	27
2000	33
2500	41
3150	45
4000	
5000	



R - curve of sound reduction
Rw -weightet sound reduction value

TEST RESULTES OF SOUND INSULATION (Rw) FOR FTV R AND QBISS ONE ELEMENTS

FTV R panels in a thickness of 80 mm have been tested in compliance with standards EN ISO 140-3 and EN 20354. Sound insulation of a panel in compliance with standard EN ISO 140-3 reaches 30 dB.

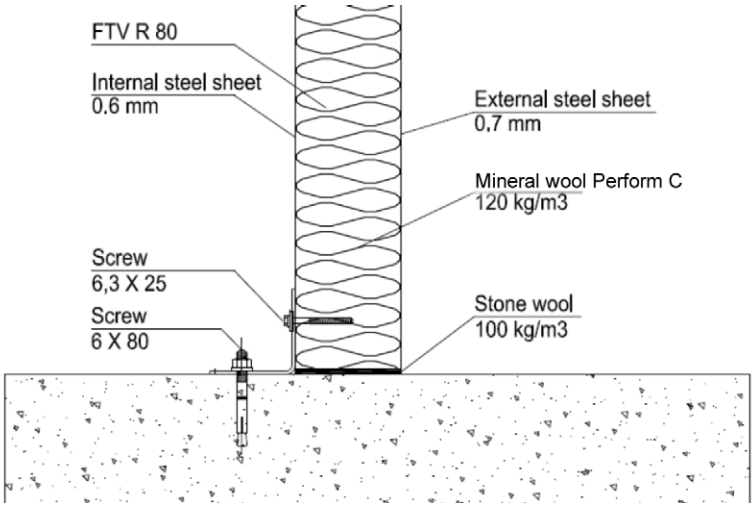
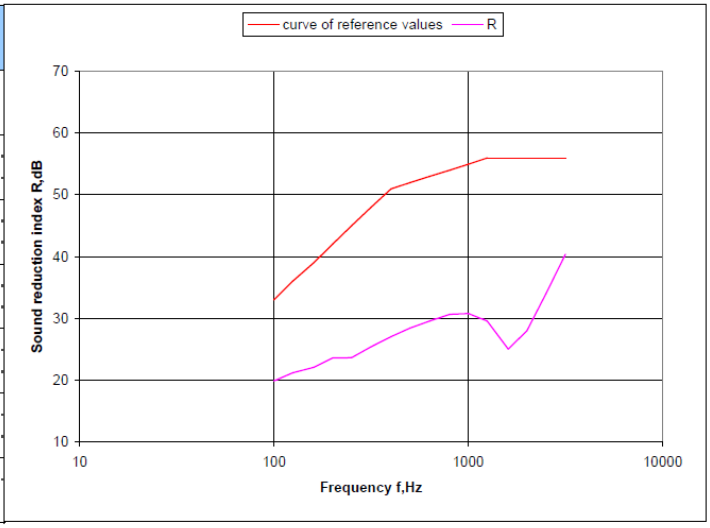


Diagram:

Frequency f Hz	R One-third octave dB
50	
63	
80	
100	20
125	21
160	22
200	24
250	24
315	25
400	27
500	28
630	30
800	31
1000	31
1250	30
1600	25
2000	28
2500	34
3150	40
4000	
5000	



R - curve of sound reduction
Rw -weightet sound reduction value

Qbiss One façade element:

The form of Qbiss One is similar to FTV R panel. On this basis it is assumed that Qbiss elements reach the same results of sound properties (min. 31 dB).

TEST RESULTS OF SOUND INSULATION (Rw) FOR SNV PANELS

SNV panels in a thickness of 60 mm have been tested in accordance with standards EN ISO 140-3 and EN 20354. Sound insulation of a panel in compliance with standard EN ISO 140-3 reaches 32 dB. The following thickness types have been measured:

- SNV 60 Rw (C;Ctr) = 32 (-1;-4) dB,
- SNV 100 Rw (C;Ctr) = 33 (-1;-4) dB,
- SNV 150 Rw (C;Ctr) = 33 (-1;-4) dB,

Roof panels SNV 32 dB, 12.09.2007

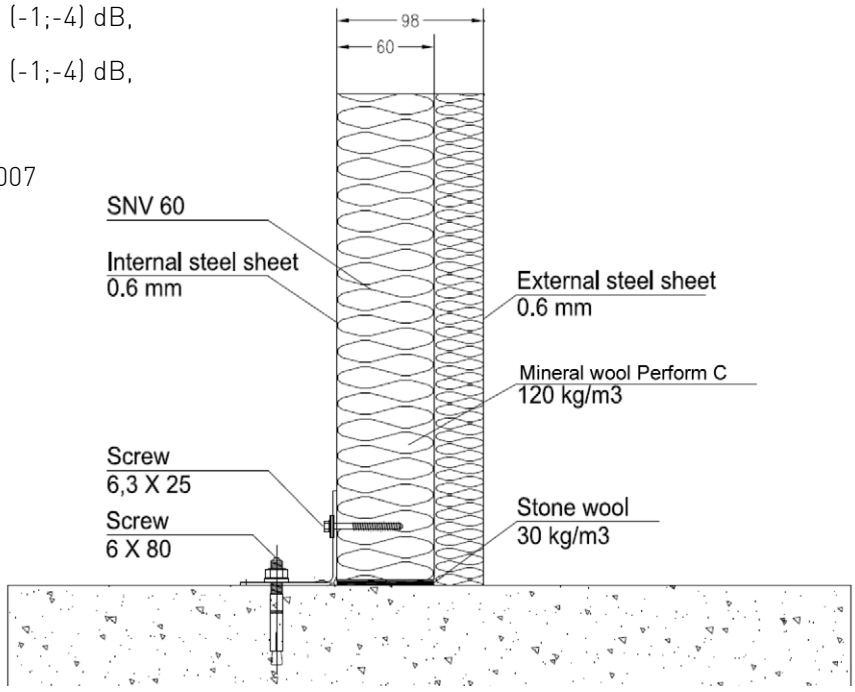
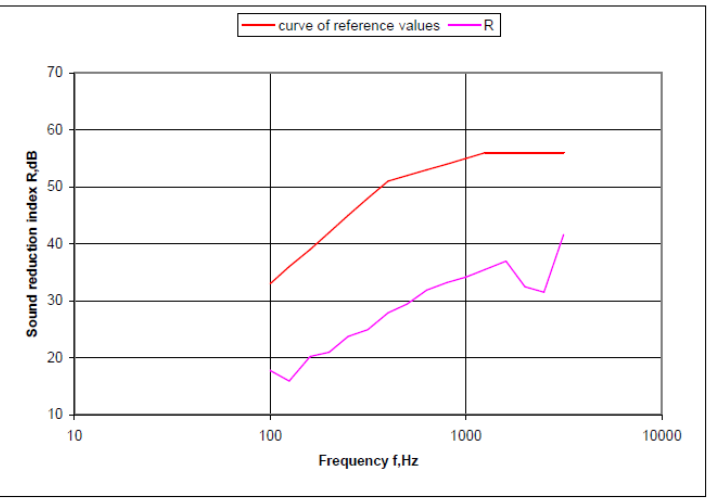


Diagram:

Frequency f Hz	R One-third octave dB
50	
63	
80	
100	18
125	16
160	20
200	21
250	24
315	25
400	28
500	29
630	32
800	33
1000	34
1250	35
1600	37
2000	32
2500	32
3150	42
4000	
5000	



R - curve of sound reduction
Rw -weightet sound reduction value

RESULTS OF MEASUREMENTS OF ACOUSTIC PANELS

TEST RESULTS OF SOUND INSULATION (Rw) FOR AC ACOUSTIC PANELS

RESULTS:

Frequency f Hz	R (third-oct.) dB
50	
63	
80	
100	18,4
125	22,9
160	24,9
200	24,5
250	27,5
315	29,4
400	30,4
500	31,7
630	33,2
800	34,5
1000	36,2
1250	36,7
1600	35,3
2000	29,6
2500	31,2
3150	39,4
4000	45,2
5000	49,1

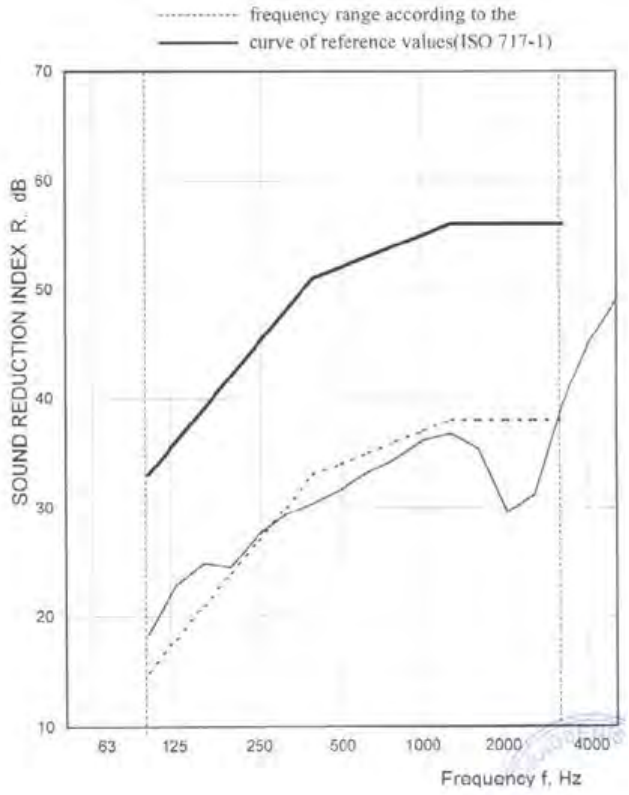


Fig. 7: Sound insulation– Trimoterm FTV 60 –ac (Test report P – 21/05-510-2 – ZAG Ljubljana)

For simple evaluation and comparison the evaluated co-efficient Rw is used with the additional adjustment co-efficients C and Ctr .

- The co-efficient of sound insulation Rw [dB] gives general information on the properties of sound insulation at 500 Hz relating to the sound reference curve (ISO 717-1)
- The adjustment co-efficients C and Ctr give information on sound properties for various noise sources.
- Co-efficient of sound insulation Rw + C [dBA] gives information on sound insulation at the noise spectrum with comparable intensity in the complete third spectrum.
- Co-efficient of sound insulation Rw + Ctr [dBA] gives information on sound insulation at the noise spectrum with the emphasised lower thickness in the lower frequency range.

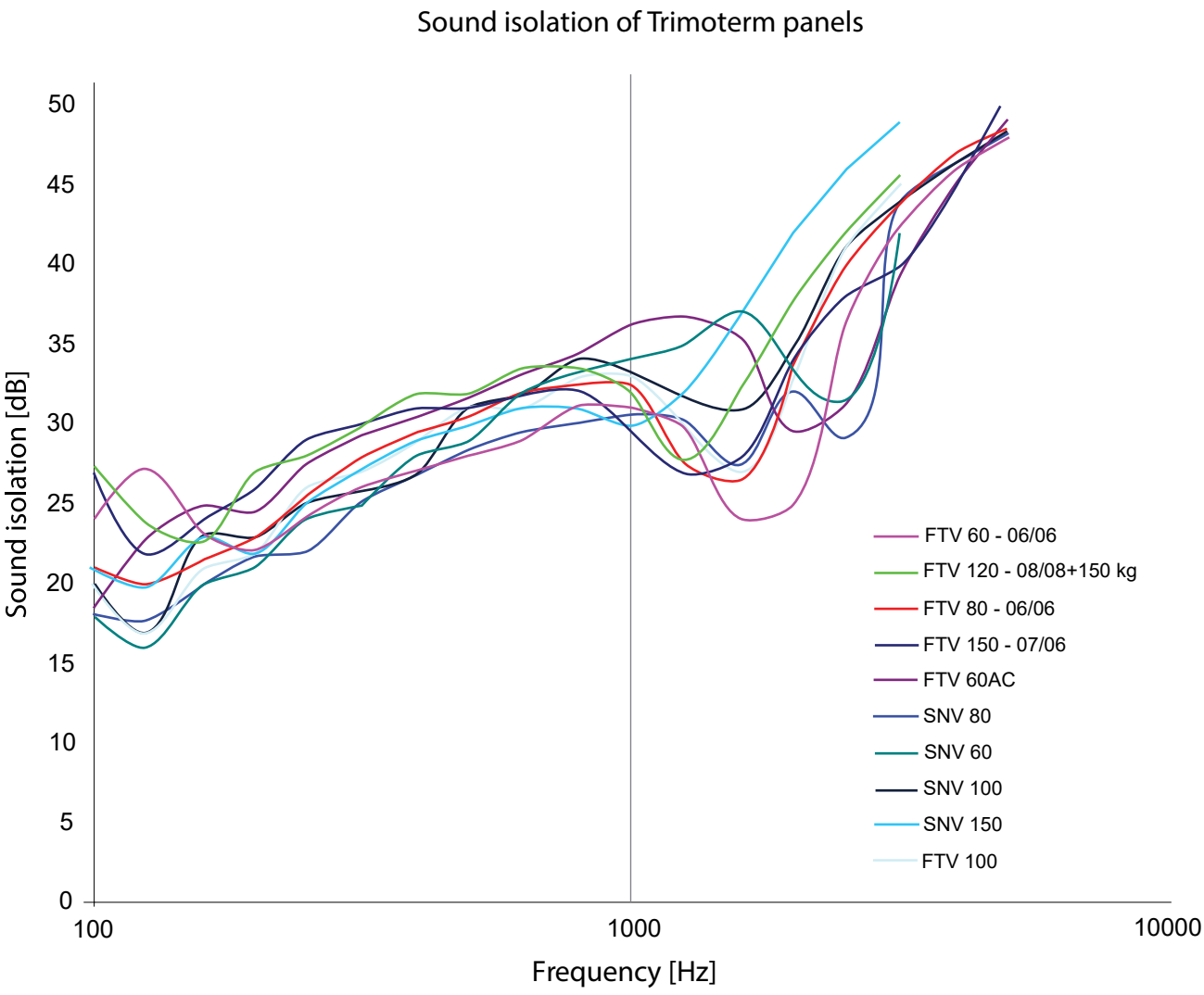
The evaluated co-efficient of sound insulation (EN ISO 717-1): Rw = 34 dB, C = -2 dB, Ctr = -3 dB

TEST RESULTS OF SOUND ABSORPTION (as) FOR AC ACOUSTIC PANEL

Acoustic panels in a thickness of 60 mm have been tested in accordance with standards EN ISO 140-3 and EN 20354. Sound absorption in compliance with standard EN 20354 reaches 8.3 dB.

On the basis of technical-acoustic properties of large thickness types we declare that panels of large thickness types (80 to 240 mm) reach the same or better results of sound insulation.

Sound insulation for selected types of panels in a common diagram:



SYSTEM SOLUTIONS

USE OF ACOUSTIC PANELS FOR FACADES, ROOFS

Acoustic panels can be used for the performance of external façades, partition walls, divisions and internal cladding under consideration of the limitations.
Standard type details for vertical and horizontal façades are used for the design and performance.
During the assembly special attention has to be paid to sealing, especially to joints between classical construction elements (main beam, parapet, wall) and panels.

The improvement of acoustic properties is achieved by the use of Trimoterm Ac acoustic panels with the additional cladding or a multi-layer composition.
The performance is suitable for the existing facilities and new constructions.
An external structure can be light (i.e. Trimoterm panels) or a solid wall made of concrete or a brick wall. With respect to the construction-physical conditions the use depends on the thickness of thermal insulation of the outer shell and thickness of the additional cladding.

Larger scope of applicability can be achieved by the use of:

- Minimal thickness of an acoustic panel
- Increased thermal insulation of the outer shell.

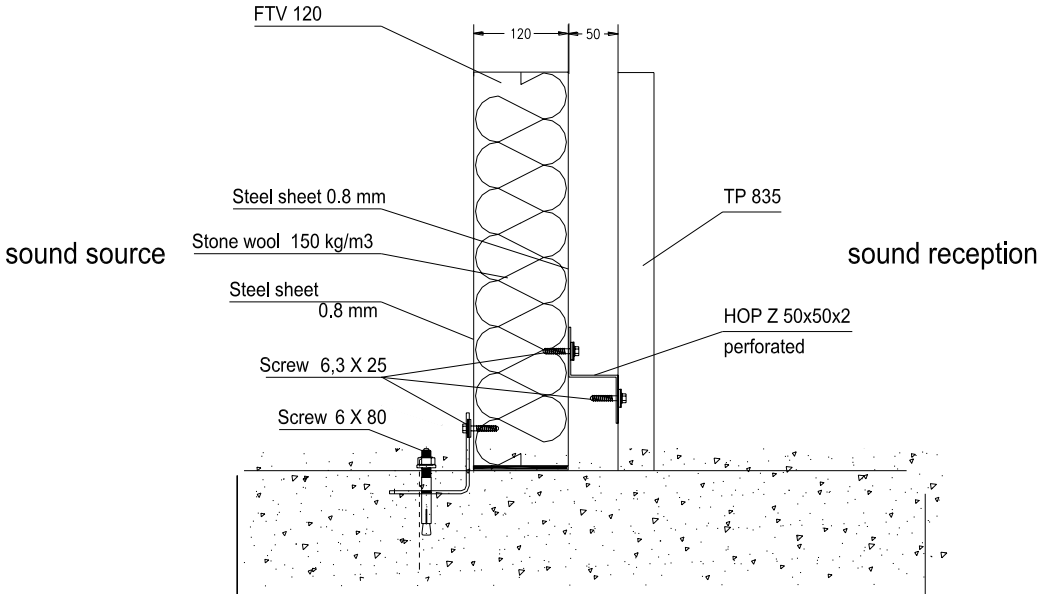
Assembled façades and roofs

Trimoterm acoustic panels can be used for the improvement of acoustic properties of rooms also when they are assembled:

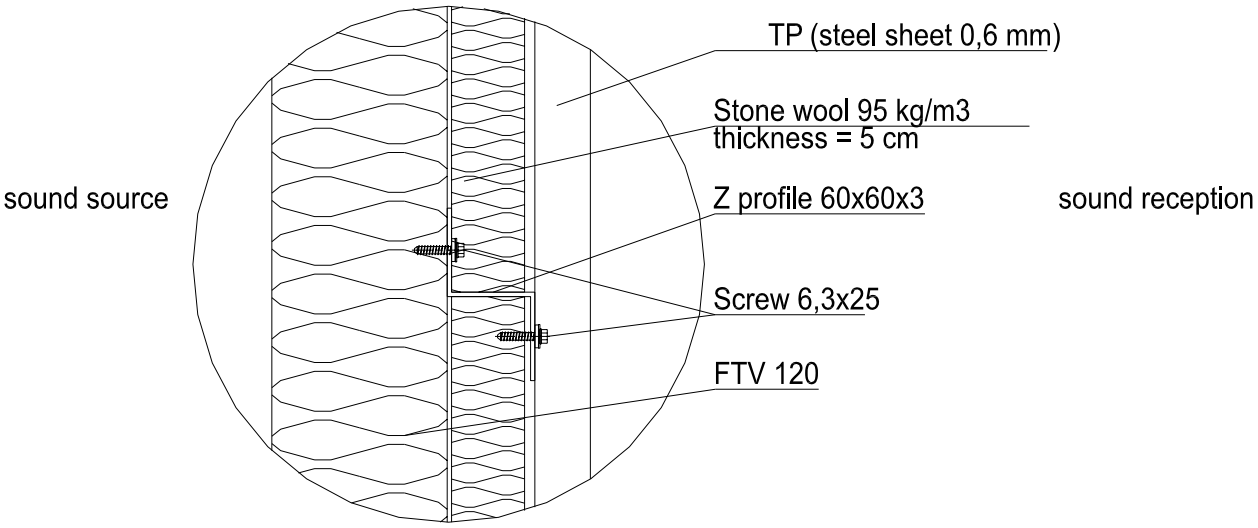
- Panel + inner cladding
- Panel + external cladding
- Double panel

Panel with external cladding

Sound Insulation of a panel with external cladding – profilation TP is Rw= 38 dB



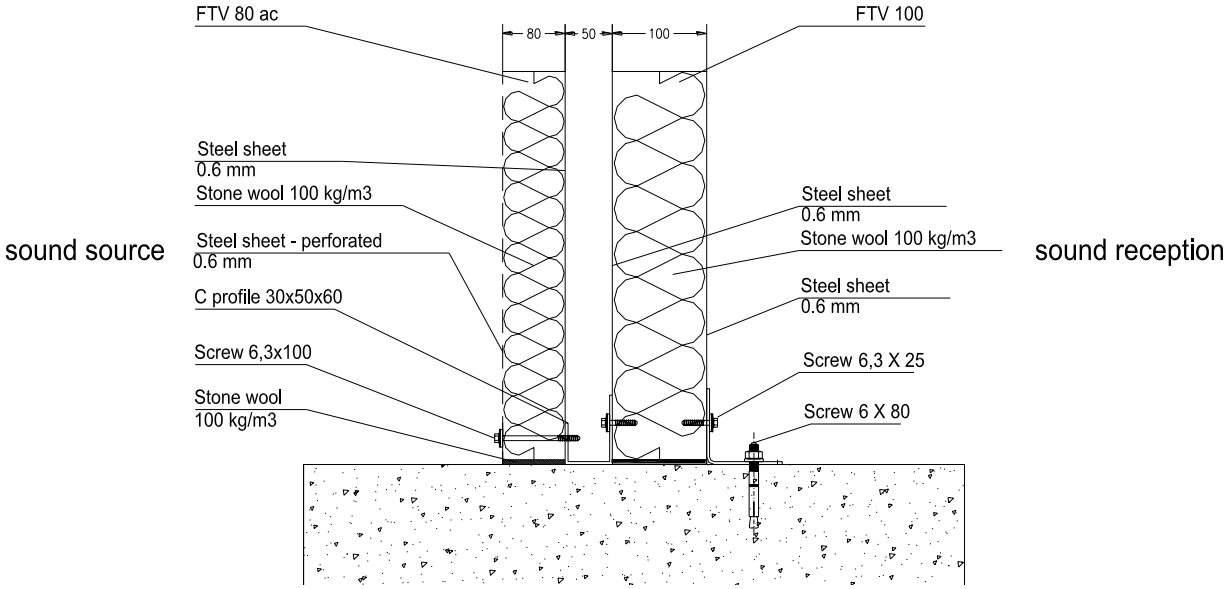
Sound insulation of a panel with external cladding –profilation TP and additional wool in a thickness of 5 cm and density of 95 kg/m^3 is Rw= 46 (-3;-8) dB



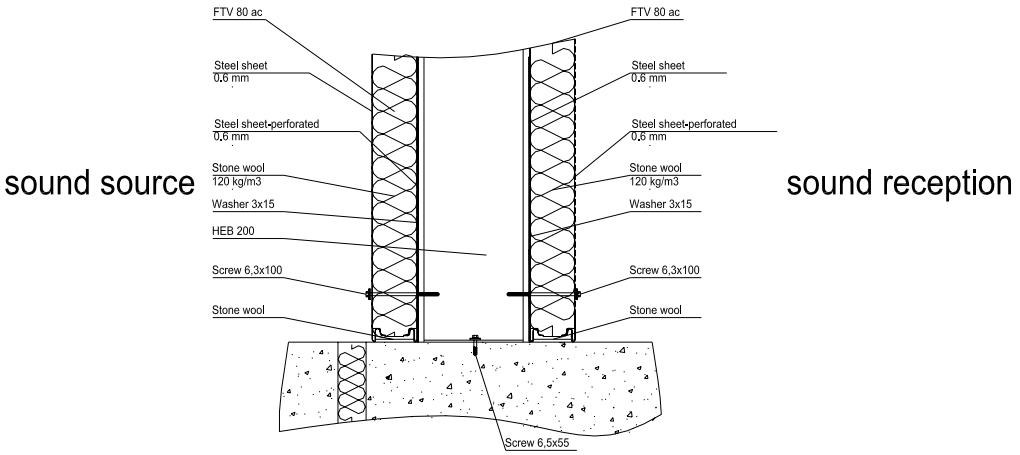
Double panel

A wall with a double panel is made for better sound insulation and if necessary, also with additional insulation. Usually, cladding is made of the Trimoterm Ac acoustic panel that is installed in the warm side of the facility. When the acoustic panel is also on the external side the installation in accordance with the limitations stated in on page 10 is permitted or it is suitable for partition walls.

Sound insulation of a panel with inner cladding made of the FTV 80 ac acoustic panel is Rw= 44 (-2;-8) dB when the perforation is on the side of noise source.

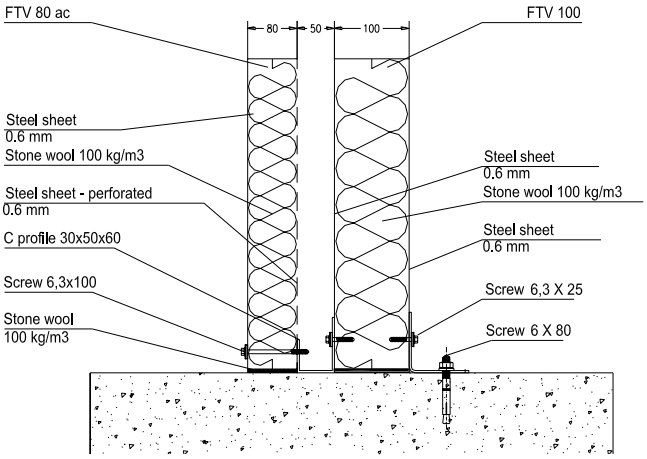


Rw= 54 (-4;-10) dB



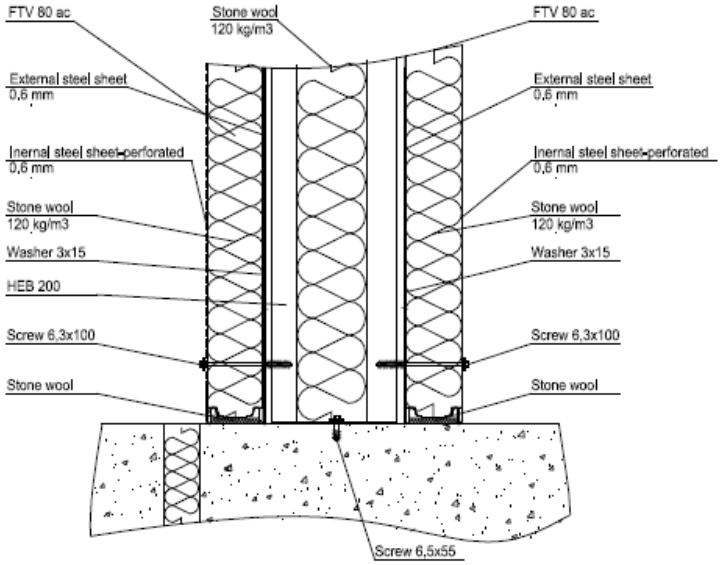
Sound insulation of a wall with inner cladding made of the FTV 80 ac acoustic panels is Rw= 54 (-3;-8) dB when the perforation is in the intermediate space.

sound source

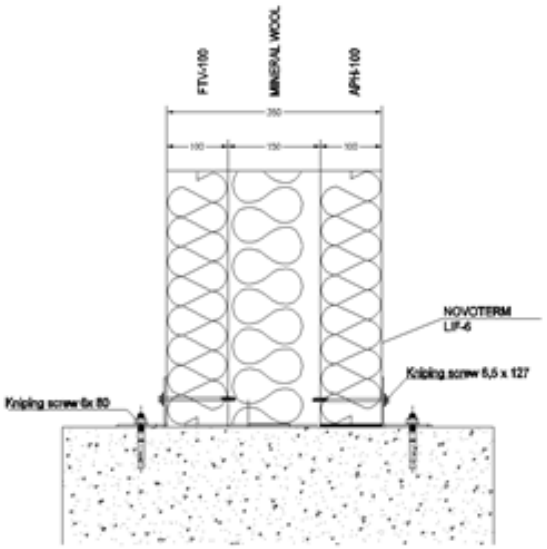


sound reception

If perforation is on the side of the sound recipient in both cases and air space and thermal insulation are between them sound insulation is Rw= 58 (-5;-12) dB



When a wall is made of Trimoterm FTV 100 panel, 150 mm spacing, filled with mineral wool and Trimoterm Ac Acoustic sandwich panel, sound insulation is Rw= 60 (-2;-7) dB



USE OF ACOUSTIC PANELS FOR THE PROTECTION IN INDUSTRY

Particularities of acoustic panels

Sound chambers are used for insulation of too loud machines and equipment or chambers in when adequate working conditions have to be provided (noise, temperature, humidity,...). Standard and acoustic (absorption) panels can be used for chamber cladding.
Chambers, whose cladding has been made of Trimoterm panels reduce noise by 15 to 30 dB; it depends on noise properties (low, high frequency) and the size and number of openings.

While planning attention has to be paid to the:

Sub-structure:

The substructure has to be performed to prevent spreading of any vibrations from machines or floor over it.

Type and quality of cladding:

To the greatest extent possible acoustic properties of cladding have to comply with the properties of noise that a machine emits. Special attention has to be paid to sealing, especially to joints with classical construction elements (the main beam, parapet, wall) and panels.

Ventilation and maintenance of temperature:

The majority of machines require air supply for cooling needed for their normal operation. A chamber has to be have openings that are big enough (with respect to the characteristics of the machines) that enable supply and outlet of cooling air. All openings have to be acoustically treated.
Special care is to be paid to ventilating if volatile or combustible substances are present in the process.

Other:

If it is only possible the machine has to be operated and supervised only from the outer shell. If supervision or maintenance is required in a chamber from time to time, special passages or paths for persons have to be arranged. The chamber shall have suitable dismantling surfaces that enable quick removal in case of failure or exchange of tools.

*- Data for sound chabers are summarised from standard SIST EN ISO 15667:2001.

Summary, warnings and recommendations

- Before making an offer exact data about the requirements (Rw, Rw´, α, the standards requirements comply with, etc.) have to be obtained. Rw is the measured value of the basic wall in a laboratory, Rw´ is the value measured in the facility.
- Data contained in the document are summaries of tests and experience of Trimo. Detailed information can be obtained from Trimo. A designer specialised in sound has to prepare documents for a concrete project.
- Tables of permissible distances for Trimoterm panels are not valid for Trimoterm AC acoustic panels. Because of perforation and thus weakening of sheet metal permissible distances are slightly shorter and have to be calculated for each project separately.

- Perforation RT Ø4 x 8 Apf = 22% is used for Trimoterm AC acoustic panels.

- Sound insulation of the Trimoterm AC panel in compliance with standard EN ISO 140-3 reaches 34 dB, sound absorption in compliance with standard EN 20354 reaches 8.3 dB.

- All Trimoterm panels are sound insulated. Sound insulation is measured in a laboratory, but only acoustic panels have absorption.

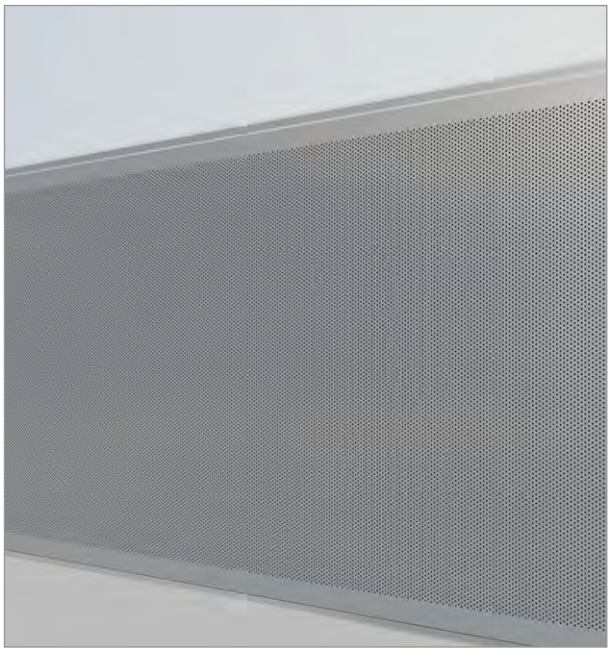
- When the sound insulation requirement is higher than 34 dB it is necessary to assemble a wall from several elements. The document presents the values measured on assembled walls. For an individual project a combination among the presented ones can be selected or a new one is prepared made of other materials. A control calculation of construction physics relating to inner conditions and location of a facility has to be prepared for assembled walls.

Literature

- EN 14509:2006,
- EN 15254-5:2009,
- Trimo Test Reports
- Devies,J.M., 2001; LIGHTWEIGHT SANDWICH CONSTRUCTION, Blackwell Science Ltd, London

Appendices

- Details – Acoustic system of assembled walls – AZ
- Details – Sound chamber - AN



Published by: Trimo d.o.o., EN / 02/2017