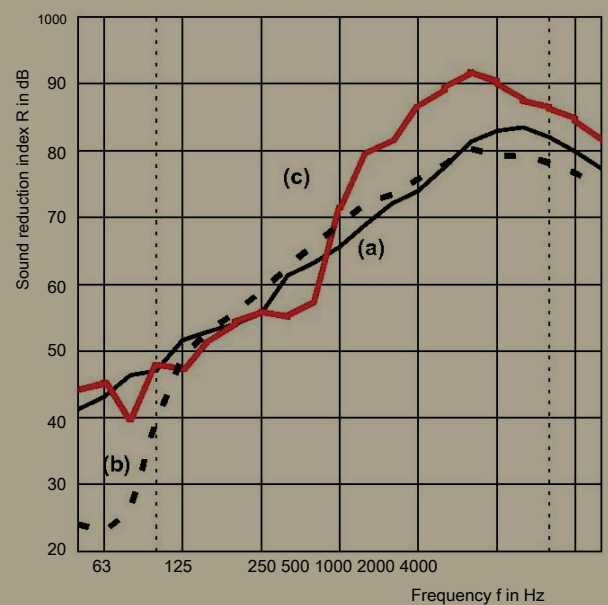




Schallschutz in timber - Basics and preliminary design



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imprint

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1 _ Preliminary note

V or 4109 "Sound insulation in buildings" with its established minimum requirements, the new forecasting method and the key for the timber member 33 "data for the mathematical proof of sound insulation (component catalog) - wood, easily and drywall" the light of the continually evolving DIN saw to develop a supplementary guide to the practice in timber construction: the editors and authors it at the time, with the information service timber magazine "basis and preliminary design sound insulation in timber".

Furthermore, for the first time its own sound insulation class system in timber for contractual agreement with builders was created that contains the recommended target levels for increased comfort and soundproofing. For this purpose, were taken into account, inter alia, the low frequencies while airborne and impact sound of Intermediate floor and detached partitions on spectrum adaptation terms. A system innovation that makes the timber with clients and builders still trustworthy and highlighting it under the construction.

The present work was created based on years of experience from practice and results from science. It was made possible through the collaboration of all major timber associations and by promoting German Environmental Foundation. The writing is the foundation of a series of sound insulation in wood construction. Other writings for verification of components in timber and sound insulation refurbishment to follow.

With the present document "Sound insulation in timber: fundamentals and preliminary design" a current contribution to the better handling of sound insulation in the planning and execution of wooden buildings was made. They will be further developed at regular intervals. Suggestions and ideas on this can wood be submitted to the consultation timber of the information service.

The reader or user is using this document, in addition to the sound insulation foundations, the concrete description of the constructive influences Advice for the installation, orientating Vorbemessungstabellen and a detailed component catalog, which considers own component testing also results from the accompanying research projects on flat roofs and insulation material from renewable raw materials, offered.

2 _ Basics

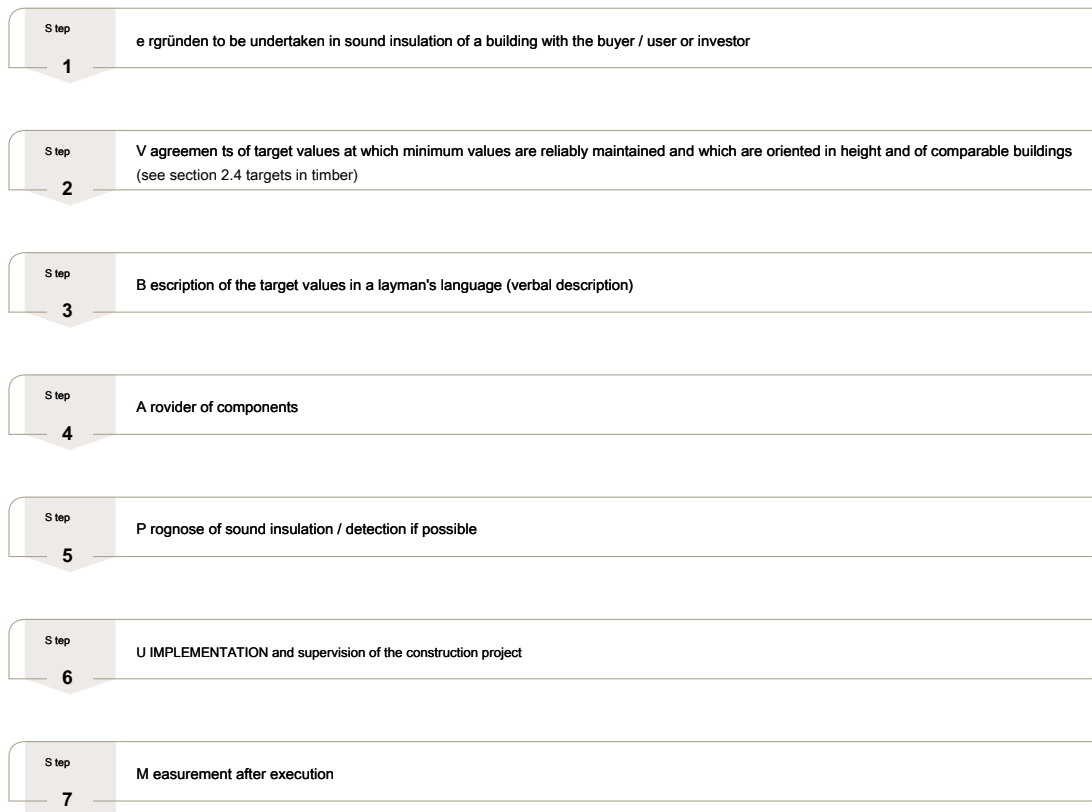
Is in this document by soundproofing the speech, the sound insulating effect of individual parts and components to the installation, however, meant no room acoustic influences.

2.1 _ detection of sound insulation - Procedure

Sound insulation building regulation minimum requirements are set as to all other structural areas. DIN 4109-1: 2018-01 "Sound insulation in buildings - Part 1: Minimum requirements" [1] defines the minimum standards for different building uses. By this standard, the long time applicable standard DIN 4109: replaced 1989-11, which also has implications in terms of future contractual terms, as the new norm is state of the art, while the former noise standard was considered obsolete. Basically, it is now necessary to clarify whether building regulation minimum standards can be agreed as a civil legally binding minimum. In any construction project is to be checked, which contractual arrangements can be made specifically regarding sound insulation or must be taken. In the basement housing the bandwidth of users is naturally very large. A uniform sound level of protection for all buildings would therefore not make sense. For a luxury apartment in a prime location of the minimum sound insulation is not the measure of things, here buyers can expect more. but the buyer or user request is not sufficiently explored regarding sound insulation very often. In many construction and purchase contracts are then to find clauses such as "sound insulation according to DIN 4109". This minimum sound insulation to protect the residents and to maintain a certain minimum confidentiality must always be maintained anyway. but there may be, depending on the users claim more extensive requirements.

expect. In this context, the term "Art Generally accepted rules" falls again and again the. These are rules that are scientifically proven to have been proven in practice and be on the long-term experience. Thus, minimum values are not necessarily equate with generally accepted engineering standards.

For sound insulation in multi-storey buildings it had been proven in the past to go at least in some areas beyond the minimum requirements of DIN 4109-1 [1] also, as this has been carried out in a variety of buildings and usually also the expectations of users and buyers corresponded. Crucial was there also that necessarily the planned construction was not decisive, but the same by all the buildings type reached levels that thus defines the state of the generally accepted rules of technology. To the sound protection to agree legally binding with a client in the usual multi-storey buildings, we recommend the following procedure:



In the flow chart it is clear that we should agree as fully as possible with the customer, the target values, if necessary, separately for housing units. the Supreme Court has to be the target level in a layman's language described by way of Supreme Court decisions. Specifying dB values or references to standards are donor unsuitable for an agreement with the order. After the agreement of targets so the buyer or customer is to visualize what to expect this in reality. Formulations for describing Schalldämmmaßen as "loud speech audible but not understandable" common. On the derivation of the descriptions and other features

the description, please refer to Appendix A of this document. For additional help, for example, the recommendations of Section 2.4 represent "targets for the timber". These target values, the subjective acoustic perceptions of the user are as a benchmark for the most important separation components. This requires consideration of spectrum adaptation values. thus it can be achieved between the sound insulation levels targeted improvement of the perceived sound insulation. Is desired by the client, increased sound insulation that exceeds the usual level, a consulting and description should be this "soundproofing debits" and clearly in the contract work possible

are committed. Here too the special characteristics are to be considered each design to ensure that the targets agreed with the proposed design can be achieved. This requires a fast building acoustics preliminary design is reasonable, as presented in chapter 4.

Summary:

Before forecasts should be made in sound insulation, the target value is agreed as precise as possible and without any room for interpretation. This includes the safe compliance with minimum standards. For a legally binding agreement also the explanation of the targets in a layman's language is essential. In the timber it is recommended to zoom to pull the target values described in Section 2.4 as an agreement basis. Moreover, to dispense with "promises" that suggest from the perspective of the client or user that a higher sound insulation is due to (z. B. "comfort apartment, the highest standards"). Such marketing can affect the due technical level, in particular leave if the location of the object and the requested price expected this.

2.2 _ minimum requirements for sound insulation

Minimum requirements - even if they are not expressly agreed - always adhered to. The building regulation minimum standard is the entrepreneur at least assured as implied, because the client can expect a building that meets the building regulations requirements. The DIN 4109-1 [1] shall stipulate the values. In the scope of the standard is to read as follows:

"Based on a basic sound level of $L_{AF,eq} = 25$ dB for such rooms requiring protection in. As apartments, residences, hotels and hospitals following protection goals are achieved:

- health,
- Confidentiality in normal speech,
- Protection from unreasonable harassment.

It can not be expected that noise will not or perceived from the outside or from adjacent rooms when not harassing, even if the specified in this standard are met. "

It thus becomes clear that it is in such demand values are minimum values that ensure unrestricted not rest in your own home. In the context of building regulations building acoustic requirements are imposed on the following types of buildings:

- Multi-family dwellings
- Office building
- Mixed-use building
- Terraced and semi-detached houses
- Hotels and lodging facilities
- Hospitals and sanatoriums
- Schools and similar facilities

It is also important, the basis of protection against external noise for all types of buildings that serve the stay of people. In DIN 4109-1 [1] to protect against external noise is devoted a separate section. For multi-storey buildings, the minimum values for the main components are presented in housing in Table 1 in part.

For the construction of buildings with floor structures in accordance with DIN 4109-33 [1] (wood ceilings) In accordance with DIN 4109-1: 2018

a lower minimum requirement value to the impact sound. It should be emphasized that the exemption is temporary. Here the impact noise, the minimum value is opened up, this is likely to mean for the explanation in Section 2.1 for the construction practice in the cases we nigsten a relief. The list in Table 1 is not full time, but is for the most important components partition wall and separating floor not under- or surpassable minimum values. Section 2.4

is again shown as minimum standards can be described verbally. In this context it is pointed out again: Minimum values represent the building regulation Minium to peaceful coexistence and health imaging. That which is usually achieved with a construction, may already be above that minimum level, becoming the benchmark of what to expect a builder or user legitimately. Under no circumstances may the be

Table 1 | excerpts minimum values for sound insulation of DIN 4109-1 [1] for housing

1	2	3
Component / transmission:	DIN 4109-1: 2018 minimum values	Source in DIN 4109-1: 2018
partitions		
storey buildings		
1	party wall	$R'_{w} \geq 53 \text{ dB}$ Table 2 line 13, column 3
Terraced and semi-detached houses		
2	House partitions (erdberührt or not) to the lowest floor lounges ²⁾	$R'_{w} \geq 59 \text{ dB}$ Table 3 row 4, column 3
3	House partitions to common areas with at least one floor including ²⁾	$R'_{w} \geq 62 \text{ dB}$ Table 3 line 5, column 3
Separating ceilings and horizontal components		
4	Flat separating ceiling airborne sound	$R'_{w} \geq 54 \text{ dB}$ Table 2 row 2, column 3
5	Apartment compartment floor impact sound	$L'_{n,w} \leq 50 \text{ dB}$ Table 2 row 2, column 4
6	Apartment compartment floor impact sound level for ceiling according to DIN 4109-33: 2016	$L'_{n,w} \leq 53 \text{ dB}$ ¹⁾ Table 2 row 2, column 4, footnote b
7	Roof terraces and loggias with underlying residential premises	$L'_{n,w} \leq 50 \text{ dB}$ Table 2, row 7, column 4
8th	balconies	$L'_{n,w} \leq 58 \text{ dB}$ Table 2, row 8.1, Column 4
9	Flight of stairs and stair landing	$L'_{n,w} \leq 53 \text{ dB}$ Table 2, line 12, column 4

¹⁾ Special arrangements for ceiling structures, the 4109-33 DIN: attributable 2016th

²⁾ for illustration see Section 4.3.1

Currently is not available in all states, the DIN 4109-1: 2018, refers to in Table 1, building inspection introduced. The state of implementation is very heterogeneous. Partly DIN 4109: 1989 / A1 4109-1 with change DIN: 2001 or DIN 4109-1: 2016 Change E DIN 4109-1 / A1: 2017-01. This is particularly important for timber construction, since the reduced footfall demand value for ceiling according to DIN 4109-33: 2016 Row 6 in Table 1 in the version of DIN 4109-1: 2018 and for ceilings in two-family homes in version E DIN 4109-1 / A1: is 2017-01. Therefore, the regulations must be observed in the respective province. It is intended that the DIN 4109-1: 2018 to include in the new version of MVV TB in 2019, is thus to be expected during the year of 2019.

are build end level below the minimum standard. Critical situations may arise in the planning if this minimum standard eg. B. can not be achieved at a renovation, with a planned execution. In such cases it is advisable to go for planners, if necessary the design to achieve the minimum standards. Undercutting is allowed for a fundamental reorganization not in every case. In other cases, as part of renovations a precise legal analysis is required. Possibly. Here again the level at the time of building creation. For these reasons, this should be regulated by contract specific.

Note:

If the targets are achieved above the minimum standard by certain characteristics such. As the mass or properties of floor coverings, so we recommend this in the agreement as necessary to represent. Compliance with the minimum requirements by easily replaceable component layers in the structure is not recommended. If during the use of the exchange of these layers is to ensure that the valid construction minimum value is reached and after the exchange. The standard series DIN 4109 also explicitly states that minimum requirements without soft elastic floor coverings such. B. carpeting must be achieved.

Summary:

The minimum requirements for sound insulation for various types of buildings are shown in DIN 4109-1 [1]. Make sure there are no people coming by noise in the building for damage and a minimum level is reached of confidentiality.

These standards identify a non unterschreitbare minimum. but they do not necessarily show the required "Bausoll" because this can be in many cases above the minimum standard depending on building type. Usually, requirements are imposed only on vulnerable spaces between foreign residence and use units (also two-family house or "family house with granny flat"). you want to retain a single-family building acoustic evaluation, this is to be regulated in the construction contract. For the protection against external noise is to be noted that the minimum requirements are also placed on single-family homes, without this being separately agreed in the construction contract.

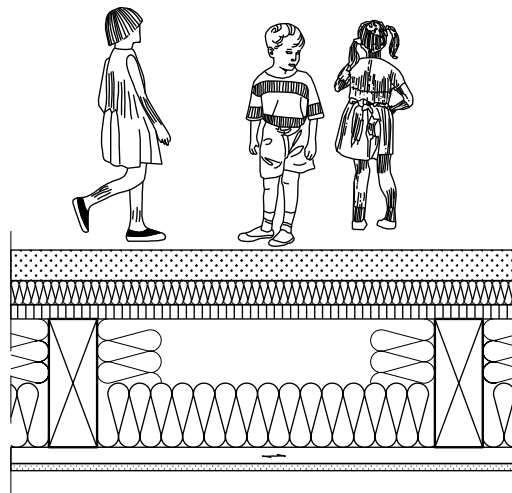
2.3 _ considering low frequencies

In building practice in terms of low-frequency sound transmission inside buildings and in the perception of traffic noise show with increasing frequency complaints. The sound insulation decreases with frequency. That is, all conventional in construction practice constructions exhibit an increased passage of sound at low frequencies.

Meant frequencies are typically below 100 Hz. Particularly high levels of interference while having impact sound transmission. It comes when excited by running or, for example, the games of children on the partition ceilings to a suggestion of the sound energy which transmits significant portions under the above 100 Hz. In Fig. 2.2 the unrated run is plotted over the frequency level schematic. The graph shows that a majority of the sound energy is transmitted in the reception space below 100 Hz. Here, the levels are partially 40 dB higher than the frequencies above 100 Hz.

At frequencies below 100 Hz, the levels are perceived by users to be disturbing, if no appropriate consideration is made in the construction of partition members.

The building regulations detection method always aim in the standard detection methods depend on the frequency range of 100 Hz to 3150 Hz in footfall. So the critical frequency ranges remain in the measurement of components under 100 Hz disregarded, it creates a "deaf spot".



A bb. 2.1

Excitation of low frequencies while running

In Fig. 2.2, the usual evaluation range for the impact sound is highlighted in red. This range is determined by $L_{n,w}$ or $L'_{n,w}$ characterized.

Sets one component only on the basis of $L_{n,w}$ or $L'_{n,w}$

from, one leaves the critical frequency ranges to chance as between $L_{n,w}$ and the actual levels of interference and no connection is present. To these "spot deaf" to compensate spectrum adaptation terms have been introduced. In the case of the impact noise is a suitable criterion for evaluating the actual interference effect when users of the spectrum adjustment value $C_{1, 50-2500}$ Recourse (blue region in). By adding to $L_{n,w}$ thus finds a correction to the frequency band of 50 Hz to 2500 Hertz, and the critical areas of 50 Hz to 100 Hz are mapped. Wood beams and hardwood ceilings can achieve very good results with standard construction methods of construction in the low frequency range. Requirement is that the range adjustment value $C_{1, 50-2500}$ (Spectrum adaptation term impact for the frequency band of 50 Hz - 2500 Hz) input in the analysis finds.

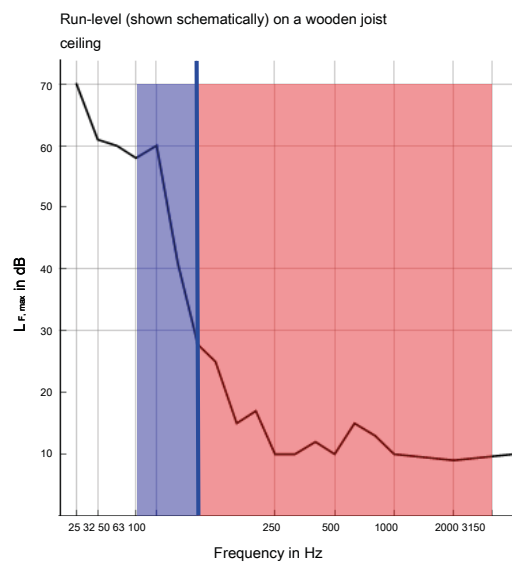


Fig. 2.2

Schematic course of the run level in ceiling structures of wood.

in red: Measurement and evaluation range of the standard impact sound measurement

in blue: extension to 50 Hz for the spectrum adaptation term $C_{1, 50-2500}$

blue line: frequency limit of the "norm" -
Be trachtungsweise

Note:

in test certificates or parts catalogs, the values of C are often stated or C without further mention of the frequency range. Caution is warranted. It must be ensured that it is the spectrum adjustment value for the desired frequency band. Therefore, in case of impact noise on the index "I, 50-2500" respect. There are spectrum adjustment values for many frequency bands and types of excitation, so the full index is to be considered. For airborne sound insulation, the analogy is not easily transferable. This shows that a transmission in the low frequency range does not exhibit the same levels of interference as in the impact sound. Exceptions are detached partitions in section

Summary:

If the actual arriving at the user disturbance should be considered in the impact sound transmission, then the spectrum adaptation term $C_{I, 50-2500}$ in addition to the rated standard impact sound level $L_{n,w}$ consulted. For the timber design, these are given in Chapters 4 and 6, for the constructions in which there is a need of consideration. The application of the $C_{I, 50-2500}$ has not been required in building regulations detection methods in Germany. If this applied and observed with the results shown in 2.4 targets so connected for the residents and the building a significant additional benefit.

are 2.4 and 4.3 times more taken up, and Ver Kehr noise noise.

Spectrum adaptation terms:

Basically, a component is in terms of its sound-deadening effect are evaluated against other noise sources using spectrum adaptation terms. The excitation in the measurement by pink noise or the tapping machine does not match over all

Frequencies of the real excitation by traffic noise, or a walking person. Therefore, corrections are required to map the frequency ranges that cause the disorder in practice.

description		frequency range
Impact sound:		
C_I	I = Impact; Description of the consideration of the deviation of the standard hammer mill from Geher	100 Hz - 3150 Hz
$C_{I, 50-2500}$	such as C_I . However, inclusion of the frequencies of 50 Hz to 2500 Hz related to disturbance by walking perceptually detectable	50 Hz - 2500 Hz
Airborne sound:		
$C_{50-5000}$	Picture of residential noise; Effectiveness of the components with respect to conventional residential noise taking into account the low frequencies	50 Hz - 5000 Hz
$C_{tr, 50-5000}$	tr = Traffic; Adjusting the sound insulation of traffic noise; Assessing the effectiveness of a component against traffic noise noise taking into account the low frequencies.	50 Hz - 5000 Hz

2.4 _ targets in timber

For users and planners, it is imperative target values are mapped to agree that coordinated with the construction and with conventional designs. Therefore in the following recommendations for targets that meet these specifications. In particular, the low-frequency sound transmission is given to the impact sound attention. The enhanced low-frequency sound transmission, however, is not only a challenge

d it wood construction, but to all construction in building acoustics.

The large number of acoustic parameters in wooden components can be more easier to bring same improvements. Therefore geson-made targets are for wooden structures, in cooperation with the customer to agree. In Table 2 recommendations are stored for building acoustic targets, which can be implemented in building practice.

Table 2 | Normative request and recommendation for important targets

1	Sound level of protection		
	2	3	4
Component / transmission:	BASE DIN 4109-1: 2018	BASE +	COMFORT
1 party wall	$R'_{w} \geq 53 \text{ dB}$	$R'_{w} \geq 56 \text{ dB}$	$R'_{w} \geq 59 \text{ dB}$
2 Townhouse partition	$R'_{w} \geq 62 \text{ dB}$	$R'_{w} \geq 62 \text{ dB } R_{w*} + C_{1,50-5000} \geq 62 \text{ dB } ^{1) 5)}$	$R'_{w} \geq 67 \text{ dB } R_{w*} + C_{1,50-5000} \geq 65 \text{ dB } ^{1) 5)}$
3 Flat separating ceiling	$R'_{w} \geq 54 \text{ dB}$	$R'_{w} \geq 57 \text{ dB}$	$R'_{w} \geq 60 \text{ dB}$
4 Flat separating ceiling impact sound	$L'_{n,w} \leq 53 \text{ dB } ^{3)}$	$L'_{n,w} \leq 50 \text{ dB } L_{n,w*} + C_{1,50-2500} \leq 50 \text{ dB } ^{2)}$	$L'_{n,w} \leq 46 \text{ dB } L_{n,w*} + C_{1,50-2500} \leq 47 \text{ dB } ^{2)}$
5 Roof terraces and loggias with underlying residential premises	$L'_{n,w} \leq 50 \text{ dB}$	$L'_{n,w} \leq 50 \text{ dB}$	$L'_{n,w} \leq 46 \text{ dB}$
6 Blankets under arcades (in all sound propagation directions)	$L'_{n,w} \leq 53 \text{ dB}$	$L'_{n,w} \leq 50 \text{ dB}$	$L'_{n,w} \leq 46 \text{ dB}$
7 Flight of stairs and stair landing	$L'_{n,w} \leq 53 \text{ dB}$	$L'_{n,w} \leq 50 \text{ dB}$	$L'_{n,w} \leq 46 \text{ dB}$
8th External noise by noise area and requirements of DIN 4109	Requirements of DIN 4109 incl. Consideration $C_{tr, 50-5000}$ for the opaque component ⁴⁾		
9 Other components	DIN 4109-1: 2018	DIN 4109-1: 2018	DIN 4109-5: 2019 ⁵⁾

¹⁾ Additional air sound request value only to the component without flanks

²⁾ additional impact sound request value only to the component without flanks

³⁾ Special arrangements for ceiling structures, the 4109-33 DIN: attributable to 2016, otherwise $L'_{n,w} \leq 50 \text{ dB}$

⁴⁾ Window area shares over 30% special consideration, pure component requirement

⁵⁾ Requirement of the double-shell wall, both walls

⁶⁾ after each amended or E-DIN 4109-5: 2018

The individual steps can be written be as follows:

Level: BASIC

If the level BASIS agreed, the building regulations minimum values shown in section 2.2 are met. For an effective agreement, however, must be clearly communicated and documented that only the minimum sound protection is ensured.

This level is in many areas below what is attainable by conventional constructions, and can only be agreed if the purchaser, user or investor will be made clearly understood that only minimum values are provided and what they mean (verbal description of the level).

Verbal description of the class BASIS:

Loud speech:	understandable
Language in the raised speech:	generally understandable
Language in normal speech:	generally not understandable, still audible
walking noises:	generally disturbing

Level: BASIC +:

When using this class, the protection level is above the stated minimum requirements of level BASIS. Following these values can be assumed that an average standard. The consideration of low **frequencies in the impact sound by the $C_{1, 50-2500}$ leads to a significant** improvement of the acoustic levels. This class should be applied if no special arrangements are made and a common level should be achieved.

This class is achieved through cost-effective Kon constructions.

Consideration of the spectrum adaptation terms leads to an acoustically correct evaluation of the usual potential for disruption.

Verbal description of the class BASE +:

Loud speech:	generally understandable
Language in the raised speech:	generally not understandable
Language in normal speech:	not be understood
walking noises:	not interfere ¹⁾

¹⁾ This is accomplished by taking into account the $C_{1, 50-2500}$ reached

Level COMFORT:

In this category may be assumed that increased soundproofing. For the footfall beyond and the sound transmission in series and double houses the spectrum adjustment values for low frequencies greater appreciation than in the class BASIS +. In contrast to the established processes by building the range adjustment values are applied only to the component without further edge considerations. Opposite the class BASIS and BASE + is to expect a further, clearly perceptible improvement.

Specific agreement:

The classes shown must not be agreed compulsorily as a whole but can be used for individual apartments or parts of buildings. Here the penthouse in class COMFORT example, would be mapped and the entire building in BASE +. The same applies to individual components. It can from the classes BASE + and COMFORT the individual components are assigned individually with the requirements if they are above the level BASIS. However, the verbal description "component as" must then be adjusted. For practice, it is recommended to describe the class as a whole to agree and.

The verification and implementation are presented in Chapters 4 and 6. FIG. It should be noted that the building inspectorate the detection method of DIN 4109-2 for all three stages: 2018 [1] are applicable.

The class COMFORT can be achieved through optimized and tuned frequency compatible components. But it is also to be expected höher construction costs. This he put it a considerably increased acoustically-Nazi comfort.

Note to other construction methods:

Since it is in the enhanced low-frequency sound transmission to a fundamental physical phenomenon, the application is not limited these classes on the timber. It should be emphasized clearly here that this level declared agreement are applicable to all methods of construction (including material design).

Verbal description of the class COMFORT:

Loud speech:	generally not understandable
Language in the raised speech:	not be understood
Language in normal speech:	inaudible
walking noises:	not bothersome or barely perceptible ¹⁾

¹⁾ This is accomplished by taking into account the $C_{1,0-2500}$ reached. It is assumed that the A-level is below 33 dB (A) and is thus perceived only rarely.

Summary:

For the most important components required values can be agreed as target values for timber construction. The classes described can be implemented cost-effectively with acoustically optimized designs in wood construction. By special attention to the low-frequency transmission, in particular the impact noise, can be realized when soundproofing a noticeable improvement to the user.

2.5 _ Technical basics of building

acoustics

The basics of building acoustics provide an understanding of the acoustical transfer mechanisms. For single, flat components can these summarize the influence of grammage (mass law) and the flexural strength (bending wave resonance or coincidence frequency and plate natural frequencies) of the component. For multi-layered devices, the resonances between the individual shells (mass-spring-mass resonances) are also relevant. This can occur, for example as a double wall, screed or ceilings resonance. Its effect on the sound depends largely on the attenuation in the resonance frequency can be increased by suitable insulating materials between the component layers. The insulation reduces the transmission of sound by its sound absorption, which is often characterized through the longitudinal flow resistance of the products. The transmission is also on the type of sound excitation, ie the airborne or structure-borne or impact sound stimulus dependent.

Subsequently, these variables are introduced briefly by examples from the timber to enable an assessment of the structural influences on the sound insulation of components, such as occurs in chapter 3. Here, the explanations are limited in favor of clarity on the practical aspects. For further explanation, see building acoustics, for example [2], [3].

2.5.1 _ mass law

The resistance (the impedance) of a component relative to the excitation by a sound pressure wave increases with increasing mass of component (inertia). For bending soft, single-shell components from it can be a link between the sound reduction index R and the mass per unit area m' . Derived, as was done for the first time by Berger [4].

$$R \approx 20 \lg (f m') - 47 \text{ dB} \quad (1)$$

f ... frequency in Hz

m' ... basis weight in kg / m

This so-called Berger's mass law can be both a function of frequency f represent, as well as the weighted sound reduction measure R_w as a single value. This purpose, a composition diagram (see Fig. 2.3), which was obtained empirically from measured data of different materials and thicknesses plate or member [2].

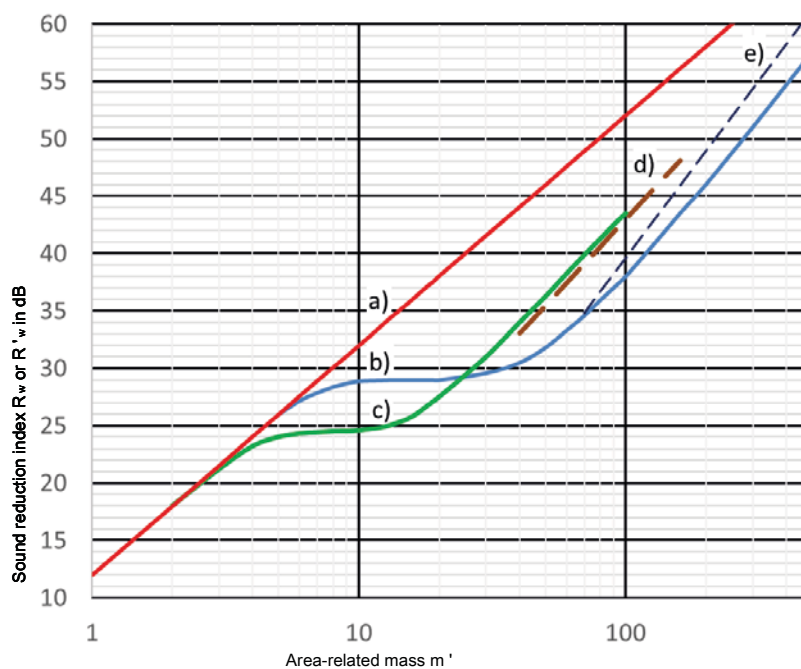
In determining the airborne sound insulation index R_w based on the mass per unit area m' is between the different materials - concrete, masonry, glass, and wood and wood materials or sheets - distinguished. While flexurally soft sheets such as thin sheets or rubber sheets with doubling of m' an increase in the R_w show at 6 dB, a plateau is formed from at bie ge stiffer plates, on which the sound hardly increases even with increasing mass. This is because with

increasing plate thickness in addition to the mass per unit area also increases the flexural rigidity of the plate and limiting the impact on the soundproofing. In addition to the mass of the part, the influence of the bending stiffness is therefore to be considered in common building materials plate.

used for area-related masses above the plateau region (see Fig. 2.3, e). Unlike the original mass curve (see Fig. 2.3, b) these data were obtained in the test without side paths and converted to the expected impact sound reverberation time in the construction situation.

The prognosis of the evaluated sound transmission by means of a mass curve has been incorporated in the detection method of DIN 4109 [1] for solid components (masonry, concrete). There is the relationship

The mass dependence can be also for the impact sound transmission single-shell solid ceilings show and is used in DIN 4109 for the impact sound detection of reinforced concrete slabs.



A bb. 2.3

Sound reduction index
single-shell components in
dependence of the mass per unit
area m'

a) ideal flexurally soft components according to [2], [4]

b) gypsum, concrete, bricks, R'_{w} according to [2]

c) wood-based panels, R'_{w} according to [2]

d) Solid wood elements, R_w according to [7], [5]

e) concrete, lime sandstone, bricks,

R_w reverberation time corrected according to [1]

2.5.2 _ coincidence frequency

Components and plate materials form when excited by sound pressure waves due to their bending stiffness or bending vibrations **bending waves in the plate plane of which has a wavelength λ_B as well as the airborne sound wave λ_L is frequency dependent. These** bending waves distinction is made between the forced bending wave corresponding in wavelength of the "embossed" air sound wave, and the free bending wave whose wavelength is due to the flexural rigidity of the plate. The sound input and -abstrahlung on single-layer components is particularly large when the (projected) **wavelength of the airborne sound λ_L**

λ_L the wavelength of a free bending wave matches (see Fig. 2.4). The sound insulation of the device is correspondingly low in the range of coincidence frequency, the frequency-dependent course of showing a significant drop (see Fig. 2.6).

The coincidence condition is fulfilled for all frequencies that are **greater than the coincidence frequency limit f_c , which can be** calculated according to equation (2) for the grazing incidence of sound.

$$f_c = \frac{c_0^2}{2 \pi} \sqrt{\frac{m'}{B'}} \quad \text{With:} \quad B' = E \frac{t^3}{12 (1 - \mu^2)} \quad (2)$$

c_0 ... sound velocity (343 m / s at 20 ° C)

m' ... basis weight in kg / m

B' ... bending stiffness in N m

E ... Young's modulus in N / m

t ... Plate thickness in m

μ ... Poisson's ratio

to (2) by combining the material parameters in a material constant K can be greatly simplified to:

$$f_c = \frac{K}{t} \quad (3)$$

K ... constant of the material according to Table 3 in Hz m

t ... plate thickness in m

Fig. 2.4
Excitation and emission
of bending waves

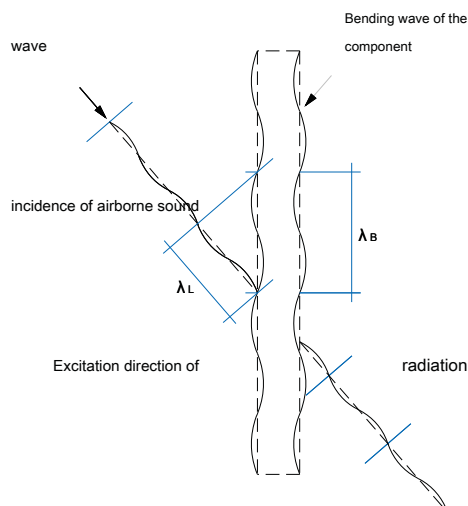


Table 3 | coincidence factor K and coincidence frequencies f_c

some materials in the timber [10] supplemented [6], [11]

building material	K in Hz	thickness t	Coincidence frequency f_c
Plasterboard	30 (25 - 35)	12.5 mm	2500 Hz ¹⁾
		15 mm	2000 Hz ¹⁾
		18 mm	1600 Hz ¹⁾
		25 mm	1250 Hz ¹⁾
Gypsum fiber boards	35 (32 - 38)	10 mm	3150 Hz ¹⁾
		15 mm	2500 Hz ¹⁾
		18 mm	2000 Hz
chipboard	30 (23 - 36)	10 mm	3150 Hz ¹⁾
		19 mm	1600 Hz ¹⁾
OSB	25 (20 - 30)	12 mm	2000 Hz ¹⁾
		15 mm	1600 Hz ¹⁾
cement screed	16 - 17	50 mm	315-400 Hz
reinforced concrete	16 - 17	160 mm	100-125 Hz
brick	16 - 17	115 mm	200-315 Hz

¹⁾ Measured value of the coincidence slump (third octave) [6], [11]

2.5.3 _ plates eigenfrequency

At finite dimensions, the component reflected at the component edge bending waves to standing waves, which are referred to as eigenmodes and the associated frequencies as natural frequencies of the component overlap. The natural frequencies of a plate or a single-component with articulated stored plate edge may according to equation (4) from the bending stiffness B 'grammage m 'and dimensions l_x and l_y be -

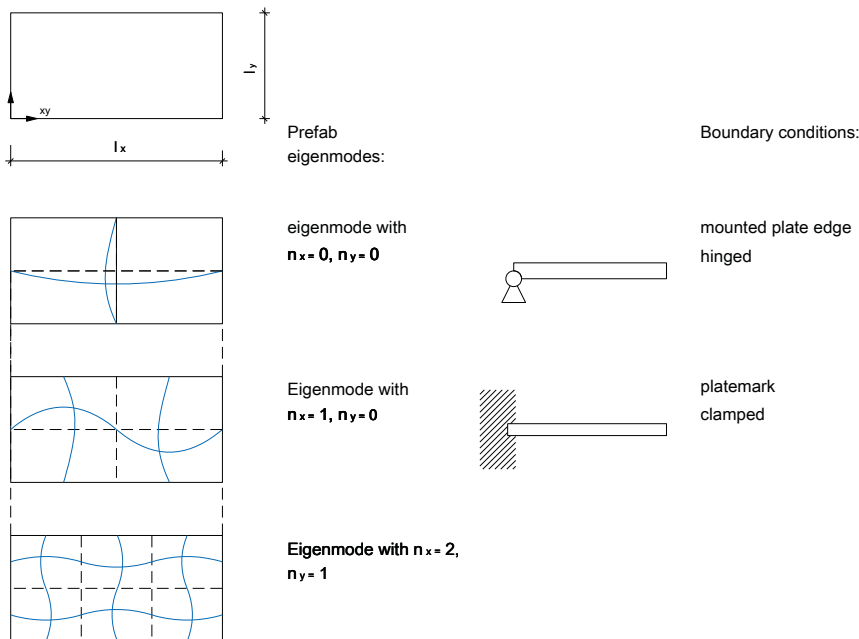
be counted. The ordinal numbers n_x and

n_y specify the number of eigenmodes maxima in the x and y directions.

Is the coincidence frequency f_c known, the simplified shape can be used according to equation (5). For wall sheathing, which are secured mechanically to the stands, the expected resonant frequency is located between the calculation for articulated plates and clamped edges according to equation (6).

Fig. 2.5

Plates eigenmodes and constraint



$$f_{n_x, n_y} = \frac{\pi}{2} \sqrt{\frac{B'}{m}} \sqrt{\left(\frac{n_x}{l_x} \right)^2 + \left(\frac{n_y}{l_y} \right)^2} \quad \text{With: } B' = E \frac{t^3}{12(1-\mu^2)} \quad (4)$$

c_0 ... sound velocity (343 m / s at 20 ° C)

f_c ... coincidence frequency of (2)

m' ... basis weight in kg / m

n_x, n_y ... order $n = 0, 1, 2, 3$

l_x, l_y ... Plate Dimensions in m ($l_x \rightarrow l_y$)

B' ... N m in bending stiffness

E ... Young's modulus in N / m

t ... Plate thickness in m μ Poisson's

ratio ...

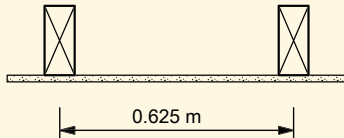
articulated manner:

$$f_{0,0} = \frac{c_0}{4} \sqrt{\frac{B'}{m}} \sqrt{\left(\frac{1}{l_x} \right)^2 + \left(\frac{1}{l_y} \right)^2} \quad (5)$$

clamped:

$$f_{0,0} = \frac{c_0}{4} \sqrt{\frac{B'}{m}} \sqrt{5.14 + 3.13 \left(\frac{l_x}{l_y} \right)^2 + 5.14 \left(\frac{l_y}{l_x} \right)^2} \quad (6)$$

Application example: Single-skin component



Design:

Wall sheathing screwed on wooden stand, center distance $e = 0.625$ m

Planking: 10 mm gypsum fiber board, $m' \approx 12 \text{ kg/m}^2$

Dimensions: 2.65 m x 0.625 m

Sound reduction index:

$R_w \approx 30 \text{ dB}$ (as shown in Fig. 2.3 for $m' \approx 12 \text{ kg/m}^2$)

$R_w \approx 32 \text{ dB}$ (measurement result, fig. 2.6)

Coincidence frequency:

$$f_c = \frac{K}{t} = \frac{35000}{11.1} \text{ Hz} = 3150 \text{ Hz}$$

1. plate natural frequency (plate edges clamped):

$$f_{0,0} = \frac{c_0}{4 l_x^2} \sqrt{5.14 + 3.13 \left(\frac{l_x}{l_y} \right)^2 + 5.14 \left(\frac{l_x}{l_y} \right)^4}$$

$$f_{0,0} = \frac{\left(\frac{343 \text{ m/s}}{4 \cdot 2.65 \text{ m}} \right)^2}{3500 \text{ Hz}} \sqrt{5.14 + 3.13 \left(\frac{2.65 \text{ m}}{0.625 \text{ m}} \right)^2 + 5.14 \left(\frac{2.65 \text{ m}}{0.625 \text{ m}} \right)^4} = 50 \text{ Hz}$$

Sound insulation of single-component (summary):

- In the lower frequency range, the sound insulation of the component is determined by the position of the plate eigenfrequencies with their respective dips in the sound insulation.
- Above this range, the Berger's mass law shows, according to equation (1) with a frequency-dependent pitch of the sound attenuation of approximately 6 dB per octave. By doubling the basis weight of the curve by 6 dB is displaced parallel.
- The location of the coincidence range depends on the bending stiffness of the component. With bendable plates

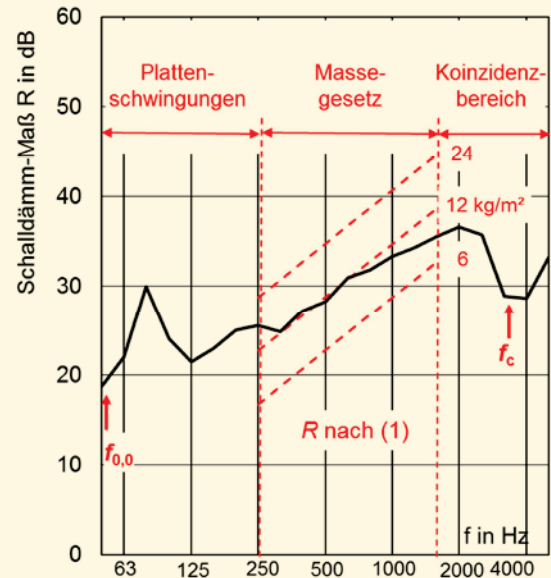


Fig. 2.6

Measurement and forecast results

(As in the illustrated example), the coincidence frequency is in the upper frequency range and affects the sound insulation, the less the lower the bending stiffness. The ideal situation is when the break is completely above the measuring range. Therefore, in a multi-layered planking version with (pliable) thin plates is cheaper than the single-layer version with a correspondingly thicker plate. For rigid components, it is, however, cheaper to move the coincidence frequency to the lowest possible frequencies. If the coincidence frequency between these two ideal cases, results in an increase in mass by thicker components only a slight improvement of sound insulation (plateau region in Fig. 2.3).

2.5.4 _ mass-spring-mass resonance

As the previous sections show, the acoustic single-shell components can primarily be improved by increasing the basis weight. However, single-separation components with high grammage contradict the prefabrication approach of contemporary wood and lightweight construction. but significantly higher sound insulation at low masses can be achieved, the component layers are decoupled by soft elastic interlayers also with multi-layered structures. The sound-technical behavior of a two-shell structure can be mass-spring-mass system according to describe Wintergerst [8] with the. Two Bowls with the basis weights

the sound insulation. resonant frequencies

$f_0 > 100 \text{ Hz}$ should be avoided if possible. Good improvements are for $f_0 < 50 \text{ Hz}$ achieved. The spring may be formed by pressure-resistant insulating boards (impact sound insulation or thermal insulation composite systems). The dynamic stiffness s' these plates is given as a material parameter by the manufacturer. However, a between the component layers of a closed layer of air which is compressed by the swinging plates has spring properties, the dynamic stiffness s' thick layer over the air d is writable.

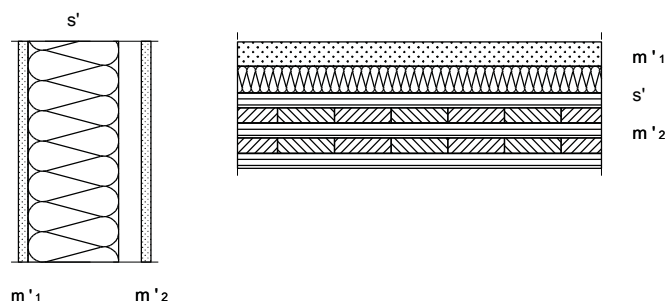
Fig. 2.7

Double shell construction as a mass-spring-mass system.

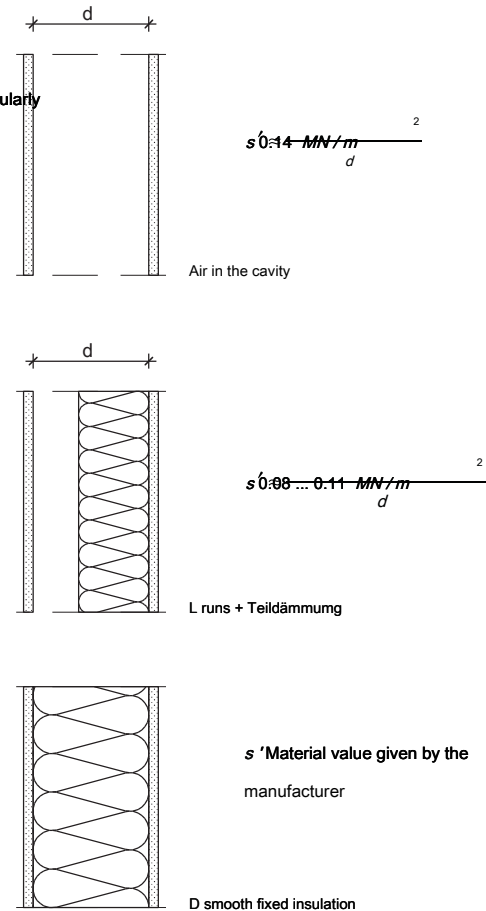
Links: bivalve Wandkonstruktion,
Right: Mas-intensive wood ceiling
with floating floor,

m'_1 and m'_2 are coupled together via a spring having a dynamic stiffness s . the mass-spring-mass system is excited to oscillate by air or impact noise excitation, which at the resonant frequency f_0 particularly large are (is correspondingly small there the sound). Above the resonance frequency f_0 a significant improvement over the same weight, single-component is obtained. That is, the smaller f_0 is, the greater the improvement

Bottom: calculation of the mass-spring-mass resonance f_0 according to [8]



dynamic stiffness s' the intermediate layer



If the soft elastic intermediate layer designed as a pressure-resistant insulating board, which is calculated according to equation (7) to the dynamic stiffness s' in MN / m³.

$$f_0 = 160 \sqrt{s' \left(\frac{1}{m_1'} + \frac{1}{m_2'} \right)} \quad (7)$$

If the soft elastic intermediate layer designed as a static air layer whose rigidity is used as a function of the air layer thickness d . Equation (8) is in accordance with DIN 4109 is a partial insulation with a porous insulating material ($5 \text{ kPa s / m} \leq r \leq 50 \text{ kPa s / m}^2$) ahead.

$$f_0 = 160 \sqrt{\frac{0.08}{d} \left(\frac{1}{m_1'} + \frac{1}{m_2'} \right)} \quad (8th)$$

s' ... dynamic stiffness in MN / m³

m_1' ... grammage of the
the first component layer in kg / m

m_2' ... grammage of the
second device layer in kg / m

d ... air layer thickness (separation of
Device layers) in m

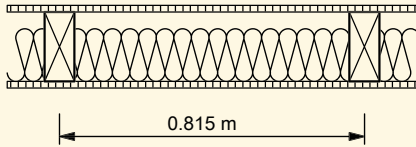
2.5.5 _ decoupling

The improvement of the bivalve component above the resonant frequency is significantly reduced by a coupling of the shells by means of a compound (rack, beam, etc.). The rigid connection acts as a sound technical short circuit, which can be avoided by a structural decoupling of the component layers. Suspended ceilings are used for this purpose with elastic suspenders or spring rails meet at wooden beams. For walls, this can by separate stand detached linings or resilient intermediate layers are obtained (see section 3.1.1.1).

2.5.6 _ damping / sound absorption

The attenuation of the component has a significant influence on the resonant peak of the component vibrations and thus to the collapse of sound insulation in this area. During the attenuation of the construction (column, beam, skins, etc.) relatively low, carries an open-pored insulation material in the cavity very significantly to reduce the slump at. The damping takes place both by friction between the individual insulation fibers, and between the insulation structure and the sound pressure wave. To ensure this, the insulation of the invading alternating pressure wave should provide a suitable resistance. This is described by the longitudinal flow resistance r , which should be in accordance with DIN 4109 in the range $5 \text{ kPa s / m} \leq r \leq 50 \text{ kPa s / m}^2$, in order to ensure a good damping. As insulating material, for example, mineral fiber, wood fiber, Jutefaser-, Hanffaser-, flax, cellulose, Schafwoll- or cotton insulation materials, are also used open-cell foam plastics in the specified area of the longitudinal flow resistance. Not suitable are closed-pore foam plastics (polystyrene plates, PU-foam).

Application example: A double-wall component



Wall structure: 15 mm OSB board, $m' = 9.0 \text{ kg/m}^2$ 160 mm wooden stand, center distance $e = 0.815 \text{ m}$ 15 mm OSB board, $m' = 9.0 \text{ kg/m}^2$

Coincidence frequency:

$$f_c = \frac{K}{t} = \frac{250}{0.15} \text{ m} = 1700 \text{ Hz}$$

M Leaving resonant spring-mass

$$f_0 = 160 \sqrt{\frac{0.08}{d} \left(\frac{1}{m'_1} + \frac{1}{m'_2} \right)}$$

$$f_0 = 160 \sqrt{\frac{0.08}{0.16 \text{ m}} \left(\frac{1}{\frac{9.0 \text{ kg}}{m_2}} + \frac{1}{\frac{9.0 \text{ kg}}{m_2}} \right)} = 53 \text{ Hz}$$

Sound attenuation of the clam-shell member (summary):

- Below the mass-spring-mass resonance f_0 the component behaves like a single-wall equal mass. At the resonant frequency f_0 it comes to the resonance intrusion of sound insulation. Above the resonant frequency, the sound absorption increases with an improvement of 18 dB per octave. Shifting the resonance frequency to lower frequencies is lower by a softer spring (larger shell spacing or insulation board with s') and by increasing the Beplankungsmassen (m'_1, m'_2) possible. Here, it makes sense to start with the lighter paneling.

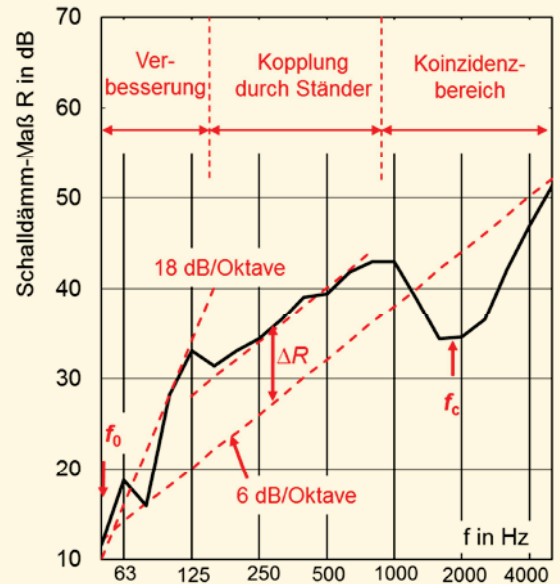


Fig. 2.8

Measurement and forecast results

- At higher frequencies, the coupling causes an acoustical short circuit through the stator. The sound increases as the same weight single wall only with 6 dB per octave. The size of the parallel displacement ΔR is dependent on the coupling strength (axial spacing of the stand) and the plate materials. Improvements can be achieved (etc. separate stand, facing shells, suspended ceilings) by decoupling.
- In the area of coincidence as can be seen by the tracking adjustment (match the projected wavelengths) in single-component of the slump in sound insulation. Is planked symmetrical wall, as in the illustrated example, the burglary is particularly pronounced strong. An improvement can be achieved by angularly flexible, multilayered and unbalanced executed planking.

3 _ Constructive influences on the sound

The airborne and impact sound insulation of components can be influenced strongly by structural measures. The most important factors influencing the insulation of walls, ceilings and roofs are explained below for the assessment of these measures.

3.1 _ walls

The wall construction inside and outside walls are taken into account in wood. The scope mainly includes party walls, building walls and exterior walls for use in high ambient noise levels, as well as interior walls in their own living area. Here, first the sound of pure wall construction without internals (doors, windows, ventilation elements, etc.) should be considered.

3.1.1 _ wall constructions

Most wall wood assemblies can be, regardless of their specific application to a few basic elements traced. Below differentiation is made between the timber panel construction and solid wood construction.

3.1.1.1 _ timber panel construction

Wooden panel walls as inner or outer walls consist of a stud frame (wooden stand, Rähm) made of solid wood or web beams, the at least one side clad with sheet materials and the cavities of which usually are filled with an insulating hollow spaces (see Fig. 3.1).

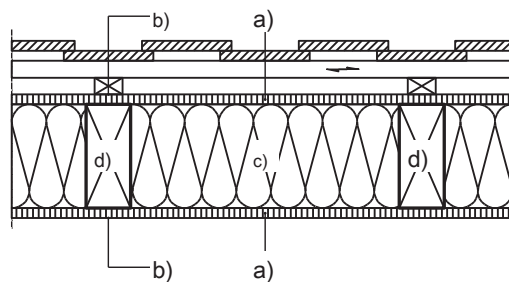


Fig. 3.1

Example of a timber panel construction as exterior wall

The key for the sound effect parameters are:

a) planking

Usual skins are made of wood materials (chipboard, OSB, cement-bonded particle board, wood fiber board, wood wool board) or gypsum materials (gypsum board, gypsum fiber board). With respect to the sound-technical suitability following material properties are relevant:

- Grammage It results from density and thickness of the plate material, and largely determines the excitability of the panel by the sound pressure.

- bending stiffness

It determines together with the mass per unit area and the plate geometry (wall height, stand grid, plate thickness), the position of the natural frequencies of the plate vibrations and limiting coincidence frequency.

To improve the sound insulation of a wood panel wall increase the basis weight while bending softness of skins (that is the coincidence frequency limit f_c to strive ≥ 2000 Hz). (Depending on the purpose of the optimization R_w / Improve the sound insulation at low frequencies), a separate analysis of the natural oscillations of the skins may be required.

b) fixing the planking

The planking acts acoustically seen (compare with the "membranes" of a microphone / speaker) as a sound pick-up or sound-emitting surfaces. By interrupting the transmission of sound from sound-participating schallabgebender to face the sound insulation of the structure can be improved. Constructively this can be achieved by a separation of the stator mill or a decoupled mounting of the panel. The decoupling can (detached or acoustically decoupled) also be achieved by an additional installation level as the facing layer.

c) cavity insulation

The sound technical influence of cavity insulation is made up of the static load-bearing and depressant effects in the hollow space, which is why fiber insulation materials are used for this purpose almost exclusively. In addition, the increase in mass makes for some insulation positive impact. In pressure-resistant insulating materials an increased noise transmission is possible through the contact with the planking. With such materials should be taken to ensure that they are not thicker than the stud frame, so that the insulation does not exert any pressure on the planking. Furthermore, should the insulation panels without lateral air gap are fitted into the supporting frame. When using blow-in insulation should be taken to be that no unfilled cavities form. To select the insulation material see also section 2.5.6

d) Effect of stud frame and screen

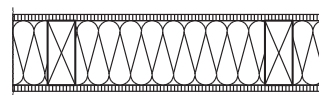
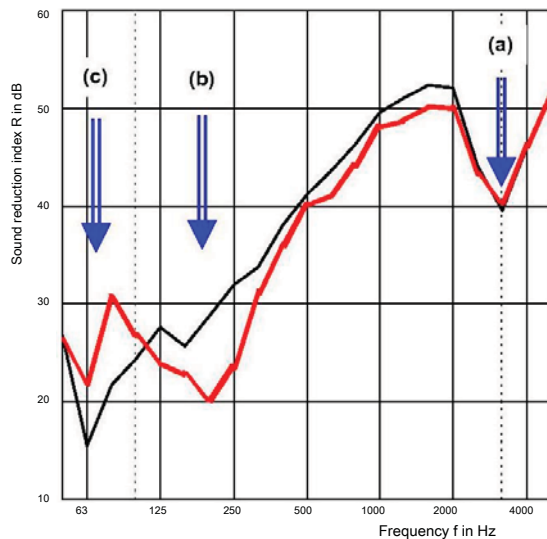
The upright depth has only a relatively minor effect on the sound, depending on the type of cladding. For large series of measurements on wood panel walls, it was found that a reduction of the stator depth of 160 mm to 60 mm rated only a loss in the sound reduction index R_w

has from 0 to 4 dB result. A change in the stator raster shifts the natural frequencies of the skins strong [9] [11]. This results in a significant change in medium- to low-frequency range of Schalldämmkurve. By increasing the levels rasters is usually an improvement in the R_w

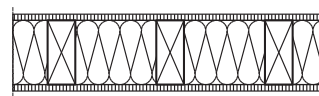
achieved. In Fig. 3.2, this is exemplified for a simple wood panel wall. The frequency-dependent sound reduction indices clearly show the predictable according to section 2.5 drops due to the coincidence frequency, the mass-spring-mass resonance, and the plate eigenfrequencies.

The influence of the planking natural frequencies of the sound insulation is covered in Section

3.1.4.2 used for the optimization of building partitions.



Wall structure 1) pitch 625 mm



Wall construction 2) pitch 313 mm

A bb. 3.2

Sound insulation of a wood panel wall

Sound insulation of a wood panel wall with the following structure:

- 12.5 mm gypsum fiber board
- 60/120 mm wooden stand, filled with 100 mm mineral wool
- 15 mm gypsum fiber board. Plate width 1.25 m, overall height of

2.65 m, overall width of 3.387 m.

The skins are bolted to the supporting frame. Wall structure 1): stand raster 62.5 cm,

R_w = 42 dB wall construction 2): stator raster 31.3 cm, R_w = 39 dB

The frequency dips at (a), (b) and (c) are correlated with: (a) coincidence frequency limit for

wall structure 1) and 2) (b) 1. Plate natural frequency for wall construction 2) (c) twin shell

resonance for wall structure 1) and 2) and

1. oscillating plate for wall construction 1)

Since stud frame and Rähm constructive sound bridges are, is such in high sound-absorbing structures. B. Flat partitions attempts to reduce sound transmission through a separation of stud frame and Rähm. By separation of the stator

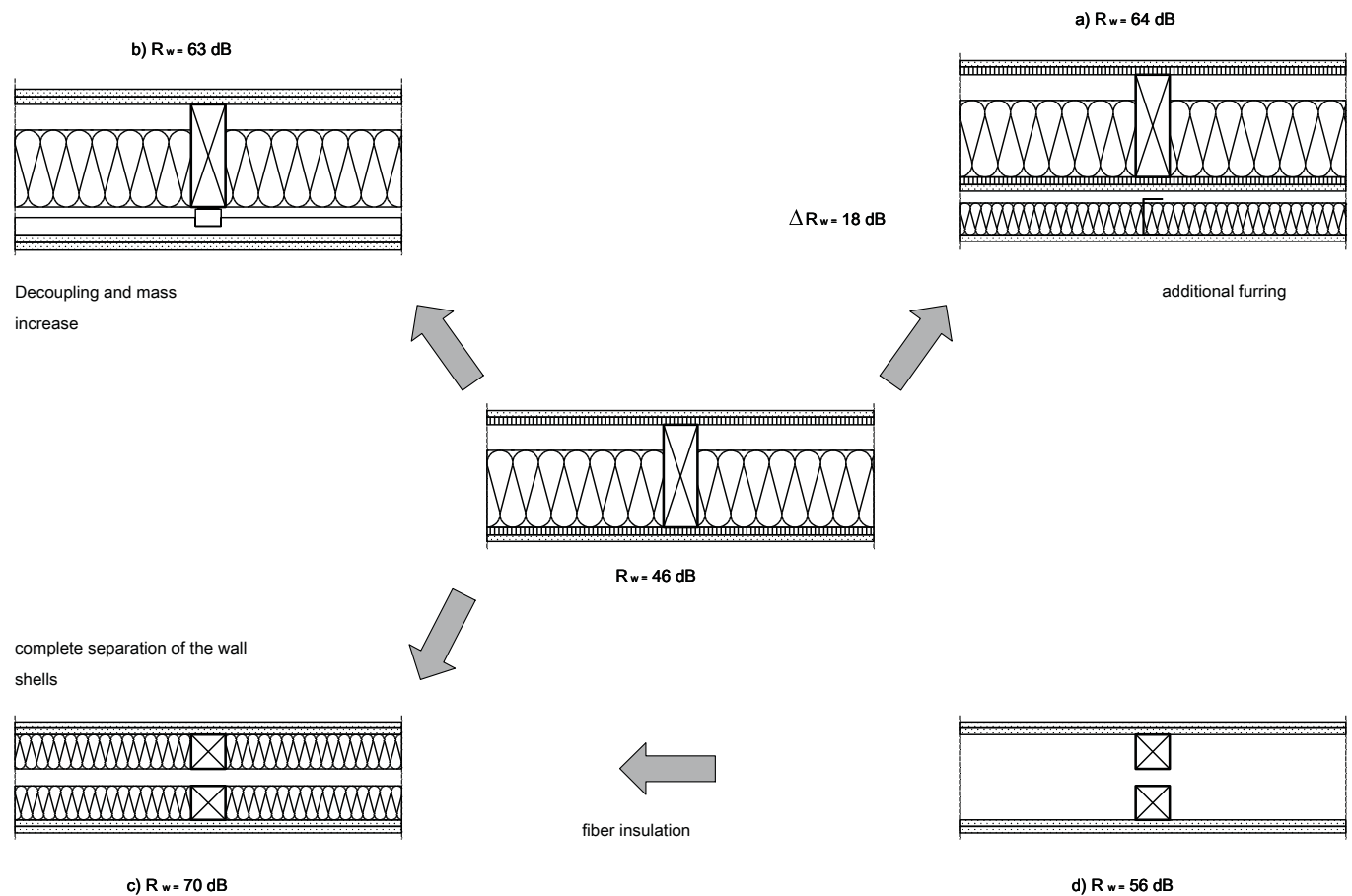
factory alone can achieve a significant improvement in sound insulation already. However, the complete decoupling of the two Beplankungsschalen is achieved only when the additional separation of the entire Rähms.

The influence of constructive measures on the sound insulation of Holztafelbauwänden can of Fig. 3.3 can be read. Of Ge from a standard inner wall (wooden stand on both sides of double paneled) having a sound reduction index $R_w = 46$ dB can be obtained by a free-standing facing shell with an improvement of $\Delta R_w = 18$ dB already party wall quality can be achieved (Fig. 3.3, a). Alternatively, this is also due to the decoupling of a wall shell and increase Beplankungsmasse possible (Fig. 3.3, b).

Even more sophisticated solutions can be fully separated by partition walls with wall shells reach (Fig. 3.3, c). Here the influence of the insulation between the uprights on the transmission of sound in the compartment can be shown. Since no feedback is provided by the stator, this takes full effect and is reduced by the inserted fiber insulating material by 14 dB. The construction details of wall structures can the component catalog are taken in Chapter 6th

A bb. 3.3

Influence of constructive measures on the sound insulation of wood panel walls



a) additional installation level as freestanding facing shell ($\Delta R_w = 18$ dB)

b) decoupling of the wall sheathing with simultaneous increase in mass

c) complete separation of the wall shells

d) Influence of the cavity insulation in separate wall shells

3.1.1.2 _ Solid wood constructions

With solid wood constructions, the base wall of glulam, Brettsperholz- or stacked board elements. Also, box elements or thick wood-based panels are as basic elements sets (ver same fig. 3.4).

For sound insulation main influencing parameters are:

a) thickness and basis weight of the solid wood element

The maximum sound insulation of the solid wood elements is determined by the surface weight and rigidity. With massive single-components can be m 'determine the sound from the mass per unit area. This purpose, a Mas siediagramm which was obtained empirically data from many measurement (see section 2.5.1, Fig. 2.3). The determination of the relationship for solid wood elements is provided in Fig. 3.5 represents. improve direct mount planking the sound reduction index of the wall structure by increasing the area-related mass and can be taken into account in the mass per unit area. In normal component thickness solid wood elements reach Reviewed sound reduction between 30 and 45 dB. Directly mounted planking act of the wall structure by increasing the mass per unit area.

b) cladding

In principle, the sound insulation can be obtained by cladding (z. B. thermal insulation) or skins of sheet materials (usually gypsum board or gypsum fiber board) possibly in combination with a facing layer are significantly increased. Some systems also be nō term for reasons of fire or Wär meschutzes additional cladding or planking of the wall construction.

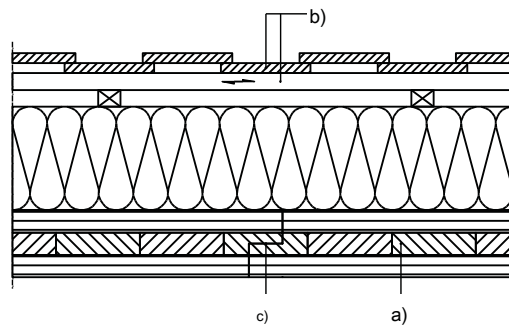


Fig. 3.4

Example of a solid wood construction as exterior wall

c) joints sound

Solid wood panels are manufactured in a modular components generally. These elements are coupled together at the construction site via different connection systems. In small-sized elements (40 to 100 cm width) transmitted over this link joint joints sound can strongly influence the sound insulation of the basic structure. The influence of the joint sound depends on the actual installation conditions (coupling joint width) and can not be sweepingly. By cladding the base structure on at least one side (. Eg by GKBPatten, outer insulation, facing shell) of the joints sound is significantly reduced.

A bb. 3.5

Mass law for single solid wood components [5]

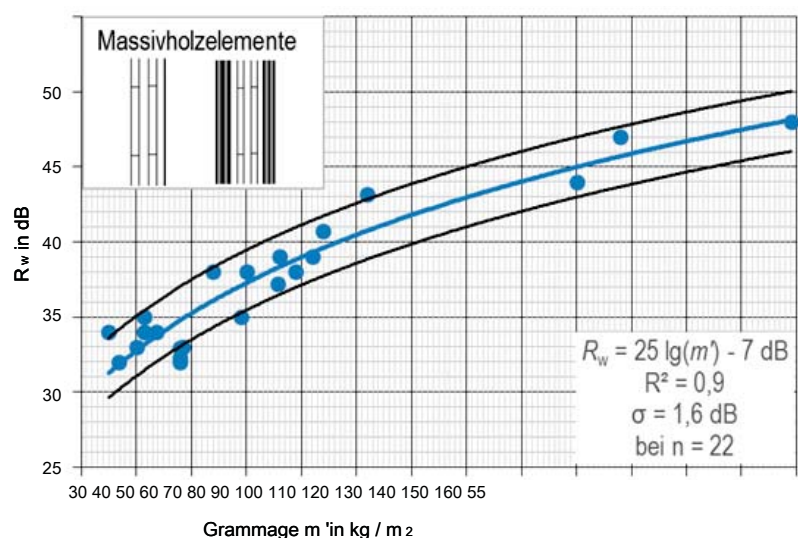
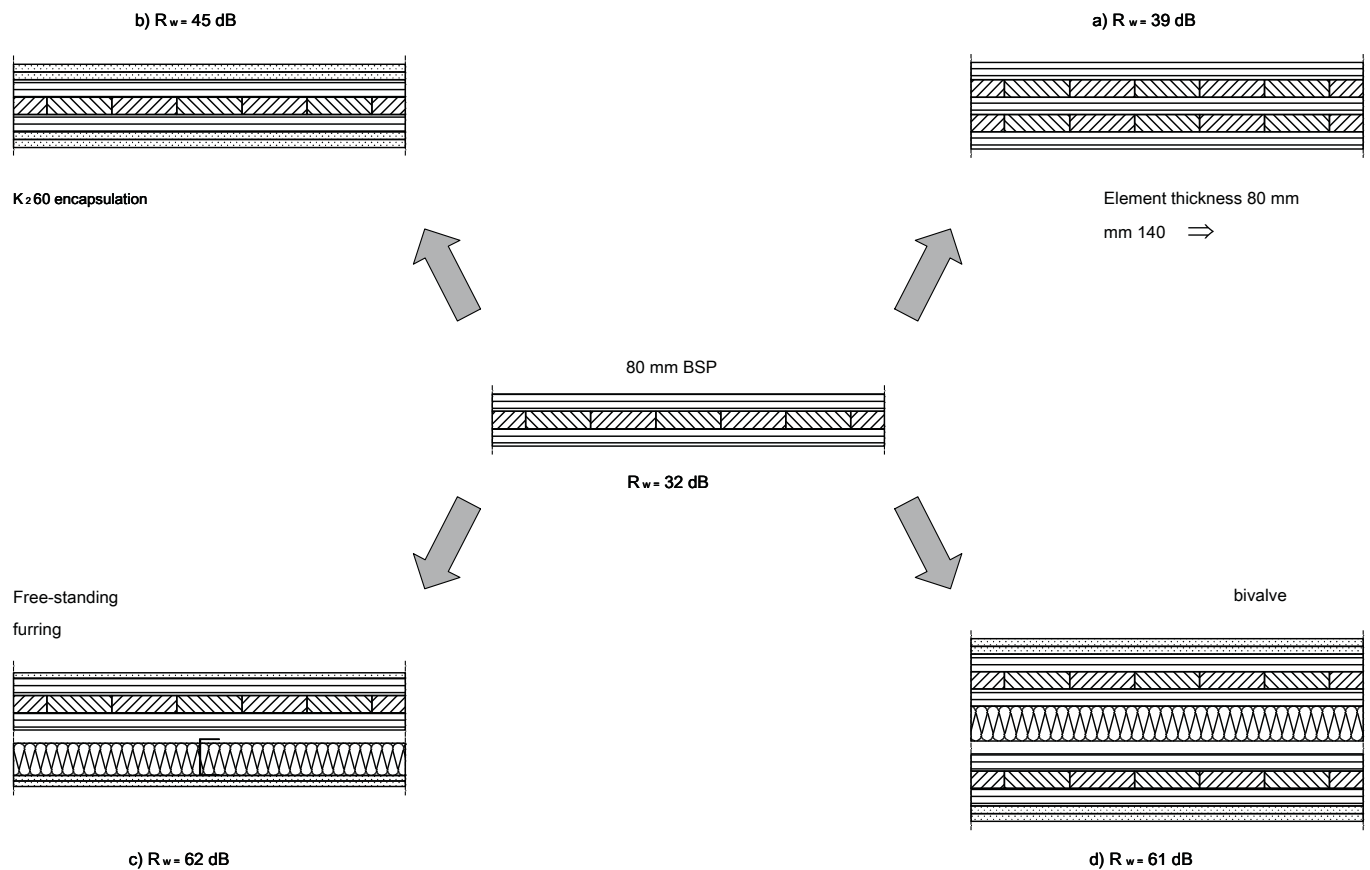


Fig. 3.6

Influence of constructive measures on the sound insulation of solid wood walls

The influence of the structural measures on the sound insulation of solid wood walls is shown in Fig. 3.6. By increasing the mass element through the element thickness or Zusatzbeplankungen (Fig. 3.6 a and b) increases the sound reduction index according to the example shown in Fig. 3.5 mass law. The improvement

by an installation level as freestanding facing shell in the dry construction method or embodiment as a double-shell structure each including Zusatzbeplankungen, 3.6 c) and d) is shown in Fig.. The construction details of wall structures can the component catalog are taken in Chapter 6th



a) increase in mass by increasing the element thickness of 80 mm to 140 mm

b) increase in mass due to fire protection (both sides 2 x 18 mm GF)

c) additional installation level as freestanding furring

d) complete separation of the wall shells

3.1.2 _ exterior walls

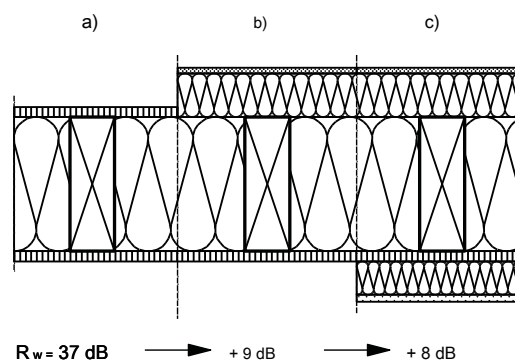
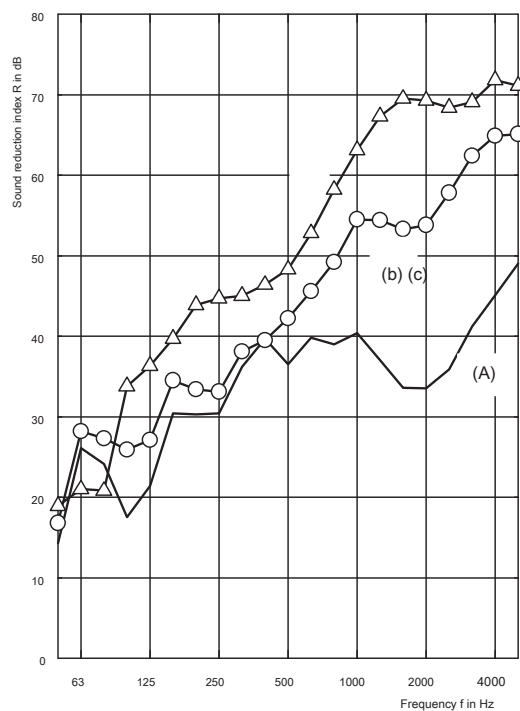
Conventional exterior wall constructions are based on the above basic structures. (Chart wood or solid timber wall) to the fundamental structure is applied an outer insulation and - if it is conducive - an inside facing layer as an installation plane.

Examples of the sound insulation of wood panel exterior walls and the improvement by foreign

insulation and installation planes are shown in Fig. 3.7. The frequency-dependent representation of the sound indicates that the low-frequency enhancement is quite low due to these measures, however. In cases with low-frequency excitation spectra (e.g. road truck with a high proportion), the use of constructions having improved sound absorption at low frequencies be useful (see section 3.1.4.1).

Fig. 3.7

Design measures at a wooden panel exterior wall



a) wood panel wall on both sides with planking OSB, $R_w = 37$ dB

b) Wooden panel with outer wall 60 mm wood fiber EIFS, $R_w = 46$ dB

c) Wooden panel with outer wall 60 mm wood fiber EIFS and facing shell, $R_w = 54$ dB [17].

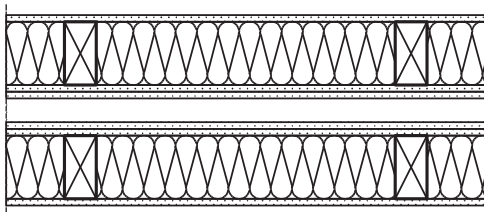
3.1.3 _ building partitions

The construction method of a building partition wall is mainly determined by the requirements of statics and fire protection. Usually two set apart wall panels are in Germany used for this purpose, by way of example in Fig. 3.8 shown. The use of plasterboard or gypsum fiber boards is due to the requirements of fire safety. Is the consistent separation of the two shells of buildings partition pulled into the terminal areas, so with the exception may sound longitudinal line through a roof surface, Nebenwegübertragungen are usually neglected. The sound flanking transmission via a steep roof to be considered in a building partition unless the pitched roof is structurally disrupted here. The wall structures alone can in fault-free execution

Fig. 3.8

Schematic diagram of a building wooden partition panel walls with construction

- 1 position plasterboard ¹⁾
 - 120/60 mm Holzständer ²⁾ with 120 mm fiber insulation ³⁾
 - 2 layers of plasterboard ⁴⁾
 - 45 mm without parting line insulation
2. shell constructed symmetrically



¹⁾ 12.5 mm gypsum fiber board with a basis weight of at least 15 kg / m² or as

12.5 mm plasterboard GKF with a basis weight of at least 10 kg / m²

²⁾ Holzständer of constructive solid wood with stand height 62.5 cm

³⁾ Fiber material with an apparent density $\rho = 30 - 50 \text{ kg / m}^3$ and flow resistance $r \geq 5 \text{ kN s / m}^2$ or

Cellulose insulation material with density $\rho = 45 - 60 \text{ kg / m}^3$ and flow resistance $r \geq 5 \text{ kN s / m}^2$

⁴⁾ 2 x 15 mm gypsum fiber board with a basis weight of at least 18 kg / m² or as

2 x 18 mm gypsum board GKF with a basis weight of at least 15 kg / m²

already sound reduction degree of $R_w \geq 66 \text{ dB}$ provide. The sound insulation at medium and high frequencies here is very good and as Fig. 3.9, is comparable with the results of masonry and concrete walls. However, differences between the designs show up at low frequencies, in particular below 100 Hz. residents this low-frequency sound transmissions may perceive as "booming". Acoustically improved constructions are described in Section 3.1.4.2.

In addition to those described herein gypsum board and OSB or particle boards are often used in load-bearing walls.

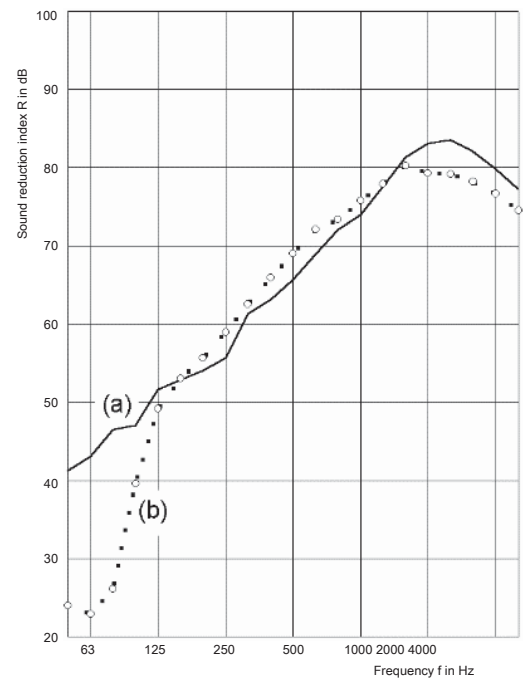


Fig. 3.9

Sound insulation of building partition walls in standard wood panel construction (mean - curve b) is compared with the average value of building partition walls in masonry construction (curve a)

3.1.4 _ Constructive optimization of the walls

3.1.4.1 _ application for exterior walls

Exterior walls are used for harassment by traffic noise with very low frequency components, so it must be ensured that the sound is good enough in the frequency range below 100 Hz. For these purposes as part of a research project were [17] optimized walls

developed in timber panel construction that have a very improved sound insulation at low frequencies. The

Schalldämmkurven these walls (see Fig. 3.10) clearly show that these optimized constructive functions at frequencies below 100 Hz a sound having that lies substantially above the outer walls of timber frame construction.

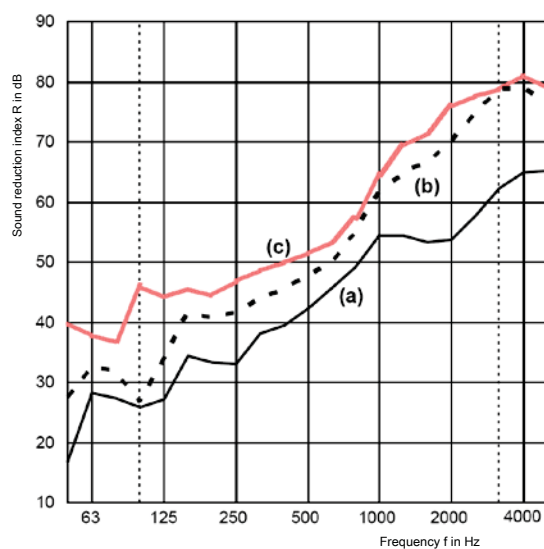
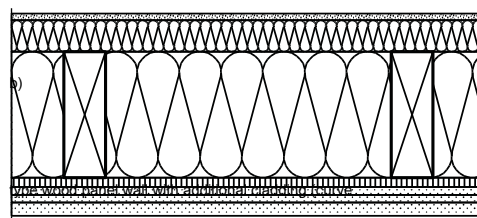
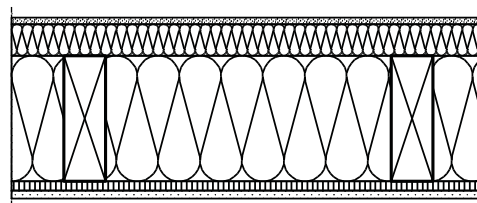
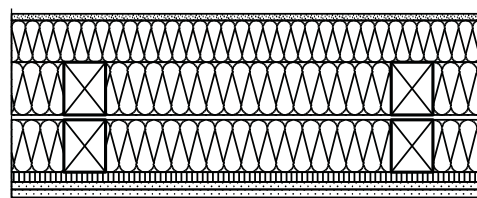


Fig. 3.10

Low frequency sound insulation of outside walls optimized in wood panel construction compared with standard wood panel outer wall (curve a):



Typ wood panel wall with a divided column (curve c)

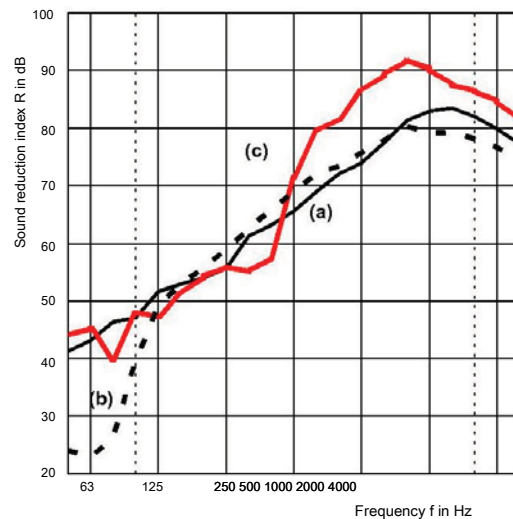


3.1.4.2 _ application for building

partition walls

Fig. 3.9 is shown for conventional building partitions in timber construction that their sound insulation is in the range of low frequencies lower than in conventional building partitions in masonry or concrete. As the sound at frequencies below 100 Hz, although not reflected in the sound reduction level and thus has no national technical relevance, the low-frequency sound transmissions but certainly felt by the residents of such buildings as disturbing, in the field of wood construction designs have been developed, in the low frequency range as good

Sound insulation have [11]. The starting point for this development was the identification of the vibration behavior of the skins of wood panel walls as a cause of this low-frequency sound transmissions. The approach for optimizing the sound insulation is to simultaneously reduce the stator frame of the wood panel walls and the upright depth and invest the money saved hereby place in an increase in the separation joint width. The thus optimized wall has indeed in the medium frequency range smaller deficits compared to conventional wood panel wall structures, the drop in frequency at frequencies below 100 Hz, however, is almost completely eliminated.

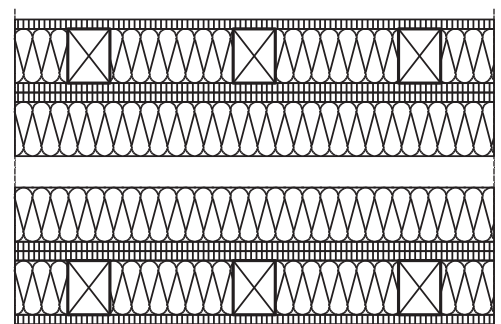


A bb. 3.11

A low frequency sound insulation optimized building partition in wood panel construction compared with mean building partitions in masonry and concrete construction (curve a)

Average building partitions in wood panel construction (curve b)

Optimized building partition in wood panel construction with stand 313 mm grid and increased separation joint width (curve c), from [18], [11]



3.2 _ Ceiling

As ceiling construction in wood construction very different design variants are used. A selection of typical construction methods and device layers such ceilings are shown in Fig. 3.12. The wooden beamed ceiling showed in Fig. 3.12 a) ge, the classic ceiling construction is in timber. It is performed with joists or trusses as a supporting element. Alternatively, solid wood floors are used which allow lower because of their extensive support structure construction heights. They may, as in Fig. 3.12 d) shown as a flat timber element (stacked board, glued laminated timber, laminated timber element) or be installed as a rib or box element (Fig. 3.12 b and c).

Wood-concrete elements (FIG. 3. 12 e) were to use the advantages of the steel tables loaded on train wood element moment and also the pressure-loaded concrete layer develops. These can be implemented with all types of ceilings (a to d).

Partition ceilings are usually executed with a floating screed or dry screed elements on impact sound insulation boards. To weight and damping of the soffit a Rohdeckenbeschwerung can be used on or in the element. In the wood-concrete ceiling, this function is taken over by the (static reasons applied) concrete layer. When in Fig. 3.12 c) illustrated ceiling box for damping vibration absorbers are used in the element. Suspended ceilings are most common in Kombination with beamed ceilings used. Here you can Kings replace the Rohdeckenbeschwerung proper interpretation and thus allow very lightweight ceiling structures.

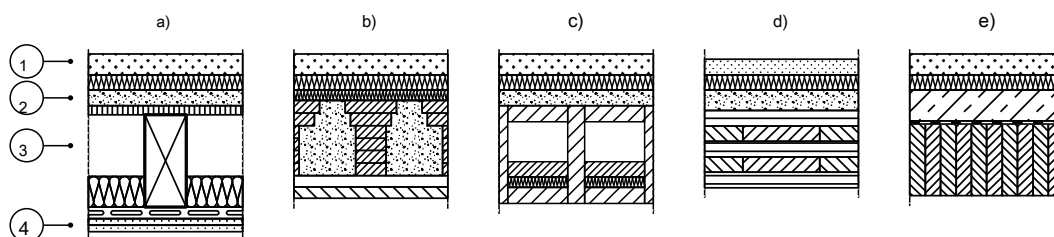


Fig. 3.12

Design variants and component layers of a wooden ceiling

- a) beamed ceiling (solid wood, joists, truss)
- b) Brettsperrholz- ribs element of massive wood sheets (here with split weighting in the element)
- c) box element of massive wood sheets (here with vibration damper in the element)
- d) Solid wood ceiling (stacked board, glued laminated timber, laminated timber element)
- e) wood-concrete ceiling (in conjunction with solid wooden elements or wooden beam ceilings box)

Screed; floating screed or dry screed member on impact sound insulation panels if necessary Rohdeckenbeschwerung or concrete soffit composite layer possibly with cavity insulation, absorber or weighting suspended ceiling optionally rigidly mounted or decoupled

3.2.1 _ ceiling structures

The mode of action of the individual component layers depends on the specific material parameters. Below guidance is provided for the planning and execution of the ceiling structures that are required for optimal air and Trittschalldämmwerte.

3.2.2 _ screed constructions

In ceiling structures can be dry ESTRI che use building boards based on wood-based panels or gypsum. Alternatively come cement, magnesia or anhydrite with the specified minimum thickness according to the requirements of DIN 18560 [13] and EN 13318 [14] are used. In order to reduce an increase in the acoustic longitudinal line in the floor, it must be separated in the door area. A completely sound-bridge-free installation of the screed is required. Particular care is required when carrying out installation cables in the floor, such as radiators or in the sleeper area of the door.

The sound-technical effect of a floating floor to a wooden ceiling is **determined by the Impact sound reduction .DELTA.L_{w,t}** (Described also known as impact sound and for the application in

Timber with .DELTA.L_{w,h} designated). They must be distinguished from the weighted impact sound reduction .DELTA.L_w from measurements on heavy solid floors (concrete floors) in accordance with DIN EN ISO 10140-1 is obtained. For the same floating screed when measured on heavy solid ceilings in accordance with DIN EN ISO 10140-1 are better numerical values .DELTA.L_w

determined as in the determination of .DELTA.L_{w,t} on a wooden ceiling. The impact sound reduction depends on various factors, in particular, are:

- grammage of the screed plate,
- Softness of the impact insulation, described by the dynamic rigidity s' ,
- Vibration damping in the screed plate,
- Construction of the soffit.

The applications and the advantages and disadvantages of the most common in Germany screed systems are listed in Table 4 below.

Usable impact sound insulation boards

In practice, impact sound insulation boards made of different materials such. B. mineral fiber, wood fiber or polystyrene impact sound insulation boards with dynamic

Table 4 | In Germany in timber floor structures used

Floating screed			
construction details	commitment	benefits	disadvantage
Cement and anhydrite on footfall	new	high impact sound reduction possible cost	Building moisture by cement screed, required setting time
dry screed ¹⁾ on footfall	Even expansion, renovation of old buildings	low mounting heights, no building moisture, installation possible by builder	relatively low impact noise reductions
Poured asphalt on footfall	New construction, renovation of old buildings	no building moisture, very short "setting time", lower building heights possible than in the cement screed	expensive mastic asphalt tends to cold flow, therefore relatively stiff tread records with low impact sound reduction can be used

¹⁾ z. B. As plasterboard, particleboard, OSB and cement-bonded chipboard

Rigidities 6 to 50 MN / m³ is used. When selecting a suitable impact insulation admitted and the relevant standards must be observed. The specified in the component catalog thicknesses of the impact sound insulation boards are to be understood as the minimum thickness, the specified dynamic stiffnesses as maximum values. The dependence of the standard impact sound of the dynamic rigidity of the insulating material used is shown in fig. 3.13.

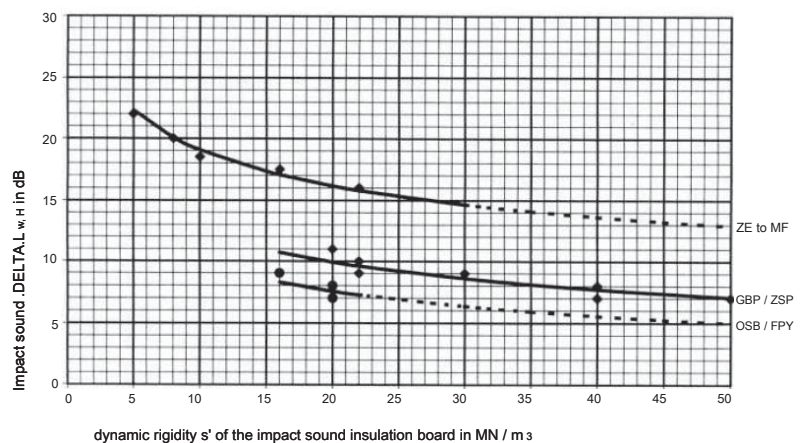


Fig. 3.13

Improvement of sound insulation by a floating screed on wood ceilings. Impact sound reduction (impact sound) for various screeds on mineral fiber insulation boards of different footfall dynamic stiffness.

For dry screeds system solutions are offered in combination with the appropriate impact sound insulation boards manufactured by companies that comply with the intended use (flooring). When laying the impact sound insulation boards, make sure that a complete installation. Prior to introducing a Wet stroke a moisture barrier (film) is to be introduced to protect the impact insulation and to prevent sound bridges in the area. Installations can the Rohdeckenbeschwerung be transferred to an additional height adjustment board (insulation board) or.

ZE to MF = 50 mm cement screed on mineral fiber footfall sound insulation boards ZSP

= 22 mm cement-bonded particleboard

GBP = 25 mm plasterboard

OSB = 18 mm OSB installation plate

FPY = 22 mm chipboard

Trade noise insulation boards having a dynamic rigidity $s \leq 6 \text{ MN / m}^3$ are not currently on the market. To bodies from the component catalog in Chapter 6 realize with these requirements for the impact sound insulation boards, a stratification of impact sound insulation is required. This can be such. B. achieve characterized in that an additional impact insulation is used as a height adjustment disk. The overall stiffness s'_{ges} the two layers is calculated to be based on the principle of the series:

$$\frac{1}{s'_{\text{ges}}} = \frac{1}{s'_1} + \frac{1}{s'_2}$$

The stratification of impact sound insulation boards, make sure that the permissible compressibility $c_{\text{tot}} = c_1 + c_2$ and the required thickness of the screed according to DIN 18560-2 is observed [13].

Example:

Footfall: Mineral fiber-sh, $s' = 8 \text{ MN / m}^3$, CP5

Height compensation plate: EPS DES sg, $s' =$

20 MN / m, CP2 $s'_{\text{tot}} = 6 \text{ MN / m}^3$, $c_{\text{tot}} = 7 \text{ mm}$

-> Increasing the thickness of the screed according to DIN 18560 required

execution of

Edge insulation and edge tiles

The edge insulation strips should be separated from the screed (incl. floor) completely separated from the surrounding walls. The protruding edge (or similar tiles, parquet) only after the installation of the floor to remove. The joints between the edge tiles and floor tiles are to be permanently elastic and may not have sound bridges by tile adhesive or tile grout. In open wooden beams, an additional seal in the edge connector, and between beams and wall may be required. This is especially true for the connection for ceiling penetrations, such as fireplaces.

3.2.3 _ Rohdeckenbeschwerungen

Wooden ceilings are to be regarded as typical lightweight construction elements, in some cases (eg. As with open beamed ceilings or elevated footfall requirements) however, it is useful to complain this ceiling systems for increasing the sound insulation. To be the soffit weight ring plate materials or beds can be used. The data on the mass per unit area are minimum. The thickness information is obtained with conventional weightings of mass and density. Plattenbeschwerungen can (or similar) with tile adhesive are adhered to the bare ceiling or stored (about 5 mm) in a bed of sand. Thus, a full-surface contact with the soffit and thus a sufficient attenuation is ensured. The Plattenbeschwerung should not be too large format, a format of up to approximately 30 cm x 30 cm has proven itself. In packings appropriate measures against migration of the bed must be taken (formation of cavities). This is possible (x cm field size is about 80 x 80 cm) by the introduction of the bed in Pappwaben, sand matting, a slatted grating or the elastic binding with latex milk. Further binders are currently in development. As development criteria are - in addition to the same acoustical improvement compared to unbound bulk - the rapid curing, the possible introduction of a screed pump and the lowest possible building moisture to name. Further binders are currently in development. As development criteria are - in addition to the same acoustical improvement compared to unbound bulk - the rapid curing, the possible introduction of a screed pump and the lowest possible building moisture to name. Further binders are currently in development. As development criteria are - in addition to the same acoustical improvement compared to unbound bulk - the rapid curing, the possible introduction of a screed pump and the lowest possible building moisture to name.

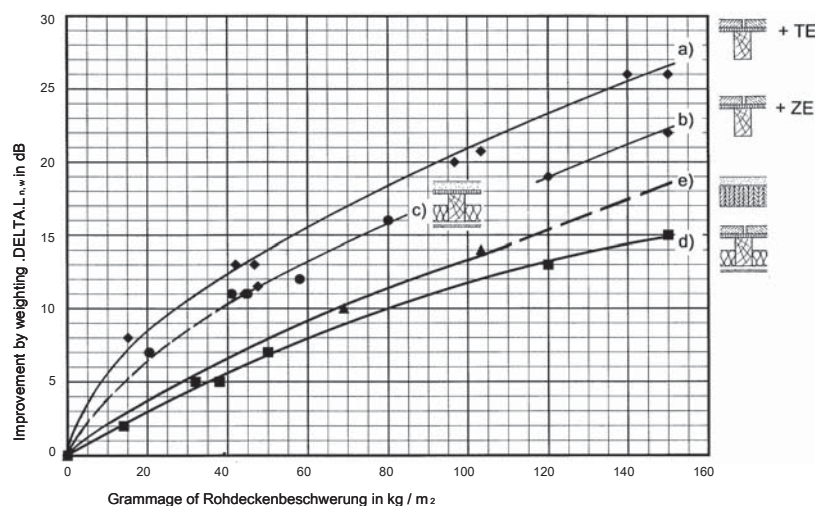


Fig. 3.14

Improvement of sound insulation by Rohdeckenbeschwerungen

- a) Plattenbeschwerung in open wooden beams with dry screed
- b) Plattenbeschwerung in open wooden beams with cement screed
- c) lifting devices on wooden beams with lower blanket
- d) Plattenbeschwerung on wooden beams with lower blanket
- e) lifting devices on solid wood ceilings

The achievable improvement of impact sound insulation depends on the basis weight of the introduced weighting, ie on the density of the plates or packing, and plate thickness or height of the bed. Also note that the sound technical effect on the ceiling type (open or closed wooden beams, solid wood -

blanket) depends. The trend can be combined with lifting devices at the same basis weight greater improvement of impact sound insulation achieved than with Plattenbeschwerungen. The improvement by the introduced mass of Rohdeckenbeschwerung may Fig. 3.14 taken from [12].

When dealing with Rohdeckenbeschwerungen is important to ensure that when the Plattenbeschwerung be placed in a dry state on the bare floor to prevent moisture damage both the bulk material as well.

3.2.4 _ vibration absorber

Vibration absorbers comprised of a mass and a spring acting on the component or as an oscillatory system (A-mass oscillator) to be installed. By the component vibration of the vibration absorber is brought into resonance, in which it damps the vibration member strong. In contrast to broadband damped weighting thus the vibration absorber acts in a narrow frequency range that can be influenced by the size of the mass and stiffness of the spring. For wooden ceiling absorber to reduce the impact sound transmission at low frequencies can be used for damping oscillations of the ceiling in the frequency range from 30 Hz to 100 Hz. In Fig. 3.12 c) a box element is represented with vibration damper, consisting of a concrete block on an insulating board.

3.2.5 _ supporting structure and insulation in the beam gap

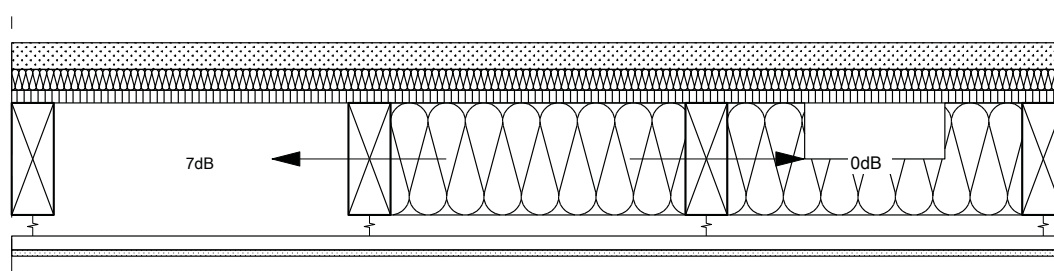
The dimensioning of the support structure, so the bar height at joists and the element thickness of lumber elements can be effected by static criteria. Their influence on the sound transmission is low with a minimum thickness. therefore, minimum dimensions are given for the dimensioning of the component catalog. The joists can be executed with solid wood beams, joists or trusses. As solid wood elements glulam, Brettspertholz- or stacked board elements are possible. For joists with suspended ceilings no noticeable improvement is in Holztafelbauten by larger bar spacings ($e = 0.625$ m at $e = 0.815$ m) achieve.

The cavity insulation in ceiling beams with elastically suspended ceilings comes with regard to the reduction of sound transmission greater importance than is the case with rigidly mounted sub-ceilings. By doubling the thickness of insulation, an improvement of 1 is achieved to 3 dB. Compared to the blank Gefach a 200 mm thick fiber insulating material resulted in an improvement of 7 dB in the evaluated normalized impact sound level L in comparative measurements n, w .

A bb. 3.15

Influence of insulation arrangement at rated impact sound of a ceiling structure with floating floor and ceiling of suspended

If the stuffing yarn pulled up the side of the bar, the results were equivalent (see Fig. 3.15).



The same applies to the type of insulation material. Improvements to the rated impact sound by increasing the density of the insulating material of 15 kg / m^3 to 30 kg / m^3 in the range of max. 1 dB. For Einblasdämmstoffe itself has a density $\approx 40 \text{ kg / m}^3$ found to work well p. In this type of insulating material, a film and an additional batten layer is to be inserted beneath the joists to allow the introduction of the insulating material. A cladding is unfavorable at this point of sound-technical point of view, because it causes an additional mass-spring-mass resonance. To select the insulation material see Section 2.5.6.

3.2.6 _ ceilings

The usual in timber clothing of the roof beams or the solid wood ceilings with plasterboard (gypsum board or gypsum fiber boards) can be of different suspended ceiling systems are designed as a direct or clothing in form. Depending on the mounting is made of sound-technical point of view distinguish between:

- direct cladding of the ceiling elements
- rigidly mounted ceilings (for. example, with a batten layer)
- decoupled mounted or suspended ceilings (for example with spring rails or elastic hangers)

Direct clothing of the ceiling elements

The direct clothes is mainly used for solid wood elements, in order to meet the higher fire safety requirements or customer requirements for a white sub-view. Acoustically, the direct Clothing acts by their small masses hardly increase from. When mounting the clothing the working of solid wood elements (sources / shrinkage) to be taken into account.

Rigidly fixed ceilings

A standard design for wooden beams transversely fastened to a batten layer to a beam suspended ceiling. Compared to open beamed ceiling, the sound is improved by up to 15 dB. A double clothing of the false ceiling (two layers of gypsum board) does not bring any significant improvement (about 1 dB).

Decoupled mounted ceilings

By the attachment of the false ceiling by means of spring strips, spring clips or elastic hangers good decoupling of the false ceiling is reached. The improvements gegenüber the open beamed ceiling must be market with suspension systems of up to 25 dB. This is an improvement of about 10 dB with respect to the above rigidly mounted sub-ceiling.

Evolved hangers with elastic bearings can target the hangers are designed for the optimum natural frequency and thereby achieve further improvements. The design is specified by the manufacturer based on the pressure in the bearing, which results from the distance between the hangers and the basis weight of the **suspended ceiling. As ge suitably range of this natural frequency f_0 becomes**

$$12 \text{ Hz} \leq f_0 \leq 25 \text{ Hz}$$

proposed. The so balanced sub-ceiling achieved a reduction of low-frequency impact sound transmission. In contrast to the rigidly mounted sub-ceiling is a significant improvement, he shall submit to the decoupled mounting by additional cladding (3 - 6 dB at mass duplication). Here, too, several thin layers of clothing are favorable to minimize the bending stiffness of the false ceiling.

Both the rigid mount and the decoupled mounted ceilings cause by the trapped air layer has a mass-spring-mass resonance, which results in the resonance region to amplified sound transmissions. Since the improvements enter through the lower blanket until above this resonance frequency is desired to move it to the lowest possible frequencies.

Structurally this can be achieved by:

- an increase in the air layer thickness (drop height)
- an increase in mass (mass per unit area of the lower cladding)
- Hangers with a low spring rate and the greatest possible mounting distance

These constructive sizes can be seen that a lower ceiling subsurface ceiling elements (solid wood elements) significantly lower improvements will bring as a wood beam ceilings. The main cause is in the low air film thickness between the flat elements and the lower ceiling. For example, a spring rail mounted with a single layer of clothing with a solid wood ceiling, arises in relation to the construction without suspended ceiling only an improvement of **about 4 dB in $L_{n,w}$** . The impact sound transmission in committing the ceiling can even be felt by residents louder (see section 2.3).

3.2.7 _ Gehbeläge

Soft elastic Gehbeläge:

Carpeting improve the sound insulation. However, they are often overestimated in their effect on wood-beamed ceilings. The operation of carpets is to cushion the placement of the human foot and to insulate a part of the sound energy already in the introduction to the ceiling. This effect of carpets mainly affects the high-frequency Anregung and is relatively low at low frequencies.

Soft elastic Gehbeläge on screed floors must not be used to detect the minimum requirements of Intermediate floor in apartment buildings according to DIN 4109, as the floor covering can be replaced by subsequent users.

For practical reasons, is therefore recommended not to take into account when planning the ceiling structures by improving soft elastic coverings. In addition, in many homes on faces hard flooring (tiles in kitchen, bathroom and dining room and hardwood or stone flooring in hall, hallway and living room) lie.

Tiles and other hard, heavy coverings

Tiles are non-positively connected to the floor and thus occupy a special position among the Gehbelägen. The increase in the total mass (tiles + screed) causes a slight improvement in the sound at low frequencies. By the time increment of the bending stiffness clothes and because of the better sound input into the screed sound insulation in the high frequencies, however deteriorated.

the impact sound transmission is hardly changed by a wood covering (eg. as parquet). Floating parquet floors results in improvements in the medium and high frequencies.

The improvement in sound insulation of a wood joist ceiling (without screed) solely by means Gehbelägen is insufficient. However, the use of Gehbelägen can be useful as an additional measure.

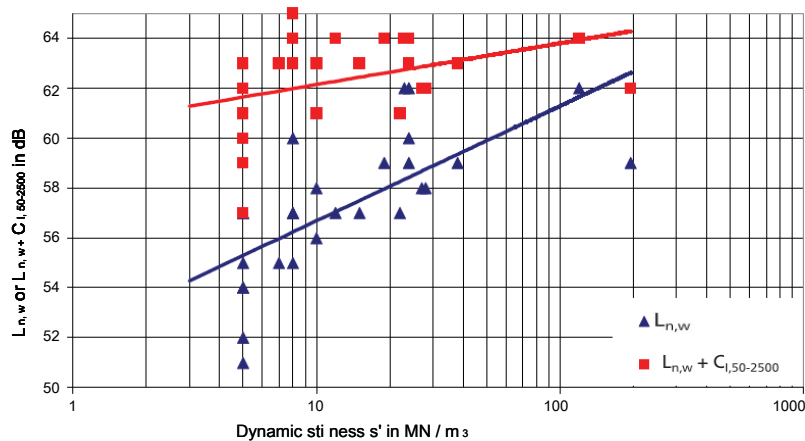


Fig. 3.16

Impact sound insulation of wooden beams with different floor structures. The screed assemblies

differ only by the dynamic stiffness s' of the impact sound insulation boards. blue: analysis with $L_{n,w}$

red: analysis with $L_{n,w} + C_{l,50-2500}$

3.2.8 _ Constructive optimization of the ceiling

The impact sound insulation of wooden ceilings is a field of intense research activity for quite some time. In most cases, the standard impact sound level of the ceiling structure has been studied and analyzed here. However, the area must be considered low-frequency sound broadcasts for the subjective perception of the residents.

3.2.8.1 _ influence of concrete structures

When asked about parameters affecting the low-frequency sound of the impact is to examine the floor construction because this screed se as a mass-FederMas system often has resonance frequencies in the relevant frequency range to the next. For the forecast of the acoustic properties of concrete structures, the dynamic stiffness s' of the impact sound insulation is an important factor. The impact on the low-frequency sound insulation is illustrated in Fig. 3.16, where the impact sound is compared by wooden ceilings, which differ only in the strength of its impact sound insulation boards.

The analysis was performed for both the $L_{n,w}$ (Frequency range of 100 Hz to 3150 Hz) and for $L_{n,w} + C_{l,50-2500}$ (performed frequency range of 50 Hz to 2500 Hz). The analyzes clearly show that for the consideration of the low frequency sound insulation in the form of $L_{n,w} + C_{l,50-2500}$ the choice of the dynamic stiffness of the impact sound insulation is not very decisive. A significant IMPROVE tion arises only at very low dynamic stiffness when the mass spring-mass resonance of the floor structure is deep enough.

3.2.8.2 _ influence through

Rohdeckenbeschwerung

To improve the sound insulation of wood ceiling is often the weight of the soffit required [12]. In practice it has been found that a significant improvement in function of the additional mass of the evaluated normalized impact sound pressure level $L_{n,w}$

is possible. To examine how this action affects the low-frequency sound, were in Fig. 3.17 for different wood ceilings, the standard impact sound level $L_{n,w}$

and $L_{n,w} + C_{1,50-2500}$ plotted against the respective

ZusatzBeschwerungsmasse. Fig. 3.17 shows that the correlation

between $L_{n,w}$ and $C_{1,50-2500}$

and the additional mass is significantly better than the

correlation between $L_{n,w}$ and the additional mass. It can be

concluded that the additional mass of Rohdeckenbeschwerung is a decisive parameter for the low-frequency sound insulation.

To optimize a wooden ceiling solely on the weighting high additional materials, however, are (from 100 to 300 kg / m²) is required.

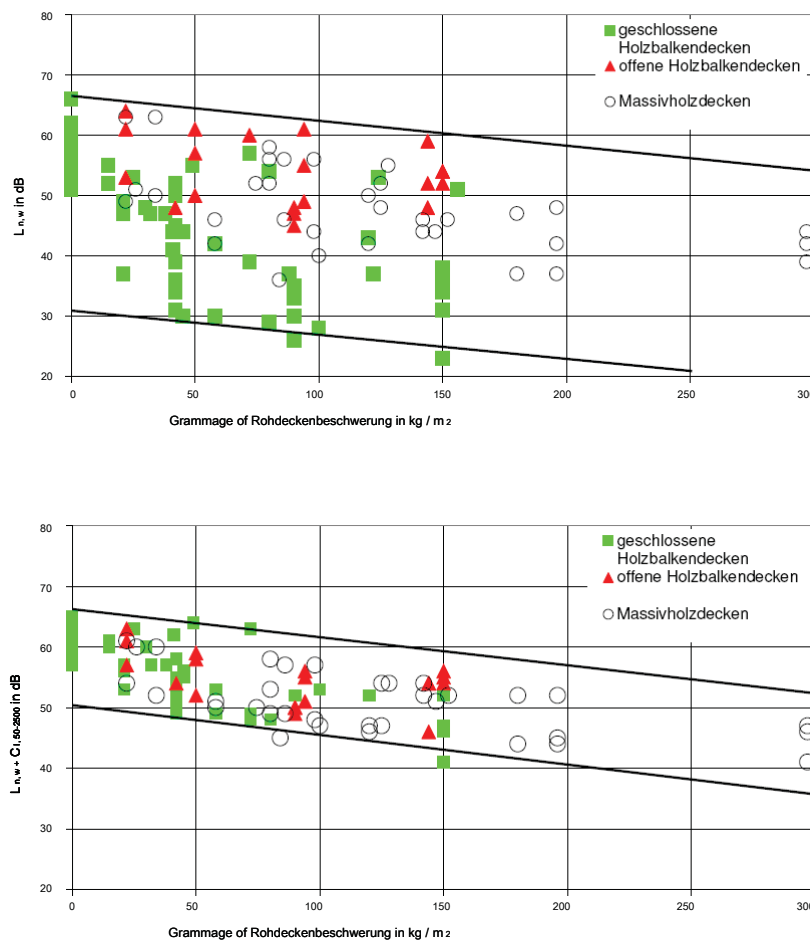


Fig. 3.17

Impact sound insulation of wooden beams in dependence of the basis weight of the Zusatzbeschwerung

above: analysis with L_n

w

Bottom: analysis with $L_{n,w} + C_{1,50-2500}$

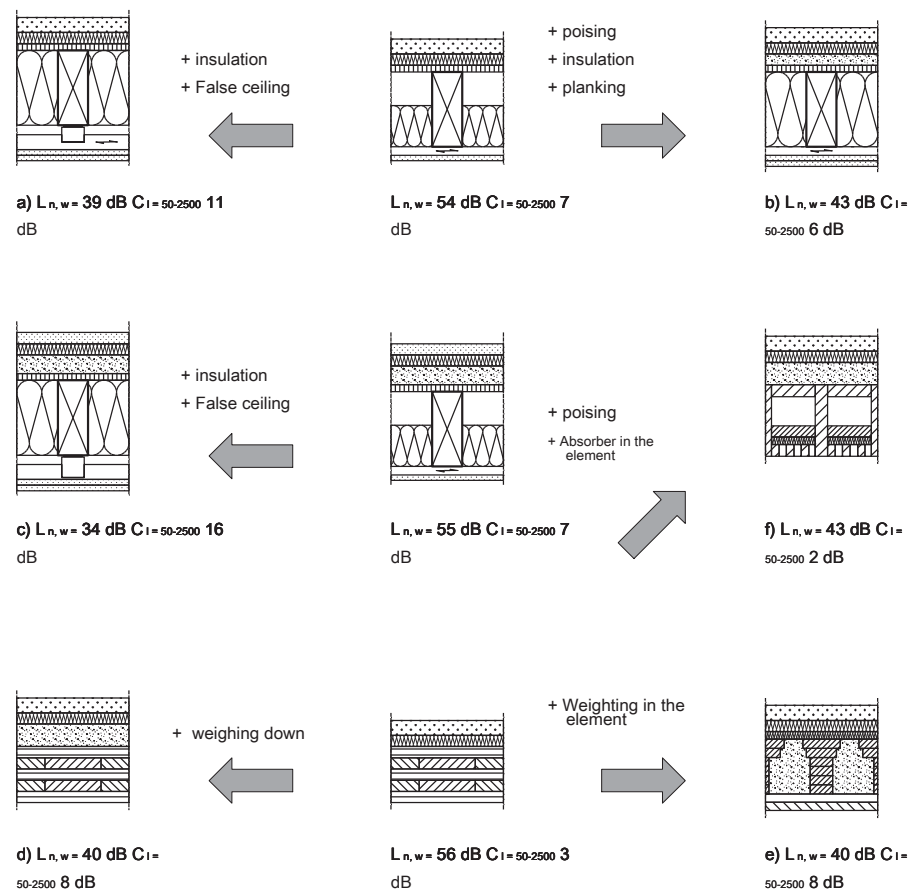
3.2.8.3 _ examples of wooden ceilings with improved

low-frequency sound

Shall wood ceilings are planned, as to its sound insulation also reflect the subjective perception of the residents, as is the low-frequency sound in

to consider terms of reduced impact sound transmission. To this end, in section 2.4 targets for the $L_{n,w} + C_{i, 50-2500}$

which made union a better assessment of the ceiling structure to given. Structures that correspond to the sound level of protection BASIS +



A bb. 3.18

Examples of wooden ceilings with improved low frequency sound insulation for use as Intermediate floor compared to a simple wooden ceiling (single-family ceiling) as a starting point. Additional measures:

- a) Unterdeckenabhängiger + 2 x 12.5 mm GKF / 200 mm fiber insulating material in the compartment
- b) 60 mm crushed / battens + 2 x 12.5 mm GKF / 200 mm fiber insulating material in the compartment
- c) Unterdeckenabhängiger + 2 x 12.5 mm GKF / 200 mm fiber insulating material in the compartment
- d) 60 mm gravel
- e) split in the ceiling element (Brettsperholz-fin member)
- f) 70 mm gravel / absorber (in the ceiling element box member)

($L_{n,w} + C_{1,50-2500} \leq 50 \text{ dB}$) are shown in Fig. 3.18. You can (Fig. 3.18, middle) of typical single-family house ceiling be achieved by the given to additional measures.

Fig. 3.18 a) and b) shows wooden beams with factory vorfertigbarer suspended ceiling with double clothing (2 x 12.5 mm GKF). At 3.18 a) the suspended ceiling is decoupled with compression loads, elastic suspenders; in Fig. 3.18 b) is a Rohdeckenbeschwerung (60 mm gravel, used $m' = 90 \text{ kg} / \text{m}^2$). Both structures contain a 200 mm starke cavity insulation fiber insulation.

A solution with dry screed elements is illustrated in Fig. 3.18 c). The improvement over the initial situation is achieved by the decoupled and twice held suspended ceiling. The complete ceiling structure was realized with insulating materials made of renewable raw materials, and shows that even with stiffer impact sound insulation boards (wood fiber boards $s' = 30 \text{ MN} / \text{m}^3$) is a good impact sound insulation can be achieved.

For solid wood elements (Fig. 3.18 d to f) is a Rohdeckenbeschwerung the best method to reduce the impact sound transmission. It can on the element (Fig. 3.18 d) or in the element (Fig. 3.18 e) are introduced. In construction f) additional vibration absorbers were installed in the box member, which reduce the impact sound transmission at low frequencies, as the **comparison of $L_{n,w} + C_{1,50-2500}$ shows. The structure corresponds with respect to the low-frequency impact sound transmission already the COMFORT acoustic insulation. Other structures of this level with different basic ceiling type are quantitatively provides to same in the component catalog (Chapter 6).**

3.3 _ Steildächer

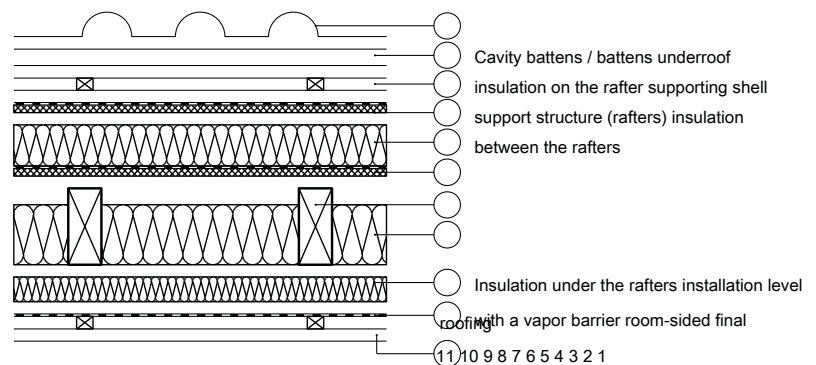
3.3.1 _ roofs

This section usual steep roof structures are described in terms of their transmission sound insulation and sound absorption edge. The description of an individual component layers such functions Steildachkonstruk follows [1] and is illustrated in Fig. 3.19.

The constructions of pitched roofs with insulation between rafters and Aufsparrendämmsystem are discussed. In the case of pitched roofs with rafters is between the insulation systems with rigid foam -Dämmplatten and distinguish such from fibrous insulating materials.

Abb. 3.19

Presentation of the component layers of a pitched roof of [1]



3.3.1.1 _ pitched roofs with insulation

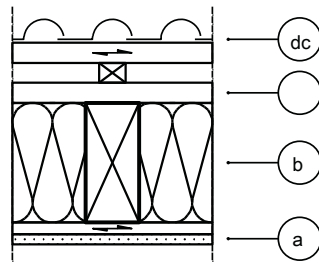
between rafters

The basic structure of a pitched roof having a rafter insulation is from the inside to the outside as follows (see also 0):

- room side cladding on transverse battens or spring rails
- rafters resting on purlins, rafters in place of solid wood and a web support may be used, thermal insulation fitted between the rafters
- sub-roof (as undervoltage underlayment) or deficit (lower roof boards, MDF-board or hydrophobised soft wood fiber plate)
- counter battens and battens with roofing

A bb. 3.20

Construction of a pitched roof with insulation between rafters



The key for the sound effect parameters are:

a) room side cladding

Are common cladding gypsum materials (gypsum plaster board, gypsum fiber board). When a set of a tongue and groove form is compared with the gypsum boards with deficits in the range of 5 - 7 dB can be expected. These are mainly due to leaky joints between the profile boards. To avoid this defect, the profile boards can be mounted on a GKB plate as second garment. With regard to the fixing of the clothing is possible this to decoupled via spring rails against the rafters

PeIN. Compared to the standard mounting on battens is an improvement in the sound reduction index R_w expected by about 2 dB.

b) insulation cavity / support structure

The thermal insulation is used with about 10 mm interference between the rafters. Usually a Mineralfaserdämmfilz is used here. Alternatively, cellulose insulation, cotton or wood fiber panels can be used. Closed cell polystyrene insulation boards are not recommended for this purpose as these poorer acoustic properties as fiber insulation materials have. Comparing the different fiber insulation materials (mineral fiber, cellulose insulation, cotton) were no significant differences found in terms of sound insulation with comparable characteristics (density, flow resistance). The reduction value of the roof structures varies with the thickness of each contributed to thermal insulation made of fiber insulation material. With the same insulation thickness, a higher rafters tend to behave a little better than a less high rafters. The influence of the roof pitch on R_w is rather low and little to be set as 2 dB. When using a cellular beam instead of rafters made of solid wood-like sound insulation can be achieved.

c) Influence of the roof sheathing

As roof sheathing following variants are possible:

- Tongue and groove formwork
- Gespundete formwork
- Waxed MDF possibly with covering of cover sheets
- Hydrophobised soft wood fiber plate

Alternatively, only one underlayment can be applied. A carefree roof sheathing behaves with regard to the sound absorption

characteristic R_w less favorable than if only one underlay sheet is used. The use of roof sheathing is however advantageous if the low-frequency sound is to be improved specifically. If an outer roof boards are used, they can be additionally weighted to improve the sound insulation. For this purpose are particularly single- or multi-ply bituminous sheeting. The level of improvement is determined by the mass to set.

3.3.1.2 _ pitched roofs with rafter

The basic structure of a pitched roof having a rafter is inside out as follows (see also Figure 3.21.):

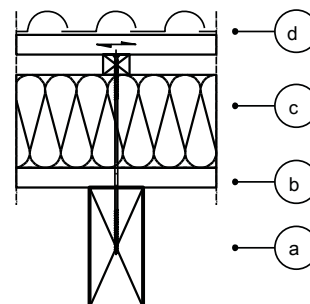
- a) rafters resting on purlins
- b) the room side paneling nailed to the rafters
- c) thermal insulation (rigid foam or fiber insulating material) screwed on counter battens to the rafters
- d) shortfall, counter battens and battens with roofing

A bb. 3.21

Construction of a pitched roof with rafters

d) Influence of roofing

As roofing usually verfalzte clay or concrete tiles are used. Due to the lower G_e Klobuk a reduced by about 2 dB sound insulation is measured at Tondachsteinen. Verfalzte concrete roof tiles and plain tiles behave roughly equivalent in terms of the achievable sound insulation. Sheet metal roofing from trapezoidal sheet are much less favorable because of the lower mass per unit area.



The key for the sound effect parameters are:

b) roof boarding

Typically, a roof boarding of multilayer plates or tongue-and-groove boards is used. To improve the sound insulation, the roof sheathing can still complain. To weight to soft materials such as suitable. B. bitumen sheeting, elemented cement-bonded chipboard or plasterboard with factory prefabrication.

c) rafter

The thermal insulation applied externally to the roof boarding. With respect to the sound insulation between insulating boards made of rigid polyurethane foam or fiber insulation

to distinguish (mineral fiber or wood fiber). With insulating panels made of fiber insulation, the sound insulation is decisively influenced by the pressure of the insulating panels to the roof sheathing. For optimized sound insulation of the contact pressure must be kept as low as possible. In practice this can be achieved through the use of double-threaded screws, were between mineral fiber and wood fiber

no systematic differences in the sound insulation R_w detected.

Compared with these fiber insulation is insulation made from rigid PU foam behave schalltechnisch unfavorable. When insulation boards made of rigid polyurethane foam to improve the sound insulation can be done even by a lamination of the insulation board with mineral or wood fiber board. This laminated Daemmplatte may be space or externally.

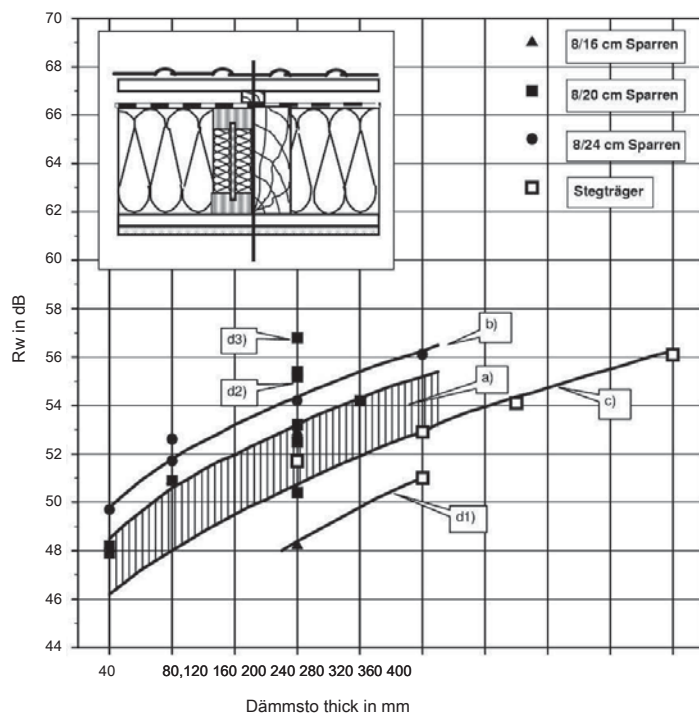


Fig. 3.22

Sound reduction index R_w pitched roofs with insulation between rafters as a function of the insulation thickness

- a) solid wood rafters 8/16 to 8/20 cm cm (shown with variation)
- b) solid wood rafters 8/24 cm
- c) web beam with full or partial thermal insulation, height 240 mm, 400 mm d1) solid wood rafters or joists with roof sheathing or roof panel d2) on the room side clothing doubled and spring rails decoupled d3) design as d2)

with additional of weighted roof boarding The specified sound reduction index R_w are laboratory measurements.

Influence of insulation thickness

The reduction value of the steep roof constructions with a rafter from fiber insulating material varies with the thickness of each applied insulation.

d) Influence of roofing

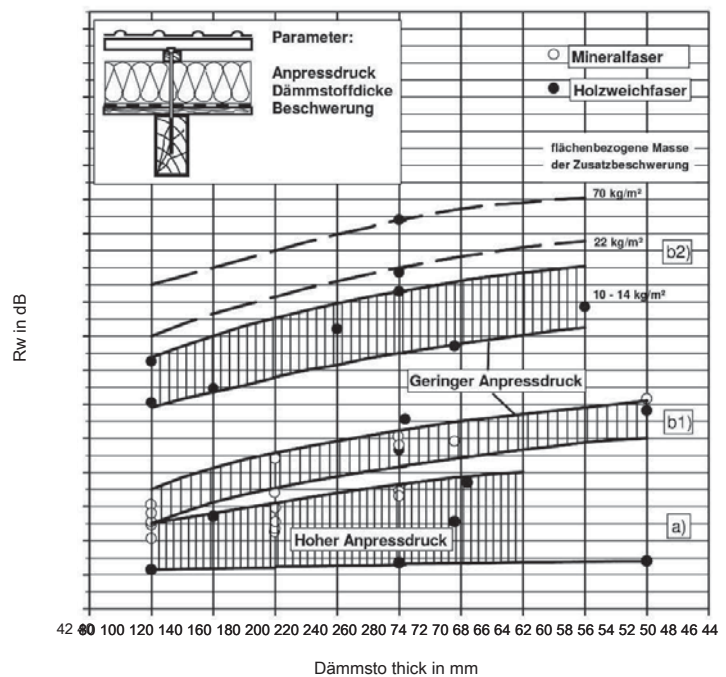
As roofing usually verfalzte clay or concrete tiles are used. In Tondachsteinen reduced by approximately 2 dB sound insulation was measured. Verfalzte concrete roof tiles and plain tiles behave roughly equivalent in terms of the achievable sound insulation. Sheet metal roofing from trapezoidal sheet are much less favorable because of the lower mass per unit area.

3.3.2 _ impact of construction on the transmission sound insulation of pitched roofs

The sound reduction index R_w pitched roofs with insulation between rafters 3.22 is shown in Fig.. This figure shows that the sound insulation of pitched roof is improved with increasing thickness of insulation. By using suitable Beschwerungsmaßnahmen and by decoupling the room side clothing to improve the sound insulation to be obtained up to 6 dB with respect to the basic construction.

The transmission sound insulation R_w pitched roofs with rafters of fibrous insulating material is 3.23 shown in Fig.. Here it can be seen that the sound insulation of pitched roof is improved with increasing thickness of insulation. By reducing the contact pressure of the fiber insulation material by mounting with double threaded screws, as well as by using suitable Beschwerungsmaßnahmen a significant improvement of sound insulation in relation to the basic design can be achieved.

The effectiveness of weightings in the sound insulation is 24/03 again shown a separately in Fig.. As weightings in principle soft materials are, in practice bitumen sheets are used. With high demands also elemented cement-chip plates (plate size of 30 cm x 30 cm) can be used. With such a laboratory could Beschwerungsmaßnahme sound reduction up to 62 dB measured, see [17]. The Plattenbeschwerungen are large enough to stick to the roof sheathing.



A bb. 3.23

Sound reduction index R_w pitched roofs with rafters made of fiber insulation

material as a function of the insulation thickness.

a) High contact pressure of the fiber insulating material by screwing with a single threaded screw or assembly with rafter nails. b1) Low contact pressure of the fiber insulating material by

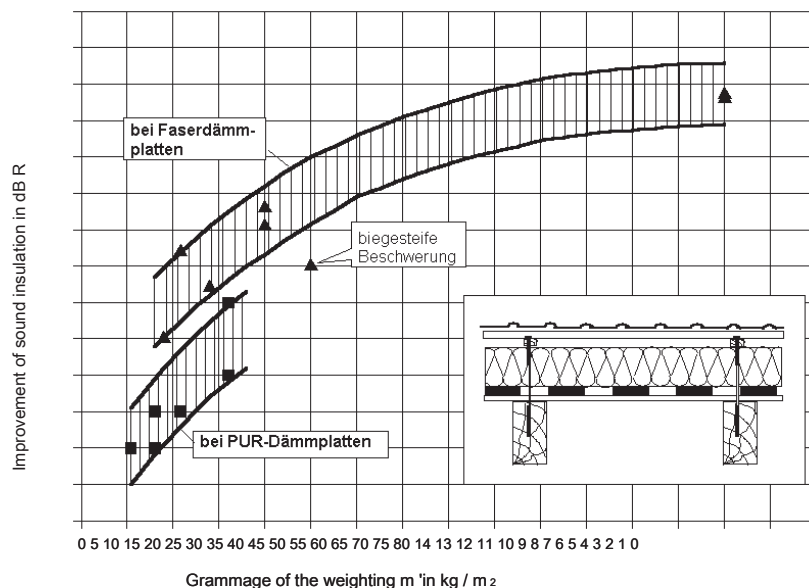
Screw with double-threaded screw. b2) Low contact pressure of the fiber insulating material by

Screw with double-threaded screw and additional weight the roof sheathing. The specified sound reduction index R_w are laboratory measurements.

The sound insulation R_w pitched roofs with rafter insulation made of polyurethane foam (see Section 6) is displayed in the component catalog. An improvement in the sound insulation of the basic construction can be achieved by the use of polyurethane insulation with a lamination of fiber insulating materials. To further improve the sound insulation weightings to the roof sheathing be used. The effectiveness of the weighting depends on the applied additional mass. The expected improvement in the sound reduction index are shown in Fig. 3.24.

3.3.3 _ sound insulation of pitched roofs at low frequencies

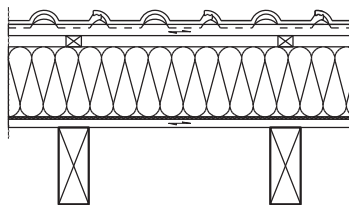
Pitched roofs are used for harassment by traffic noise with very low fees, it must be ensured that the sound is good enough in the frequency range below 100 Hz. For these purposes as part of a research project developed [17] special pitched roofs, which have improved sound insulation at low frequencies, ie below 100 Hz. Four of these roof structures are shown in Fig. 3.25 and Fig. 3.26 represented with their Schalldämmkurven. They show that these improved structures below 100 Hz have a sound absorption at frequencies well above the usual sloping roof constructions. A more detailed description of the presented roofs can be found in the literature [17].



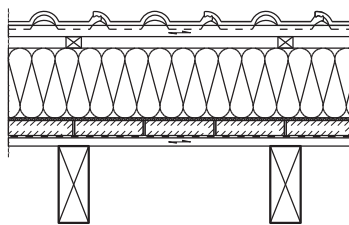
A bb. 3.24

Improve the sound insulation R_w pitched roofs with rafters (fiber insulation boards or insulation boards PUR)

flexurally soft by employing weightings (z. B. bitumen webs elemented cement-bonded chipboard or plasterboard with factory prefabrication) on the roof boarding.



Construction curve (b)



construction of curve (c)

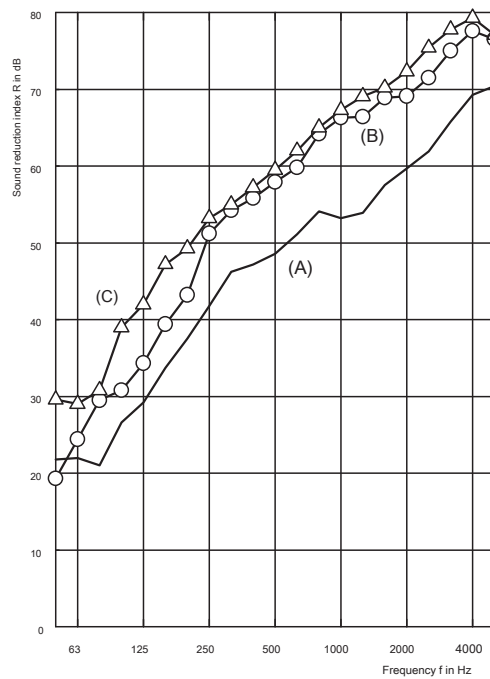
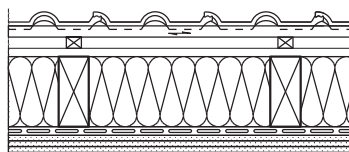
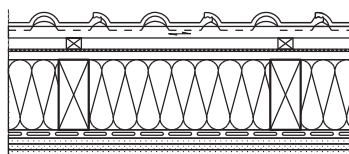


Abb. 3.25

Sound insulation of optimized steep roofs with rafter compared with a standard ball roof construction wood fiber with low pressure (curve a): type ballasting the roof boarding with 12 kg / m² - curve (b) Typ ballasting the roof boarding with 70 kg / m² - curve (c) Example [17]



Construction curve (b)



Construction curve (c)

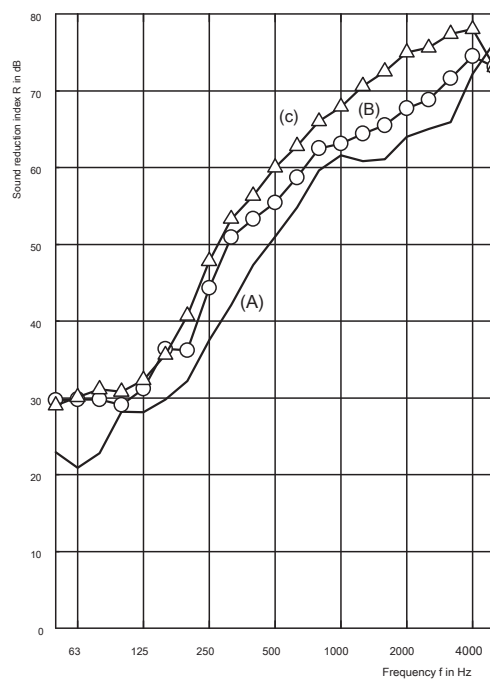


Fig. 3.26

Sound insulation of optimized steep roofs with insulation between rafters compared with a standard ball roof structure (curve a): type decoupling by spring rail - curve (b) type decoupling by spring rail and weighting roof boarding - curve (c) Example [17]

3.4 _ flat roofs

3.4.1 _ roofs

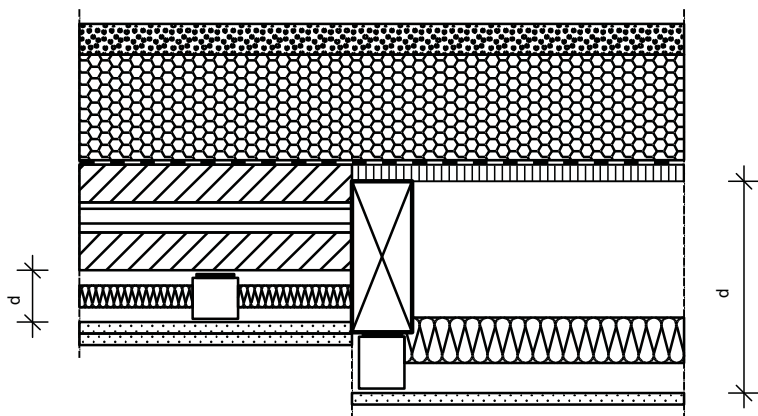
Visible support structures can be realized with a view rafter roofs, roof elements of solid wood elements (Brettspertholz-, glulam, stacked board elements) or rib and box elements. This single-construction of basic designs require a weighting in or on the element for acoustically-quality versions additional masses in the form. Alternatively, the airborne and impact sound insulation can be improved by a (decoupled) False ceiling.

A bb. 3.27

Ceilings on flat roofs.

Acoustically effective air layer

thicknesses d



3.4.2 _ suspended ceiling and

room-side clothing

The clothing of the false ceiling is usually done with plate materials. Advantageous is a large surface density with low bending stiffness of the plate materials. Therefore, a plurality of thin layers should preferably be applied instead of a thick layer. Closed gypsum board formwork groove-and-groove can be achieved over due to the lower joint component and the higher grammage significantly better sound reduction.

Under tops act for the "mass-spring-mass system", which only **above its natural frequency f_0 has a significant improvement of** airborne and impact sound insulation. In order to achieve the **greatest possible improvement, it therefore makes sense f_0 to shift** towards lower frequencies. This can be done by appropriate hangers by the aforementioned high surface density of the plate materials as well as a decoupled mounting of the suspended ceiling. To get a good decoupling to ensure should be run as the constructive required number of suspension points anymore. The spring stiffness of the suspension system is proprietary. Your sound technical effectiveness can be (see component catalog Chapter 6 details) based on the location of the natural frequency for a given load guarantee.

Parallel to the hangers also acts as the area enclosed by the swinging lower ceiling and compressed air volume as a spring. The rigidity of this air layer depends on the volume or the air layer thickness d from. is chosen, the larger d is, the softer the spring. A suspended ceiling therefore acting under a rafter roof significantly better than under a flat solid wood element (see Fig. 3.27).

3.4.3 _ insulation

Non-pressure-loaded insulation materials between rafters and in the false ceiling have a sound-absorbing, in the sound energy by friction and is transformed between the insulating fibers in heat energy. For this purpose, an open cell structure of the insulation material is necessary on the one hand enables the sound pressure wave penetration and on the other hand, opposes a sufficiently large resistance. A good sound-absorbing effect is achieved by insulating materials, whose length-related flow resistance R between 5 kPa s / m^2 and 50 kPa s / m [1]. This can be both with fiber insulation materials from renewable resources than can be achieved with conventional insulating materials. Closed cell insulating boards (z. B. Foam Boards) are not suitable.

Pressure-loaded roof insulation have in addition to the absorbing effect also has the task of decoupling. For pitched roofs are used for this purpose in roof constructions with sound insulation requirements often fiber insulation boards. This is possible even with flat roofs with sheet metal covering (see component catalog Chapter 6). For flat roofs, rigid foam insulation boards are mostly used because of the higher load. These behave initially unfavorable because of its high stiffness, low density and lack of absorption. In connection with thin sealing systems hail or bird impact can lead to noticeable Licher noise. A significant improvement is possible, however, by a ge prop Netten construction above the insulation layer.

3.4.4 _ sealing, roof covering and a floor covering

The structure above the insulating layer is varied depending on use. For non-accessible flat roofs gravel beds, extensive green roofs or roofing membranes are used. The version with roofing sheets without additional mass results expected lower sound reduction. However, previous comparative measurements [22] were significantly lower than the same sound reduction with gravel pads grammage for roof structures with extensive roof greening. The cause is still to be clarified. In gravel pads or extensive roofs, the influence is also to take into account the moisture behavior. For slightly sloping roofs Metal roofing are used. Light roof waterproofing and metal roofing behave total less favorable than serious, more layers applied waterproofing membranes. In addition, with tin roofs, the noise must be considered when heavy rain. Also because of the moisture protection structured release liners should be used, thereby effecting an effective reduction of noise.

As used roof terraces, accessible roofing can with concrete slabs in the gravel, slabs on pedestals or a wood pallet to be executed. While the concrete slabs are effective in the gravel by their mass per unit area, an additional reduction of transmission by decoupling measures can be achieved with pedestals and wooden grids (elastic bearing on structural bearings). For this, the decoupling material from

Manufacturer adapted to a suitable natural frequency of the structure. As a practicable range for the natural frequency $f_0 = 60$ to 70 Hz are desired, the deflection

under the additional burden of a walking person should be mm with $\Delta t < 1.5$. Embodiments are shown in Fig. 3.28.

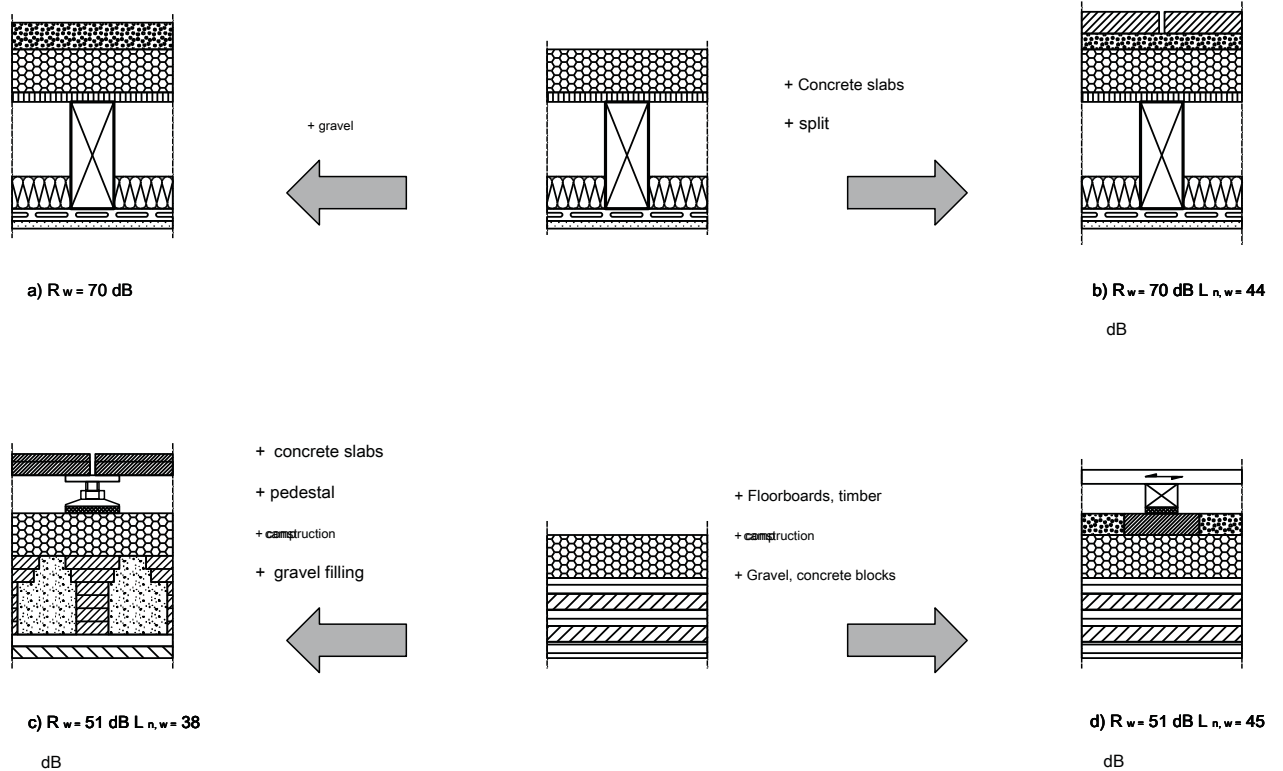


Fig. 3.28

Flat roofs rafter or solid wood elements with different structures:

- a) 50 mm gravel
- b) 40 mm Concrete plates, 30 mm crushed
- c) 40 mm Concrete plates, > 40 mm pedestal, structural bearings 12 mm
- d) 26 mm boards, 44 mm square timber, structural bearings 12 mm, 40 mm crushed and Betonplattung (under structural bearings)

4 _ Building acoustics preliminary design of timber structures

In the following sections, the building acoustics planning is represented by a simple and lying on the safe side preliminary design for an example situation in multi-storey timber construction. The focus is placed on the data sources and the procedure. The preliminary design usually takes place at an early planning stage, so the foundation for a solid building acoustics planning can put through a proper preliminary design and a aufwän ended component repair can be avoided at a later date.

The following building acoustics in the planning process to the preliminary design exact calculation in the detection method according to DIN 4109-2 [1] results, depending on the geometric conditions in the respective building situation, for the detection of airborne sound in buildings of wooden panel construction same or better results. Building of solid wood construction can not yet be calculated according to DIN 4109-2 [1] currently. For often decisive impact sound detection of partition ceilings, the calculation gives the same results as per DIN 4109-2 [1], since the detection method allows no consideration of the geometric relationships and differently executed flanks.

In addition are therefore presented next to the Vorbemessungsverfahren additional combination matrices for separating ceilings and partitions that allow one hand, a quick and safe selection of different combinations of components and on the other hand cover component combinations that are not calculated in accordance with DIN 4109-2 [1]

can. The necessary calculation was carried out calculations according to [30]. For a description of these calculations and the application built the detection method for wood is made to the progenies of this publication.

Vorbemessungsbeispiel:

As an example of the preliminary design to a Ge serve to MBO buildings of building class. 4 this fig. 4.1 and 4.2 show the essential information. For building acoustics preliminary design has proven itself to first examine the partition ceilings since the building acoustics highest demands are placed on them in the timber. then with the definition of the ceiling structure, the edges of the further construction in part will turn parts. This determines the structure of this chapter.

In addition to the requirements for sound protection requirement also features fire protection should be considered. The focus is on high fire-retardant construction. For timber construction requirements of building material class fire resistance, and the so-called encapsulation of the components will be provided depending on the state. Of particular note is the encapsulation as nonflammable here layers mm in a total thickness of about 36 is required. This leads to severe non-combustible Beplankungsschichten who are building acoustics have a positive effect if properly arrangement. A respected in tegrale, cross-disciplinary planning, fire, noise, heat insulation and sta tic aspects alike, in the mo nen timber is essential.

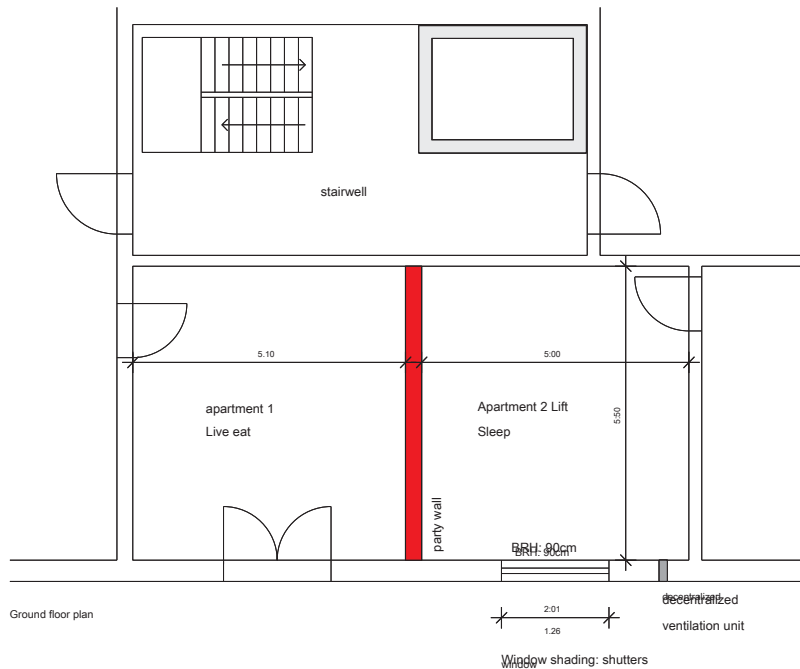
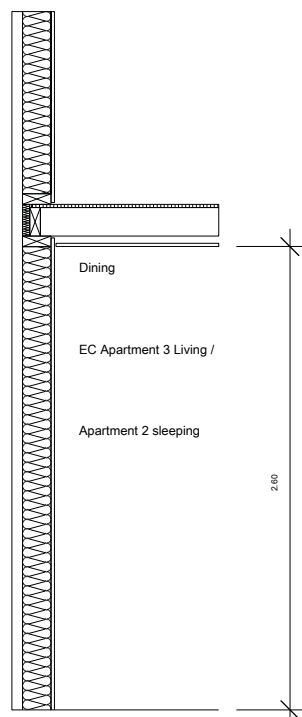


Fig. 4.1:

Layout situation of Example

Rated

Fig. 4.2:

Section in the
examination zone

A method of building acoustic airborne sound
in predimensioning

Since the air passage of sound is measured in all the partition
members to the general procedure is shown. The concrete
examples are explained in each section again.

Vorgehensweise in the preliminary design for the airborne
sound insulation:

1. Target value for R'_{w} determine if
also required for $R_{w} + C_{50-5000}$
(Z. B. BASE +).
2. deriving the component levels from the target value of + 7
dB according to the equation (9) and selecting an
appropriate component. For this purpose can Table 20,
used in Chapter 6 30 and 35, which also notes contain
the fire.
3. Evaluate the flank scenario and the preferences of
edges that criterion $D_{n,t,w} +$ reach 7 dB according to
the equation (10).
4. row and semi-detached partitions matching the
criterion $R_{w} + C_{50-5000}$.

This preliminary design is applicable to both the vertical as well as
horizontal sound transmission in buildings of wooden panel
construction. For separating components with solid wooden edges,
a calculation is analogous to the method of the solid DIN 4109-2 [1]
required, as the edge of transmission rather than the rated standard
edge level difference $D_{n,t,w}$ can be described.

Vorbemessung:

Component:

$$R_{w, \text{component}} \geq R'_{w, \text{target value}} + 7 \text{ dB} \quad (9)$$

Crossing:

$$D_{n, f, w, \text{component}} \geq R'_{w, \text{target value}} + 7 \text{ dB} \quad (10)$$

 $R'_{w, \text{target value}}$:

Agreed target,

z. As in the construction contract BASIS +

 $R_{w, \text{component}}$:

Evaluated sound catalog of a component, such. B. Chapter 6 or DIN 4109-33 [1]

 $D_{n, f, w, \text{component}}$:

Weighted standard flank level difference from a component catalog,

z. B. DIN 4109-33 [1]

Note:

The supplement of 7 dB 2 dB taken into account the prediction of the uncertainty calculation Enver driving and 5 dB, the flanking transmission.

A method of building acoustics

predimensioning during footfall

In the preliminary design for the impact sound a target value

dependent selection from a table we needed gen heterogeneous

situations on the flanks and the ceilings. To set, special Lich is the

criterion $L_{n, w} + C_{1, 50-2500}$

fen to Che if thereon requirements ge is shown.

Procedure for the preliminary design for footfall:1. establishes a target value for $L'_{n, w}$ **and $L_{n, w} + C_{1, 50-2500}$ (z. B. BASE +).**

2. General preselection of a ceiling construction (see analogous to airborne sound Table 20).

a. Type of ceiling: joist or solid wood

b. Type of screed: mineral screed on mineral fiber or wood fiber or dry screed

c. Type of false ceiling: rigidly connected or disconnected

3. Election of the paneling of the walls located below the ceiling (the most unfavorable wall sheathing must be selected).

4. Election of the required element value from Table 5 below.

5. Find a component design that reaches the component parameter (eg. As in Chapter 6).

6. Reading the $C_{1, 50-2500}$ from the

Component kata log for the selected design and

alignment with the corresponding target value (z. B.

BASE +).

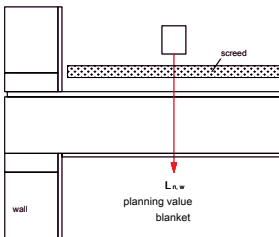
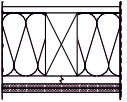
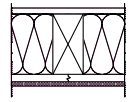
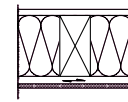
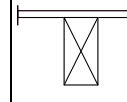
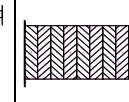
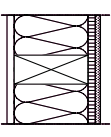
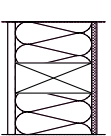
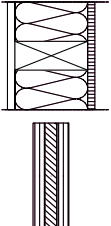
Note:

Are targets between BASE + and COMFORT to choose the line for

COMFORT must be used. For targets $L'_{n, w} < 46$ dB is the simplified

selection no longer applicable.

TABLE 5 | Vorbemessungstabelle for sound insulation levels BASE + and COMFORT for footfall

				1	2	3	4	5
Trittschallvorbemessung für Treendecken für die Klassen BASIS+ und KOMFORT¹⁾ 								
				Beamed ceiling with decoupled 2-layer suspended ceiling	Beamed ceiling with decoupled one-ply sub-ceiling	Beamed ceiling direct gypsum clothing ²⁾	visible Holzbalken-blanket	Solid wood blanket
								
				required $L_{n,w}$ for the separator member				
1	Holztafelbauwand with cervical and GipsBeplankung		screed	A	BASIS+	$L_{n,w}$ 38 dB	$L_{n,w}$ 41 dB	$L_{n,w}$ 43 dB
					KOMFORT	4)	4)	4)
				B	BASIS+	$L_{n,w}$ 40 dB	$L_{n,w}$ 43 dB	$L_{n,w}$ 45 dB
					KOMFORT	$L_{n,w}$ 34 dB	$L_{n,w}$ 37 dB	$L_{n,w}$ 39 dB
				C	BASIS+	$L_{n,w}$ 40 dB	$L_{n,w}$ 43 dB	$L_{n,w}$ 45 dB
					KOMFORT	$L_{n,w}$ 36 dB	$L_{n,w}$ 39 dB	$L_{n,w}$ 41 dB
2	Holztafelbauwand with Gipsbe-plan effect		screed	A	BASIS+	$L_{n,w}$ 37 dB	$L_{n,w}$ 40 dB	dB
					KOMFORT	4)	4)	4)
				B	BASIS+	$L_{n,w}$ 39 dB	$L_{n,w}$ 42 dB	$L_{n,w}$ 45 dB $L_{n,w}$ 39
					KOMFORT	$L_{n,w}$ 33 dB	$L_{n,w}$ 36 dB	dB $L_{n,w}$ 45 dB $L_{n,w}$
					BASIS+	$L_{n,w}$ 39 dB	$L_{n,w}$ 42 dB	wf 41 dB
					KOMFORT	$L_{n,w}$ 35 dB	$L_{n,w}$ 38 dB	
3	Holztafelbauwand with HWSBeplankung or Solid wood walls ³⁾		screed	A	BASIS+	$L_{n,w}$ 33 dB	$L_{n,w}$ 37 dB	$L_{n,w}$ 38 dB
					KOMFORT	4)	4)	4)
				B	BASIS+	$L_{n,w}$ 34 dB	$L_{n,w}$ 38 dB	$L_{n,w}$ 39 dB
					KOMFORT	4)	4)	4)
				CC	BASIS+	$L_{n,w}$ 37 dB	$L_{n,w}$ 41 dB	$L_{n,w}$ 42 dB $L_{n,w}$ 43
					KOMFORT	4)	4)	4)

1) Basis +: $L'_{n,w}$ 50 dB, comfort: $L'_{n,w}$ 46 dB, $L_{n,w}$ + $C_{1,00-2000}$ separate proof

2) Here also plaster coverings on wooden battens without further decoupling measures

3) Also right planked hardwood walls

4) Special measures are required, see section 4.1.3 "Constructive influences on the flanking transmission"

- A  ZE / WF: cement screed or mastic asphalt and wood fiber impact sound insulation boards
- B  ZE / MW: cement screed or mastic asphalt and mineral fiber or EPS impact sound insulation boards
- C  Dry screed on mineral fiber, EPS - or wood fiber sound insulation panels

4.1 _ partition ceilings

The partition ceilings beamed ceilings and hardwood ceilings are to be considered. It is carried out the design of these two types of ceilings in airborne and impact sound insulation for the exemplary floor plan and section situation in Fig. 4.1 and 4.2.

As an example, the partition ceilings are represented only in buildings in timber panel construction. For pure solid wood construction of this publication reference is made due to the complex joints assessment and its calculation on the combination matrix in Table 7 and the progenies.

4.1.1 _ Vorbemessungsbeispiel for wood-beamed ceilings

Subsequently, a preliminary design of building acoustic wooden ceiling beams in buildings of wood panel construction for example, the situation in Fig. Conducted 4.1 and 4.2. For the preliminary design, the sound level of protection is initially set the building in consultation with the client. In this example, the sound level of protection was BASE + selected according to Section 2.4 for the separator ceiling. This can be assumed that an average standard that can be implemented with economic ceiling structures. The additional consideration of low frequencies in the impact sound by the $C_{1, 50-2500}$ leads to a significant improvement of the acoustic level compared to the minimum requirements of DIN 4109-1 [1].

Trittschallverbesserung

Step 1:

The first step in the preliminary design is the removal of the target values of Table 2, Section

2.4 for the selected sound insulation level:

$$\text{Acoustic insulation BASE} + L'_{n,w} \leq 50 \text{ dB}$$

$$L_{n,w} + C_{1, 50-2500} \leq 50 \text{ dB}$$

Step 2:

to allow specifications for ceiling construction, the choice of Table 20th

Ceiling as wooden beamed ceiling type of false

ceiling: min 2-layer plasterboard ceiling as

decoupled suspended ceiling screed.:

Cement screed on mineral fiber insulation

Step 3:

Defining the edge constructions: wood panel construction, room side paneled with wood-based and plasterboard.

With different configurations of the flanking walls it is necessary to choose the least favorable flank to perform lying to the design on the safe side.

Step 4:

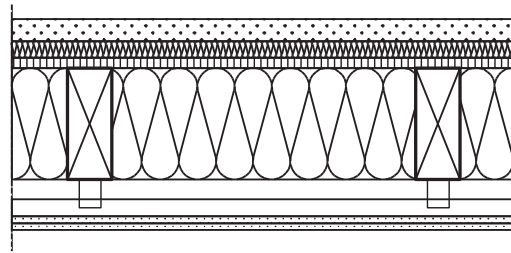
On the basis of the target value for the ceiling including byways ($L'_{n,w} \leq 50 \text{ dB}$), the required for this normalized impact sound pressure $L_{n,w}$ the ceiling will now be removed without byways of Table 5 below. For the selection of the design specifications are used in Step 2 and 3. FIG. The selected ceiling construction

(Beamed ceiling with decoupled 2-layer sub-layer) results in column 1, the selected edge construction to line 1. For a screed type B (cement screed on mineral fiber acoustic tiles), and the sound level of protection BASE + is there the $L_{n,w} \leq 40$ dB.

Step 5:

Now, from the component catalogs of the section 6 or DIN 4109-33

[1] a ceiling with $L_{n,w}$ To search ≤ 40 dB:



Component values: $L_{n,w} (C_{t,50-2500}) = 37$ dB

(12 dB) $R_w = 82$ dB

Fire safety rating: Encapsulation: K: 60 possible fire

resistance: F60-B

→ Suitable for GK 4

Selected ceiling construction according to Figure 4.3 with.:

$L_{n,w} = 37$ dB < 40 dB

Step 6: Check the target value for $L_{n,w} + C_{t,50-2500}$.

Selected ceiling construction according to Figure 4.3 with.:

$L_{n,w} + C_{t,50-2500} = 37 \text{ dB} + 12 \text{ dB} = 49 \text{ dB} < 50 \text{ dB}$

Luftschallverbesserung

Step 1:

Choice of the target value from Table 2, Section 2.4 for the selected sound insulation level:

Sound insulation level: BASIC + $R'_w \geq 57$

dB

Step 2:

Calculation of the evaluated sound transmission loss R_w the ceiling without byways, the R'_w to meet the target value $w \geq 57$ dB is required:

$R_w \geq R'_w + 7 \text{ dB}$ $R_w \geq 64$

dB

Assessment of the selected deck structure according to Fig.

4.3:

$R_w = 82 \text{ dB} > 64 \text{ dB}$

Step 3:

Calculation of the required standard edge level difference $D_{n,f,w}$ the flanking walls:

$D_{n,f,w} \geq R'_w + 7 \text{ dB}$ $D_{n,f,w} \geq 64 \text{ dB}$ (required value)

Assessment of the selected edge in wood panel construction according to Fig. 4.2:

The ceiling separates the wall components completely (Plattformframing).

$D_{n,f,w} = 67 \text{ dB}$ according to DIN 4109-33: 2016 5.1.3.2

D para. $n, f, w = 67 \text{ dB} > 64 \text{ dB}$

Fig. 4.3:

Structure of the ceiling example for the design of Chapter 6, Table 25, line 17

Digression: Alternative preliminary design for COMFORT
(impact sound and airborne sound)

Choice of target values in Table 2, Section 2.4 for the selected
sound insulation level:

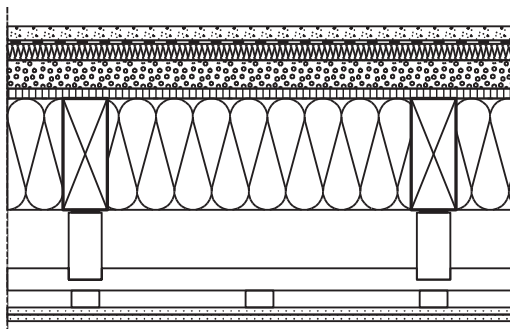
Sound insulation level: COMFORT R'_{w}

$$\geq 60 \text{ dB}$$

$$L'_{n,w} \leq 46 \text{ dB}$$

$$L_{n,w} + C_{1,50-2500} \leq 47 \text{ dB}$$

Cover selection with otherwise identical specifications as the
previous example. There is selected a construction with dry
screed and weighting:



Component values: $L_{n,w} (C_{1,50-2500}) = 34 \text{ dB}$

(11 dB) $R_w = 81 \text{ dB}$

Fire safety rating: Encapsulation: K2 possible fire

resistance: F60-B

→ Suitable for GK 4

Note:

It is a bed with $m' \geq 45 \text{ kg/m}^2$ required. The suspension height of the
false ceiling is from the lower edge joists 140 mm at a natural
frequency of the suspended ceiling $f_0 < 20 \text{ Hz}$.

Calculating $L_{n,w}$ and R_w the ceiling without side paths that are
necessary to achieve the targets:

$$L_{n,w} \leq 36 \text{ dB}$$

(Table 5, column 1, line 1, screed C, sound insulation level
COMFORT)

$$R_w \geq 67 \text{ dB (target value } R'_{w} + 7$$

dB)

Calculation of the required standard edge level difference $D_{n,t,w}$ the
flanking walls:

$$D_{n,t,w} \geq 67 \text{ dB (target value } R'_{w} + 7 \text{ dB)}$$

Assessing the blanket of Fig. 4.4:

$$R_w = 81 \text{ dB} > 67 \text{ dB} \quad L_{n,w} = 34 \text{ dB} < 36 \text{ dB} \quad L_{n,w} + C_{1,50-2500} = 34 \text{ dB} +$$

$$11 \text{ dB} = 45 \text{ dB} < 47 \text{ dB}$$

Assessing the edge in timber panel construction, completely
interrupted in the ceiling shock:

$$D_{n,t,w} = 67 \text{ dB}$$

according to DIN 4109-33: 2016 5.1.3.2 D para. $n, t, w = 67$

$$\text{dB} = 67 \text{ dB}$$

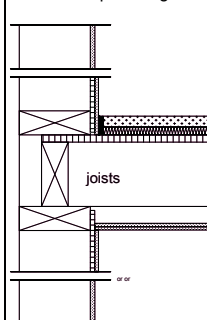
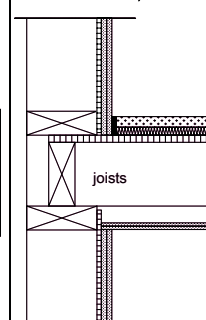
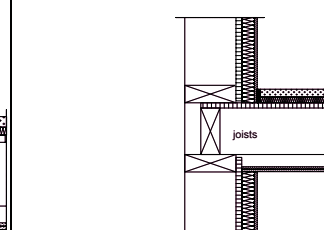
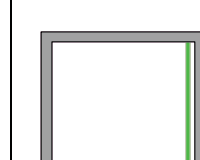
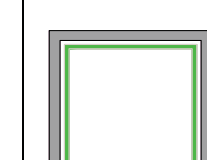
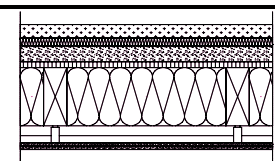
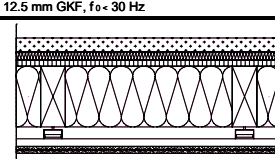
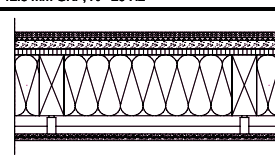
can be seen from the illustrated pre-calculation for the sound level
of protection COMFORT that at this level, the impact sound
transmission is dominant over the flanking walls ($L_{n,w} \leq 36 \text{ dB}$ to $L'_{n,w} \leq 46 \text{ dB}$). It is therefore wise to carry out a detailed calculation that
takes into account additional measures at the flanking walls.

Fig. 4.4:

Structure of the ceiling example for
the design of Chapter 6, Table 25,
line 30

The ceiling wall combination matrix in Table 6 shows how the
different sound levels of protection can be achieved with
optimized ceiling and sidewalls. The results are for different wall
DeckenKom combinations shown from 10 m^2 dividing component
surface. This is a fast from choice, but can not replace a detailed
proof.

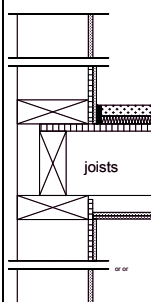
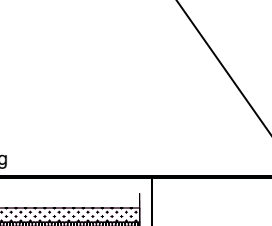
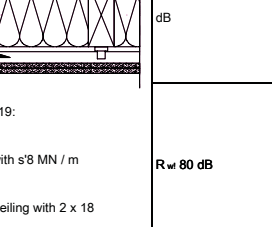
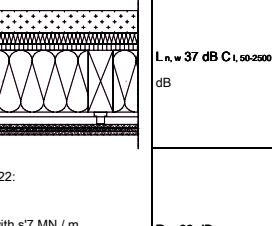
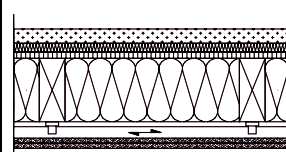
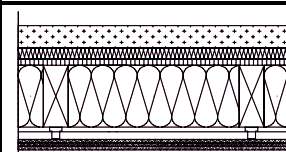
TABLE 6 | Combination matrix for wood-beamed ceilings

		1	2	3	4
L'n,w and R'w für verschiedene Holzdeckens- und Wandkombinationen 1)					
Wall and joints education cover training	Holztafelbauwände with HWS + GK or 1 ply GfBBeplankung  joists or of	Holztafelbauwände inside with 2 x 18 mm GF plate, K z 60 3)  joists	Holztafelbauwände inside with furring up and down "R w 5 dB 2)  joists 1-sided facing layer on 2 sides of the room, more space sides with gypsum fiber or HWS + GKBBeplankung  1-sided facing layer 4 on pages room 		
	 Chapter 6, Table 25, line 15: - ! 50 mm ZE - ! 30 mm TS-insulation with s' 30 MN / m³ - ! 90 kg / m² bed - decoupled suspended ceiling with 2 x 12.5 mm GKF, f o < 30 Hz	L n,w 32 dB C t, 50-2500 = 14 dB R w = 82 dB	L' n,w < 48 dB L n,w + C t, 50-2500 = 46 dB R' w = 60 dB + BASE	L' n,w < 46 dB L n,w + C t, 50-2500 = 46 dB R' w = 65 dB COMFORT	L' n,w < 47 dB L n,w + C t, 50-2500 = 46 dB R' w = 62 dB + BASE
 Chapter 6, Table 25, line 17: - ! 50 mm ZE - ! 30 mm TS insulation with s' 8 MN / m - decoupled suspended ceiling with 2 x 12.5 mm GKF, f o < 20 Hz	L n,w 37 dB C t, 50-2500 = 12 dB R w = 82 dB	L' n,w < 48 dB L n,w + C t, 50-2500 = 49 dB R' w = 60 dB + BASE	L' n,w < 47 dB L n,w + C t, 50-2500 = 49 dB R' w = 65 dB + BASE	L' n,w < 47 dB L n,w + C t, 50-2500 = 49 dB R' w = 62 dB + BASE	L' n,w < 44 dB L n,w + C t, 50-2500 = 49 dB R' w = 67 dB + BASE
 Chapter 6, Table 25, line 27: - ! 22 mm TE - ! 30 mm TS-insulation with s' 30 MN / m³ - ! 90 kg / m² bed - decoupled suspended ceiling with 2 x 12.5 mm GKF, f o < 30 Hz	L n,w 34 dB C t, 50-2500 = 16 dB R w = 80 dB	L' n,w < 45 dB L n,w + C t, 50-2500 = 50 dB R' w > 60 dB + BASE	L' n,w < 44 dB L n,w + C t, 50-2500 = 50 dB R' w = 65 dB + BASE	L' n,w < 45 dB L n,w + C t, 50-2500 = 50 dB R' w = 62 dB + BASE	L' n,w < 42 dB L n,w + C t, 50-2500 = 50 dB R' w = 67 dB + BASE

1) separating member area> 10.0 m, m ceiling height 2.60, all sides equal, square room floor plan

2) facing shell with "R w = 5 dB, for example, installation plane, building acoustic design of the facing layer is required (improvement geg., Column 1)

3) improvement of 2 x 18 mm GF over cladding with 1 x 12.5 mm GF: "R w 3.5 dB

		1	2	3	4	
L'_{n,w} und R' für verschiedene Holzbalkendecken- und Wandkombinationen¹⁾						
Wall and joints education  cover training		Holztafelbauwände mit HWS + GK or 1 ply GFBepunktung 	Holztafelbauwände inside with 2 x 18 mm GF plate, K ≥ 60 s_j 	Holztafelbauwände inside with furring up and down *R_w 5dB s_j 		
4	 Chapter 6, Table 25, line 19: - ! 50 mm ZE - ! 30 mm TS insulation with s'8 MN / m - decoupled suspended ceiling with 2 x 18 mm GKF, f _o < 20 Hz	L'_{n,w} 42 dB C_{I, 50-2500} = 7 dB R_w 80 dB	L'_{n,w} < 53 dB L_{n,w} + C_{I, 50-2500} = 49 dB s_j R' w > 60 dB BASIS	L'_{n,w} < 50 dB L_{n,w} + C_{I, 50-2500} = 49 dB R' w > 65 dB + BASE	L'_{n,w} < 51 dB L_{n,w} + C_{I, 50-2500} = 49 dB s_j R' w > 62 dB BASIS	L'_{n,w} < 49 dB L_{n,w} + C_{I, 50-2500} = 49 dB R' w > 67 dB + BASE
5	 Chapter 6, Table 25, line 22: - ! 80 mm ZE - ! 40 TS insulation mm with s'7 MN / m - decoupled suspended ceiling with 3 x 12.5 mm GKF, f _o < 20 Hz	L'_{n,w} 37 dB C_{I, 50-2500} = 9 dB R_w 83 dB	L'_{n,w} < 48 dB L_{n,w} + C_{I, 50-2500} = 46 dB s_j R' w > 60 dB + BASE	L'_{n,w} < 46 dB L_{n,w} + C_{I, 50-2500} = 46 dB R' w > 65 dB COMFORT	L'_{n,w} < 47 dB L_{n,w} + C_{I, 50-2500} = 46 dB s_j R' w > 62 dB + BASE	L'_{n,w} < 46 dB L_{n,w} + C_{I, 50-2500} = 46 dB R' w > 67 dB COMFORT

1) separating member area > 10.0 m, m ceiling height 2.60, all sides equal, square room floor plan
 2) facing shell with *R_w = 5 dB, for example, installation plane, building acoustic design of the facing layer is required (improvement geg., Column 1)
 3) improvement of 2 x 18 mm GF over cladding with 1 x 12.5 mm GF: *R_w = 3.5 dB
 4) Subjectively perceived already COMFORT
 5) Subjectively perceived already BASIS +

Note: Airborne noise considered. He indicated the results can therefore be directly compared with the target values of the agreed noise protection levels.

4.1.2 _ Vorbemessungsbeispiel for solid wood

ceiling

Below is represented in the same way as for the wood-beamed ceilings, a preliminary design for solid wood ceilings in buildings in timber panel construction.

Fig. 4.5:

Structure of the selected solid wood ceiling Chapter 6, Table 26, line 3

Trittschallvorbemessung

Step 1:

The first step in the preliminary design is the Ent acquisition of the target values from Table 2, Absch Nitt

2.4 for the selected sound level protection:

$$\text{Acoustic insulation BASE} + L'_{n,w} \leq 50 \text{ dB}$$

$$L_{n,w} + C_{l, 50-2500} \leq 50 \text{ dB}$$

Step 2:

to allow specifications for ceiling construction, the choice of Table 20th

Cover design: solid wood

ceiling type of false ceiling:

exposed wood surface without suspended ceiling screed:

Cement screed on mineral fiber footfall sound insulation

Step 3:

Defining the edge constructions: wood panel construction, room side paneled with wood-based and plasterboard

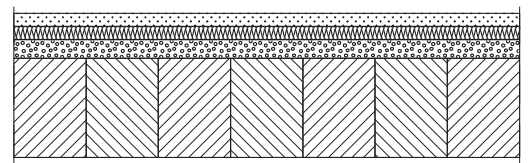
Step 4:

On the basis of the target value for the ceiling including byways ($L'_{n,w} \leq 50 \text{ dB}$), the required design value of the ceiling being removed without side paths from Table 5 below. The chosen ceiling construction (solid wood ceiling without Unterdecke) leads to column 5, the selected Flankenkonstruktion to line 1. For a trich type B (cement screed on mineral fiber acoustic tiles), and the sound level of protection BASE + is there the design level $L_{n,w} \leq 45 \text{ dB}$.

Step 5:

Now, from the component catalogs of the section 6 or DIN 4109-33

[1] a ceiling with $L_{n,w}$ To search $\leq 45 \text{ dB}$:



Component values: $L_{n,w} (C_{l, 50-2500}) = 40 \text{ dB}$

(8 dB) $R_w = 72 \text{ dB}$

Fire safety rating: Encapsulation: no fire resistance:

F60-B

Selected ceiling construction according to Figure 4.5 with.:

$$L_{n,w} = 40 \text{ dB} < 45 \text{ dB}$$

Step 6: Check the target value for $L_{n,w} + C_{l, 50-2500}$.

Selected ceiling construction according to Figure 4.5 with.:

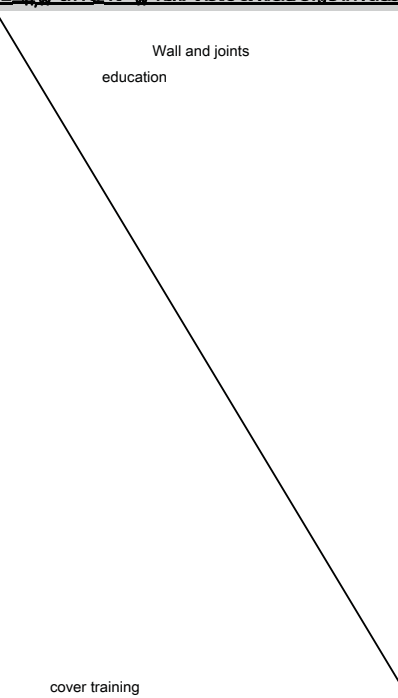
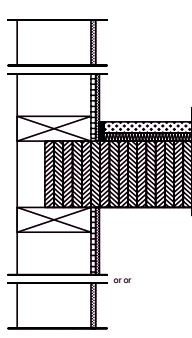
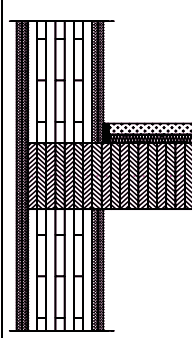
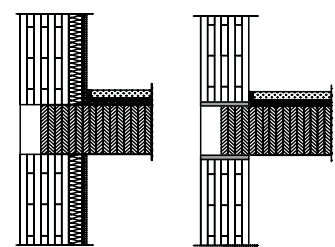
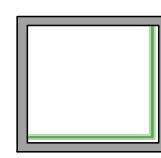
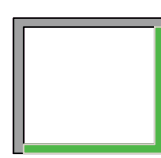
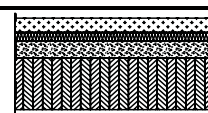
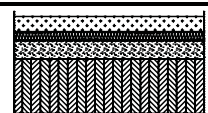
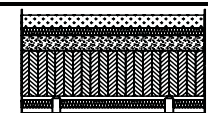
$$L_{n,w} + C_{l, 50-2500} = 40 \text{ dB} + 8 \text{ dB} = 48 \text{ dB} < 50 \text{ dB}$$

In regard to airborne sound design:

In the example, only the impact sound insulation is pointed by. with $R_w = 72 \text{ dB}$ and Plattformframing construction is omitted sound detection of the air in favor of clarity. For pure solid wood construction of the airborne sound insulation can be quite bemessungsmaßgebend and must be checked.

The ceiling wall combination matrix in Table 7 shows how the different sound levels of protection can be achieved with optimized ceiling and sidewalls. The results are shown for different ceiling-wall combinations from 10 m^2 dividing component surface. This is a fast choice, but can not replace a detailed proof.

TABLE 7 | Combination matrix for solid wood ceiling

			1	2	3	4
L' _{n,w} and R' _w für verschiedene Massivholzdecken und Wandkombinationen ¹⁾						
Wall and joints education  cover training			Holztafelbauwände with HWS + GK or 1 ply GFBeplankung  or or	Solid wood panels with 2 x 18 mm GFPlatte, R_w = 44,8 dB, K ≥ 60 2) 3) 4) 5) 6) 	Solid wood walls inwardly facing shell with the top and bottom *R_w 5 dB, base wall R_w = 32.8 dB 2) 3) 4) 5)  1-sided detached furring CW + 12.5 mm GK on 2 sides of the room and other room sides with wooden stud wall with HWS + GK or GF  Improvement by elastomer insert up and down on two sides of the room and other room pages Holzständerwand HWS + GK or GF 7) 8) 	
1	 Chapter 6, Table 26, line 3: - ! 50 mm ZE - ! 40 TS insulation mm with s'7 MN / m - ! 90 kg / m² bed - R_w = 48 dB without screed	L_{n,w} 40 dB C_{l, 50-2500} = 8 dB R_w 72 dB	L'_{n,w} < 48 dB L_{n,w} + C_{l, 50-2500} = 48 dB R'_w 60 dB + BASE	L'_{n,w} < 47.2 dB L_{n,w} + C_{l, 50-2500} = 48 dB R'_w 56 dB + BASE	L'_{n,w} < 46 dB L_{n,w} + C_{l, 50-2500} = 48 dB R'_w 56 dB + BASE	L'_{n,w} < 46 dB L_{n,w} + C_{l, 50-2500} = 48 dB R'_w 59 dB + BASE
	 Chapter 6, Table 26, line 4: - ! 50 mm ZE - ! 40 TS insulation mm with s'7 MN / m - ! 150 kg / m² bed - R_w = 51 dB without screed	L_{n,w} 38 dB C_{l, 50-2500} = 4 dB R_w 77 dB	L'_{n,w} < 46 dB L_{n,w} + C_{l, 50-2500} = 42 dB R'_w 60 dB COMFORT	L'_{n,w} < 46 dB L_{n,w} + C_{l, 50-2500} = 42 dB 9) R'_w 57 dB + BASE	L'_{n,w} < 45 dB L_{n,w} + C_{l, 50-2500} = 42 dB 9) R'_w 58 dB + BASE	L'_{n,w} < 45 dB L_{n,w} + C_{l, 50-2500} = 42 dB 9) R'_w 59 dB + BASE
3	 Chapter 6, Table 27, line 2: - ! 50 mm ZE - ! 30 mm TS insulation with s'8 MN / m - ! 90 kg / m² bed - decoupled suspended ceiling (180 mm) with 2 x 12.5 mm GKF, f₀ < 30 Hz	L_{n,w} 23 dB C_{l, 50-2500} = 26 dB R_w 82 dB	L'_{n,w} < 46 dB L_{n,w} + C_{l, 50-2500} = 49 dB R'_w 60 dB + BASE	L'_{n,w} < 43 dB L_{n,w} + C_{l, 50-2500} = 49 dB R'_w 59 dB + BASE	L'_{n,w} < 42 dB L_{n,w} + C_{l, 50-2500} = 49 dB R'_w 57 dB + BASE	L'_{n,w} < 42 dB L_{n,w} + C_{l, 50-2500} = 49 dB R'_w 60 dB + BASE
1) separating member area > 10.0 m, m ceiling height 2.60, all sides equal, square room floor plan 2) Solid wood wall with d_{min} = 80 mm, R_w = 32 dB, Solid wood element s'1 36 kg / m² 3) Solid wood ceilings with d_{min} = 140mm, R_w = 39 dB, Solid wood element s'1 36kg / m plus. The respective weighting 4) improve by free-standing front shells with *R_w 8 dB 5) The Sound reduction index is simplified for one-sided cladding of the wall determined by direct skins and for T-joints with K_{st} = 21 dB or K_{Fd/Df} = 14 dB, linings on one side are taken into account (for the cross-joints are similar values before) 6) If, instead of GF plates used GKF plates, then a deterioration 1.5 to 3 dB can be expected for airborne and impact sound 7) elastomer must also be above the Holztafelbauwänden, there may be an additional improvement 8) Elastomer Properties: K_{st} = 35 dB or K_{st}; K_{st} = 22 dB, characteristic frequency of the elastomers: f₀ (Note pressure from a static pre-load) 20 Hz 9) already COMFORT complied When impact sound, but not the airborne sound insulation						

Color coding of sound insulation levels in Table 7: green - BASE + blue - COMFORT

Note:

For the evaluation of the ceiling was belle in Ta 7 already forecast
uncertainty $u_{\text{prog}} = 3 \text{ dB}$ for the impact sound and $u_{\text{prog}} = 2 \text{ dB}$ for the
 airborne sound considered. The results reported thus can be
 directly compared with the target values of the agreed noise
 protection levels.

4.1.3 _ Constructive influences on the flanking transmission

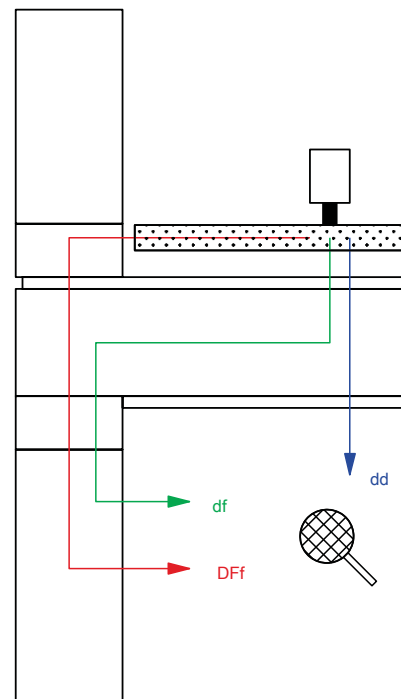
For the evaluation of the components in the installation situation
 looking at the ceiling alone is not sufficient. Rather, in high
 sound-absorbing wooden ceilings, the building acoustic events of
 the flanking transmission can be dominated. Therefore, the
 flanking transmission is to pay a lot of attention in building
 acoustics. For the footfall 4109-2 [1] is a differentiated approach
 as for airborne sound not previously possible in the detection
 method according to DIN. So it's always zoom to pull the worst
 edge and be messungsmaßgebend.

Fig. 4.6:

Flanking paths for impact
 sound excitation of a ceiling

Flanking transmission in impact sound excitation

In assessing the impact sound individual sound transmission paths
 are considered. This is on the one hand the way across the beam
 ends in the underlying wall (bypassing the false ceiling) on the way
 Df in Fig. 4.6 and the other the way across the
 Estrichranddämmstreifen on the way DFf in Fig. 4.6 in the flanking
 wall.



These two ways to increase the rated impact sound in the building
 and are taken into consideration when calculating a separate
 correction summands. Basically, that the influence of the flanking
 walls is greater, the better the sound insulation of the ceiling itself is
 clear. This is shown in Fig. 4.7. There, the influence of the flanking
 transmission (path Df and DFf) than the standard premium to the L_n .
 w represents the ceiling without byways.

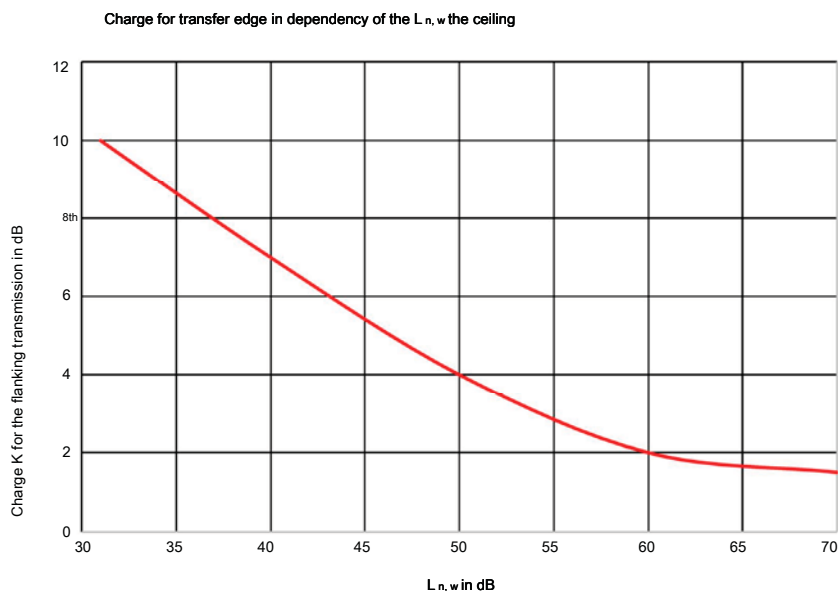


Figure 4.7.:

Depending on the flanking transmission of the quality of the ceiling used

It turns out that the flanks with increasing quality of the ceiling increasingly to be taken into account. While with ceilings with $L_{n,w}$ about 60 dB for the successful transmission the flanks of approximately 2 dB, the supplement is for ceilings with $L_{n,w} = 35$ dB already at about 9 dB.

- Connection of the wall sheathing to the Wandgefach: the softer the coupling to the wall layer, the lower the transmission via this route.
- Additional lining (installation level).
- Execution of the floor structure and the edge connector.

The flanking transmission is detected only roughly by this standard amount. Depending on the version of the false ceiling and the walls flanking significant deviations from the fitted curve in Fig. 4.7 are possible. The transmission paths Df and DFf contained in the illustrated supplement K are determined by the following factors:

Factors influencing the flanking transmission

- Coupling the ceiling to the flanking walls (Deckenaufleger).
- Design type of the flanking wall (or solid wood timber panel wall).
- Type of wall sheathing (the stiffer and easier to the wall paneling, the bigger the transfer).

Influence of the transmission path Df to the total transmission

The influence of the flanking transmission on the way Df over direct transmission through the ceiling (way Dd) depends largely on the execution of the suspended ceiling. During screed and Rohdeckenbeschwerung the transfer on the paths Dd and Df abmindern equally strong, the suspended ceiling affects only the way Dd. is higher the quality of the false ceiling is carried out, the greater the influence of the path Df on the total transmission. Here significant improvements can be achieved by additional measures at the flanking walls.

In open beamed ceilings and hardwood ceilings without suspended ceilings, the flanking paths occur, however, not so much in evidence, as would be the case with false ceiling due to the energetic addition. Thus solid wood ceilings can achieve to stand without ceilings certainly better values when installed as the pure comparison of $L_{n,w}$ would suggest the ceiling.

Influence of the transmission path DFf to the total transmission

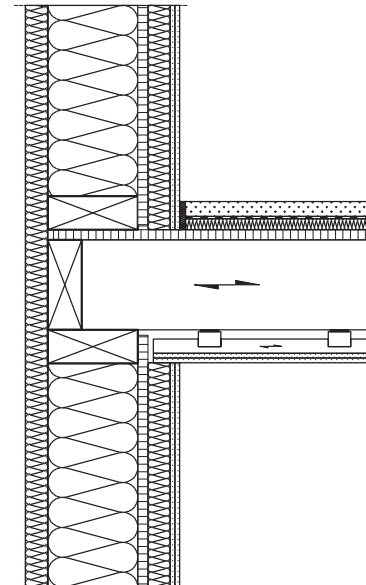
The second correction summand in the impact sound transmission takes into account the transmission over the screed in the flanking wall. In this transmission, the screed type exposes initially apparent.

Dry lines show the best values with respect to the cross transmission on the way DFf because of their lower stiffness and higher internal damping. Another influence the execution of impact sound insulation and edge insulation strips. Since the path DFf is not reduced by additional Rohdeckenbeschwerungen nor suspended ceilings, it is especially noticeable in high-quality ceiling structures to light whose transmission has been greatly reduced in the ways Dd and Df.

Special additional measures

In the Vorbemessungstabelle Table 5 is the Footnote 4) marked with the words "special measures required." In these designs the flanks transmission such dominant that the target values can not be reached with conventional ceiling structures. Here, the edges must be significantly improved. This can be done by decoupled facings / installation levels at all cross paths. However, it is important to ensure that the suspended ceiling to behind the furring enough

as shown in Fig. 4.8. this is necessary for effective fire protection cladding already very common, with also other measures such as mineral fiber penetration seals may be required. are for this higher edge education currently no rated values before, thus the verification is not possible. In addition, elastic layers between bar and wall head bring an improvement. It is recommended that in such extreme situations to consult a soundproofing professional planners and perform necessary pattern measurements on sample areas.



Edge evaluation for airborne sound transmission

For separating ceilings which the HolztafelbauWände vertically completely interrupt ("Plattformframing") section In accordance with DIN 4109-33 [1], D 5.1.3.2 $n_{t,w} = 67$ dB. As a result, the edge criterion in the case of air-borne noise to the sound level of protection COMFORT meets all targets shown. For the balloon framing construction so far no confirmed findings are.

A bb. 08.04:

Schematic representation
of a furring as improved
impact sound edge

Flanking walls of solid wood construction have significantly higher flanking transmission than Holztafelbauwände. The significantly stiffer solid wood elements need to set measures to achieve the various sound levels of protection. Proven additional measures are:

- Decoupling the flanking wall by the elastomer bearing between the ceiling and wall.
- Installation levels as facings.
- **Fire protection required Zusatzbeplankungen (K₂ 60 encapsulation).**

4.2 _ partition walls in multi-storey buildings

In addition to the partitions separating ceilings from acoustic point of view, the highest to be demands made in multi-storey buildings. They ensure confidentiality in their own homes. For a residentially optimal use a partition should be, however, the width of 30 cm not exceed. The following is a preliminary design by the exemplary system of thumb is performed.

4.2.1 _ Vorbemessungsbeispiel for partitions

For the Vorbemessungssituation a simplified pre-calculation is performed with the partition described below from the component catalog in Chapter. 6

Step 1:

Choice of the target value from Table 2, Section 2.4 for the selected sound insulation level:

Sound insulation level: BASIC + R'w ≥ 56

dB

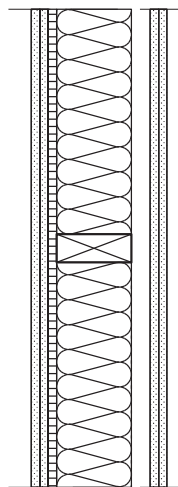
Step 2:

Calculation of the evaluated sound transmission loss R_w the partition without byways, the R' to meet the target value w ≥ 56 dB is required:

$$R_w \geq R'w + 7 \text{ dB } R_w \geq 63$$

dB

Selection of a suitable partition wall of housing 1 by Apartment 2 with R_w ≥ 63 dB from the component catalog in Chapter 6:



Component value: R_w

= 63 dB

Fire safety rating: Encapsulation: K₂ 60 fire

resistance time: F60-B

Assessment of the partition of Figure 4.9.:

R_w = 63 dB (demand value) = 63 dB (component characteristic value)

Step 3:

Calculation of the required standard edge level difference D_{n,t,w} flanking components:

$$D_{n,t,w} \geq R'w + 7 \text{ dB } D_{n,t,w} \geq$$

63 dB

A bb. 09.04:

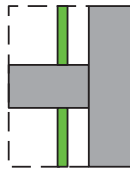
Flat partition Chapter 6, Table

41, line 2

Selection of the flanking outer wall

For the flanking outer wall a lationsebene In stal is provided. Here, from DIN 4109-33 [1], Table 28, line 1, the following value can be read:

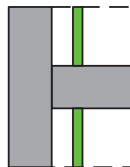
$D_{n,t,w} = 68 \text{ dB} > 63 \text{ dB}$ DIN 4109-33: 2016 Table 28,
line 1



Selection of flanking inner wall of the stairwell

The request to the stairwell wall is similar high as to the party wall. It can be assumed, therefore, that the same construction comes as the party wall used. . The furring of the partition of Figure 4.9 can be attached living room side then on the stairwell wall and are interrupted by the party wall:

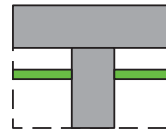
$D_{n,t,w} = 68 \text{ dB} > 63 \text{ dB}$ DIN 4109-33: 2016 Table 28,
line 1



Selection of the flanking ceiling

For a beamed ceiling with broken above the partition suspended ceiling, as it will be used in this example, the following applies:

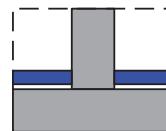
$D_{n,t,w} = 67 \text{ dB} > 63 \text{ dB}$ DIN 4109-33: 2016 Table 36,
line 8



Selection of the flanking floor structure

For floating screeds, which are interrupted by the partition, the following applies:

$D_{n,t,w} = 67 \text{ dB} > 63 \text{ dB}$ DIN 4109-33: 2016, Section
5.3.1.1



Summary and information on other combinations of components

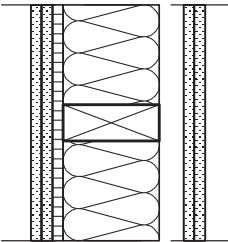
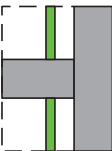
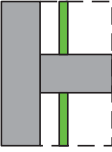
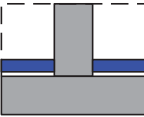
The summary of the Vorbemessungsbeispiels and a supplementary example with accompanying massive wooden ceiling are shown in Table. 8 and 9 For pre-calculation of DIN 4109 [1], so a partition area of 10 m², a ceiling height of 2.80 m and a partition width of 4.50 m is assumed that the reference values. The component data are thus to be seen directly from the parts catalogs, such as from DIN 4109-33 [1], in section 6 of this document or from test certificates. The detailed forecast results in separation component surfaces over 10 m or ceiling heights less than 2.80 m to better results. This can lead to a more economical structural implementation.

matrix created in Table 10 below. The calculations were carried out according to [30]. Similarly, a combination matrix for pure solid wood construction in Table 11 was created. For this combination matrices less of a ceiling height 2.60 m has been assumed. For the calculated results R'_{w} in Table 10 and 11, the Pro has already gnoseunsicherheit $u_{\text{prog}} = 2 \text{ dB}$ in accordance with DIN 4109-2 [1] deducted. The readings can be compared so directly with the target value of the corresponding sound levels of protection.

The preliminary design shown is only possible for flanking components whose flanking transmission by the weighted standard edge level difference $D_{n,t,w}$ can be described.

Accompanying solid wood components, this is not the case. In order to provide for the combination of wood panel components with solid wood parts planning values are available, the combination was

Table 8 | Preliminary design of a partition wall, ceiling with beams as an edge

1	2	3	4
preliminary design partitions			
target value	Sound level of protection BASE + $R'_{w} \geq 56 \text{ dB}$	Vorbemessungsaufschlag = 7 dB	Component value $\geq$ 63 dB
Component or transmission path:	R_w or $D_{n,t,w}$	execution	evaluation
1 component right	$R_{w, \text{component}} = 63 \text{ dB}$		= 63 dB 63 dB
2 Outer wall edge Installation level interrupted by partition	$D_{n,t,w} = 68 \text{ dB DIN 4109-33}$: 2016 Table 28, line 1		68 dB > 63 dB
3 Stairwell edge Installation level interrupted by partition	$D_{n,t,w} = 68 \text{ dB DIN 4109-33}$: 2016 Table 28, line 1		68 dB > 63 dB
4 blanket Partition interrupts suspended ceiling	$D_{n,t,w} = 67 \text{ dB DIN 4109-33}$: 2016 Table 36, line 8		67 dB > 63 dB
5 ground Partition interrupts screed	$D_{n,t,w} = 67 \text{ dB DIN 4109-33}$: 2016 Section 5.3.1.1		67 dB > 63 dB

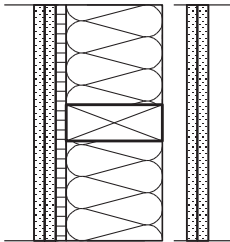
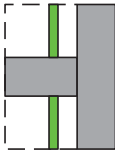
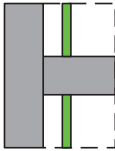
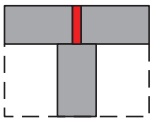
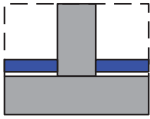
B eplankung with cervical or GK wall or ceiling



body screed - dry or wet



Table 9 | Predimensioning a partition with separate solid wood ceiling as flank

1	2	3	4
preliminary design partitions			
target value	Sound level of protection BASE + $R'_{w} \geq 56 \text{ dB}$	Vorbemessungsauflage = 7 dB	Component value $\geq$ 63 dB
Component or transmission path:	R_w or $D_{n,t,w}$	execution	evaluation
1 component right	$R_{w, \text{component}} = 63 \text{ dB}$		= 63 dB > 63 dB
2 Outer wall edge Installation level interrupted by partition	$D_{n,t,w} = 68 \text{ dB DIN 4109-33}$: 2016 Table 28, line 1		68 dB > 63 dB
3 Stairwell edge Installation level interrupted by partition	$D_{n,t,w} = 68 \text{ dB DIN 4109-33}$: 2016 Table 28, line 1		68 dB > 63 dB
4 ceiling edge Solid wood, separated with loading	$R_{Ft,w} = 64 \text{ dB } ^{1)}$		64 dB > 63 dB
5 ground Partition interrupts screed	$D_{n,t,w} = 67 \text{ dB DIN 4109-33}$: 2016 Section 5.3.1.1		67 dB > 63 dB

¹⁾ Calculated according to [30], with the measurement data for 160 mm solid wood element + m = 90 kg / m² grt, $R_w = 54 \text{ dB}$

Planking with cervical or GK wall or ceiling body



screed - dry or wet separation of levels



Table 9 shows that the sound level of protection BASE + by separation of solid wooden ceiling is reached. Continuous solid wood ceilings provide the necessary edge sound insulation in the rarest cases.

The Flankendämm index $R_{Ft,w}$ flanking solid wood ceiling was determined for this purpose, the reference sizes of the DIN 4109 according to [30] with measurement data from [21].

TABLE 10 | Combination matrix for edge situation of partition walls in timber panel construction

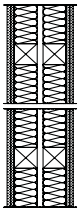
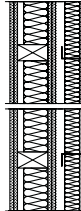
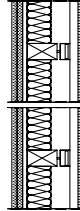
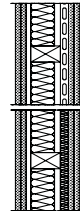
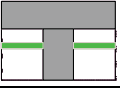
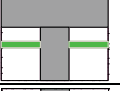
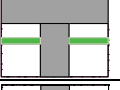
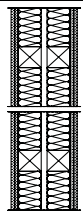
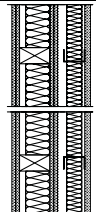
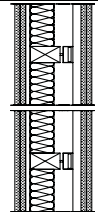
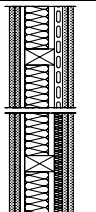
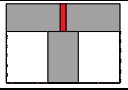
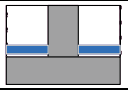
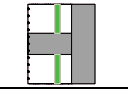
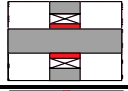
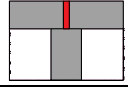
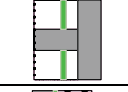
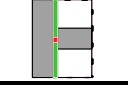
R' für verschiedene Holztafelstrennwand-Flankenkombinationen		1	2	3	4
wall component 1)		 Cape. 6, tab 41, Z.. 8: - Double shell wood panel wall - 2-ply GF both sides, 10 mm + 12.5 mm - R_w 66 dB	 Cape. 6, tab 41, Z.. 4: - Wood panel wall with free standing furring (CW profile) - R_w 64 dB	 Cape. 6, tab 41, Z.. 2: - Wood panel wall (K 60) - 2 x 18 mm GKF + HWS - 2 x 18 mm GKF on CD-profile with whip-arm - R_w 63 dB	 Cape. 6, Table 41, Z. 6th: - Wood panel wall with spring rail as subsequent clothing - R_w 61 dB
edge combination					
1	Joists with separate sub-ceiling D _n , τ _w = 67 dB				
	Wall to ceiling, floor separated D _{n,τ,w} = 67 dB		R' _w > 58 dB	R' _w > 58 dB	dB
	Coupling wall 1 with separate installation level D _{n,τ,w} = 68 dB				
	Coupling wall 2 with separate installation level D _{n,τ,w} = 68 dB		BASE +	BASE +	BASE +
2	Joists with separate sub-ceiling D _n , τ _w = 67 dB				
	Wall to ceiling, floor separated D _{n,τ,w} = 67 dB		R' _w = 56 dB	R' _w > 56 dB	R' _w = 56 dB R' _w = 57
	Coupling wall 1 with separate installation level D _{n,τ,w} = 68 dB				
	Coupling wall 2 with separate sheeting D _{n,τ} , w = 61 dB		BASE +	BASE +	BASE +
3	Joists with separate sub-ceiling D _n , τ _w = 67 dB				
	Wall to ceiling, floor separated D _{n,τ,w} = 67 dB		R' _w = 55 dB	R' _w > 54 dB	R' _w = 54 dB
	Coupling wall 1 with separate sheeting D _{n,τ} , w = 61 dB				
	Coupling wall 2 with separate sheeting D _{n,τ} , w = 61 dB		BASE	BASE	BASE
1) separating member area > 10.0 m, ceiling height 2.60 m		Planking with cervical or GK wall or ceiling body screed  Separation of levels 			

TABLE 10 | continuation

R'_{w} für verschiedene Holztafel-Trennwand-Flankenkombinationen		1	2	3	4
wall component 1) edge combination		 Cape. 6, tab 41, Z.. 8: - Double shell wood panel wall - 2-ply GF both sides, 10 mm + 12.5 mm - $R_{w} = 66$ dB	 Cape. 6, tab 41, Z.. 4: - Wood panel wall with free standing furring (CW profile) - $R_{w} = 64$ dB	 Cape. 6, tab 41, Z.. 2: - Wood panel wall (K: 60) - 2 x 18 mm GKF + HWS - 2 x 18 mm GKF on CD-profile with whip-arm - $R_{w} = 63$ dB	 Cape. 6, Table 41, Z. 6th: - Wood panel wall with spring rail as subsequent Clothing - $R_{w} = 61$ dB
4	visible solid wood ceiling with separating cut through wall 2) 3)		$R'_{w} = 56$ dB	$R'_{w} = 55$ dB	$R'_{w} = 55$ dB
	Wall to ceiling, floor separated $D_{n,t,w} = 67$ dB				
	Coupling wall 1 with separate installation level $D_{n,t,w} = 68$ dB				
	Coupling wall 3: cross joint with dry or wood panel wall, $D_{n,t,w} = 67$ dB				
5	visible solid wood ceiling with separating cut through wall 2) 3)		$R'_{w} = 55$ dB	$R'_{w} = 54$ dB	$R'_{w} = 54$ dB
	Wall to ceiling, floor separated $D_{n,t,w} = 67$ dB				
	Coupling wall 1 with separate installation level $D_{n,t,w} = 68$ dB				
	Coupling wall 2 with separate sheeting $D_{n,t,w} = 61$ dB				
1) separating member area > 10.0 m; ceiling height 2.6 0m 2) Mindestbeschwerung! 90 kg / m ² ; Solid wood $d_{min} = 140$ mm; $R_w = 54$ dB 3) $R_{fl} = 61$ dB; $K_{fl} = 7$ dB; mixed flanking paths are ignored		with cervical or GK Wall or ceiling body screed planking Separation of levels			

Color coding of the sound level of protection Table 10: yellow - green BASIS -
BASIS +

TABLE 11 | Combination matrix for edge situation of partitions of solid wood construction

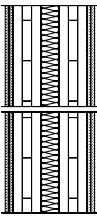
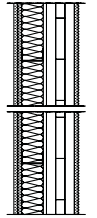
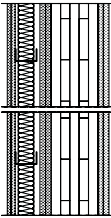
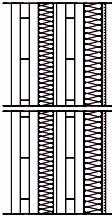
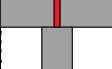
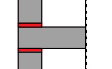
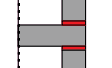
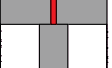
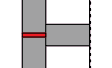
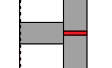
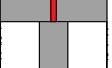
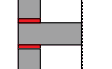
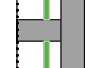
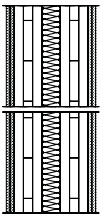
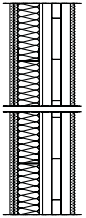
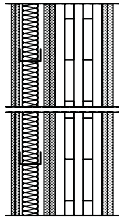
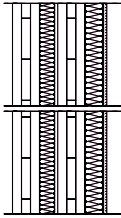
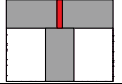
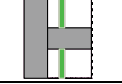
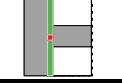
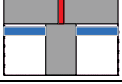
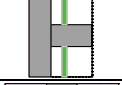
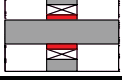
		1	2	3	4
R' für verschiedene Massivholzstreuwand-Flankenkombinationen					
wall component 1)					
edge combination		Cape. 6, tab 42, Z.. 4: - 2 x 90 mm MH wall with 60 mm pitch - 2 x 12.5 mm GKF unilaterally - R_w 61 dB	Cape. 6, tab 42, Z.. 1: - 100 mm MH Wall - 75 free-standing attachment cup-mm (CWProfil) with 2 x 12.5 mm GKF - R_w 62 dB	Planning Value: 6) - MH-wall with 2 x 18 mm GF 140 mm on both sides - 75 mm free-standing furring with 2 x 12.5 mm GKF - R_w 63 dB	Cape. 6, tab 42, Z.. 1: - 100 mm MH Wall - 50 mm + 10 mm MW separation - 90 mm MH Wall - 60 mm battens on rubber strap with 12.5 mm GKF - R_w 63 dB
1	visible solid wood ceiling with separating cut through wall 2)				
	Wall solid wood ceiling, floor separated 2) 3)		R' w% ≤ 56 dB	R' w% ≤ 48 dB	R' w% ≤ 54 dB
	Coupling type 1 with interrupted MH wall 4)				
	Coupling type 1 with interrupted MH wall 4)		BASE +	not met minimum requirement	BASE
2	visible solid wood ceiling with separating cut through wall 2)				
	Wall solid wood ceiling, floor separated 2) 3)		R' w% ≤ 56 dB	R' w% ≤ 47 dB	R' w% ≤ 53 dB
	Coupling type 2: with separate solid wood wall 4)				
	Coupling type 2: with separate solid wood wall 4)		BASE +	not met minimum requirement	BASE
3	visible solid wood ceiling with separating cut through wall 2)				
	Wall solid wood ceiling, floor separated 2) 3)		R' w% ≤ 57 dB	R' w% ≤ 50 dB	R' w% ≤ 56 dB
	Coupling type 1 with interrupted MH wall 4)				
	Coupling Type 3: continuous solid wood wall with furring 5)		BASE +	not met minimum requirement	BASE +
1) separating member area > 10.0 m, m clear height 2.60 m GKF = 800 kg / m ³ wood = 450 kg / m ³ GF = 1150 kg / m ³ The calculation method is based on the latest research results and has not yet been established normative. 2) Mindestbeschwerung m ² by bulk 90 kg / hardwood d _{min} = 140 mm, m ² = 153 kg / m ² , R _w = 54 dB (from measurement) 3) #R _w , screed ≤ 14 dB, 50 mm ZE to Mineral fiber 4) 90 mm MH + 2 x 12.5 GKF, m ² = 61 kg / m ² , GKF- od. GF-planking not continuous 5) #R _w , vs% ≤ 16 dB detached with 1 x 12.5 mm GKF, distance 70 mm 6) Planning value as the calculation result from measurement data of the base wall and the facing layer					
				Planking with cervical or GK Wall or ceiling body Screed - dry or wet Separation of levels	   

TABLE 11 | continuation

		1	2	3	4
R' für verschiedene Massivholzstreuwand-Flankenkombinationen					
wall component 1)					
		Cape. 6, tab 42, Z.. 4: - 2 x 90 mm MH wall with 60 mm pitch - 2 x 12.5 mm GKF unilaterally - R_w ≥ 64 dB	Cape. 6, tab 42, Z.. 1: - 100 mm MH Wall - 75 free-standing attachment cup-mm (CWProfil) with 2 x 12.5 mm GKF - R_w ≥ 62 dB	Planning Value: 6) - MH-wall with 2 x 18 mm GF 140 mm on both sides - 75 mm free-standing furring with 2 x 12.5 mm GKF - R_w ≥ 63 dB	Cape. 6, tab 42, Z.. 1: - 100 mm MH Wall - 50 mm + 10 mm MW separation - 90 mm MH Wall - 60 mm battens on rubber strap with 12.5 mm GKF - R_w ≥ 63 dB
edge combination					
4	visible solid wood ceiling with separating cut through wall 2)				
	Wall solid wood ceiling, floor separated 2) 3)		R' w% ≤ 55 dB	R' w% ≤ 54 dB	R' w% ≤ 56 dB
	Coupling type 4: wood panel wall with separate installation level, D _{n,t,w} = 68 dB				
	Coupling Type 5: wood panel wall with separate planking, D _{n,t,w} = 61 dB		BASE	BASE	BASE +
5	Solid wood ceiling + 2 x 12.5 mm GFBeplankung, separated by separating cut through wall 7)				
	Wall solid wood ceiling, floor separated 2) 3)		R' w% ≤ 57 dB	R' w% ≤ 56 dB	R' w% ≤ 59 dB
	Coupling type 4: wood panel wall with separate installation level, D _{n,t,w} = 68 dB				
	Coupling type 6: cross joint with dry or wood panel wall D _{n,t,w} = 67 dB		BASE +	BASE +	COMFORT
1) separating member area > 10.0 m, m clear height 2.60l GKF = 800 kg / m ² wood = 450 kg / m ² GF = 1150 kg / m ² The calculation method is based on the latest research results and has not yet been established normative. 2) Mindestbeschwerung m ² by bulk 90 kg / hardwood d _{min} = 140 mm, m ² = 153 kg / m ² , R _w = 54 dB (from measurement) 3) #R _{w, screed} ≤ 14 dB, 50 mm ZE to Mineral fiber 6) Planning value as the calculation result from measurement data of the base wall and the facing layer 7) special ceiling construction according detail: #R _{w%} ≤ 3 dB + 2 x planked 12.5 GF directly, otherwise known as 2)					
				Planking with cervical or GK	
				Wall or ceiling body	
				Screed - dry or wet separation of levels	
					

Color coding of the sound level of protection Table 11: red - not complied with minimum requirement yellow - green BASIS - BASIS + blue - COMFORT

4.2.2 _ flanking transmission of Holztafelbauwänden and beamed ceilings

For the Holztafelbau the mixed transmission paths F_d and D_f to see in Fig. 4.10 as negligible. Therefore provide measures that take effect on the way F_f , a big improvement. This convenient approach explained by the fact that over the relatively soft on the walls closing with each other vernachlässigbare little sound energy is transmitted. Much of the sound transmission on the Flankenweg F_f is transferred from the Beplankungslage. The Gefachkonstruktion (stand and thresholds) contribute little to the flank transmission. From this, targeted measures to reduce sound transmission can be derived.

facings

A common measure of improvement, both components themselves and on edges, are facings. They can be an improvement in all areas (ground = floating screed, ceiling = false ceiling and wall = z. B. Installation level) attach. In the case of the edges of partitions, these can be both at the transmission chamber side, reception side or both sides attached. The most well-known applications - even if only in part, for acoustic reasons - are the installation level, false ceiling and floating floor screed. It is crucial that the facing layer is interrupted by the separating member. Runs through this before partition, no improvement can be realized. Otherwise it should be already waived penetrations for cables or lines in the port range for fire safety reasons. Table 12 shows possible improvements to edges by linings on walls, floors and ceilings. Caution is improved as edges in the use of suspended ceilings in solid wood ceilings.

Fig. 4.10:

Transmission paths for partition walls on the flank (F_f , D_f , F_d)

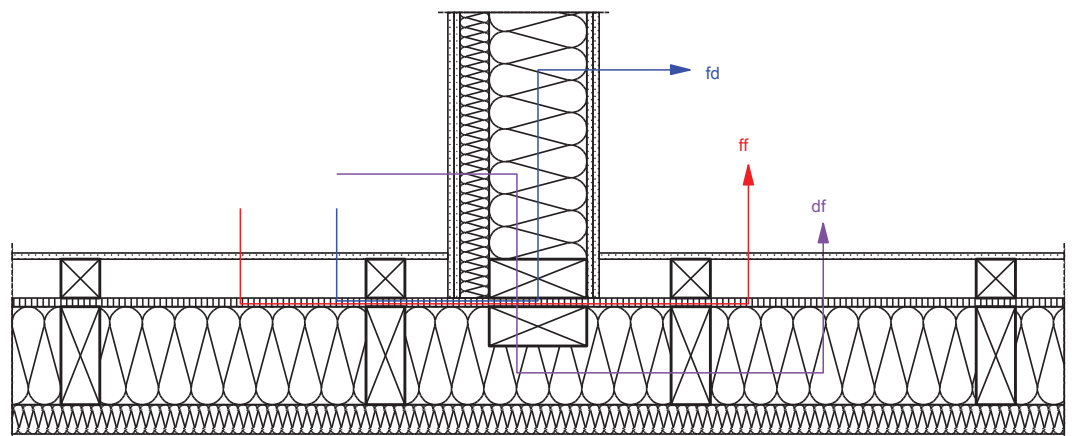
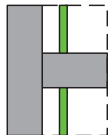
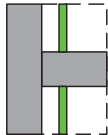
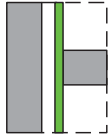
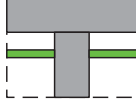
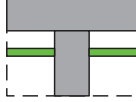
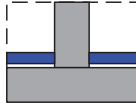


TABLE 12 | Planning data for Holztafelbauwände with facing wall

facings			
execution	$D_{n,t,w}$	presentation	Application in multi-storey buildings
wall edge			
Broken furring on spring rail	$D_{n,t,w} = 68 \text{ dB DIN 4109-33:}$ 2016 Table 28, line 1		to COMFORT
Broken furring on wooden slat	$D_{n,t,w} = 68 \text{ dB DIN 4109-33:}$ 2016 Table 28, line 1		to COMFORT
Scrolling False wall on spring rail or wooden lath	$D_{n,t,w} = 50 \text{ dB DIN 4109-33:}$ 2016 Table 28, line 2		not suitable
ceiling edge			
Continuous false ceiling plasterboard	$D_{n,t,w} = 52 \text{ dB DIN 4109-33:}$ 2016 Table 36, line 1		not suitable
2-layer sub-ceiling on wooden battens interrupted by partition	$D_{n,t,w} = 61 \text{ dB DIN 4109-33:}$ 2016 Table 36, line 7		Minimum requirements of DIN 4109-1: 2018
2-layer blanket on sub decoupled suspension (z. B. spring rail) interrupted by partition	$D_{n,t,w} = 67 \text{ dB DIN 4109-33:}$ 2016 Table 36, line 8		to COMFORT
bottom edge			
floating screed interrupted by partition	$D_{n,t,w} = 67 \text{ dB DIN 4109-33:}$ 2016 Section 5.3.1.1		to COMFORT

Planking with cervical or GK wall or ceiling body



screed - dry or wet



separate layers no

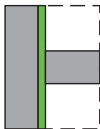
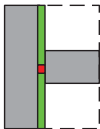
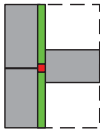
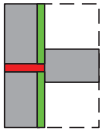
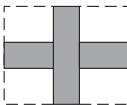
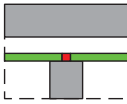
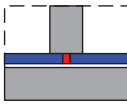
As mentioned earlier, much of the sound energy is transmitted through the planking. Therefore, it has proven useful to separate layers no behind the including wall. According to Table 13, the Beplankungslage is compared to continuous planking an improvement at the junction of 5 dB obtained by the separation. According to the rule of thumb for assessing this is not yet sufficient for a reliable goal attainment. If, however, executed one of four sides so it can in the detailed forecasting methods and component surfaces 10 of the values sqm to adhere to BASE + come. A complete separation of stator, threshold, and Rähm

Beplankungslage reaches values to $D_{n,t,w} = 68$ dB. However, it is almost impossible to implement building practice to leave wall ends without further fittings. In the conventional screw in the area of the stator there is a reduction of 7 dB. Also here, the aforementioned for separate Beplankungslage: in many cases can be explained by a detailed forecast BASE + reach the minimum values of DIN 4109-1 [1] be safely reached. The slight difference between the screw stud **frame ($D_{n,t,w} = 61$ dB), and only interrupted Beplankungslage ($D_{n,t,w} = 58$ dB)** makes it clear that for the building practice relevant transmission, the facing layers are relevant to the Flankenweg Ff to a large extent (see Table 13).

direct mounting

Walls are connected to flanks without further separation or facings, a suitability of the edge is not given for the multi-storey buildings. A **"blunt" At closing without further action reaches values of $D_{n,t,w} \approx 50$ dB - 53 dB.** is carried out according to the rule of thumb which at least a supplement of 7 dB to the target value, passing Beplankungsschichten are not executable without cladding for multi-storey buildings.

T A B L E 13 | Planning data for flanking Holztafelbauwände with separate cladding layers

separate layers no			
execution	$D_{n,t,w}$	presentation	Application in multi-storey buildings
wall edge			
Rähm and thresholds continuously; Planking continuously	$D_{n,t,w} = 53 \text{ dB DIN 4109-33:}$ 2016 Table 27, line 1		not suitable
Rähm and sleepers continuously; Beplankungslage interrupted	$D_{n,t,w} = 58 \text{ dB DIN 4109-33:}$ 2016 Table 27, line 2		limited use at an edge; differentiated forecast required
screwed wall behind the partition wall completely separated (Rähme and stand) and	$D_{n,t,w} = 61 \text{ dB DIN 4109-33:}$ 2016 Table 27, line 5		Minimum requirements of DIN 4109-1: 2018
Wall behind the partition wall completely separated and not screwed	$D_{n,t,w} = 68 \text{ dB DIN 4109-33:}$ 2016 Table 27, line 4		to COMFORT
Intersection of walls; cross kick	$D_{n,t,w} > 70 \text{ dB}$ adoption		to COMFORT
ceiling edge			
Suspended ceiling suspended plasterboard partition on	$D_{n,t,w} = 54 \text{ dB DIN 4109-33:}$ 2016 Table 36, line 3		not suitable
bottom edge			
Screed in the partition wall with separating cut, otherwise continuously	$D_{n,t,w} = 57 \text{ dB DIN 4109-33:}$ 2016 Table 41, line 2		not suitable

B eplankung with cervical or GK wall or ceiling



body screed - dry or wet separation of levels



Figure 11.4.:

Schematic representation rectangular cut on Partition

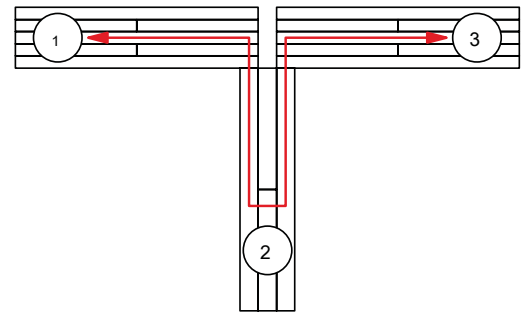
4.2.3 _ flanking transmission of massive wood elements

The performance of a cross hanging in solid wood construction primarily on the following factors:

- Sound reduction of the component incl. Possibly existing chippings.
- Facings that are not in the transmission path will not be considered (at the top edge of a partition so the above lying screed is not considered).
- **Stoßstellendämmmaß $K_{i,w}$ the ceiling wall combination (here, the flow advances z., by separation of the ceiling or elastomers).**
- Improvement through facings, each lying on the transmission path to be considered, for example. B. suspended ceiling (Caution: see the notes below).

Separating cut above the partition

Be flanking elements built of solid wood construction, these flanking paths are to undergo a very accurate observation. Here, the static feasibility must be checked by joints. Continuous solid wood ceilings meet the minimum requirements only limited hours in the circumstances. For higher sound level of protection as BASIS + and comfort can with elastic intermediate layers or preferably with separating cuts on the road. 1 - 3 in Fig be worked 4.11.



If the solid wood ceiling element used in partition walls in wood panel construction, the transmission paths and F_d D_f can be neglected.

The consideration of the flanking transmission is the same as the pure Holztafelbau just down the road F_d . Table 14 shows for this purpose the building acoustic evaluation of the major joints of training at Massivholzdecken as an edge component. Instead of the **rated standard edge level difference $D_{n,t,w}$ is for this situation to the rated R Flankendämmmaß $R_{f,w}$ specified, the determined measured values according to [21] according to the masonry construction method in DIN 4109-2 [1] and to the reference parameters ($S_0 = 10 \text{ m}^2$, $l_r = 2.80 \text{ m}$) was converted. Thus, a preliminary design is also possible with these planning values.**

however, is also the partition are in Massivholzbauweise executed, the transmission paths and F_d D_f can be instrumental and should therefore be considered in forecasting methods. A simple preliminary design is therefore not possible. The influence of these pathways are shown in Table 15 for some ceiling Wall connections [21].

T ABLE 14 | typical shock variants complained solid wood ceilings on partitions in timber panel construction

Solid wood ceiling as an edge component on wood panel walls			
execution	Flankendämmmaß $R_{Ft,w}^{2)}$	presentation	Application in multi-storey buildings
ceiling edge			
complained solid wood ceiling continuously ¹⁾	$R_{Ft,w} \geq 61$ dB		differentiated prognosis limited suitability at an edge, it is necessary
complained Solid wood ceiling with separating cut above the partition ¹⁾	$R_{Ft,w} \geq 64$ dB		to COMFORT

¹⁾ Solid wood ceiling with weighting, min. $R_w \geq 54$ dB

²⁾ Instead of $D_{nL,w}$ can for pre-calculation $R_{Ft,w}$ be used.

Wall or ceiling body separation of levels

T ABLE 15 | typical shock variants complained solid wood ceilings on partitions of solid wood construction

Solid wood ceiling as an edge component in solid wood walls			
design ceiling	Model wall	presentation	Measured values for l_{ub} = 4.30 m, $S_{s,ub}$ = 11.8 m²
ceiling edge			
160 mm BSP continuously	80 mm BSP		$R_{Ft,w} = 44$ dB $R_{Fd,w} = 50$ dB $R_{Df,w} = 50$ dB
, 60 mm crushed, $m'' = 90$ kg / m² 160 mm BSP continuously	80 mm BSP		$R_{Ft,w} = 61$ dB $R_{Fd,w} = 55$ dB $R_{Df,w} = 55$ dB
160 mm BSP isolated	80 mm BSP		$R_{Ft,w} = 50$ dB $R_{Fd,w} = 51$ dB $R_{Df,w} = 51$ dB

W or ceiling and-body separation of the planes

Solid wood ceilings with suspended ceilings for improving the flanking transmission

Is it possible improvement measures not perform such a separation size of solid wood ceiling for structural reasons, a suspended ceiling is often introduced as acoustically effective furring on this Flankenweg. This measure reduces the sound transmission through the Flankenweg it considerably, but can the impact sound transmission of the ceiling component in the low frequency range in some cases substantially affect.

to $L_{n,w} + C_{l,50-2500}$ deteriorated. Fig. 4.12 shows the comparison of three solid wood ceiling with various ceilings without suspended ceiling.

Structure of the ceiling in Fig. 4.12: cement screed: 120 kg / m² sound insulation: 30 mm MW with $s \leq 8$ MN / m³ bed:

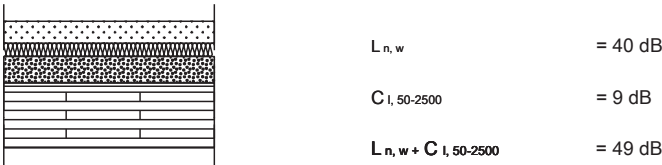
elastically bound or unbound with 90 kg / m² and d = 60 mm solid wood elements: 120 mm

4.12.:

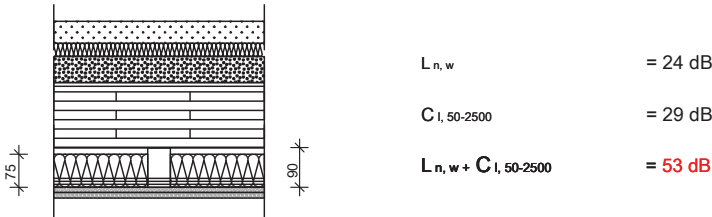
Comparison of solid wood cover with different cover bottom and without suspended ceiling

With solid wood ceilings with suspended ceilings, the $L_{n,w}$ improved. However, it can occur at low suspension heights that

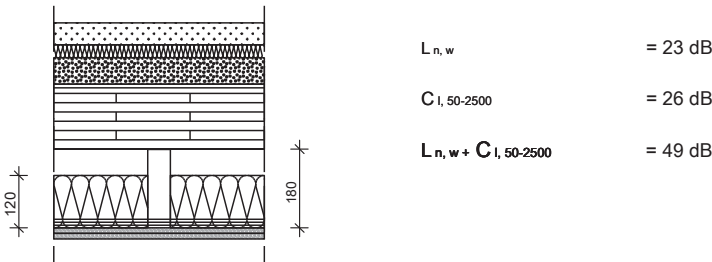
Solid wood ceiling without ceiling



Solid wood ceiling suspended ceiling (90 mm suspension height)



Solid wood ceiling suspended ceiling (180 mm suspension height)



can be connected to the model parameters shows that a

deterioration of the $L_{n,w} + C_{1,50-2500}$

entering of up to 4 dB. Thereby the perceptual impact sound nuisance is greater than in the comparative ceiling without additional false ceiling for the users. It turns out that the deterioration below 100 Hz clearly fails to ceiling with 90 mm **suspension height, although the pure value for $L_{n,w}$ is greatly improved.** Here extremely careful to bring about the "standard improvement measure" furring / suspended ceiling on the flanks no degradation for users in the impact sound transmission. Therefore, the criterion for low frequencies should be checked when the preliminary design. It is especially critical if the ceiling is bemessungsmaßgebend as an edge for partition walls. Although the false ceiling improves the ceiling edge value for the Partition and its acoustical properties, but can degrade the separating floor itself. If the suspended ceiling is required for the insulation of flanking paths, **they should be designed so that it no deterioration at $L_{n,w} + C_{1,50-2500}$ comes.**

This is usually in suspension height from 20 cm the case.

Alternatively, and preferably can be if it is statically possible to run the solid wood ceiling with a cut above the partition, see also Table 9 below.

4.3 _ partitions for detached and terraced houses

For detached and terraced houses, two-shell construction methods have been established. Under two shells is to be understood here is that each of the building includes its own wall. The two walls are placed apart from each other. The respective walls can turn consist of several layers. Depending on building type and class also requirements are placed on fire protection which must be observed.

Test modes and special needs

In the said wall type, the special feature is that, in both the impact sound transmission from stairs and the airborne sound transmission path play a role. Discomfort in row and semi-detached partitions in two shells often deal with harassment by footfall of stairs of the adjacent building. The harassment is perceived as a roar and is therefore attributable to low-frequency transmission. Measures to improve on these walls should primarily address the low-frequency frequency range. According to recent research results it is here mainly to observe the stand grid, the distance of the walls between themselves and the Beplankungsart. In townhouse partitions axial dimensions turn out to be in the low frequency range from 31 cm to be particularly favorable, as opposed to üb handy stand grid

62.5 cm. Therefore, all subsequent images on the "acoustically favorable" Raster refer cm from 31st

In this section, recommendations are made for the walls and the stairs in row and semi-detached houses.

4.3.1 _ Vorbemessungsbeispiel for detached and terraced house walls

So far not detached and terraced house walls in wood construction for all Flanken design values before. This is especially true be wall flank the ceiling nodes and the outside. However, it is assumed that the sound transmission is very low.

These are for measuring approximately vernachlässigt bar when the joint is continuous. The semi done in this section a simplified practical preliminary design for the in Fig. Partition situation and represented 4.13 and 4.14 the target value of the sound level of protection BASIS +.

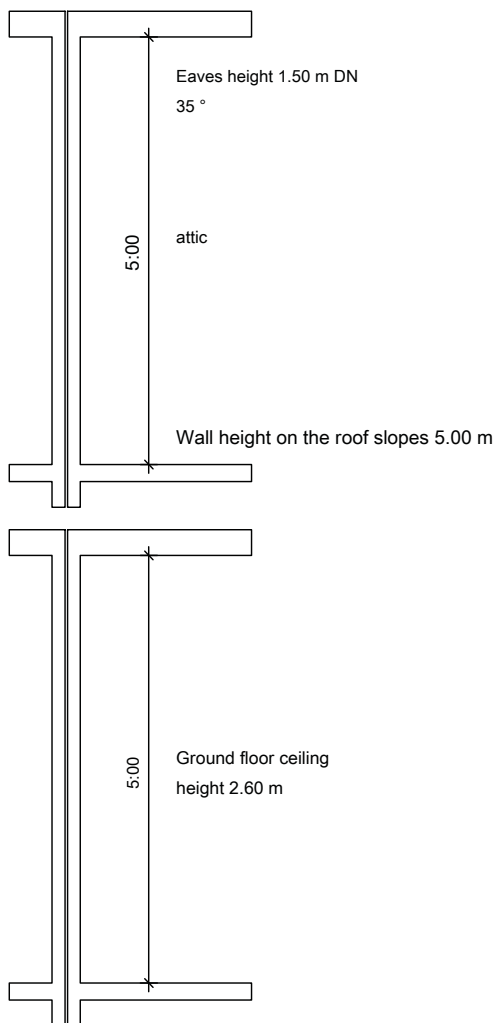


Figure 4.13.:

below:

Floor plan ground floor situation, above:

Floor plan situation top / attic

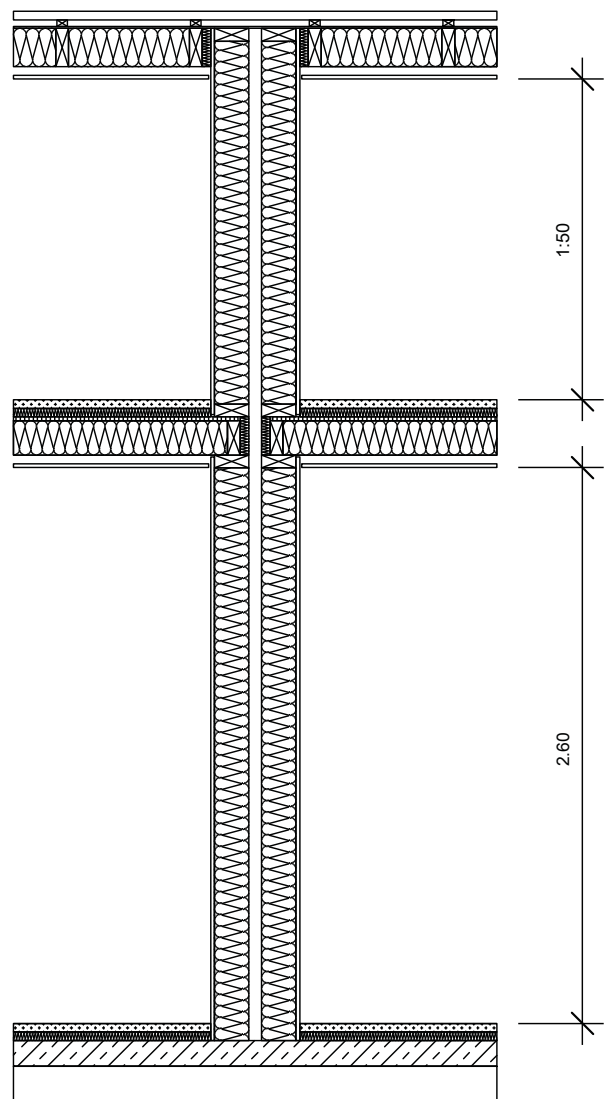


Figure 4.14.:

Cut situation for dimensioning

Step 1:

Choice of target value

Sound insulation level: BASIC + R 'w

≥ 62 dB

$R_w + C_{50-5000} \geq 62 \text{ dB}$

This means that all transmission paths are to be selected with a building acoustic characteristic value of 62 dB + 7 dB = 69 dB.

Step 2:

Choice of a component with $R_w \geq 69 \text{ dB}$ of Chapter

6:

It is appropriate to consider two situations:

1st floor with continuous floor plate and floating floor

2. floor with underlying separate ground floor

Lower building closure: reinforced concrete floor slab d = 180 mm with floating screed the laid

Step 3 and Step 4: Evaluation of the flank situation as well as the criterion for low frequencies.

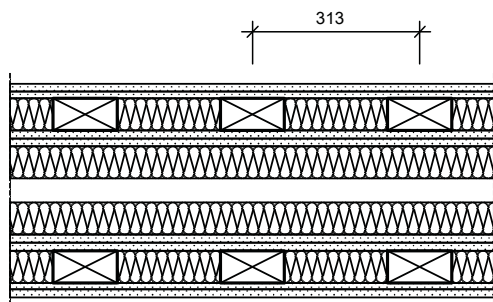


Figure 4.15.:

Device structure Chapter 6, Table

43, line 8

Component values: $R_w (C_{50-5000}) = 69 \text{ dB}$

(-2 dB)

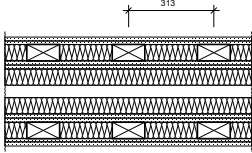
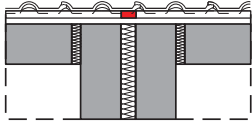
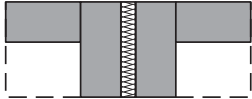
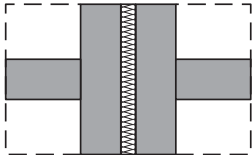
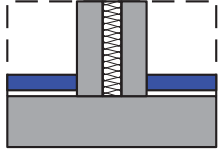
Fire safety rating: fire resistance: F30-B - F90-B

Konstruktionsempfehlung

For a detached double wall following basic rules should be followed:

- 31 cm as the axis grid with wood panel building walls
- Structure of the two sides or the stand position offset asymmetrically
- Post diameter should be chosen as small as possible static in favor of a large distance between the walls
- the largest possible mass of the space side planking

TABLE 16 | Preliminary design of a detached partition common to ground and first floor

1	2	3	4
Predimensioning row and semi-detached partitions			
target value	Sound level of protection BASE + $R'_{w} \geq 62 \text{ dB}$	Vorbemessungsauflage = 7 dB	Component value $\geq$ 69 dB
Component or transmission path:	R_w or $D_{n,t,w}$	execution	evaluation
1 component right	$R_{w, \text{component}} = 69 \text{ dB}$		= 69 dB 69 dB
2 roof edge	75 dB DIN 4109-33: 2016 Table 30, line A with Table 34, line 1		75 dB > 69 dB
3 Flank outer wall	$\geq 75 \text{ dB}$ equivalent as line 2		75 dB > 69 dB
4 floor connection	$\geq 75 \text{ dB}$ equivalent as line 2		75 dB > 69 dB
5 ground Partition interrupts screed, min base plate. d = 180 mm	$R_{Ft,w} = 70 \text{ dB}$ calculation according masonry construction method with $K_{Ft, \text{min}}$		70 dB > 69 dB
An additional criterion for low frequencies			
6 component right	$R_w + C_{50-5000} =$ 69 dB + (-2 dB) = 67 dB	Target: $R_w + C_{50-5000} = 62 \text{ dB}$	67 dB > 62 dB

Wall or ceiling body screed - dry or wet

separation of levels



4.3.2 _ Constructive influences on the flanking

transmission

Lower building closure

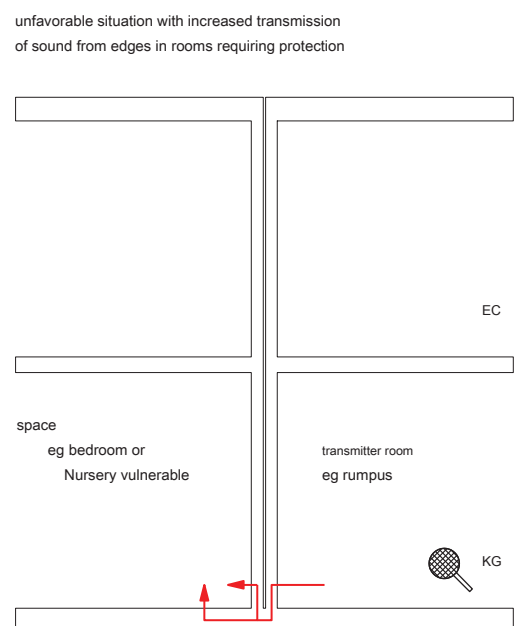
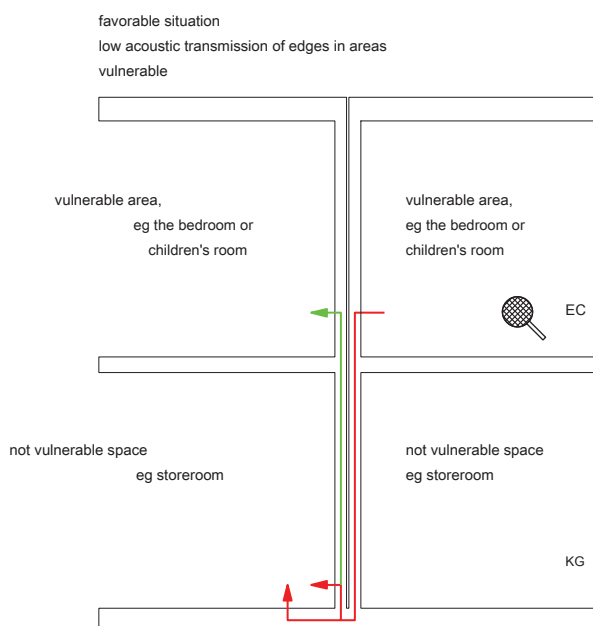
For the design is crucial if the lower building closure is scrolling, or be under it, for example, not vulnerable cellars found which are also separated by a gap from each other. Basement building with parking and adjoining rooms have proven to be less expensive than building on a continuous base plate. The storage in the basement acts as an acoustic buffer space for the transmission of sound energy. Here, however, be careful: A lounge can not be an acoustic buffer space. Are located in the basement rooms requiring protection, is usually

since assumed that here statements continuously is the lower building. Only in very rare cases, the base plate is also provided with a groove for the differential settlement. Fig. 4.16 shows schematically the situation.

For separate edge ways in which the sound transmission through not vulnerable areas takes a "detour", show considerably better sound insulation. Therefore, higher demands are placed on buildings with underlying separate floor spaces than in projectiles with a continuous floor member. The situation in Fig. 4.16 corresponds to the right with a continuous floor slab and screed, as shown in the pattern design, but for a ground floor.

A bb. 4:16:

schematic diagram of building
acoustics favorable and unfavorable
space arrangement with double and
terraced houses



flanking roof

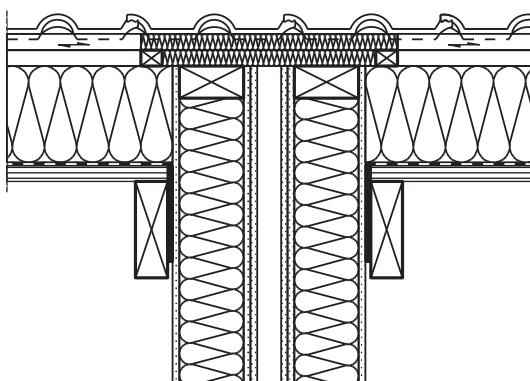
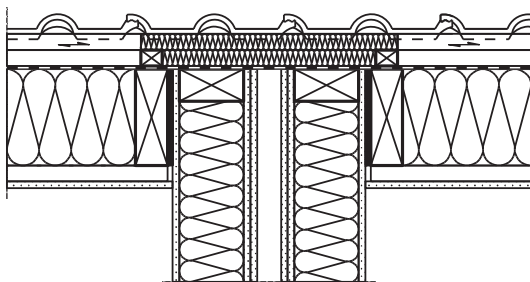
For the edges on the top floor is complete separations have proven. As mentioned above, a complete separation of the walls is required for the high demands. Particularly noteworthy in the roof edge following points are:

- completely separate, assemble any necessary metal clasps on both sides battens. The laths of the roof tiles may not run past the separating wall continuously. Here also fire protection requirements play a role. In the area of the partition, these battens should be replaced by two metal profiles.
- separate roof sheathing on the wall. Ideally, the Kopfrähm the wall stands above the roof sheathing. The same applies to rigid foam roof insulation.

Figure 17.4.:

Structural attachment of pitched roofs (insulation between rafters / On-saving rendämmung) on building walls. The first rafter is assembled with 1 to 5 cm distance from the partition in each case. The cavity is contained.

- Separation of the formwork in the canopy area.
- The cavity to be filled with sound-absorbing insulation, which may include a fire protection necessary Aufmörtelung is useful if this does not bridge the separate slats. In high-sound-insulating roofs of the main sound transmission path runs via the hollow space between the roof covering and the insulation or partition wall. To reduce this noise transmission, this cavity should be up to the roof covering with mineral fiber (fire protection requirements note) are required. If necessary, can be filled with mineral fiber also the voids in the respective first rafter fields. Alternatively, specially designed for these requirements soundproof bulkheads are used.
- Roofing or waterproofing membrane can pass through.
- Roof construction parts such as purlins or rafters must not bypass the wall joint.



When standing on the roof membrane partitions the flanking transmission can be neglected. Inadequate planning and execution of Bauanschlüssen of partition walls on steep roofs always leads as to complaints of inadequate sound insulation between adjacent rooms. Accordingly, such connections are given by the following further instructions for proper construction. For connection to a two-leaf partition Ge buildings is the basic structure for roofs with insulation between or rafter insulation in Fig. 4:17 shown.

In addition to the foregoing points, note the following:

partition wall

The partition is to run independently of the construction under the roof battens.

joints

The joints between partition wall and roof structure are carefully execute.

Influence of purlins

The purlins in the two areas are completely separate. They may not go through past the separating wall. The remaining cavities in the Auflagerlöchern the purlins are airtight close. Possibly, is to introduce a gypsum board for fire safety reasons.

Cover edge and vertical wall edge

Parts of the ceiling node as the outer wall must not bridge the parting line. The following design rules should be tet oh:

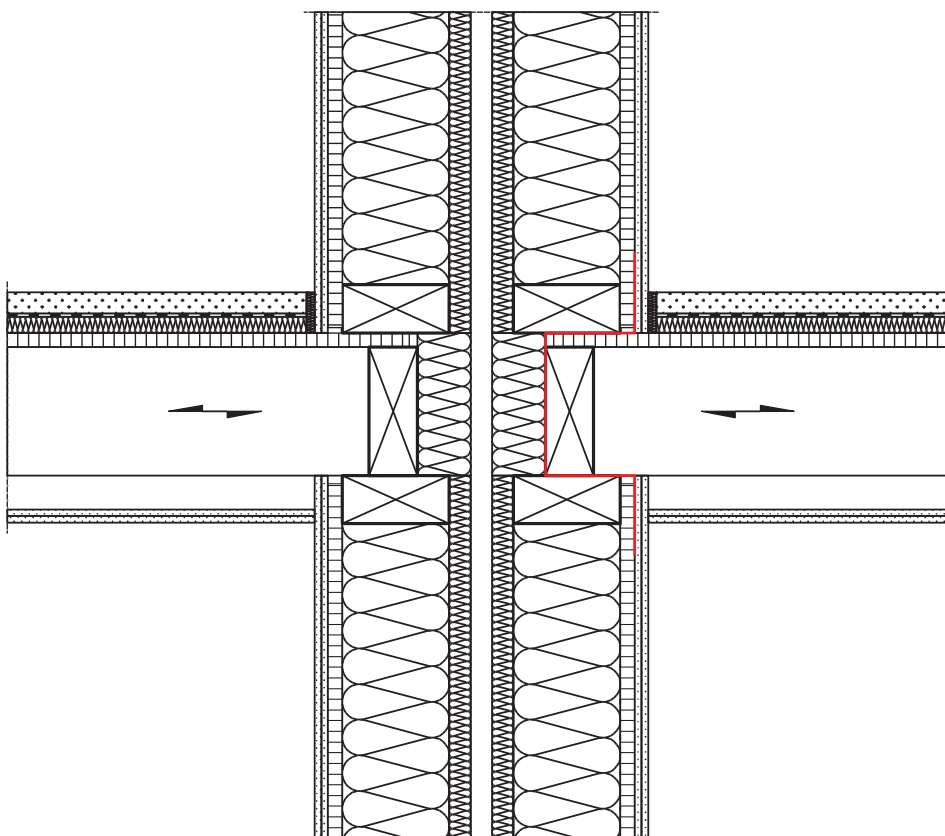
- When installing the insulation in the cavity before the ceiling face side to Gebäudefuge and the outer wall is to pay attention to securing the position.
- Separation of all layers of the outer wall in the joint plane. Plaster layers must be separated driving rain by separating profiles with foams.

Subject to these conditions, the transmission can be neglected for these flanks because the weighted standard -

- make level difference $D_{n,f,w}$ is at least 70 dB.

Figure 18.4.:

Presentation ceiling nodes preceded by a highly absorbent insulation, in red: mounting an air seal foil



4.3.3 _ stairs in double and row houses

Because of illustrated at the beginning of this section, issue of impact sound transmission between twin and row houses design recommendations will be given for the execution of stairs. A footfall measurement is not possible for the stairs. Therefore, only execution recommendations can be given.

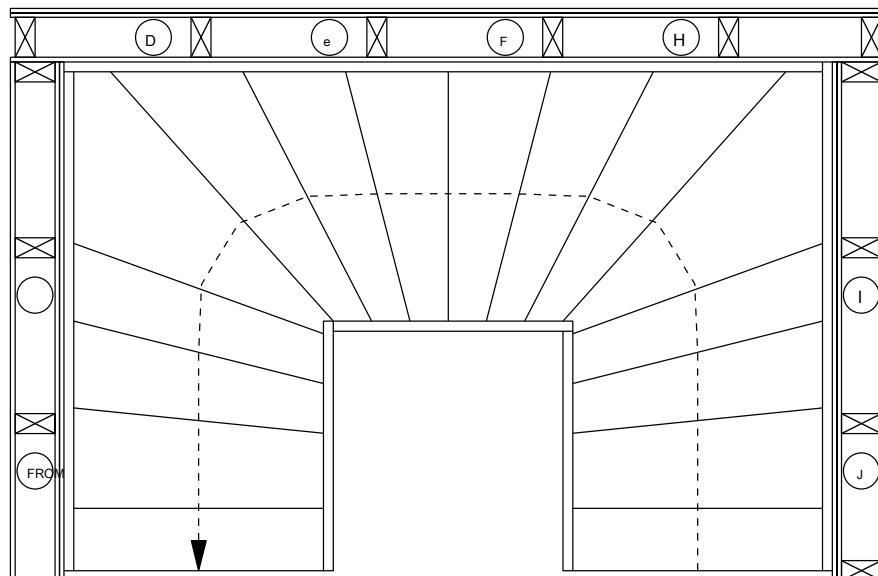
Steel Wood stairs

A two quarter-coiled steel wooden staircase is fixed times on the side walls on the building structure usually on entering and exit as well as 1 to 2 times on the partition wall and a maximum of 2, wherein the connection via a rigid support takes place. Possible bearing points for such a staircase structure are shown schematically in Fig. 19.4. Leads to the partition wall as a bivalve Gebäudetrennwand made in wood panel construction, so formal the requirements of

DIN 4109: 1989-11 and, most likely, the proposals for increased sound insulation ($L'_{n,w} = 46 \text{ dB}$) in accordance with DIN 4109 Supplement 2: observed 2007-08: 1989-11, or the sound protection level II by VDI 4100th

A plot of the normalized impact sound pressure level L_n against the frequency of a steel-wood staircase 4.20 is shown in Fig. In Fig. 4.20, however, that sound technical weak points of the structure is visible, are in the low frequency range, so that it in this frequency range to disturbing noise pollution ("rumble") join ie, between 50 Hz and 200 Hz. These low-impact sound transmissions coincide with dips in the Schalldämmkurve as they are seen in the airborne sound insulation of building partitions in timber, see Section 3.1.4. Measures to reduce the "hum" are presented in Section 3.4.4.

Figure 19.4.:
Connection of wooden stairs to the building structure.



Access to the partition wall in a wooden frame construction: Points D, E, F, H connections to the side walls in wood frame construction: Points A, B, I, J

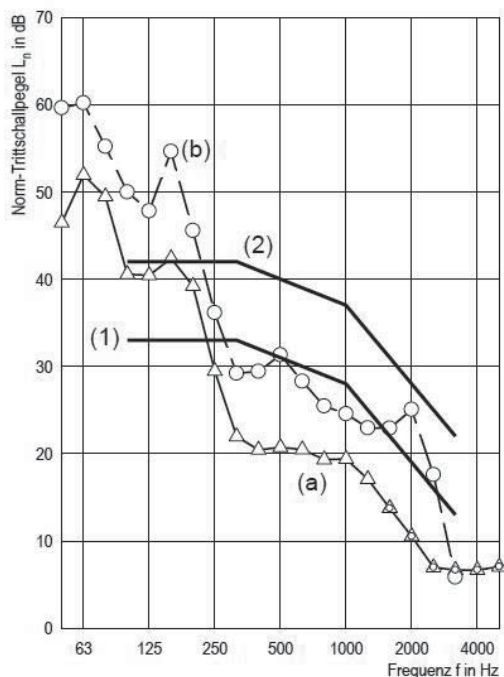


Figure 4.20.:

separating a steel wooden staircase connected to a double-shell building sound insulation wall timber construction with a sound reduction level of $R_w = 71$ dB.

are shown two versions: Curve (a) with the reference curve (1): only connection to the side wall, $L_{n,w} = 31$ dB curve (b) with the reference curve (2): normal connection of the staircase to separation and sidewalls, $L_{n,w} = 40$ dB

Both versions are curves in addition to the measured sound reduction $L'_{n,w}$ the respective shifted reference curves according to EN ISO drawn. 717-2 The exceeding of the measured curve on the reference curve to determine the height of the evaluated normalized impact sound pressure level $L_{n,w}$ from [19].

Massivholztreppe

Massivholztreppe be connected through the outside wall of the partition, usually serve up to 4 screw for fastening the cheek to the partition wall. Possible screwing points for such a staircase structure are shown schematically in Fig. 19.4. Along with a bivalve building separation wall in timber construction are in such connection the stairs to the building partition formally the requirements of DIN 4109: 1989-11 and, most likely, the proposals for increased sound insulation ($L'_{n,w} = 46$ dB) in accordance with DIN 4109 Supplement 2: 1989-11 observed.

the two partition leaves. The same stairway, attached to a single-partition is, therefore, achieve a significantly poorer impact sound insulation. The strong dependence of the sound insulation of a staircase of the wall construction is evident when graphically **footfall sound insulation of the staircase $L'_{n,w}$ against the sound insulation of partition $R'_{w,w}$ where the staircase is attached, applying,** see Fig. 4.21. If one classifies the steps according to the different design features (type of staircase, connection to the dividing wall), **one recognizes an almost linear profile between $L'_{n,w}$ and $R'_{w,w}$. With** knowledge of the sound insulation of the partition wall of sound insulation in a lightweight stairs can be estimated in timber because of this relationship. A forecasting method based on these findings is described in [27], [28], [29]. First comparisons with different construction situations have yielded good results.

Influence of the partition to the sound insulation of the stairs

The results described above have been achieved with stairs, tied to faultless made bivalve building partitions. The very good Trittschalldämmwerte these stairs have their cause in the consistent separation and decoupling

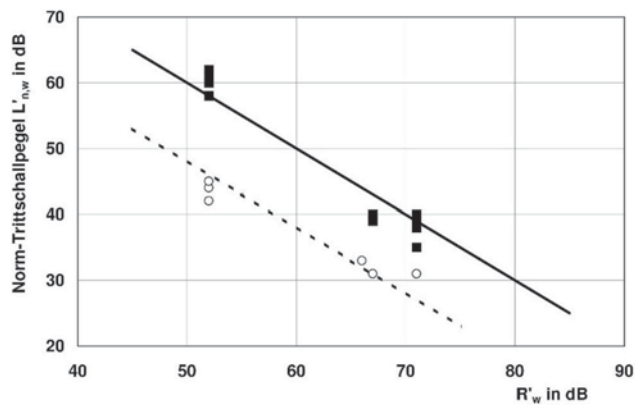


Figure 21.4.:

Sound insulation of steel wooden stairs in the timber depending on the airborne sound insulation

R'_w the partition (single and double shell) from [19]. two are shown various dene versions of the

access to the partition.

- Observations: steps with 1 to 2 points of support in the partition wall.

○ - Observations: Stairs tied not to partition, but only on the side walls.

The solid and dotted lines are forward of the $L'_{n,w}$ the steps according to an empirical

method [27], [28], [29].

Improve the sound insulation of staircases

Although a lot of lightweight stairs in wood construction, the increased requirements for sound insulation according to DIN 4109 Supplement 2: meet 1989-11, it can men to complaints from residents regarding the impact sound kom. Most low-frequency sound transmission, a "roar" is criticized. However, deficits in the low-frequency sound can be compensated for by appropriate design of the staircase structures. In the following various measures and their effectiveness are described in terms of improving the impact sound insulation.

Access the stairs to the bulkhead

shows a clear improvement of the impact sound in the low frequency range

be achieved through the full decoupling of stairs from the partition.

In a steel timber staircase, this is realized by the seating of the stairs takes place entirely over the side walls. be the improvements in both the low-frequency range as well as in rated normalized impact sound pressure $L'_{n,w}$ = about 8 dB. For reasons of statics and safety in use (low-frequency vibration behavior, Structural Dynamics) takes on a steel Holztrep pe this, the stairs statics be improved. For spans up to approximately 2.2 m this can be done by increasing the beam cross section.

With solid wood stairs to similar improvements by not using a structure-borne sound contact between the cheek and partition and use can achieve a special Eckauflager. The sound-technical suitability and basic feasibility of such Eckauflager were detected in laboratory tests, see [27].

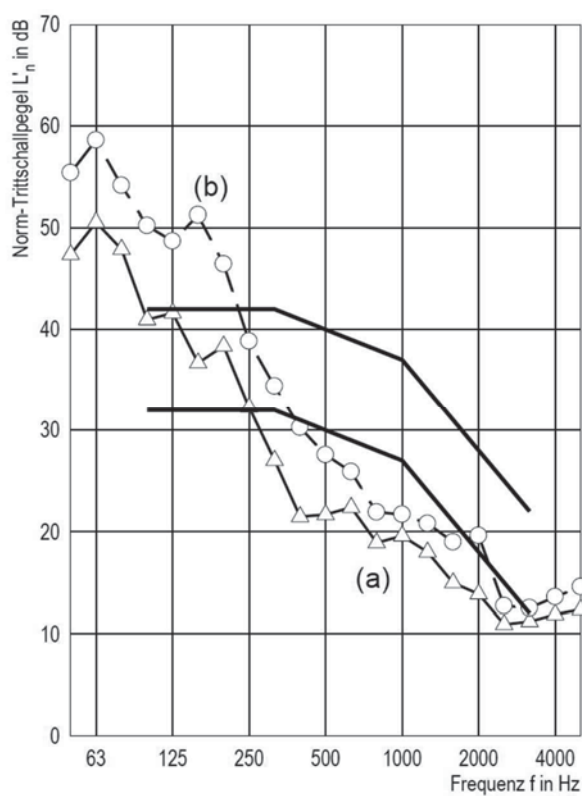
Decoupling of support points on elastomeric bearings

Because of the static or the use of security is a complete decoupling of stairs from the partition, as described above, in many cases not possible. A decoupling of the support is possible via suitable elastomeric bearings. The improvement in the sound insulation depends on the softness of the elastomer bearing. This is illustrated in Fig. 4.22. Here are two links situations are compared:

1.) rigidly connected and 2.) decoupling with a relatively soft elastomeric bearings. This example shows the standard impact sound of a soft Elasto that the stairs by the use merlagers up to 10 dB with respect to the rigidly connected reduce, ie can be improved. when using

of elastomeric bearings is on the usability of the stair construction ensured since too soft mounted stairs at

tend to commit to low-frequency vibrations and fluctuations and could therefore jeopardize the surefootedness.



A bb. 4:22:

Footfall sound insulation of a steel-wood staircase attached to a bivalve building partition in wood construction (sound reduction index of $R'_w = 67$ dB), as measured in a running construction. Shown are two variants:

Curve (a):

Connection via elastomeric bearings (make Trelleborg type STG), $L'_{n,w} = 30$ dB

Curve (b):

rigid connection of the staircase to separation and sidewalls, $L'_{n,w} = 40$ dB, from [19]

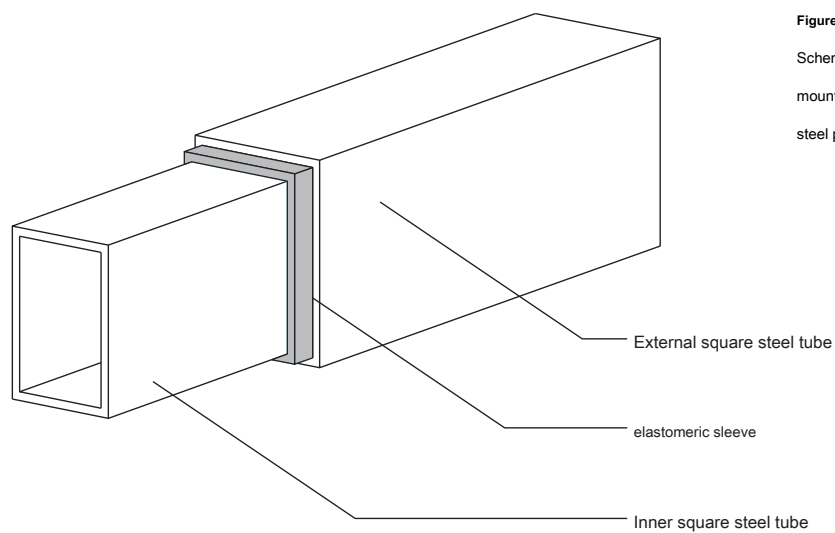


Figure 23.4.:

Schematic diagram of a resilient mounting two telescoped square steel pipes according to [19].

A practical realization of an elastomeric bearing is shown in Fig. 4.23. For this, the elastomer between two square steel tubes is pushed. The sound-technical effectiveness of this design in combination with a softer elastomer material has been shown in laboratory studies [27].

In addition to the decoupling of support is often tries to grasp even improve the sound insulation on the vibration decoupling of the steps. Experiments in which the treads were screwed via conventional elastomeric bearings practicable on the spars, have shown that improvement in impact sound occurs only in the high-frequency rumble range above 400 Hz, so in an area where stairs on building partition walls are a very decent sound insulation have. In principle, a similar problem has as the decoupling of supports on elastomers: an acoustically effective decoupling stage and Holm will only be achieved if very soft interlayers are used. However, these are not to be regarded as fit for use, because vary too much in such a manner bearing tread when walking and ensure no slip resistance. By a screw connection, the effectiveness of the elastic bearing is also reduced.

Interpretation of elastomers

As quality criterion for the storage of stairs on Baulagern (z. B. elastomers) can be use the compressibility of the bearing and the natural frequency. It must the load per bearing point of the stairs and the payload by a walker (e.g. 75 - 100 kg) on the surface of the elastomeric bearing are distributed. This results in a surface pressure in N / mm². From this, the "reduction" (depression Δt) of the elastomer allows only under static preload and under static preloading

+ Payload (walker) determined. Similarly, the natural frequency of the support from the manufacturer can be determined. The additional depression of the elastomer when walking by a person and the natural frequency should comply with of the support the following limits:

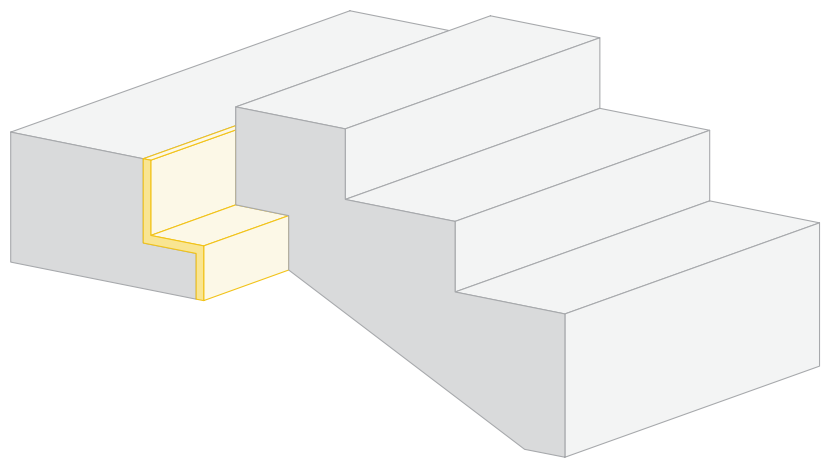
depression $\Delta t \leq 1.5 \text{ mm}$

Natural frequency $f_0 \leq 30 \text{ Hz}$

4.4 _ stairs in multi-storey

As houses for stairs in double rows and are not forecasting methods for stairs in multi-storey. Depending on the building type and building class requirements must be met also from the perspective of fire safety. In building Class 4, for example, this may only consist of non-combustible materials. This in turn means from acoustic point of view that either mild steel stairs are made with non-combustible levels or reinforced concrete staircases. Thus the wooden stairs of the previous section are eliminated. For this, the massive stairs are added. On the re-presentation of all types of staircase is omitted. The design is analogous to choose as described in Section 4.3.3.

However, as it is for the aforementioned steps currently no prediction methods available. It is recommended for both types of stairs a review of the execution by measurement.



solid stairs

z for massive stairs. B. reinforced concrete prefabricated wooden buildings receive the same finishes as for light stairs apply. Being there needs to the flight of stairs from the building decoupled. Are provided platforms, must be either the landing of the building resilient separately or provided with a floating floor. The biggest difference to the easy stairs is next to the larger mass that linear here elastomer support to be performed, which must absorb correspondingly higher loads. There are not the same elastomers, such as for the aforementioned steps usable because they have to be dimensioned for the static preload. The dependence of the dynamic modulus of elasticity of the static preload is observed. Very often, it may be useful

Summary

For stairs in multi-storey, the following recommendations can be:

- Decoupled Bearing the stairs to the building structure 24.4 with soft elastomer as possible (see also section 4.3.3) as shown in Fig..
- Possible high valued Sound reduction index of the mounting wall.
- Mounting the stairs either on exterior walls or walls that do not border on vulnerable areas.
- Stufenaufleger separated by decoupling measures of the cheek.
- No contact between the steps and the other ceiling or wall components.
- With massive stairs to the design rules of concrete structures can take mutatis mutandis.

Figure 24.4.:

Massive flight of stairs with elastomeric liner

In such stairs constructions impact sound level $L'_{n,w} \leq 48$ dB.

4.5 _ Apartment doors

For apartment entrance doors is to distinguish whether these open directly into a lounge or in an enclosed corridor. In the first case, the requirements are higher than seen in the case in a hallway. The special feature is that the goal to be achieved value 5 dB (u_{prog}) have to pitch to describe the quality of the door. This means that if 37 dB are required in the construction, would be a door with a

Prüfzeugniswert of $R_w = 42$ dB is required. It should be achieved

following target values in the modern multi-storey buildings:

floor seal

For apartment doors, the retractable bottom seal has been proven and is essential for the above targets. It is important to ensure that this sealed tightly to the floor and rests on a hard surface. The bottom seal is not against soft surfaces such. start as carpets. The gap to be bridged should not exceed 5 mm.

Figure 4.25.:

Retractable bottom seal with hump sill as an abutment, if distances are great.

Apartment door in a closed hall:

$$R_w \geq 37 \text{ dB}$$

$$\rightarrow R_{w \text{ certificate}} \geq 42 \text{ dB}$$

Front door directly into the lounge:

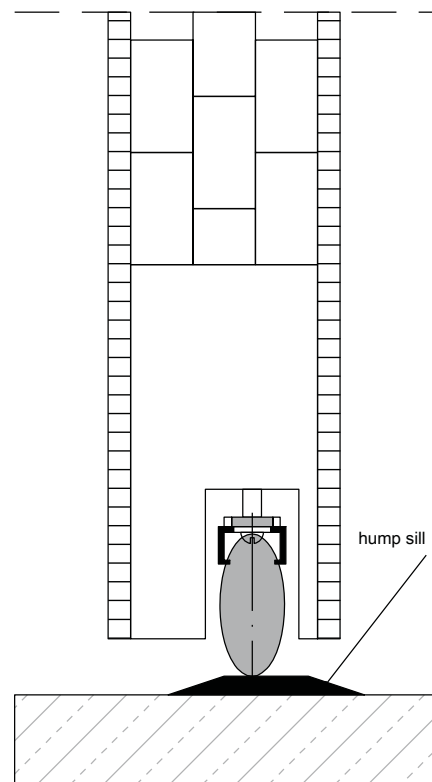
$$R_w \geq 38 \text{ dB}$$

$$\rightarrow R_{w \text{ certificate}} \geq 43 \text{ dB}$$

The main design features of doors with rated Schalldämmmaßen than 40 dB can be summarized as follows:

door leaf

When the door leaf and the sound reduction increases with increasing mass. Are lipping or generally stiffening webs introduced into the sheet, the sound insulation decreases. Improve the sound insulation can be achieved by multilayered door leaves, which have a high internal damping. In order to achieve the aforementioned sound insulation, door leaves with a basis weight of about 40 - 50 kg / m² required. These door panels often have a thickness up to 80 mm. With Beschwerungslagen the sound insulation can be further increased and possibly reduce the thickness.



Frame and frame seal

The frame is sealed with at least one circumferential seal to the door leaf. The curvature of the door leaf or too low a clamping force can reduce the contact pressure at the seal. With increasing gap size between door leaf and frame missing by the sound reduction pressure may drop to 10 dB up. The settings of the door so after commissioning of a building must be checked again. The suction. Spring deflection of the seal should be at 5 mm. Frequently it is also conducive he installed a seal between the wall plane and surrounding at perimeter frames. Both wood and steel frames reach the values referred to.

Connection to the wall construction

The joint between the stairwell wall and the door frame is completely z. B. with mineral fiber (also certain Bauschäume may be acceptable) to fill and then outside and inside sealed with sealant. Fig. 4.26 schematically shows the sealing between the frame and wall member.

Note

These features may vary by manufacturers vary widely, so always test certificates are to be requested. The installation situation and the installation conditions to be complied with are also put on the site.

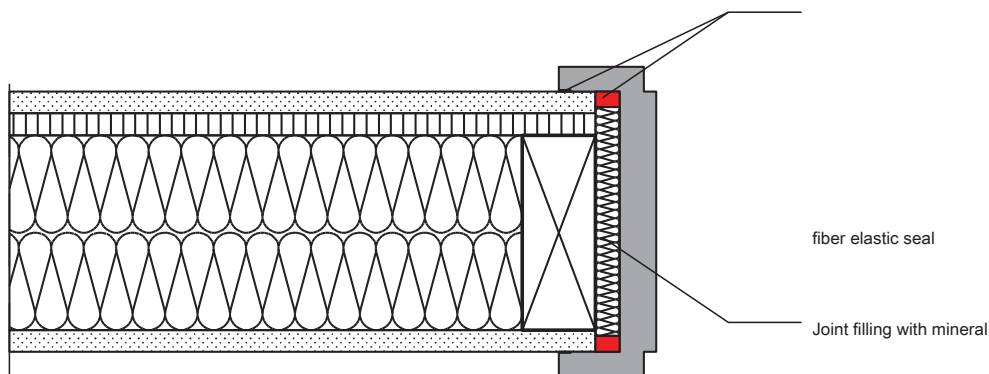


Figure 4.26.:

Schematic representation of the sealing frame to wall

4.6 _ walkways and roof terraces

Also on walkways and roof terraces demands are made regarding the impact sound. the components are to be calculated as described for the corresponding external noise range for the Sound reduction index. In the ge called components, note that it is not carried out for the impact sound only in the vertical direction a rated, son countries in accordance with DIN 4109-2 [1] in all sound propagation directions, see Fig. 27.4.

inclined diagonally under the portico. In solid are here correction values K_T available for the position. This still lacking for timber construction. For practice thus otherwise the design is currently possible, as on the safe side, as shown in Section 4.1, shall be performed immediately above the other for the situation. This is the case anyway with roof terraces in the majority of cases. Planning data for rooftop structures are listed in Section 6.2. In a design example will be omitted by referring to the procedure for separating ceilings in Section 4.1 are.

Figure 27.4.:

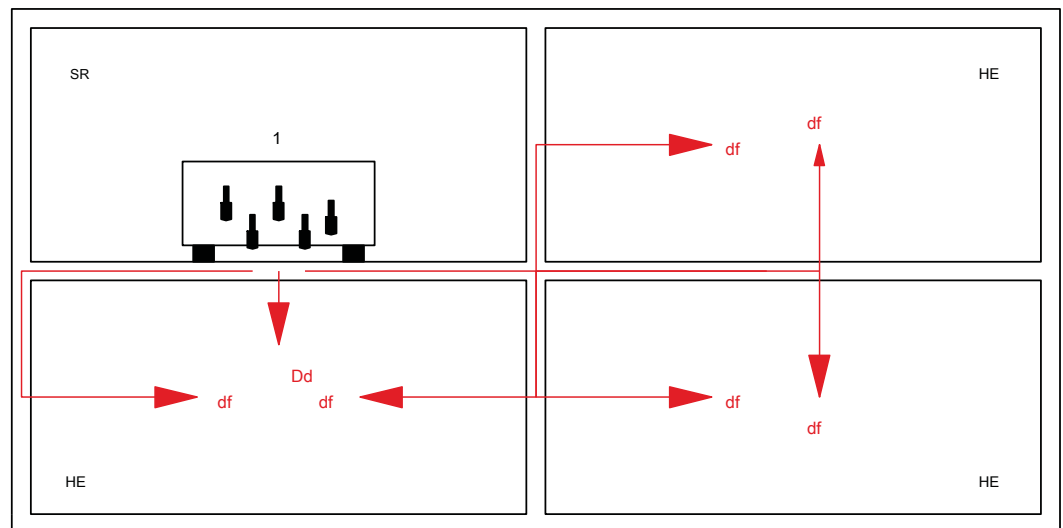
Impact sound transmission

directions, image 3 of DIN 4109-2:

2018

Especially for pergolas is usually recorded a diagonal position.

Here, the potentially vulnerable area is



Legend

- HE Reception room SR
- Source room Dd
- direct impact sound transmission through the ceiling Df
- fl ankerende impact sound transmission through walls and ceilings 1
- Hammerwerk

4.7 _ balconies

Analogous to the above section provides since 2018 also on balconies requirements regarding impact sound. Frequently a diagonal transfer will be designed into an underlying space here. The minimum requirement of DIN 4109-1 [1], Table 2, row 8.1 is $L'_{n,w} \leq 58$ dB.

This requirement can with Section

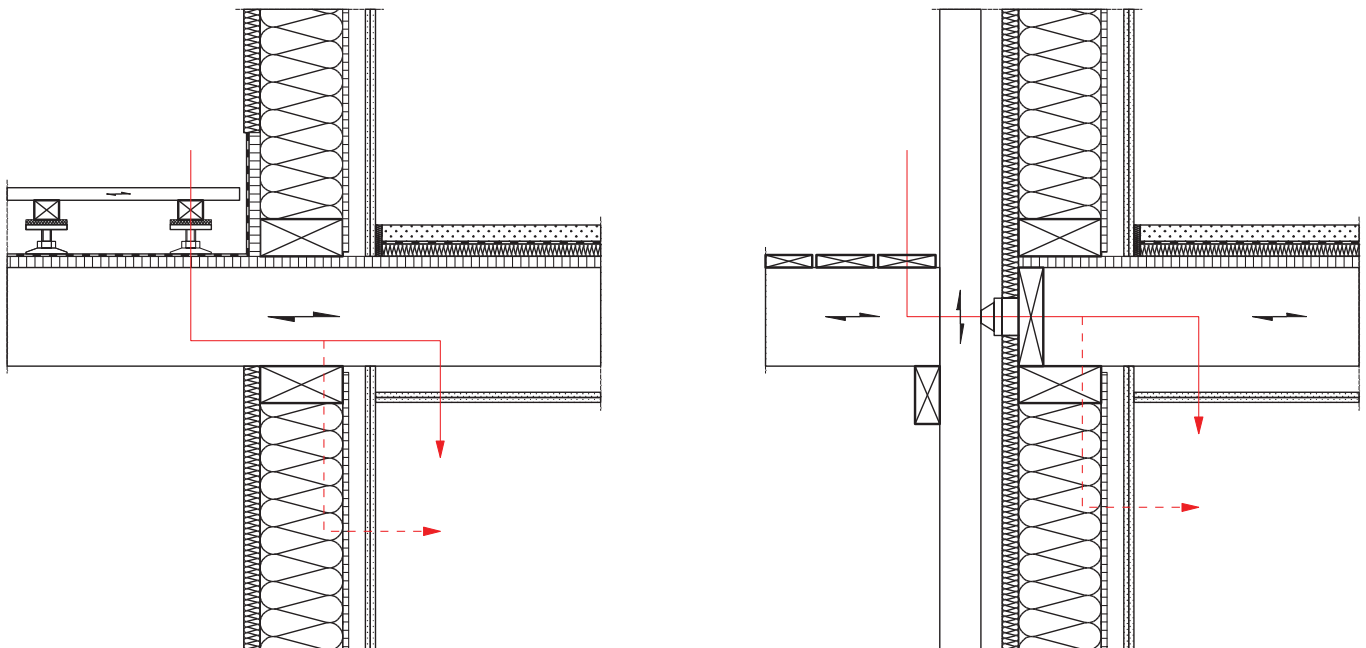
Procedure and 4.6 described the following measures be maintained safely.

There are basically two types of balcony design:

- Featured balcony made of wood or steel
- Cantilevered ceiling with light or heavy coverings

Figure 28.4.:

left: balcony cantilevered ceiling and seal with a light coating on decoupled pedestal. right: imagined balcony with decoupled horizontal bracket.



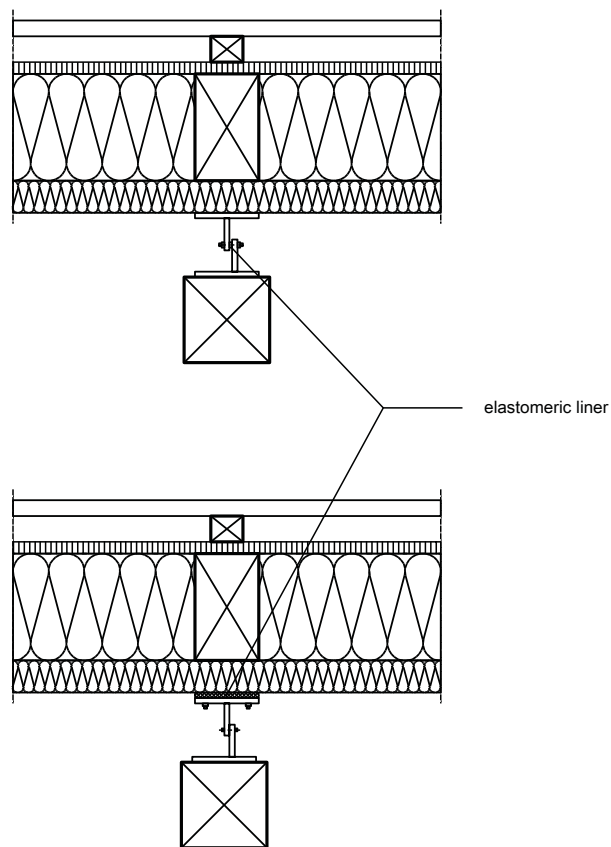
Featured balconies

For light presented balconies, which are held horizontally on the building, the same principles apply as for the light stairs. With decoupled design, the impact sound requirements in practice be followed. A forecast is currently not possible. For horizontal and vertical links of the balcony it applies in principle, this decoupled to attach. Schematically shown in Fig. 4.29 on a horizontal supporting connection.

Figure 29.4.:

Decoupled horizontal force connection

with elastomeric liners



cantilevered ceiling

In timber cantilevered ceiling for better thermal conditions with relatively simple additional measures (insulation or clothing at the ceiling surface) can be executed. For the calculation of the impact sound insulation is recommended to go before shown, as for roof terraces in section 4.6. Simplification can be assumed for the design that the vulnerable space not including diagonally, but is disposed directly vertically below it. The result is a lying on the safe side result. The version with seal is to be regarded with cantilevered ceiling anyway wooden protection reasons as fundamental structural measure. He has to doubt another "impact sound-enhancing" soft liner - optionally also with mass increase

- be mounted on the seal.

4.8 _ building equipment and sanitary articles

Also at the level that can be expected from building services, demands are made. These generally apply to the following installations:

- Supply and disposal installations
- transportation equipment
- permanently installed, industrial installations

As building services as defined above also apply

- Washing facilities
- Swimming facilities, saunas etc.
- sports facilities
- central vacuum
- Garage equipment
- permanently installed, exterior motor-driven sun protection systems and shutters
- Insta fittings and equipment of water in
- lifts

Ignore the other hand, are allowed to stay mobile machines and appliances such as washing machines or vacuum cleaners, which are operated in their own living area. For multi-storey residential buildings in residential and bedrooms, the requirements can be numerically quantified as follows:

Sanitary engineering / plumbing (water supply and sewerage systems together)

Minimum value: $L_{AF, max, n} \leq$

30 dB (A)

DIN 4109-1: 2018 Table 9, line 1

Individual noise peaks when operating the valves are not to be considered.

Other in-house, fixed technical sound sources of technical equipment, supply and disposal as well as garage facilities

Minimum value: $L_{AF, max, n} \leq 30$ dB (A) DIN 4109-1:

2018 Table 9, row 2

also requirements in DIN 4109-1 [1], Table 11 are placed on fixtures and appliances drinking water installations. For drinking water fittings components can at this point be recommended only in principle to choose attributable I of the acoustic group. Here, the slightest Fließ- und flow noise can be reported. Also for the structure-borne noise from building services no prediction methods are currently available for the wood but also the concrete construction. It is possible to give only design recommendations. Embodiments recommendations are given for various installations.

4.8.1 _ supply and waste pipes in the building

For the basic structural design of wooden buildings with regard to service plants, the recommendations may apply 30.4 example in Fig.. The recommendations apply mutatis mutandis to all disposal and supply lines and their associated components.

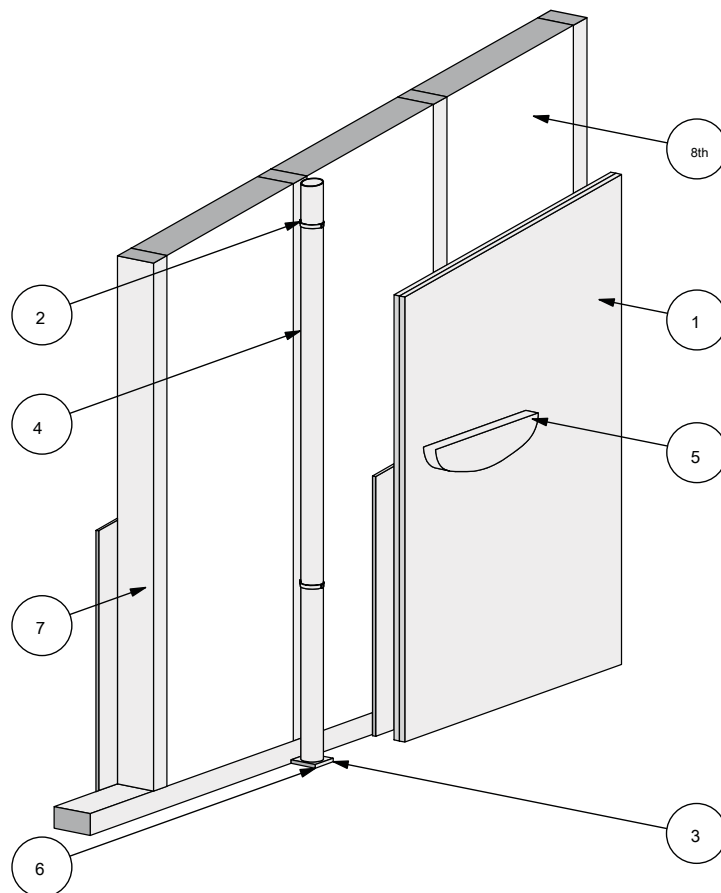
Figure 4.30.:

schematic Dar position a

Holztafelbauwand with

technical installations

1. wall installation having at least 18 mm plasterboard (preferably 2 x 12.5 mm), multi-layered wall systems with bending-flexible sheeting.



Legend

- 1 bending points facing shell, min. 18 mm GK, better 2 x 12.5 mm GK 2 decoupled system associated
- Fastening clamps 3 filling the shaft cross-section, for example. B.
- by req. fireproof bulkheads 4 pipeline with high internal damping, z. B. mineral fiber-reinforced PE pipe
- 5 sanitary article decoupled 6 lines without contact to the building
- ((Also not in slots and vias) 7 wall stud means possible always stand mount) 8 filling the cavity installation
- (Damping cavity approximately 90% of the cross section with no voids)

2. Decoupled, system associated clamps. When tightening clamps the principle of "So tight as statically necessary, but as easy as possible." It is recommended that works at a briefing date of TGA Ge to teach the technicians specifically to this point. Often clamps are tightened so that the liners "swell" side. This must be avoided. Installation instructions of the manufacturer must be observed. Clamps are ständernah to install and not in the middle of the plate location.

3. filling of the shaft cross-section on the ceiling plane to line at least with absorbent material. For a sound decoupling is hard on building materials, the structure-borne sound bridges represent to refrain. It is suitable for. As a necessary anyway soft firewall.
 - Pipes and pipe clamps are attached to a separate substructure of upright profiles (z. B. from stiffening UA) to be attached, which shell or free standing and out of contact with the planking plates were installed in the cavity.
4. Mineral fiber-reinforced PE cables with sheath with high internal damping or high basis weight.
 - Reducing the flow pressure are to the minimum necessary, if necessary, install Druckmin de rer or resting pressure at the mixer must not exceed 0.5 MPa.
5. Decoupled sanitary objects on the wall installation (soundproofing sets).
 - Mounting the conduit and sanitary items in stand nearby.
6. lines must not touch the structure without separation. Avoid sound bridges. Specifically, when laying the lines in slots should be noted that there is no contact between the pipe and the structure is present. This is especially true for the touch of wood-based panels. Here it must be ensured that they have no direct contact with lead.
 - Pumps are to be equipped with pressure and suction sides compensators such. As well as blocking masses.
 - Pump switching devices or the like are also decoupled.
 - In-line valves may only be used in the fully open position and not as throttle valves.
7. represent routing of lines, if possible on walls that do not have partitions to use foreign units.
 - be allowed to fittings installed only in the flow class for which they have been acoustically measured and valve outlet and outlet device must flow class be in terms identical. That is, in the hydraulic chain no element on the outlet side of a higher flow class as the upstream elements.
8. Installation shafts inside are fully clothed with absorbent material and to install close to the building structure.
9. 90 ° bends in the downpipes are to be avoided and z. to replace, by 2 x 45 ° bends.

Other building acoustic design principles for the TGA installation are shown in the following list:

- In lightweight installation walls of the CW studs (such as described in DIN 18183-1) of the two sides of the wall tension by means of tabs gypsum board strips or sheet metal profiles in the amount of 1/3 and 2/3 of the wall height and pressure-proof with one another to join.
- Tubs and shower trays must be verified by the manufacturer by means Musterprüfmessung.

4.8.2 _ Ventilation systems

be in terms of sound pressure level, to put this cause, requirements for ventilation systems. These values apply for their own living area.

Minimum requirement: $L_{AF, max, n} \leq$

30 dB (A)

In addition, individual noise peaks when switching on and off may max. be 5 dB higher, DIN 4109-1: 2018 Table 10 line. 1

The stated requirement here is independent of the design, in most cases, if the installation instructions are complied with for the respective construction. Which adjusting standard sound pressure level in the room then depends on the following factors:

- Air volume flow [m^3 / h]
- Flow velocity [m / s]
- Geometry of the exhaust valves
- Machine noise of the drive

In the test certificates the desired sound pressure level $L_{AF, max, n}$ given function of the air volume flow for the respective ventilation unit. This means that the architectural acoustics is to agree with the ventilation concept from. The air flow rates have to be adjusted if necessary to comply with the noise protection requirements. However, it must be considered whether compliance with the acoustic requirements still sufficient minimum volume flows are available.

4.8.3 _ chimneys and shafts through living rooms

If a chimney with flue block or installation shafts (z. B. pure electric installation shafts) through living rooms, these are sound technical improvements through a furring due to the low mass of the mantle rocks. The construction should be carried out as follows:

- Distance of a flexurally soft stand at least 10 mm without contacting the shaft wall.
- Metal upright profiles at least 75 mm, at least. 60% with absorbent material filled.
- At least a simple soft bending cladding with 15 mm plasterboard (better 2 x 12.5 mm) high basis weight.

4.8.4 _ Lifts

Similarly as in the previous sections, no calculation method is available for building acoustic design of lift systems. It can be made to the construction union Through education in this section only constructive information. The special feature of elevators is that they both airborne noise excitation cause as well as a structure-borne noise. Although the components and their ability increases as the airborne sound insulation for sound insulation, but a prediction method can not be directly derived therefrom.

In this section, only the treated today mainly installed elevator installations without a separate machine room. The recommendations made in the following paragraphs aim at a **required value of $L_{AF, max} \leq 30$ dB (A)**. For various construction situations and model measurements by several manufacturers, which can then be used as the design basis. However, lying on wooden building currently insufficient measurement results before.

- Lift shafts should lead past any vulnerable space.
- The ideal location of the well is in the stairwell with the four other leading past the stairwell or on an outside wall. The staircase serves as a "protective or buffer area".
- The elevator shaft should, if possible static, are not connected to the building.
- If it can be driven with lifts directly in homes, they should always end in a stairwell or hallway, never directly into the apartment.

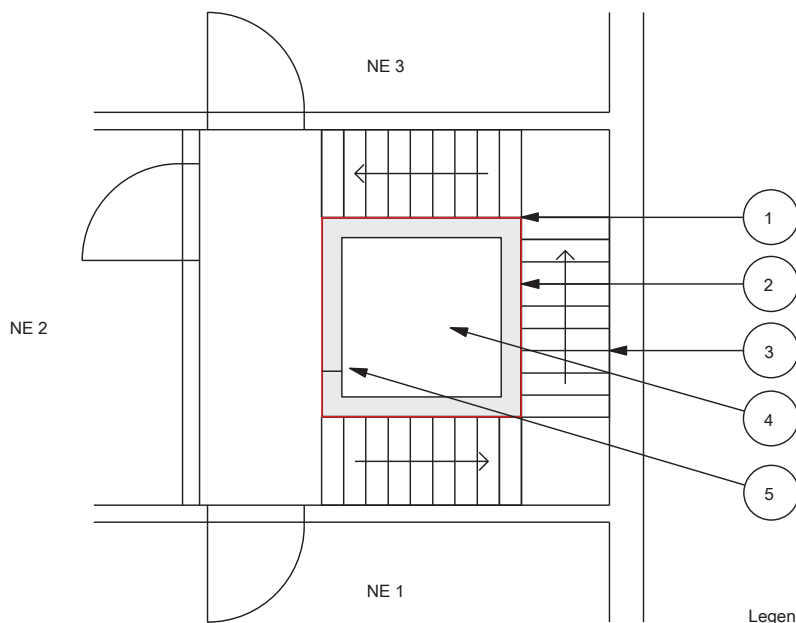
Location of the elevator shaft in the building

Above all building acoustic considerations always the position of the elevator shaft should be considered in the plan. Basically, the following aspects must be considered:

In Fig. 4.31 a favorable arrangement of the elevator shaft is shown in plan view.

Figure 4.31.:

convenient floor plan
arrangement of the elevator
shaft



Legend

- 1 parting line around the manhole
- 2 hoistway with minimum mass
- 3 decoupled stairs and landings
- 4 elevator car on rails
- 5 decoupled elevator doors

For wooden building two main cases can be distinguished:

A solid elevator shaft in a

massive staircase

B solid elevator shaft in a

Staircase in wood construction

There are other variants that are not shown separately here. For all other cases, for example, have no budget room arrangement, the manufacturers of elevators and construction work to be performed acoustician. For example, the dimensions of facings to rooms requiring protection or similar compensation measures take place through an architectural acoustics.

case A

As in a massive building communicates with VDI 2566 Part 2 [23] a comprehensive tool for planning of the lift available. It should, in close cooperation with the manufacturer of the elevator, and one architectural acoustics, the design of the elevator shaft walls and the stairwells possibly be made.

. As reference values for the case with the A in Fig shown low floor plan situation 31/4 following values can be used for preliminary design:

- Elevator shaft mass $m' \geq 480 \text{ kg} / \text{m}^2$,
 $R_w \approx 60.5 \text{ dB}$ (z. B. $d = 20 \text{ cm}$ reinforced concrete)
- Massive staircase walls and flanking components $m' \geq 480 \text{ kg} / \text{m}^2$, $R_w \approx 57.5 \text{ dB}$
- Easy elastic mounting of the lift rails EL1 according to VDI 2566, Sheet 2

case B

Similar to Case A, the situation for lift shafts in stairwells are in wood. To date no planning tools available for this case. Therefore, an analogy may be prepared by the illustrated for the case A recommendations for pre-calculation:

- Elevator shaft mass $m' \geq 480 \text{ kg} / \text{m}^2$,
 $R_w \approx 60.5 \text{ dB}$ (z. B. $d = 20 \text{ cm}$ reinforced concrete)
- Stairwell walls in wood construction, $R_w \geq 58 \text{ dB}$, for example.
B. Chapter 6, Table 41, line 5
- Easy elastic mounting of the lift rails EL1 according to VDI 2566, Sheet 2
- Wooden ceiling structure completely separate from the elevator shaft

It is further to be noted that at the time of publication of this writing there were no measurement data or planning data for this case. Evidence is therefore always to keep in close coordination with architectural acoustics or the manufacturer.

Lift technology and integration of the shaft

In addition to the aforementioned building acoustics through education around the elevator shaft and the elevator itself and its components to be of great relevance. By Sonder be quiet technology, the potential of noise can be reduced drastically in the area of the elevator. In Fig. 4:32 the typical components of an elevator are presented with the respective design recommendations.

4: joint around the elevator shaft

The free-standing shaft should be separated from the rest of the building by at least 20 mm wide (30 mm more) consistent, sound bridge-free joint. This joint is

z. to fill as with mineral fiber that is suitable for impact sound applications. The joint filling serves as protection against the accumulation of objects in the joint, which can act as sound bridges.

Fig 4:32.:

Elevator installation with typical components

. For image numbering in Figure 4:32 the following design recommendations are made:

1: structure-borne noise of the drive

and the rails

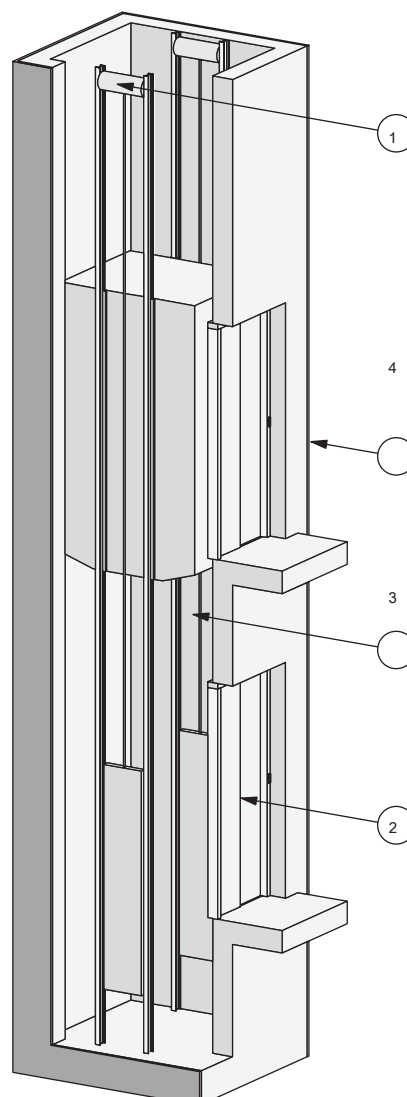
The twill sound insulation of the lift installation is significantly larger factor influencing the overall acoustics as the surrounding construction. The minimum requirement is a simple elastic bearing (EL1) of the engine, of the rails and all the built-in parts connected to the shaft. This is proven by the manufacturer.

2: elevator doors

The doors should be secured body silenced, if this can be run from fire safety point of view. About the joint is to ensure a sound bridge-free assembly. In the end positions a muffled applying the door leaves is required.

3: elevator shaft

The elevator shaft should / have m a minimum mass of 480 kg when this is free in the stairwell and is not adjacent to rooms requiring protection. If this should be the case, kustiker by a Baua further measures must be fen ergrif.



4.9 _ external components

In principle, the dimensioning of the external components is similarly constructed to the external noise, as the method for the transmission of airborne sound in the interior of buildings. Again, the contributions of all components, the sound energy can be transferred from outside into the interior, based on an "interface" and then energetically added. However, in this case, the entire contaminated with noise, **seen from the inside surface (S_{si}) a living or lounge as "release surface", and the ratio for the respective component surface (S_{si}/S_{si}) seen as a reference. In addition, the ratio of the base surface (S_{G}) the space in comparison to the noise component loaded outer surface taken into consideration. Has a large outdoor space component surfaces in relation to the base, then the demand increases for these components to ensure the same level of protection as sound in a room with more favorable surface conditions. This unfavorable constellation, for example, at a loft in the corner position of the case, the noise may face in the three sides.**

value to the outdoor component. The request must be calculated depending on the location in the noise environment for each room or any building. , Is of crucial importance where the external noise components are exposed to be examined space of the. Here, the **authoritative outdoor noise level L must be quantified as exposure** size. The determination of the relevant exterior noise level is especially when multiple noise sources such. As road and rail meet, a task for acoustic engineers. As part of the preliminary design excerpts in this document relevant external noise levels are shown for certain traffic situations.

The calculation method in accordance with DIN 4109-2 [1] takes into account the transfer of be adjacent external components and flanking internal components. For timber construction results in the favorable situation that these flanking transmission may be considered in many cases outside noise impact to be negligible. This allows a rough estimate of the required building acoustic quality facade elements as presented in Section 4.9.3.

When protection against external noise there as opposed to the partition members inside the building no fixed requirement

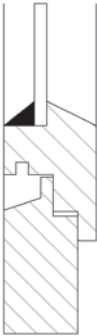
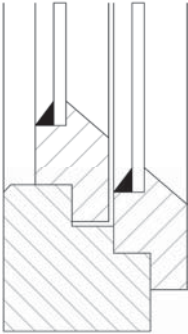
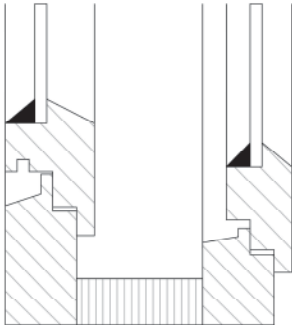
4.9.1 _ components and fittings

Planning data for outer walls and roofs can be removed 4109-33 [1] Chapter 6 or DIN. In addition to these external components, all installations, so windows and patio doors are (z. B. balcony doors), facade elements, shading elements (eg. As shutter boxes) and ventilation units to be considered.

Windows and facade elements

The selection of window and facade elements provides the protection against external noise a central aspect. In addition to the design and the structure of the glazing and the type and number of the seal playing levels a significant role. In addition, it should be noted that the window size and the type of installation also affect the sound reduction of a window element. Also, different window sizes be sitting with an otherwise identical run under schiedliche rated sound reduction, see also DIN 4109-35 [24] and EN 14351-1 [25]. A broad overview of the performance of different types of windows is given in Table 17. It should be noted, however, that individual test certificates better Anyone may also post te. The table provides only a rough guide is for planning.

Table 17 | Typical values of reachable Schalldämmmaßen for windows. See, B. [24], [25] and manufacturer's test certificates

schematic design		sound reduction achievable $R_{w, window}$
Simply glazed windows		30 dB to 40 dB ^{1) 5)}
Coupled windows		35 dB to 50 dB ^{2) 3) 4)}
casement windows		45 dB to > 50 dB ^{3) 4)}

¹⁾ With slices $R_{w, glass} \geq 50$ dB and at least two sealing levels to $R_{w, window} \approx 45$ dB, accessible generally with panes of laminated safety glass (LSG)

²⁾ the sound reduction index of the overall window is a maximum of 5 dB above that of the main wing

³⁾ $R_{w, window} \geq 50$ dB only in agreement with the manufacturers

⁴⁾ $R_{w, window} \geq 45$ dB, the detection always with certificate for composite and casement windows

⁵⁾ $R_{w, window} \geq 32$ dB, the detection always with certificate for single window

shading elements

are shading devices on the weighted standard sound level

difference $D_{n,e,w}$

characterized. As a rule, must target values are specified for this parameter in the early stages of planning, since they are heavily dependent on the manufacturer. These characteristics are then to prove on test certificates.

Note:

is widely used in test certificates $D_{n,e,w,lab}$ specified. This

characteristic value is measured in the laboratory weighted standard sound level difference with the corresponding length of the test specimen. the length is different from the incorporated shading element to the "Labor length," so this value must be corrected depending on length. As the length of the shading element and whose sound insulating effect is reduced.

ventilation units

Fittings in wall components, such as de central ventilation units or openings (forced ventilation) can be determined and sound reduction are considered in detailed design method. This is for ventilation concepts to be considered in the context particularly. In the case of decentralized ventilation units must be taken that the achievable sound insulation of the device or its review normalized level difference $D_{n,e,w}$ a strong dependence of the conveyed air

volume flow has. It must therefore be considered, in which air flow the test certificate indicating the acoustic characteristics and if so, the desired air volume flow of the ventilation concept is maintained. Similar issues arise with so-called Fensterfalzlüftern, here the built number of elements are dependent on the manufacturer to consider Reviewed sound reduction in dependency. Here, the sound insulation of the window is indicated by the Fensterfalzlüfter as a unit.

4.9.2 _ Special noise sources (heat pumps and air conditioners)

The increasing use of renewable energy for heating buildings, the proportion of heat pumps is increasing as a heating system. Acoustically particular note are air heat pumps with external devices. These will be built close to the building in many cases. is critical here is that can not only lead the heat pump for their own building to unwanted noise impact, but also the heat pump / -n neighboring cultivations in combination with the own. This can lead to an unfavorable accumulation of noise sources may. From an acoustic point of view are primarily measures that focus on the device itself beneficial. Here quieter equipment should be used and also the devices are equipped for the night hours with a so-called. "Whisper". Furthermore, the distance to the building and the arrangement of building a substantial acoustic planning subject. Here, both our own building and the neighboring buildings to be considered. Fig. 4:33 shows favorable and rather un favorable arrangements of air heat pumps.

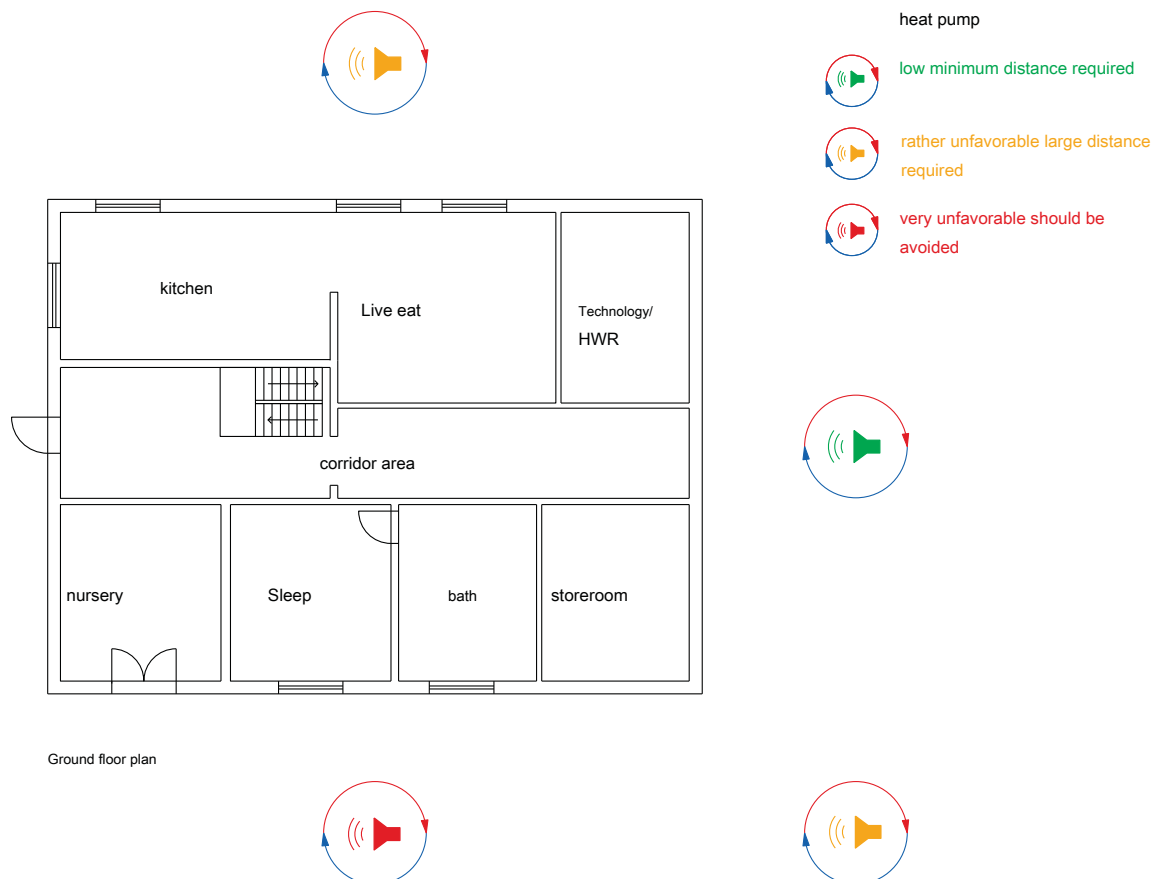
Note:

For free-standing on the ground equipment with a sound power level of 65 dB (A) $\leq L_w \leq 75$ dB (A), the ambient air quality standards for the night of 35 dB (A) in pure housing areas without any further measures in egg nem distance of 13 m (65 dB (A)) and 40 m (75 dB (A)) observed. Should the devices outside front room corners, z. be arranged as to adjacent buildings, or immediately before the reflective walls (e.g. boundary wall of an adjacent building), the distances need to be significantly increased, since with an increase of the level to be expected. are often used as protection against heat pumps and air conditioners also hedges or

provided "noise barriers". The effectiveness of plantings as a noise screen is probably more psychological. Perceptible, physically measurable sound level reductions were here very small. When noise screens / noise barriers must the effective height be relatively large in order to achieve a certain effect. This is not feasible frequently from planning legal reasons. Therefore, measures must as already mentioned primarily fix itself on the device and a minimum distance to rooms requiring protection must be maintained for noise reduction. the arrangement of the unit on the property, 4:33 plays a major role see Fig..

Fig 4:33.:

favorable and unfavorable
arrangement of heat pumps



4.9.3 _ preliminary design for external noise

Analogous to the preliminary design of the internal components can be estimated for simple cases of protection against external noise from diagrams.

For the application of the charts following restrictions apply:

- Only for rooms with exposed façade applicable (no corner rooms).
- Rectangular ground plan with a simple facade structure.
- Maximum capacity of ventilation unit in the facade with $D_{n,e}$ at least 50 dB or 10 dB above the rated sound insulation of the window.
- Wall and shading component have a higher noise insulation than the window.
- Length of the shading element corresponds approximately to the width of the facing window.
- Space facade surface must be sqm than 10 larger. Larger room facade surfaces have a favorable effect, but the effect decreases with increasing proportion of window area.
- $R_{w, window} \leq 40$ dB.
- Extrapolation of the relative numbers in the diagrams is not readily possible.

The variation in this simplified diagram of method may be up to 1 dB. For all cases outside of these constraints and for the specific design and verification a detailed calculation as presented in the following copy of this publication, is essential.

Vorgehensweise in the preliminary design:

1. Determination of the relevant exterior noise level for noise-exposed most facade.

2. Determination of the geometry and the United
hältniszahlen (room depth ratio and proportion of
window area) for a critical space.

$\frac{l}{H}$

3. Derivation of the requirement levels. $R'_{w, ges}$ with the aid of diagram. 1

4. Pre-selection of the facade components:

a) $R_{w, window}$ select window.

b) shading elements and if necessary ventilation elements by impact of the values in the legend of diagram. 2

c) determining the required sound dämmmaßes for the wall from the legend in diagram. 2

is in chart 5. From the window area proportion 2 K_{approx} determined.

6. verification

$$R_{w, windows} + K_{approx} \geq req. R'_{w, sat.}$$

7. Balance the criterion $R_w + C_{tr, 50-5000}$

if the sound level of protection COMFORT is sought.

Note:

It is an evaluative Ver drive for selecting the facade components at an early stage of planning. A detailed Un and examining and accurate detection can not be replaced by this kind of investigation.

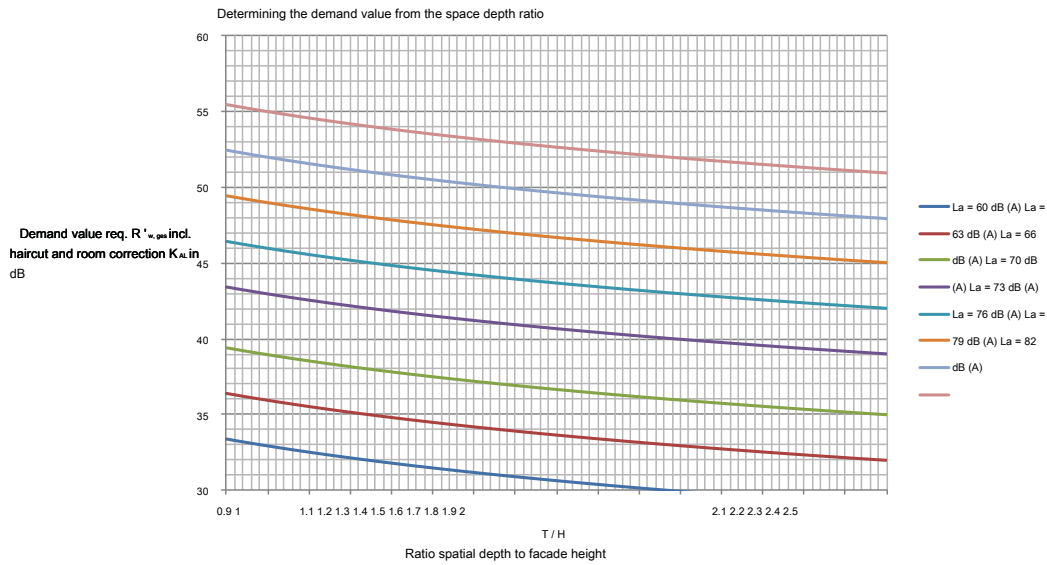


Diagram 1:

Simplified calculation of the required values for ambient noise in rooms with exposed façade. Readings on the ordinate are values of the resulting request Gesamtschalldämmmaß of the facade with space correction factor and safety margins.

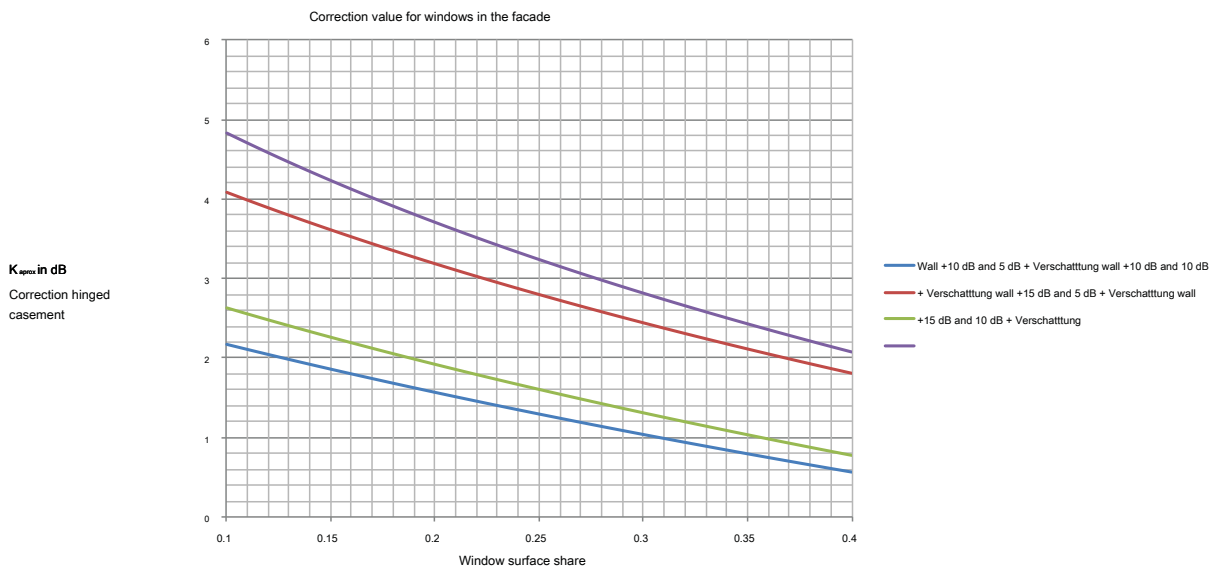


Diagram 2:

Correction surcharge $K_{a, req}$ on the window values as a function of the window portion of blue curve:

blue curve: $D_{n, e, w, shading}$ is 5 dB higher than $R_{w, window}$ and $R_{w, wall}$ at least 10 dB higher than $R_{w, window}$

green curve: $D_{n, e, w, shading}$ is 5 dB higher than $R_{w, window}$ and $R_{w, wall}$ at least 15 dB higher than $R_{w, window}$

red curve: $D_{n, e, w, shading}$ is 10 dB higher than $R_{w, window}$ and $R_{w, wall}$ at least 10 dB higher than $R_{w, window}$

purple curve: $D_{n, e, w, shading}$ is 10 dB higher than $R_{w, window}$ and $R_{w, wall}$ at least 15 dB higher than $R_{w, window}$

4.9.4 _ Vorbemessungsbeispiel

Subsequently, the pre-calculation is explained with an example embodiment.

Step 1:

level determination of the relevant exterior noise.

The determination of the exterior noise level can be represented in many situations not readily available.

Supportive can be switched on for some

Table multiple instances be used eighteenth Here are shown values, which have been formed, including the consideration of 10 dB day-night difference criteria and additional 3 dB from the nomograms in [26]. This is illustrative. are formed object specific to a concrete object has the authoritative outdoor noise level from all relevant transport, leisure and industrial noise sources.

TABLE 18 | Excerpts illustrating various significant external noise levels in road traffic routes

Examples of external noise levels L _A [dB] Road ¹⁾				
1	2	3	4	5
distance	DTV / traffic strength Cars / 24	local roads ^{2) 4)}	Federal, county roads Landes- ^{3) 4)}	Highway ^{3) 4)}
1 25 m	1000 Cars / 24	57 dB	65 dB	69 dB
1 a 25 m	5000 Car / 24h	64 dB	72 dB	76 dB
2 50 m	2000 Cars / 24	55 dB	63 dB	67 dB
2 a 50 m	5000 Car / 24h	59 dB	67 dB	71 dB
3 100 m	2000 Cars / 24	51 dB	60 dB	64 dB
3 a 100 m	10000 Cars / 24h	58 dB	66 dB	70 dB
4 500 m	2000 Cars / 24	40 dB	48 dB	52 dB
4 a 500 m	5000 Car / 24h	44 dB	52 dB	56 dB
5 1500 m	50000 Cars / 24	44 dB	50 dB	54 dB

¹⁾ Nightaddition 10 dB as required taken into consideration, also 3 dB correction

²⁾ Maximum speed max. 50 km / h, not corrugated Gussasphalt

³⁾ not deseeded mastic asphalt, no speed limit

⁴⁾ traffic lights should be located at a distance of less than 100 m, 2 dB should be pitched

Example situation:

For the example that is to be DETERMINING Ge buildings with a facade to a motorway at a distance of 100 meters away. From one of the below mentioned data sources, it appears that with a traffic volume of

24 is expected 10,000 Cars /. This results in Table 18, column 5, line 3:

$$L_A = 70 \text{ dB}$$

Note:

In practice, it often happens that several sources of noise overlap. This can not be shown in this example. In DIN 4109 [1] rules are shown several sound sources for energy overlay.

Sources of traffic data:

- DIN 18005-1 Noise abatement in town - Fundamentals and directions for planning
- BAST - Federal Highway Research Institute
- Road information systems of the federal states, such. B. BAYSIS

Note:

The data of the Environmental Noise Directive with L_{THE} can not be used for building acoustic design. The data must be processed so that the formation of a day and night level is possible.

Step 2:

For the example now is to look behind the noisy facing facade of the critical space. This geometry should have the following: $W \times D \times H = 5.0 \text{ m} \times 5.2 \text{ m} \times 2.6 \text{ m}$ determining the space depth ratio:

$$\frac{T}{H} = \frac{5.20 \text{ m}}{2.60 \text{ m}} = 2.0$$

T spatial depth perpendicular to the exposed façade in the interior

[m] H Height of the room or the noise exposure

Facade seen from the inside [m] Determination of the window area ratio: window size: $2.01 \text{ m} \times 1.29 \text{ m} = 2.53 \text{ m}^2$
window area ratio of the wall:

$$\frac{A_{FE}}{A_{FA}} = \frac{2.01 \text{ m} \times 1.29 \text{ m}}{5.20 \text{ m} \times 2.60 \text{ m}} = 0.20 \text{ } 20\%$$

A_{FE} Window area of the clear

Shell construction dimensions [m]

A_{FA} Facade surface of the clear

Space inside dimensions [m]

Step 3:

Determining the demand value from diagram 1 for $T / H = 2.0$ and $L_A = 70 \text{ dB}$

Reading from diagram 1 (see Fig 4:34.):

$$\text{req. } R'_{w, \text{ges}} \approx 40 \text{ dB}$$

Step 4:

Preselection of the facade components.

window

First, a pre-selection has to be made for the window. It is selected the following window:

$$R_{w, \text{window}} = 37 \text{ dB Source: DIN 4109-35 [24] Table 1}$$

without further corrections

Design features of the window:

- $R_{w, \text{glass}} \geq 35 \text{ dB}$ or 6 + 4 mm discs with disc interspace 16 mm

- at least an effective circumferential rebate seal

- Sufficient contact pressure of the wing

wall component

The sound reduction of the wall should be at least 10 dB above the sound insulation of the window. Chapter 6, Table 45, line 13 is a Holzrahmenbauwand with

$R_w = \text{wall } 52 \text{ dB}$ is

selected.

→ $R_{w, \text{wall}} - R_{w, \text{window}} = 15 \text{ dB} = \Delta R_w$

It is, therefore, before the favorable situation that the sound reduction wall 15 dB above that of the window.

shading device

For the shading device is specified that this with the

Prüfzeugniswert for $D_{n, e, w}$ at least 10 dB should be above the values for the window. That means

$D_{n, e, w, \text{shading}} \geq 47 \text{ dB}$ (design specification)

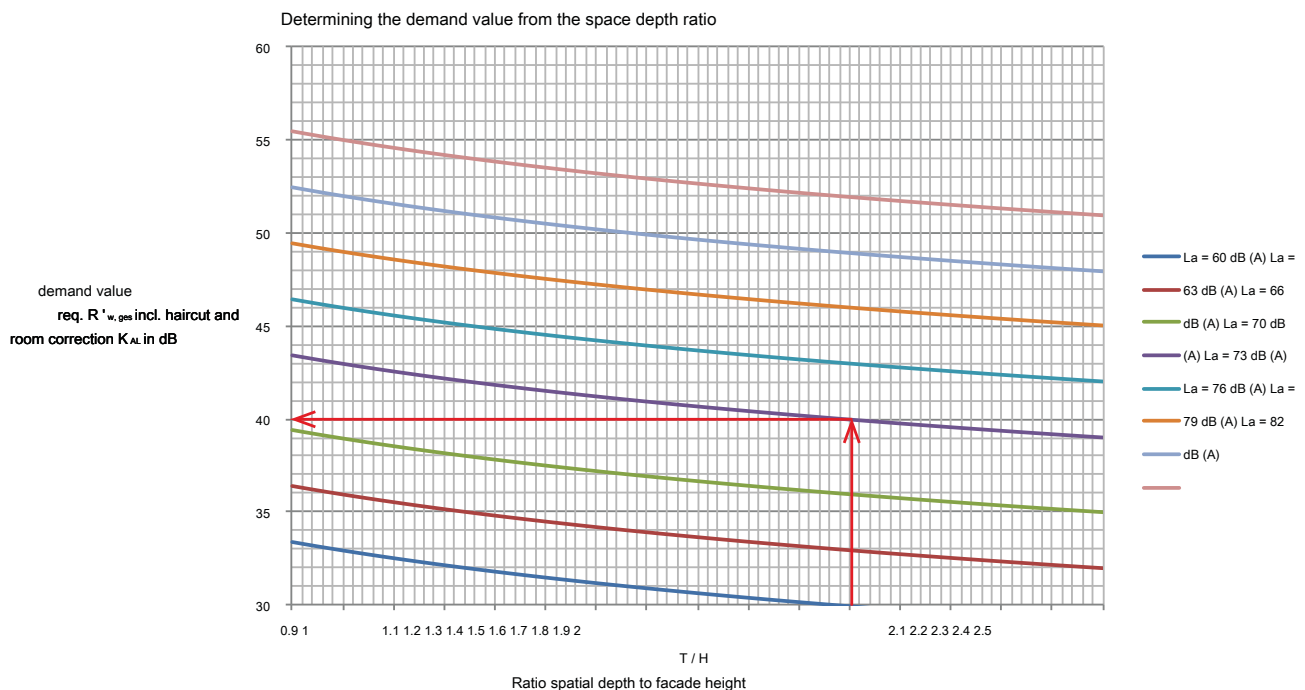
vent

It is a ventilation unit to be installed, which according to

conditions of use for the diagrams $D_{n, e, w} \geq 50 \text{ dB}$ or 10 dB greater than $R_{w, \text{window}}$ reached.

Fig 4:34.:

Diagram 1 for registration of the deep space ratio



Selected facade components

$R_{w, window} = 37 \text{ dB}$

(Selection by certificate or parts catalogs) $R_w =$

wall 52 dB

(Component Catalog Chapter 6, 15 dB higher than $R_{w, window}$)

window)

$D_{n, e, w, shadowing} \geq 47 \text{ dB}$

(Planning specification 10 dB greater than $R_{w, window}$)

$D_{n, e, w, ventilation unit} \geq 50 \text{ dB}$ or 10 dB greater than $R_{w, window}$

(Planning setting, 10 dB greater than $R_{w, window}$)

Step 5:

Determination of K_{approx} for correcting the window surface

portion in the facade of diagram 2 for

$$\frac{A_{FE}}{A_{FA}} = 20\%$$

Reading for the correction surcharge $K_{approx} \approx 3.6 \text{ dB}$ (rounded

off, see Fig. 4.35) $R'_{w, ges, approx} \approx R_{w, window} + K_{approx}$

$R'_{w, ges, approx} \approx 37 \text{ dB} + 3.6 \text{ dB} \approx 40.6 \text{ dB}$ The result of the preliminary design is on the safe side, since the area of the front section is greater than 10 m and $R_{w, the} < 40 \text{ dB}$.

K_{approx} in dB correction hinged casement

Step 6:

Comparing the Gesamtschalldämmmaßes reached with the requirement values. Proof criterion:

$$R_{w, window} + K_{approx} \geq req. R'_{w, ges}$$

$$37 \text{ dB} + 3.6 \text{ dB} = 40.6 \text{ dB} > 40 \text{ dB}$$

Under this simplified procedure the following components would

be needed to sound insulation against external noise ensured. R_w ,

window

= 37 dB

$R_{w, wall}$

= 52 dB (part catalog Chapter 6)

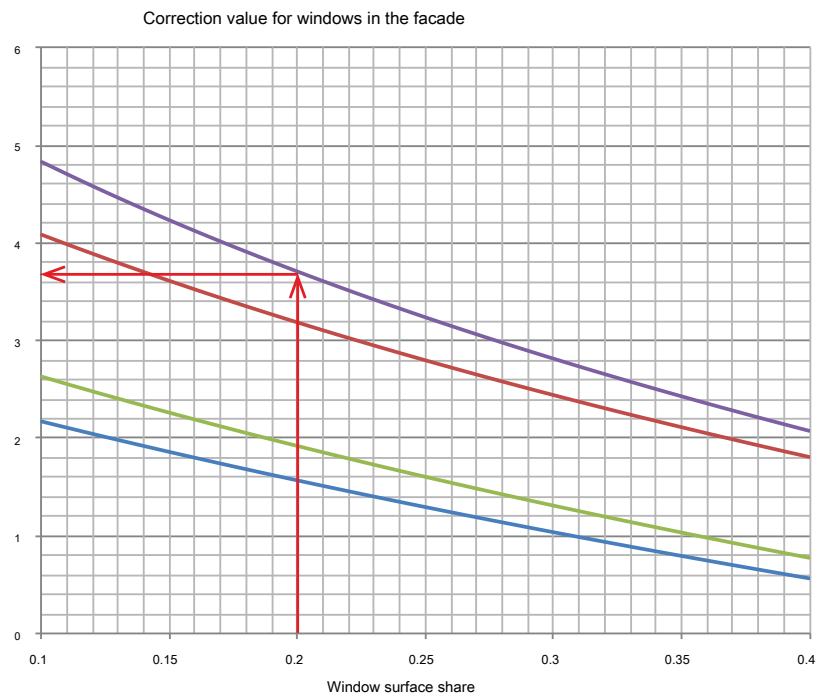
$D_{n, e, w, shadowing} \geq 47 \text{ dB}$ $D_{n, e, w, ventilation unit} \geq 50 \text{ dB}$ or at least 10

dB greater than $R_{w, window}$

(Observance of the air flow).

Figure 4.35.:

Diagram 2 with entries for the example case windows area ratio of 20% or purple curve in accordance with the selection of the facade elements



— Wall +10 dB and 5 dB + Verschattung wall +10 dB and 10 dB
 — + Verschattung wall +15 dB and 5 dB + Verschattung wall
 — +15 dB and 10 dB + Verschattung
 —

5 _ Advice for supervision

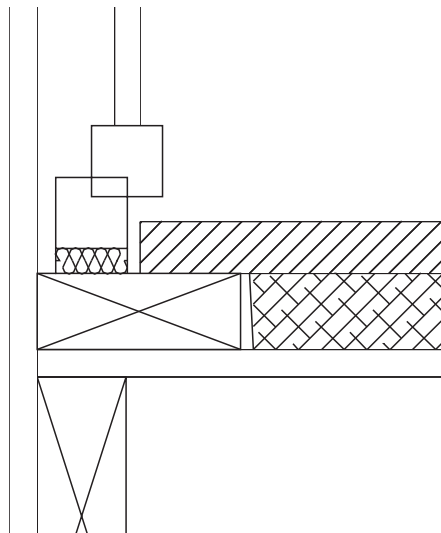
The planning of sound insulation and construction examples in Chapter 6 are always based on defect-free trades. In practice, in completed buildings, deviations from the predicted sound insulation properties are detected, resulting in errors of construction. In the consequences is subject to special sources of error executed item. The list of examples presented does not claim to completeness of.

A bb. 5.1:

Standard impact sound of a wooden joist ceiling with sound bridge over been gossenem cement screed ([16]).

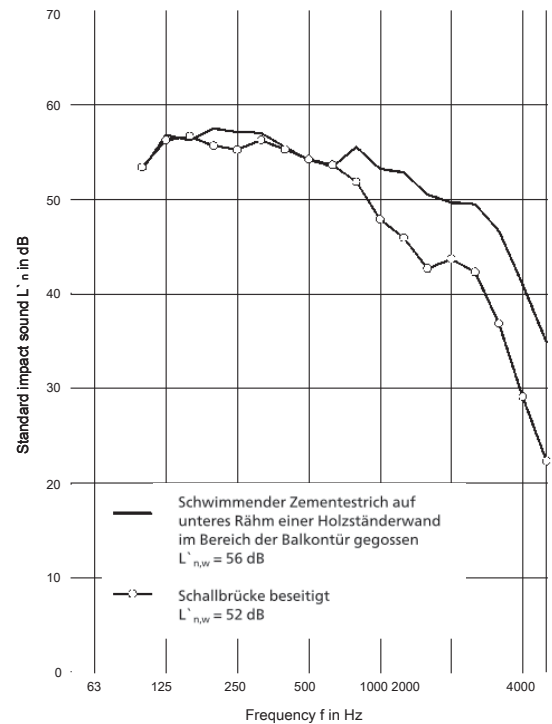
Actual state, ie screed with
cast cement: $L'_{n,w} = 56$ dB
sanierte

Beamed ceiling: $L'_{n,w} = 52$ dB

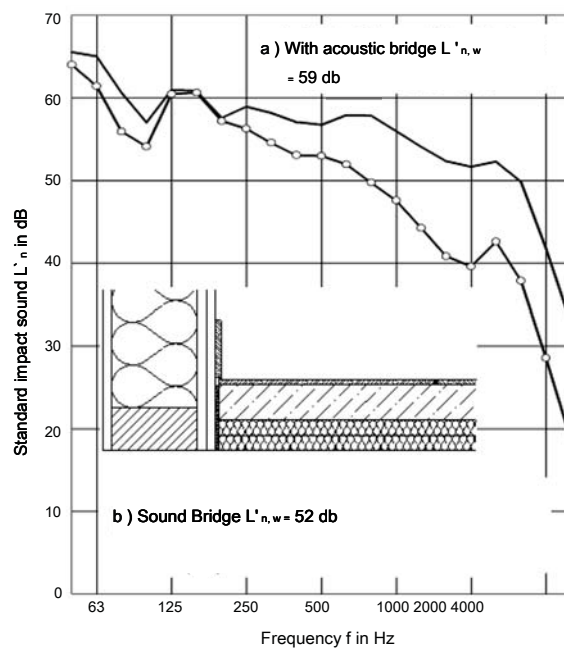


5.1 _ sound bridges in the floor

Although the sound bridge-free installation of floating floor with properly laid margins for a long time one of the generally recognized rules of the art, there are examples always be wrong planned and carried out in which De taillösungen. Each sound bridge leads to a reduction in sound insulation, in particular the impact sound insulation. In case of damage, the structure-borne sound bridges shown below were found:



- Base tiles are made too close to the floor.
- The edge strip was moved not free of defects or from the subsequent craftsmen, because this felt hindered. This allowed leveling compound, adhesive, etc. reach the edge joint. The edge strip can be cut only after the laying of the floor.
- Sound bridges are formed when poured in the range of windows, the cement screed without impact insulation directly to the untere Rähm, see example in Fig. 5.1.
- can sound bridges also arise when the insulation incorrect encounter who except for the installation plates running the floor and in the joint area. The screed is then separated Although still of the laying plate through the protective film, but the separation is acoustically ineffective.
- Under the screed plate laid heating pipes or other installations can form sound bridges. Unclean laid installation lines that extend in some areas on the impact sound insulation boards are molded into the screed. Particularly critical are intersections of heating pipes. It is recommended to avoid these generally through careful planning, since the proper (ie sound bridge-free) version requires a correspondingly higher screed.
- In tiled floors a number edge tiles are often attached to the walls. Through improper assembly tile adhesive can trick between it and enter into the edge groove wall and cure upon From



a line- or point-like sound bridge formed. If the joint between wall and floor tiles closed grout with normal Off, a structure-borne sound bridge is built systematically. Fig. 5.2 shows the influence of poorly assembled wall tiles on sound insulation in comparison with the restored state. be cleaned in case of damage should the entire circumferential Estrichfuge and sealed with permanently elastic sealant.

Fig. 5.2:
Standard impact sound with a ceiling-mounted deficient edge tiles ($L'_{n,w}$ = 59 dB) and distal edge tiles and Cleaned Estrichfuge ($L'_{n,w}$ = 52 dB) [16].

- By using a nail board when laying the screed, there may be damage to the impact sound insulation or subsequent to penetration of the slurry screed to the damaged insulation, particularly if the floor is thin to. From this result then pointwise sound bridges in the area, leading to a reduction of the impact sound insulation.

5.2 _ Incorrect insertion of

Rohdeckenbeschwerung

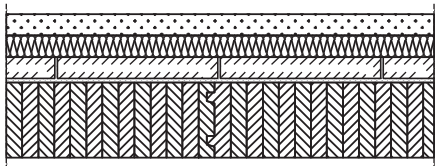
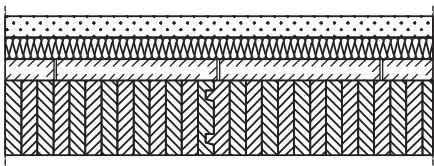
The weighting of wood ceilings to improve the sound insulation is a common procedure. Below are some examples of common mistakes:

- Rohdeckenbeschwerung concrete plates: The plates are not as prescribed, glued to the installation plates, but only launched, as an example see Table 19th
- Beds of sand are not secured against displacement or show subsidence because the bed was not compacted. This can lead to local irregularities.

- Is cast as pure Beschwerungsmaßnahme instead of a unitized Plattenbeschwerung entire surface a cement screed on the bare floor, so this option does not bend soft weighting is realized. There are higher here standard impact sound level measured compared to the design with a Plattenbeschwerung equal mass. If one tries to elementieren this cement screed layer by a trowel cut, so there is a risk that the slurry screed flows together prior to setting in the lower region un again and forms a flexurally rigid plate.

Table 19 | Evaluated standard impact sound level $L_{n,w}$ and sound reduction index R_w

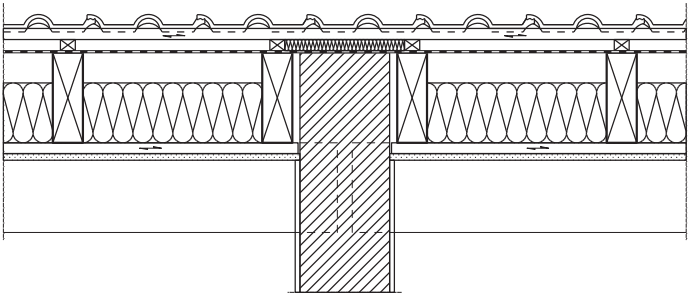
a ceiling board stack with different embodiments of the Plattenbeschwerung, [16]

loadings: Concrete slabs 40 x 300 x 300 mm	
in 8 mm sand bed	placed loosely - rough side down
	
$L_{n,w} = 44 \text{ dB}$ $R_w = 73$ dB	$L_{n,w} = 46 \text{ dB}$ $R_w = 71$ dB

5.3 _ Open joints between roof and partition

Are not properly sealed with a roof connection to a partition the joints, it can lead to transmission of sound over the joint, which drastically reduces the sound insulation of the partition. In practice, this construction error occurs frequently in pitched roofs with insulation between rafters, connected to masonry or concrete walls, whereby both separating walls

are affected and Ge walls of the building. In the wood construction is designed mostly dense by the prefabricated construction of the roof connection and does not as likely to complaints. An example of these effects is provided in Fig. 5.3 represents and described. The joints between roof and partition had a width of about 1 cm. With **open joints a standard edge level difference of $D_{n,t,w} = 51$ dB** ge measure. By sealing the joints between rafters and partition this **value was down to $D_{n,t,w} = 71$ dB** can be increased.



Roof structure from the inside to the outside:

- 12.5 mm GKB 24/48 mm
- battens 8.24 cm
- rafters
- 160 mm mineral wool 30/50 mm
- battens 30/50 mm battens
- roofing

Construction of the separation wall:

- single-calcareous sandstone solid wall
- 17.5 cm thick, $m' \approx 350 \text{ kg / m}^2$

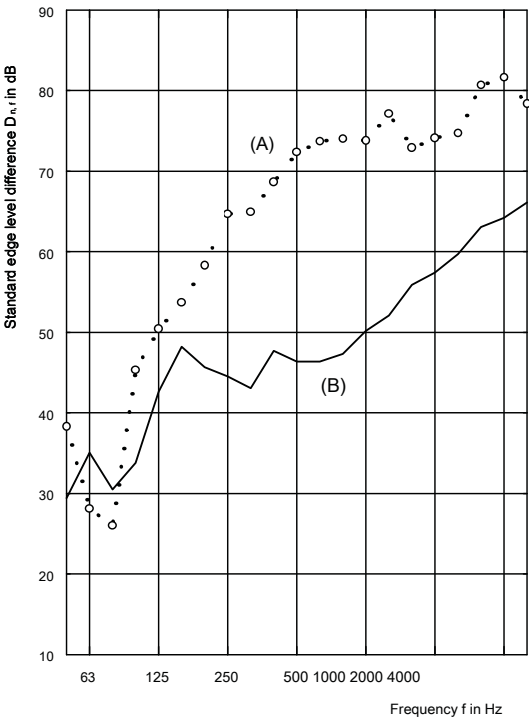


Figure 5.3.:

Deterioration of the edge soundproofing joints sound. Standard edge level difference of a roof structure with insulation between the rafters, from Example [19].

Curve (a): joint between the inner cladding of the roof and the partition wall is sealed permanently elastic, $D_{n,t,w} = 71$ dB

Curve (b): gap open, $D_{n,t,w} = 51$ dB

To avoid this Baufehlrs sealing measure shown 5.4 can be achieved by in Fig. To ensure that over the

Connecting joints is transmitted between the roof and wall joints no sound.

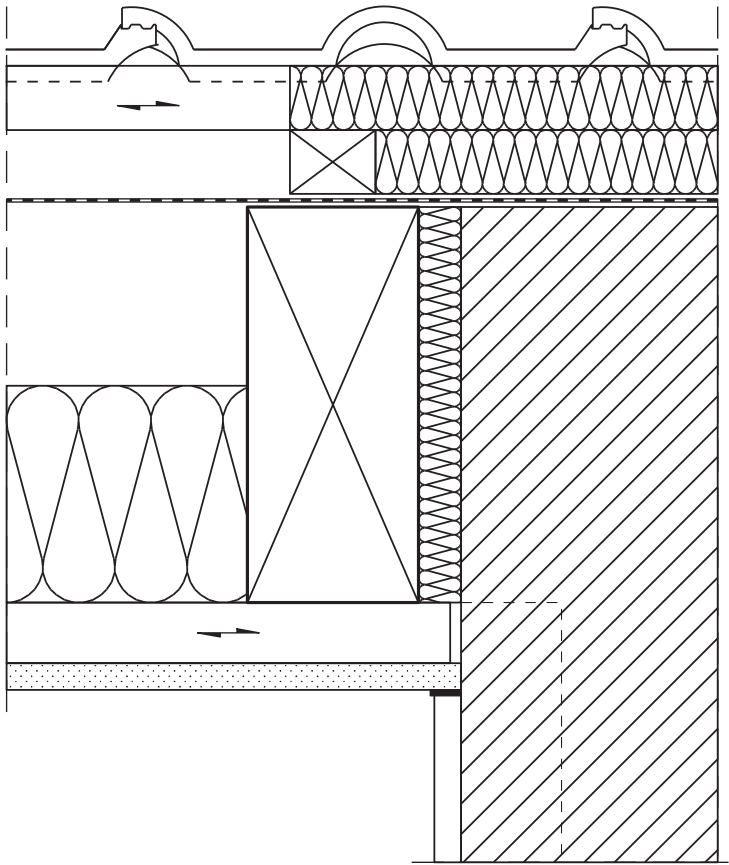
Figure 5.4.:

Suggested connection details:

Between rafters and partition 10-50 mm gap with Faserdämm material insulated

insulated latte cavity above the partition with non-combustible fiber insulation

Connection plasterboard: plaster with separation strips or permanently elastic sealed.



5.4 _ High pressure in roof insulation of pressure-resistant fiber insulation boards

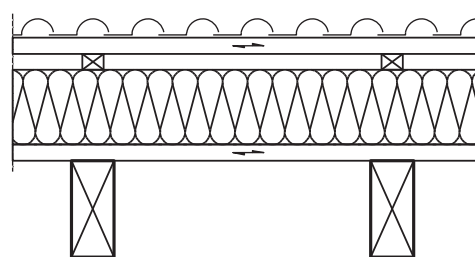
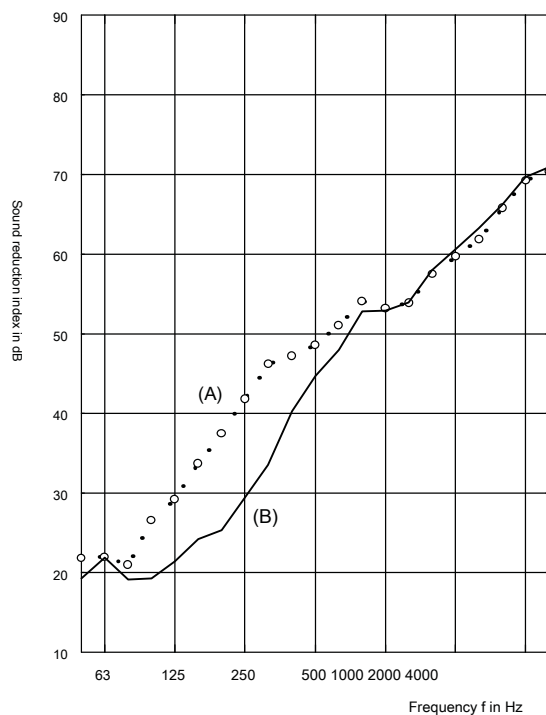
A too high pressure of the roof insulation resulting from the method of mounting. If the insulation boards nailed or screwed with rafter nails with a single threaded screw, a very high contact pressure is automatically provided. The mounting with double threaded screw guarantees a low contact pressure if properly handled.

As with transitory roof battens and canopy this influence is at an increased sound insulation ($R_{L,w,R} \geq 68 \text{ dB}$) is decisive.

Too much pressure the insulation also has an influence on the transmission sound insulation such a roof structure. By setting a high contact pressure as compared with a low contact pressure of the sound insulation R_w reduced by up to 9 dB, see Fig. 5.5.

5.5 _ fitted kitchens and furniture

Often for installation of furniture removing the skirting board is required. The fixtures are then connected accordingly by the screed directly to the wall. Thus, the edge insulation strip is bridged acoustically. Such installation situations are to be avoided and the preparation should be borne sound isolation. An indication shall be inserted in the plans, therefore, to be handed over to the respective buyers.



A bb. 05.05:

Influence of mounting: Simply thread - double-threaded screw, as in [17].

Curve (a): without pressure

(double-threaded screw), $R_w = 51 \text{ dB}$

Curve (b): with a contact pressure

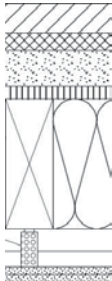
(single screw), $R_w = 42 \text{ dB}$

6 _ component catalog

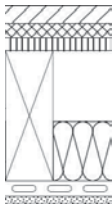
6.1 _ Component Catalog ceiling

Table 20: bodiesVehicle overview ceiling								
table	construction category		row	$L_{n,w}$ in dB	$C_{l, 50-2500}$ in dB	R_w in dB	$(C_{50-5000};$ $C_{tr, 50-5000})$ in dB	Fire protection
table 23	Beamed ceilings; without ceilings; mineral. b screeds		1	50	4	67	- 6; -19	See DIN 4102-4: 2016-05, Table 10.16 and www.dataholz.de
			2	47	4	72	- 9 -24	
			3	53	1	70	- 6; -20	
			4	51	3	70	- 7 -21	
			5	54	3	66	- 4 -16	
	Beamed ceilings; without ceilings; dry screeds		6	57	1	64	- 7; -19	
			7	54	2	65	-; -	
table 24	Beamed ceilings; rigid false ceilings; mineral. b screeds		1	54	7	63	- 8 -21	See DIN 4102-4: 2016-05, Table 10.11, Table 12.10 and www.dataholz.de
			2	48	10	65	- 12 -25	
			3	51	10	67	- 13; -27	
			4	46	12	67	- 11 -24	
			5	43	6	74	- 11 -26	
			6	43	10	76	- 16 -31	
	Beamed ceilings; rigid false ceilings; dry screeds		7	55	7	61	- 10 -23	

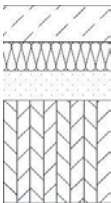
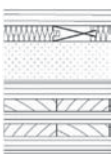
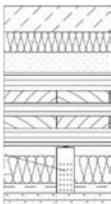
Continued Table 20: bodiesVehicle overview ceiling

table	construction category		row	L _{n,w} in dB	C _{l, 50-2500} in dB	R _w in dB	(C ₅₀₋₅₀₀₀ ; C _{tr, 50-5000}) in dB	Fire protection
table 25	Beamed ceilings; false ceilings; mineral. b screeds		1	46	7	70	- 10 -23	See DIN 4102-4: 2016-05, Table 10.1.1, Table 12.10 and www.dataholz.de
			2	34	20	73	- 12 -26	
			3	30	23	79	- 17; -33	
			4	48	6	69	- 9 -22	
			5	36	16	68	- 10 -23	
			6	31	18	71	- 9 -24	
			7	40	10	71	- 6; -19	
			8th	50	7	71	- 11 -24	
			9	46	7	76	- 13; -28	
			10	31	19	82	- 22; -37	
			11	36	18	80	- 18; -33	
			12	40	11	80	- 16 -31	
			13	43	9	78	- 15 -30	
			14	44	9	77	- 13; -28	
			15	32	14	82	- 18; -33	
			16	30	10	82	- 16 -31	
			17	37	12	82	- 16 -31	
			18	50	9	72	- 13; -27	
			19	42	7	80	- 16 -31	
			20	39	11	80	- 15 -30	
			21	37	11	82	- 17; -32	
			22	37	9	83	- 18; -33	

Continued Table 20: bodiesVehicle overview ceiling

table	construction category		row	$L_{n,w}$ in dB	$C_{l, 50-2500}$ in dB	R_w in dB	$(C_{50-5000}; C_{tr, 50-5000})$ in dB	Fire protection
table 25	Beamed ceilings; false ceilings; dry screeds		23	56	2	63	- 11 -25	See DIN 4102-4: 2016-05, Table 10.11, Table 12.10 and www.dataholz.de
			24	41	8th	69	- 10 -23	
			25	45	5	67	-7, -19	
			26	38	16	79	- 20; -35	
			27	34	16	80	- 19 -34	
			28	42	11	75	- 16 -31	
			29	34	15	80	- 16 -31	
			30	34	11	81	- 18; -33	
	Beamed ceilings; false ceilings; asphalt floors		31	50	4	64	- 7; -20	
	Beamed ceilings; false ceilings; floorboards		32	34	16	78	- 19; -33	

Continued Table 20: bodiesVehicle overview ceiling

table	construction category		row	$L_{n,w}$ in dB	$C_{l, 50-2500}$ in dB	R_w in dB	$(C_{50-5000}; C_{tr, 50-5000})$ in dB	Fire protection
table 26	Solid wood ceiling; without ceilings; mineral. b screeds		1	56	3	62	- 6 -18	see www.dataholz.de
			2	46	5	68	- 7; -20	
			3	40	8th	72	- 8 -21	
			4	38	4	77	- 13; -28	
			5	45	4	72	- 8 -23	
			6	40	9	74	- 9 -24	
			7	38	5	76	- 10 -25	
			8th	40	7	73	- 16; -32	
	Solid wood ceiling; without ceilings; floorboards		9	50	1	65	- 5 -16	
table 27	Solid wood ceiling; false ceilings; mineral. b screeds		1	24	29	81	- 21; -36	see www.dataholz.de
			2	23	26	82	- 20; -35	
			3	32	23	82	- 18; -33	
	Solid wood ceiling; false ceilings; dry screeds		4	36	23	78	- 23; -38	
			5	33	20	79	- 18; -32	

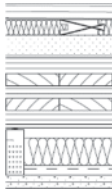
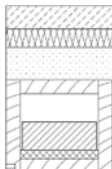
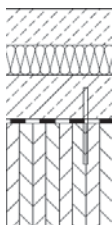
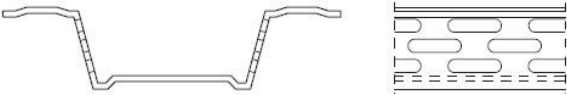
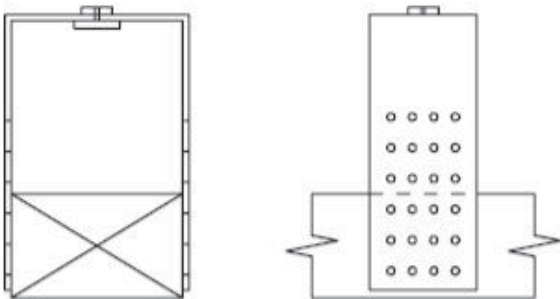
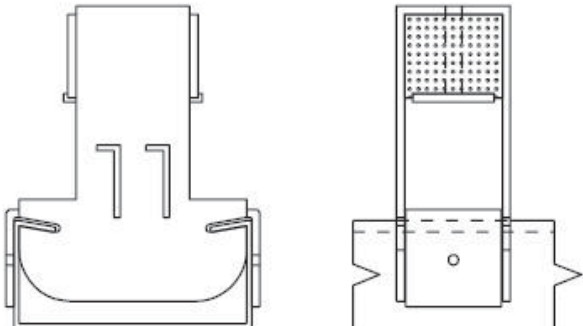
Continued Table 20: bodies/Vehicle overview ceiling								
table	construction category		row	$L_{n,w}$ in dB	$C_{l, 50-2500}$ in dB	R_w in dB	($C_{50-5000}$; $C_{tr, 50-5000}$) in dB	Fire protection
table 27	Solid wood ceiling; false ceilings; floorboards		6	36	16	77	- 15 -30	see www.dataholz.de
table 28	Solid wood ceilings Rib and box elements; without ceilings; mineral. b screeds		1	45	0	72	- 8 -23	According to the manufacturer
			2	43	2	71	- 9 -24	
			3	40	8th	75	- 13; -28	
			4	37	7	78	- 9; -23	
table 29	Wood-concrete composite slabs; without ceilings; mineral. b screeds		1	46	5	67	- 9 -22	see www.dataholz.de
			2	44	- 1	72	- 4 -18	
			3	49	2	69	- 6; -20	

Table 21: Construction material properties - Ceiling

1	Mineral-bound screed	Minerally bound screed such as cement, magnesia or anhydrite according to DIN 18560 with the specified in the table thickness d and mass per unit area m'
2	dry screed	Dry screed from: - Plasterboard according to DIN 18180 and DIN EN 520 with the specified in the table thickness d and mass per unit area m' - cement-bonded particle boards in accordance with DIN EN 634 with the specified in the table thickness d and mass per unit area m' - Wood-based panels in accordance with DIN EN 13986 d with the specified in the table thickness and basis weight m'(for more properties see Table 21, line 7 - Rohdeckenbeplankung)
3	asphalt floor	18560 d asphalt floor of mastic asphalt according to the DIN indicated in the table thickness and the basis weight m'85 kg / m²
4	floorboards	Floorboards of wood planks on the impact sound insulation boards with the specified thickness d in the table
5	impact sound insulation	Underlay made: - Mineral wool insulation panels (MW) according to DIN EN 13162 d with the thickness indicated in the table, s'dynamic stiffness and the type of application on the application: Type DES sh for screeds with mineral binders, type DES sm for Dry screeds and asphalt floors - Wood fiber insulation boards (WF) according to DIN 4108-10 and DIN EN 13171 d with the thickness indicated in the table, s'dynamic stiffness and the type of application on the application: Type DES sg - Wood fiber insulation boards with laying strips (WF + bars) and groove-and-groove joints of the insulation boards - Polystyrene foam insulation board (EPS) according to DIN 4108-10 and DIN EN 13163 d with the thickness indicated in the table, s'dynamic stiffness and the type of application on the application: Type DES sm
6	Raw ceilings poising	Rohdeckenbeschwerung of: - elastically bound dry bulk material with a bulk density / "1500 kg / m³, the residual moisture # 1.8% and a bond of latex milk (no additional safeguard against slipping required) - unbound dry bulk material with m³ of the bulk density "1500 kg /, the residual moisture # 1.8%, an additional Rieselschutzfolie and an additional safeguard against slipping of Pappwaben, sand mats, bar grating (field size about 80 cm x 80 cm) etc. - Concrete slabs mm with surface dimensions # 300 x 300, the bulk density /2,500 kg / m³, the residual moisture # 1.8% and Rieselschutzfolie; Bonding on the bare floor or storage in the sand bed - special bottom weights such as cement-bonded particle boards with the density! 1000 kg / m³ and the respectively required corresponding dimensions (installation of an additional Rieselschutzfolie required)
7	Raw ceilings planking	Rohdeckenbeplankung of wood-based panels such as: - Chipboard in accordance with DIN EN 312 with the thickness d = 18 to 25 mm - OSB according to DIN EN 300 with the thickness d = 18 to 25 mm - BFU-plates according to DIN EN 315 and DIN EN 13986 with the thickness d = 18 to 25 mm - View formwork with the thickness d = 28 mm and additional BFU-plates with the thickness d = 12 mm as an alternative in open wooden beams - additional clothing of the wood-based panels made of gypsum board or wooden beams in view formwork space directly to the wood-based panels (without additional cavity)

Continued Table 21: Construction material properties - Ceiling		
8th	Reinforced concrete layer	Reinforced concrete layer of wood-concrete composite slab; Design and construction according to EC 2
9	separating layer	Separation layer of PE films for protecting the basic ceiling and as trickle
10	Structure	Supporting structure: - Solid wood or laminated wood beams with the minimum dimensions 60 x 180 mm; alternatively as a web support having a height of 240-406 mm; Wheelbase $e/625$ mm - Laminated timber elements with the minimum thickness $d = 120$ mm - lying flat laid glued laminated timber elements with the minimum thickness $d = 120$ mm - Board stack elements with the minimum thickness $d = 120$ mm - Solid wood box elements'LIGNATUR-surface elements (LFE) 240 silence 12' with the thickness of $d = 240$ mm; more details from the manufacturer - Solid wood box elements'LIGNATUR-surface elements (LFE) 240 silence Akustik' 12 with the thickness of $d = 240$ mm and acoustic slats; more details from the manufacturer - Brettsperholz rib members'LIGNO rib Q3' of LIGNOTREND; more details from the manufacturer - Laminated timber ribs elements'LIGNO ceiling Q3' of LIGNOTREND; more details from the manufacturer
11	coupling board	Coupling board made of wood-based panels with thickness $d = 22$ mm for the frictional connection of massive wood floor elements and establishing the static disk effect
12	cavity damping	Cavity damping of: - Mineral, jute, hemp, wood, cellulose, cotton or sheep wool fiber insulation / - mat with the longitudinal flow resistor $5 \text{ kPa s} / \text{m}_2 \cdot r$ "50 kPa s / m_2 - Zellulosefasereinblasdämmstoffen according to DIN EN 15101-1 with the density = 40 - 50 kg / m_3 (space-filling), the longitudinal flow resistor $5 \text{ kPa s} / \text{m}_2 \cdot r$ "50 kPa s / m_2 and an additional Rieselschutzfolie below the wood joists (fixed by a wooden battens with the axial spacing $e = 400$ mm)
13	battens	Battens made of wooden slats having the dimensions 24 x 48 mm
14	Unterdecken-clothing	Under ceiling covering of: - Gypsum fiber boards according to DIN 18180 and DIN EN 15283-2 with the specified in the table thickness d and mass per unit area m' - Plasterboard according to DIN 18180 and DIN EN 520 with the specified in the table thickness d and mass per unit area m' - Plasterboard fire protection slabs according to DIN 18180 and DIN EN 520 d with the specified in the table thickness and basis weight m' for use in fire protection constructions
15	connecting medium	Connecting means between the wood and the concrete structures in the timber-concrete composite floor such. B. composite screws or glued HBV shear connector; Selection depending on static and ceiling type

Table 22: Abhängertypen for acoustic decoupling column		
row	1	2
	View and section	application Description
spring rail		
1		Abhängertyp made of folded sheet metal for acoustic decoupling of flexurally soft Gipsbau-, gypsum fiber or wood-based panels of the concrete slab; Spring action of Lochausstanzungen in the flange; Dimensions 27 x 60 mm; more details from the manufacturer
Direktschwingabhängiger / Direct hanging (Knauf Direktschwingabhängiger for CD 60/27; drywall Direct hanging U-CD)		
2		Abhängertyp for acoustic decoupling and attachment of wooden battens or CD-profiles with an integrated vibrating element (molded rubber part) for acoustic decoupling; not suitable for wet rooms or outdoor areas; Maximum load: 0.4 kN per hangers; more details from the manufacturer
AMC-hangers (AMCAkustik Super)		
3		Abhängertyp for acoustic decoupling and fixing of CD-profiles with an integrated vibrating element for sound decoupling; Determining the load and conversion in kg / m recommended before installation; Functionality of the AMC Abhängers given only at the proper exposure; more details from the manufacturer

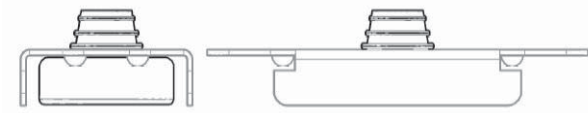
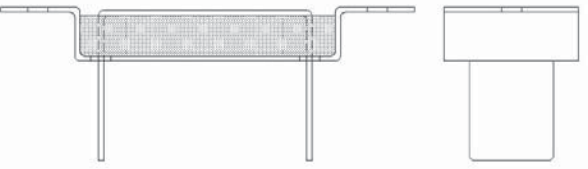
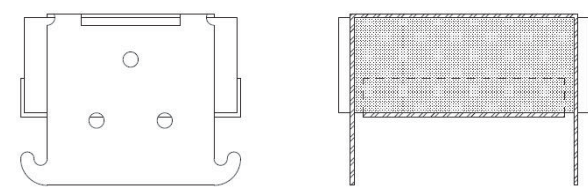
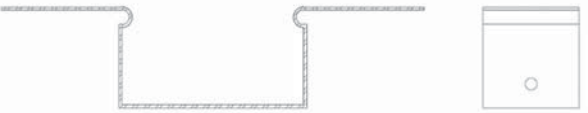
Continued Table 22: Abhängertypen for acoustic decoupling column		
row	1	2
	View and section	application Description
Direktbefestiger (plasterboard Klick-Fix Direktbefestiger for C-ceiling profile, acoustically decoupled)		
4		Abhängertyp for acoustic decoupling and attachment of wooden battens or CD-profiles with an integrated vibrating element for sound decoupling; Maximum load: 0.4 kN per hangers; more details from the manufacturer
VF-hangers (Knauf VF-hanger 8 for CD 60/27)		
5		Abhängertyp for acoustic decoupling and attachment of wooden battens or CD-profiles with an integrated vibrating element for sound decoupling; Maximum load: 0.16 kN per hangers; more details from the manufacturer
Regufoam [®] Suspended QH.F 220 plus		
6		Abhängertyp for acoustic decoupling and fixing of CD-profiles with an integrated vibrating element for sound decoupling; more details from the manufacturer
Attachment clip		
7		Abhängertyp for acoustic decoupling and mounting of CD profiles; more details from the manufacturer
Note: More Abhängervarianten are possible. As a criterion for the design of the hangers, the natural frequency of the Unterdeckenabhängung is to be applied (depending on the spring stiffness of the hangers and the basis weight of the lower ceiling lining) in the construction of tables.		

Table 23: beamed ceilings without suspended ceilings column

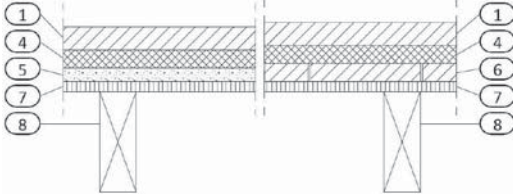
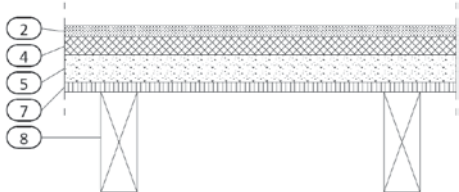
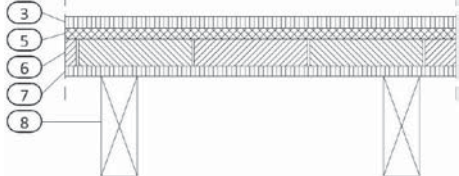
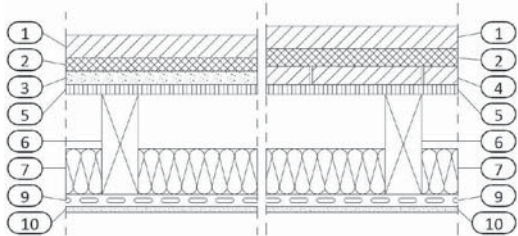
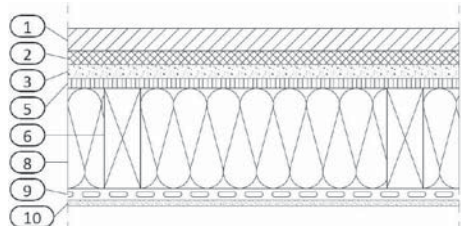
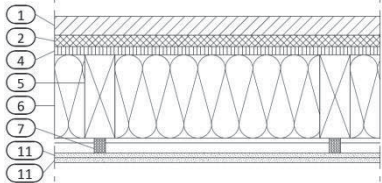
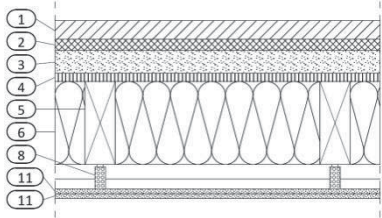
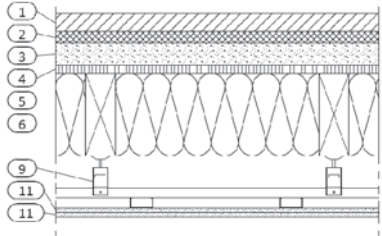
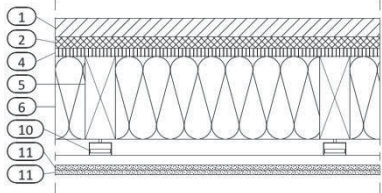
row	1	2	3	4	5	
	cut	Insulation d in mm s'in MN / m	weighing down d in mm m'in kg / m	L _{n,w} (C _{l, 50-2500}) in dB	R _w (C ₅₀₋₅₀₀₀ ; C _{tr, 50-5000}) in dB	
Beamed ceilings without suspended ceilings with bodies from mineral-based screeds						
1		MW (DES sh) d 40 s'! 6	bulk	d 30 45 m'	50 _a (4)	67 _a (-6, -19)
2			plates	d 40 100 m'	47 _a (4)	72 _a (-9 -24)
3		MW (DES sh) d 30 s'! 20	bulk	d 80 120 m'	53 _b (1)	70 _b (-6, -20)
4				d m'100 150	51 _b (3)	70 _b (-7 -21)
5		WF (DES sg) d 30 s'! 30		d 60 90 m'	54 _H (3)	66 _H (-4, -16)
Beamed ceilings without suspended ceilings with bodies from dry screeds						
6		WF (DES sg) d 20 s'! 30	bulk	d 60 90 m'	57 _a (1)	64 _a (-7, -19)
7		MW (DES sm) d 25 s'! 15 or WF (DES sg) d 60 s'! 30	plates	d 60 150 m'	54 _a (2)	65 _a (- ; -)
Minerally bound screed according to Table 21 / line 1; Thickness d of 50 mm; grammage m'120 kg / m² of dry screed gypsum board or cement-. Particle board						
according to Table 21 / line 2; Thickness d of 25 mm; m'29 kg / m² dry screed from Gipsbau-, gypsum fiber or wood-based panels according to Table 21 / line 2;						
Thickness d of 25 mm; m'15 kg / m² for impact sound insulation board according to Table 21 / line 5; Thickness d indicated; dynamic stiffness s' specified						
Rohdeckenbeschwerung from gebund./ungebund. Bulk material according to Table 21 / line 6; Thickness d indicated; m'indicated Rohdeckenbeschwerung concrete						
slabs according to Table 21 / line 6; Thickness d indicated; m'indicated Rohdeckenbeplankung of wood based panels according to Table 21 / line 7; Thickness d of 22						
mm; m'15 kg / m² structure made of solid wood or laminated wood beam according to Table 21 / line 10						

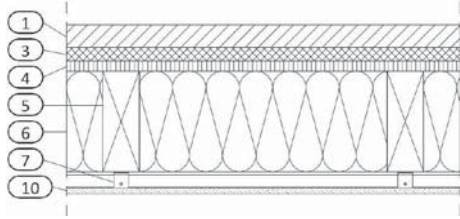
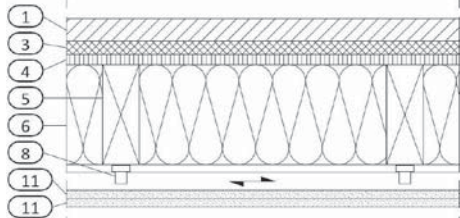
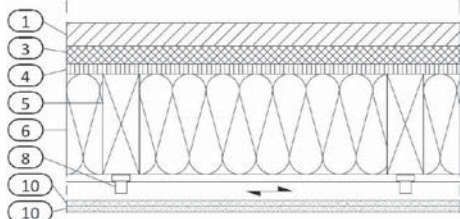
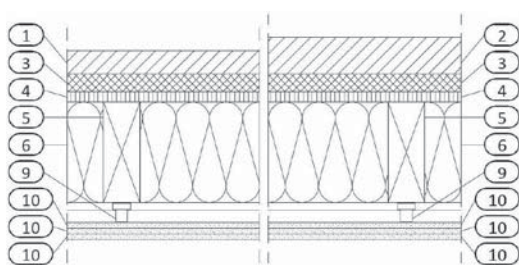
Table 24: beamed ceilings with stiff fixed ceilings column

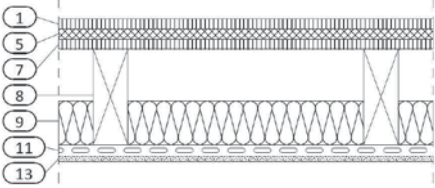
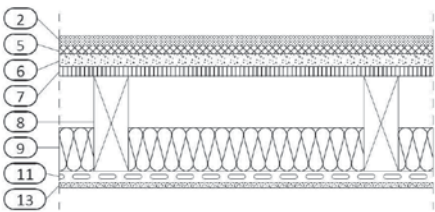
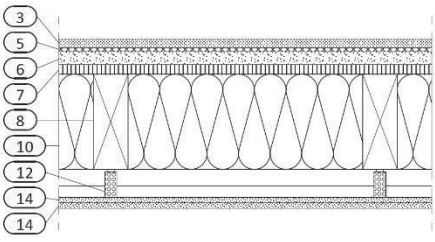
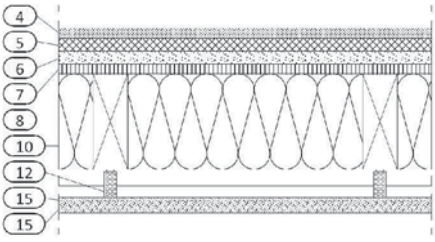
row	1	2	3	4	5	
	cut	Insulation d in mm s'in MN / m	weighing down d in mm m'in kg / m	L _{n,w} (C _{l, 50-2500}) in dB	R _w (C ₅₀₋₅₀₀₀ ; C _{tr, 50-5000}) in dB	
Beamed ceilings with stiff fixed ceilings and superstructures of mineral-based screeds						
1		MW (DES sh) d 40 s'! 6			54 _a (7)	63 _a (-8 -21)
2			plates	d 40 50 m'	48 _a (10)	65 _a (-12, -25)
3		MW (DES sh) d 20 s'! 8th	bulk	d 18 25 m'	51 _a (10)	67 _a (-13, -27)
4				d 30 45 m'	46 _a (12)	67 _a (-11, -24)
5		MW (DES sh) d 20 s'! 8th	bulk	d 60 90 m'	43 _i (6)	74 _i (-11, -26)
6			plates	d 50 100 m'	43 _i (10)	76 _i (-16, -31)
Beamed ceilings with stiff fixed ceilings and constructions from dry screeds						
7		MW (DES sm) d 20 s'! 30	bulk	d 60 90 m'	55 _a (7)	61 _a (-10, -23)
Minerally bound screed according to Table 21 / line 1; Thickness d of 50 mm; grammage m'120 kg / m² dry screed gypsum fiber board or cement-. Particle board						
according to Table 21 / line 2; Thickness d of 22 mm; m'29 kg / m² for impact sound insulation board according to Table 21 / line 5; Thickness d indicated; dynamic						
stiffness s' specified Rohdeckenbeschwerung from gebund./ungebund. Bulk material according to Table 21 / line 6; Thickness d indicated; m'indicated						
Rohdeckenbeschwerung of special bottom weights according to Table 21 / line 6; Thickness d indicated; m'indicated Rohdeckenbeschwerung concrete slabs according						
to Table 21 / line 6; Thickness d indicated; m'indicated Rohdeckenbeplankung of wood based panels according to Table 21 / line 7; Thickness d of 22 mm; m'15 kg / m²						
structure made of solid wood or laminated wood beams or -stegträgern according to Table 21 / line 10 from cavity damping insulation mats, or blow-in insulation						
according to Table 21 / line 12; Thickness d = 100 mm cavity attenuation of insulation boards, mats or blow-in insulation according to Table 21 / line 12; Thickness d =						
200 mm or d = 100 mm and the beam lifted battens made of wood laths according to Table 21 / line 13; Thickness d = 24 mm; E center distance 400 mm ceilings						
clothing from plasterboards according to Table 21 / line 14; Thickness d = 12.5 mm; m'8.5 kg / m²						

Table 25: beamed ceilings with suspended ceilings column

row	1	2	3	4	5	
	cut	Insulation d in mm s'in MN / m	weighing down d in mm m'in kg / m	L _{n,w} (C _{1, 50-2500}) in dB	R _w (C ₅₀₋₅₀₀₀ ; C _{tr, 50-5000}) in dB	
Beamed ceilings with suspended ceilings and superstructures of mineral-based screeds						
1		MW (DES sh) d 40 s'! 6	bulk	-	46 _a (7)	70 _a (-10, -23)
2				d 30 45 m'	34 _a (20)	73 _a (-12, -26)
3			plates	d 40 100 m'	30 _a (23)	79 _a (-17, -33)
4		MW (DES sh) d 20 s'! 8th	bulk	-	48 _a (6)	69 _a (-9 -22)
5				d 30 45 m'	36 _a (16)	68 _a (-10, -23)
6				d 60 90 m'	31 _a (18)	71 _a (-9 -24)
7				d 50 75 m'	40 _a (10)	71 _a (-6, -19)
8th		s'WF (DES-sg) d 60 (2 x 30) _{ges} 10		-	50 _a (7)	71 _a (-11, -24)
9		MW (DES sh) d 30 s'! 8th	bulk	-	46 _G (7)	76 _G (-13, -28)
10				d 40 60 m'	31 _G (19)	82 _G (-22, -37)
11		WF (DES sg) d 30 s'! 30		d 60 90 m'	36 _H (18)	80 _H (-18, -33)
Minerally bound screed according to Table 21 / line 1; Thickness d of 50 mm; grammage m'120 kg / m² for impact sound insulation board according to Table 21 /						
line 5; Thickness d indicated; dynamic stiffness s' specified Rohdeckenbeschwerung from gebund./ungebund. Bulk material according to Table 21 / line 6;						
Thickness d indicated; m'indicated Rohdeckenbeschwerung concrete slabs according to Table 21 / line 6; Thickness d indicated; m'indicated						
Rohdeckenbeplankung of wood based panels according to Table 21 / line 7; Thickness d of 22 mm; m'15 kg / m² structure made of solid wood or laminated wood						
beams or -stegträgern according to Table 21 / line 10 from cavity damping insulation mats, or blow-in insulation according to Table 21 / line 12; Thickness d = 100						
mm cavity attenuation of insulation boards, mats or blow-in insulation according to Table 21 / line 12; Thickness d = 200 mm or d = 100 mm and pulled up on the						
bar						
Suspension according to Table 22 / line 1; Plenum height d = 27 mm; E center distance 417 mm ceilings clothing from plasterboards according						
to Table 21 / line 14; Thickness d = 12.5 mm; m'8.5 kg / m²						

Continued Table 25: beamed ceilings with suspended ceilings column						
row	1	2	3	4	5	
	cut	Insulation d in mm s'in MN / m	weighing down d in mm m'in kg / m	$L_{n,w}$ ($C_{1, 50-2500}$) in dB	R_w ($C_{50-5000}$; $C_{tr, 50-5000}$) in dB	
Beamed ceilings with suspended ceilings and superstructures of mineral-based screeds						
12		MW (DES sh) d 30 s'! 8th	-	40 _G (11)	80 _G (-16, -31)	
13		EPS (DES sm) d 40 s'! 10		43 _G (9)	78 _G (-15, -30)	
14		MW (DES sm) d 40 s'! 20		44 _G (9)	77 _G (-13, -28)	
15		WF (DES sg) d 30 s'! 30	bulk	d 60 90 m'	32 _H (14)	82 _H (-18, -33)
16		WF (DES sg) d 30 s'! 30	bulk	d 60 90 m'	30 _H (10)	82 _H (-16, -31)
17		MW (DES sh) d 30 s'! 8th	-		37 _G (12)	82 _G (-16, -31)
Minerally bound screed according to Table 21 / line 1; Thickness d of 50 mm; grammage m'120 kg / m² for impact sound insulation board according to Table 21 /						
line 5; Thickness d indicated; dynamic stiffness s' specified Rohdeckenbeschwerung from gebund./ungebund. Bulk material according to Table 21 / line 6;						
Thickness d indicated; m'indicated Rohdeckenbeplankung of wood based panels according to Table 21 / line 7; Thickness d of 22 mm; m'15 kg / m² structure made						
of solid wood or laminated wood beam according to Table 21 / line 10						
Damping cavity of insulation boards, mats or blow-in insulation according to Table 21 / line 12; Thickness d = 200 mm or d = 100 mm and pulled up on the bar						
Suspension according to Table 22 / line 2 with CD profile; D plenum height 40 mm; E center distance 400 mm; Natural frequency f₀ < 30 Hz suspension according to Table 22 /						
line 2 with CD profile; D plenum height 65 mm; E center distance 400 mm; Natural frequency f₀ < 30 Hz suspension according to Table 22 / line 3 with 2 x CD profile; D plenum						
height 140 mm; E center distance 400 mm; Natural frequency f₀ < 20 Hz						
Suspension according to Table 22 / line 6 with CD profile; D plenum height 70 mm; E center distance 400 mm; Natural frequency f₀ < 20 Hz Under ceiling lining made of						
plasterboard fire protection plates according to Table 21 / line 14; Thickness d = 12.5 mm; m'10 kg / m²						

Continued Table 25: beamed ceilings with suspended ceilings column					
row	1	2	3	4	5
	cut	Insulation d in mm s'in MN / m	Floor and false ceiling in mm	$L_{n,w}$ ($C_{l, 50-2500}$) in dB	R_w ($C_{50-5000}$; $C_{tr, 50-5000}$) in dB
Beamed ceilings with suspended ceilings and superstructures of mineral-based screeds					
18		MW (DES sh) d 30 s'! 8th	50 35 screed suspension / CD profile / 1 x 12.5 GKF	50 _G (9)	72 _G (-13, -27)
19		MW (DES sh) d 30 s'! 8th	50 57 screed suspension / battens / 2 x 18 GKF	42 _G (7)	80 _G (-16, -31)
20		MW (DES sh) d 40 s'! 7	50 57 screed suspension / battens / 2 x 12.5 GKF	39 _G (11)	80 _G (-15, -30)
21		MW (DES sh) d 40 s'! 7	50 44 screed suspension / CD profile / 3 x 12.5 GKF	37 _G (11)	82 _G (-17, -32)
22		MW (DES sh) d 40 s'! 7	80 44 screed suspension / CD profile / 3 x 12.5 GKF	37 _G (9)	83 _G (-18, -33)
Minerally bound screed according to Table 21 / line 1; Thickness d of 50 mm; grammage m'120 kg / m² mineral-bound screed according to Table 21 / line 1;					
Thickness d of 80 mm; m'177 kg / m					
Impact sound insulation board according to Table 21 / line 5; Thickness d indicated; dynamic stiffness s' indicated Rohdeckenbeplankung of wood based panels					
according to Table 21 / line 7; Thickness d of 22 mm; m'15 kg / m² structure made of solid wood or laminated wood beam according to Table 21 / line 10					
Cavity damping insulation boards, mats or blow-in insulation according to Table 21 / line 12; Thickness d = 200 mm or d = 100 mm and pulled up on the bar					
Suspension according to Table 22 / line 7 with CD profile; D plenum height 35 mm; E center distance 400 mm suspension according to Table					
22 / line 5 with battens; D plenum height 57 mm; E center distance 400 mm; Natural frequency f₀ < 30 Hz at 2 x 12.5 mm GKF natural frequency f₀ < 20 Hz at 2 x 18 mm GKF					
Suspension according to Table 22 / line 5 with CD profile; D plenum height 44 mm; E center distance 400 mm; Natural frequency f₀ < 20 Hz Under ceiling lining made of					
plasterboard fire protection plates according to Table 21 / line 14; Thickness d = 12.5 mm; m'10 kg / m² lower ceiling lining made of plasterboard fire protection plates					
according to Table 21 / line 14; Thickness d = 18 mm; m'14.5 kg / m					

Continued Table 25: beamed ceilings with suspended ceilings column					
row	1	2	3	4	5
	cut	Insulation d in mm s'in MN / m	weighing down d in mm m'in kg / m	$L_{n,w}$ ($C_{1, 50-2500}$) in dB	R_w ($C_{50-5000}$; $C_{tr, 50-5000}$) in dB
Beamed ceilings with suspended ceilings and constructions from dry screeds					
23		MW (DES sm) d 25 s'! 15	-	56 _a (2)	63 _a (-11, -25)
24		MW (DES sm) d 20 s'! 20	bulk	d 30 45 m'	41 _a (8th) 69 _a (-10, -23)
25		WF (DES sm) d 20 s'! 30		d 30 45 m'	45 _a (5) 67 _a (-7, -19)
26		WF (DES sg) d 30 s'! 30	bulk	d 30 45 m'	38 _H (16) 79 _H (-20, -35)
27				d 60 90 m'	34 _H (16) 80 _H (-19, -34)
28		WF (DEO) d 10		d 30 12 m'	42 _H (11) 75 _H (-16, -31)
29		WF (DES sg) d 30 s'! 30	bulk	d 30 45 m'	34 _H (15) 80 _H (-16, -31)
Dry line of gypsum boards or wooden boards according to Table 21 / line 2; Thickness d of 22 mm; m'cement-15 kg / m² dry flooring plaster fiber boards or the like.					
Particle board according to Table 21 / line 2; Thickness d of 22 mm; m'cement-29 kg / m² dry flooring plaster fiber boards or the like. Particle board according to Table 21 / line 2; Thickness d of 20 mm; m'cement-25 kg / m² dry flooring plaster fiber boards or the like. Particle board according to Table 21 / line 2; Thickness d of 25 mm; m'31 kg / m² for impact sound insulation board according to Table 21 / line 5; Thickness d indicated; dynamic stiffness s' specified Rohdeckenbeschwerung from gebund./ungebund. Bulk material according to Table 21 / line 6; Thickness d indicated; m'indicated Rohdeckenbeplankung of wood based panels according to Table 21 / line 7; Thickness d of 22 mm; m'15 kg / m² structure made of solid wood or laminated wood beam according to Table 21 / line 10					
Damping cavity of insulation boards, mats or blow-in insulation according to Table 21 / line 12; Thickness d = 100 mm cavity attenuation of insulation boards, mats or blow-in insulation according to Table 21 / line 12; Thickness d = 200 mm or d = 100 mm and pulled up on the bar					
Suspension according to Table 22 / line 1; D plenum height 27 mm; E center distance 417 mm					
Suspension according to Table 22 / line 2 with CD profile; D plenum height 65 mm; E center distance 400 mm; Natural frequency $f_0 < 30$ Hz ceilings clothing of gypsum board according to Table 21 / line 14; Thickness d = 12.5 mm; m'8.5 kg / m² lower ceiling lining made of plasterboard fire protection plates according to Table 21 / line 14; Thickness d = 12.5 mm; m'10 kg / m² lower ceiling lining made of plasterboard fire protection plates according to Table 21 / line 14; Thickness d = 18 mm; m'14.5 kg / m					

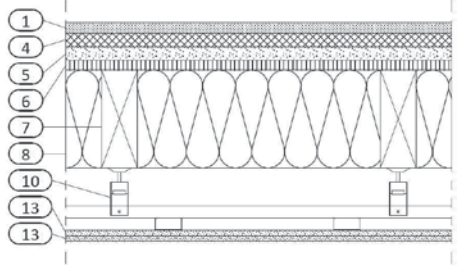
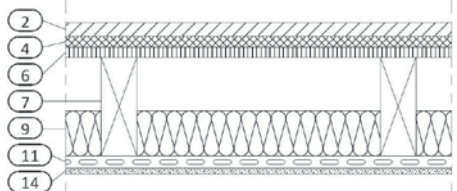
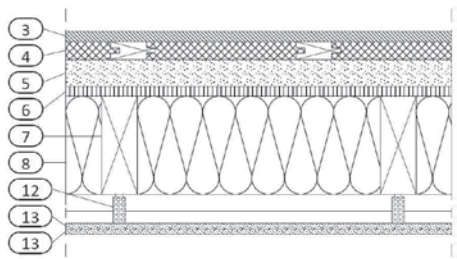
Continued Table 25: beamed ceilings with suspended ceilings column					
row	1	2	3	4	5
	cut	Insulation d in mm s'in MN / m	weighing down d in mm m'in kg / m	$L_{n,w}$ ($C_{1, 50-2500}$) in dB	R_w ($C_{50-5000}$; $C_{tr, 50-5000}$) in dB
Beamed ceilings with suspended ceilings and constructions from dry screeds					
30		WF (DES sg) d 30 s'! 30	bulk d 30 45 m'	34 _H (11)	81 _H (-18, -33)
Beamed ceilings with suspended ceilings and constructions of asphalt floors					
31		MW (DES sm) d 25 s'! 30 WF (DES sg) d 25 s'! 30	-	50 _a (4)	64 _a (-7, -20)
Beamed ceilings with suspended ceilings and superstructures of floorboards					
32		WF + strips d s' 40! 30	bulk d 60 90 m'	34 _H (16)	78 _H (-19, -33)
Dry screed of gypsum fiber board or cement-. Particle board according to Table 21 / line 2; Thickness d of 25 mm; m'31 kg / m² asphalt floor of mastic asphalt according to Table 21 / line 3; Thickness d of 30 mm; m'85 kg / m² wooden floor boards made of wood according to Table 21/4 line; Thickness d = 24 mm					
Impact sound insulation board according to Table 21 / line 5; Thickness d indicated; dynamic stiffness s' specified Rohdeckenbeschwerung from gebund./ungebund. Bulk material according to Table 21 / line 6; Thickness d indicated; m'indicated Rohdeckenbeplankung of wood based panels according to Table 21 / line 7; Thickness d of 22 mm; m'15 kg / m² structure made of solid wood or laminated wood beam according to Table 21 / line 10					
Damping cavity of insulation boards, mats or blow-in insulation according to Table 21 / line 12; Thickness d = 200 mm or d = 100 mm (pulled up on the bar)					
Damping cavity of insulation boards, mats or blow-in insulation according to Table 21 / line 12; Thickness d = 100 mm suspension according to Table 22 / line 3 with 2 x CD profile; D plenum height 140 mm; E center distance 400 mm; Natural frequency f₀ < 20 Hz					
Suspension according to Table 22 / line 1; D plenum height 27 mm; E center distance 417 mm					
Suspension according to Table 22 / line 2 with CD profile; D plenum height 65 mm; E center distance 400 mm; Natural frequency f₀ < 30 Hz Under ceiling lining made of plasterboard fire protection plates according to Table 21 / line 14; Thickness d = 12.5 mm; m'10 kg / m² ceilings clothing of gypsum board according to Table 21 / line 14; Thickness d = 12.5 mm; m'8.5 kg / m²					

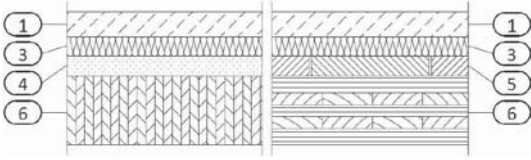
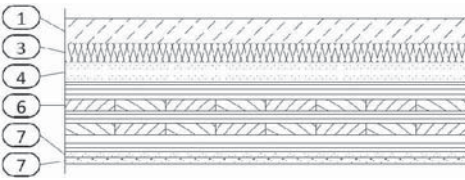
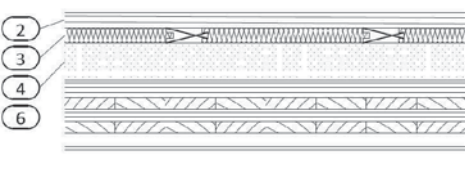
Table 26: Solid wood ceilings without suspended ceilings column						
row	1	2	3	4	5	
	cut	Insulation d in mm s'in MN / m	weighing down d in mm m'in kg / m	$L_{n,w}$ ($C_{l, 50-2500}$) in dB	R_w ($C_{50-5000}$; $C_{tr, 50-5000}$) in dB	
Solid wood ceilings without suspended ceilings with bodies from mineral-based screeds						
1		MW (DES sh) d 40 s'! 7	bulk	-	56 _a (3)	62 _a (-6, -18)
2				d 40 60 m'	46 _a (5)	68 _a (-7, -20)
3				d 60 90 m'	40 _c (8th)	72 _c (-8 -21)
4				d m'100 150	38 _i (4)	77 _i (-13, -28)
5		plates	d 40 100 m'	45 _a (4)	72 _a (-8, -23)	
6		MW (DES sh) d 30 s'! 8th	bulk	d 60 90 m'	40 _G (9)	74 _G (-9 -24)
7				d m'100 150	38 _G (5)	76 _G (-10, -25)
8th		MW (DES sh) d 40 s'! 7	bulk	d 60 90 m'	40 _c (7)	73 _c (-16, -32)
Solid wood ceilings without suspended ceilings with bodies from floorboards						
9		WF + strips d s' 40! 30	bulk	d m'100 150	50 _H (1)	65 _H (-5, -16)
Minerally bound screed according to Table 21 / line 1; Thickness d of 50 mm; grammage m'120 kg / m² wooden floor boards made of wood according to Table 21/4 line; Thickness d = 24 mm						
Impact sound insulation board according to Table 21 / line 5; Thickness d indicated; dynamic stiffness s' specified Rohdeckenbeschwerung from gebund./ungebund. Bulk material according to Table 21 / line 6; Thickness d indicated; m'indicated Rohdeckenbeschwerung concrete slabs according to Table 21 / Line 6; Thickness d indicated; m'indicated structure made Brettsperrholz-, glulam board or stack of elements according to Table 21 / line 10, lower ceiling lining made of gypsum fiber plates according to Table 21 / line 14; Thickness d = 15 mm; m'17 kg / m²						

Table 27: Solid wood ceilings with suspended ceilings column

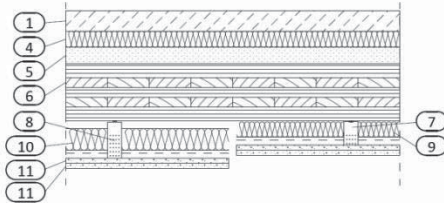
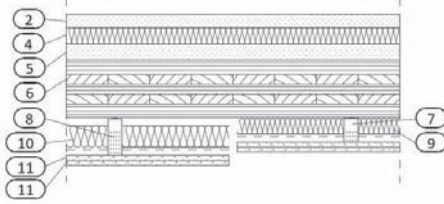
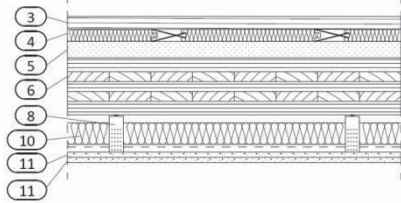
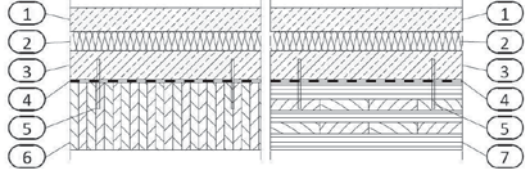
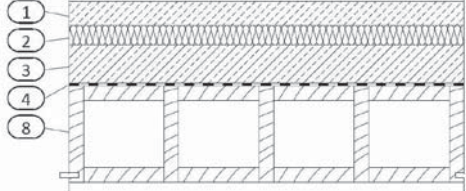
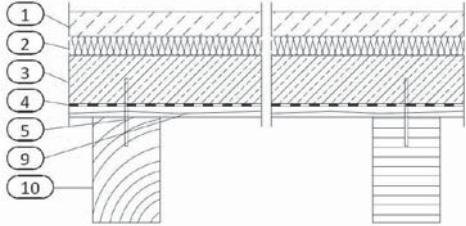
row	1	2	3	4	5	
	cut	Insulation d in mm s'in MN / m	weighing down d in mm m'in kg / m	L _{n,w} (C _{i, 50-2500}) in dB	R _w (C ₅₀₋₅₀₀₀ ; C _{tr, 50-5000}) in dB	
Solid wood ceilings with suspended ceilings and superstructures of mineral-based screeds						
1		MW (DES sh) d 30 s'! 8th	bulk	d 60 90 m'	24 _G (29)	81 _G (-21, -36)
2					23 _G (26)	82 _G (-20, -35)
3		WF (DES sg) d 30 s'! 30			d 60 90 m'	32 _H (23)
Solid wood ceilings with suspended ceilings and constructions from dry screeds						
4		WF (DES sg) d 30 s'! 30	bulk	d 60 90 m'	36 _H (23)	78 _H (-23, -38)
5					33 _H (20)	79 _H (-18, -32)
Solid wood ceilings with suspended ceilings with bodies from floorboards						
6		WF + strips d s' 40! 30	bulk	d 60 90 m'	36 _H (16)	77 _H (-15, -30)
Minerally bound screed according to Table 21 / line 1; Thickness d of 50 mm; grammage m'120 kg / m² dry screed gypsum fiber board or cement-. Particle board						
according to Table 21 / line 2; Thickness d of 22 mm; m'29 kg / m² wooden floor boards made of wood according to Table 21/4 line; Thickness d = 24 mm						
Impact sound insulation board according to Table 21 / line 5; Thickness d indicated; dynamic stiffness s' specified Rohdeckenbeschwerung from						
gebund./ungebund. Bulk material according to Table 21 / line 6; Thickness d indicated; m'indicated structure made Brettsperholz-, glulam board or stack of elements						
according to Table 21 / line 10 suspension according to Table 22 / line 2 with CD profile; D plenum height 90 mm; E center distance 400 mm; Natural frequency f ₀ < 30						
Hz; note the effectiveness of the suspension Chapters 3 and 4!						
Suspension according to Table 22 / line 2 with CD profile; D plenum height 180 mm; E center distance 400 mm; Natural frequency f ₀ < 30 Hz; note the effectiveness of the suspension Chapters 3 and 4!						
Damping cavity of insulation boards, mats or blow-in insulation according to Table 21 / line 12; Thickness d = 75 mm cavity attenuation of insulation boards, mats						
or blow-in insulation according to Table 21 / line 12; Thickness d = 120 mm under ceiling lining made of plasterboard fire protection plates according to Table 21 /						
line 14; Thickness d = 12.5 mm; m'10 kg / m²						

Table 28: Solid wood ceilings rib and box elements without ceilings column

row	1	2	3	4	5
	cut	Insulation d in mm s'in MN / m	weighing down d in mm m'in kg / m	$L_{n,w}$ ($C_{l, 50-2500}$) in dB	R_w ($C_{50-5000}$; $C_{tr, 50-5000}$) in dB
Solid wood ceilings rib and box elements without lay-in constructions of mineral-based screeds					
1		MW (DES sh) d 40 s! 7	bulk d 70 105 m'	45 _d (0)	72 _d (-8, -23)
2		MW (DES sh) d 40 s! 7	bulk d 60 90 m'	43 _d (2)	71 _d (-9 -24)
3		MW (DES sh) d 40 s! 7	bulk m'147	40 _e (8th)	75 _e (-13, -28)
4		MW (DES sh) d 40 s! 7	bulk m'196	37 _e (7)	78 _e (-9 -23)
Minerally bound screed according to Table 21 / line 1; Thickness d of 50 mm; grammage m'120 kg / m² for impact sound insulation according to line 5 in Table 21;					
Thickness d indicated; dynamic stiffness s' specified Rohdeckenbeschwerung from gebund./ungebund. Bulk material according to Table 21 / line 6; Thickness d					
indicated; m'specified additional load distribution area from soft wood fiber insulation board according to Table 21 / line 5; Thickness d = 15 mm additional weighting					
in the ceiling element from ungebund. Bulk material according to Table 21 / line 6; Thickness d indicated; m'specified					
Structure made of solid wood box elements'LFE 240 silence 12' according to Table 21 / line 10 structure made of solid wood box					
elements'LFE 240 silence 12 Akustik' according to Table 21 / line 10, structural laminated timber rib members'LIGNO rib Q3'					
according to Table 21 / line 10, structural laminated timber rib members'LIGNO Q3' ceiling according to Table 21 / line 10 coupling					
board made of wood-based boards according to Table 21 / line 11					

Table 29: wood-concrete ceilings without suspended ceilings column

row	1	2	3	4	5
	cut	Insulation d in mm s'in MN / m	reinforced concrete layer D in mm m'in kg / m	$L_{n,w}$ ($C_{i, 50-2500}$) in dB	R_w ($C_{50-5000}$; $C_{tr, 50-5000}$) in dB
Wood-concrete ceilings without suspended ceilings with abutments made of minerally bonded screeds					
1		MW (DES sh) d 40 s' 7	Reinforced concrete layer d 80 200 m'	46 _i (5)	67 _i (-9 -22)
2		MW (DES sh) d 40 s' 7	Reinforced concrete layer d m' 100 240	44 _b (-1)	72 _b (-4, -18)
3		MW (DES sh) d 40 s' 7	Reinforced concrete layer d m' 100 240	49 _f (2)	69 _f (-6, -20)
Minerally bound screed according to Table 21 / line 1; Thickness d of 50 mm; grammage m'120 kg / m² for impact sound insulation board according to Table 21 /					
line 5; Thickness d indicated; dynamic stiffness s' indicated reinforced concrete layer of the wood-concrete ceiling according to Table 21 / line 8; Thickness d					
indicated; m'indicated separating layer made of PE-foil according to Table 21 / line 9					
Coupling means for wood-concrete composite according to Table 21 / line 15 Supporting structure glulam board					
or stack of elements according to Table 21 / line 10, structural laminated timber elements according to Table 21 /					
line 10					
Supporting structure LIGNATUR-surface elements 240'LFE silence 12' according to Table 21 / line 10 floorboards of wood planks					
according to Table 21/4 line; Thickness d = 24 mm supporting structure made of solid wood or laminated wood beam according to					
Table 21 / line 10					

6.1.1 _ source directory component catalog Ceiling

Bibliography of acoustical measurements	
Abbreviation of reading	Origin of reading
a	DIN 4109-33: 2016-07 sound insulation in building construction - Part 33: Data for the mathematical proof of sound insulation (component catalog) - wood, light and dry; DIN Standards Committee construction (NABau); July 2016
b	"Application of Finite Element Method to the impact sound calculation" (partial report of the cooperation project "Investigation of the acoustic interactions of wooden ceiling and floor covering novel to the development of sound protection measures"); Rabold A., E. Rank, IBP Stuttgart, TU Munich, ift Rosenheim, German Society for Wood Research e. V. ; 2009
c	Acoustic data sheets and product data sheets; Wish Timber GmbH; more details from the manufacturer
d	Acoustic data sheets and product data sheets; Lignatur; more details from the manufacturer
e	Acoustic data sheets and product data sheets; Lignotrend; more details from the manufacturer
f	"Wooden beams on refurbishment" (Research Report); Rabold A. Bacher S., Hessinger J., German Society for Wood Research e. V., ift Rosenheim; 2008
G	"Development and distribution of a practical handbook for sound insulation in the timber in accordance with the prior art" (Research Project); Timber Germany eV; 2018 (Research Report downloaded at www.informationsdienst-wood)
H	"More than just insulation - additional benefit of insulation material from renewable raw materials" (Research Project); Technical University of Rosenheim; in processing
i	Database; ift Rosenheim
j	Acoustic data sheets and product data sheets; Binder Holz GmbH; more details from the manufacturer

6.2 _ Component Catalog flat roofs and roof terraces

table 30: bodiesVehicle overview Flachdächer and Dächer					
	pictogram	row	weighted normalized impact sound pressure level $L_{n,w}(C_{1,50-2500})$ in dB	noise insulation value $R_w(C_{tr,50-5000})$ in dB	Fire protection
Roof terrace (s. Table 32)		12	31 (19) 38	64 (-16) 52	See DIN 4102-4: 2016-05, Table 10:19 to Table 10:23 and www.dataholz.de
		3	(20) 44 (5)	(-13) 70 (-19)	
		45	45 (4) 58	51 (-6) 53	see www.dataholz.de
		67	(2) 52 (1) 31 (23)	(-6) 38 (-5) 72 (-26)	
		89	43 (5) 38	51 (-7) 51	According to the manufacturer
		10	(6) 35 (14)	(-8) 64 (-14)	
		11	44 (9) 40	66 (-17) 57	
		12	(11) 46 (7)	(-8) 65 (-12)	
		13	45 (8) 48	66 (-13) 65	
		14	(5) 49 (5)	(-12) 65	
		15	44 (3) 47	(-11) 49 (-8)	
		16	(4) 39 (14)	61 (-9) 63	
		17		(-11)	
		18			
		19			
Flat roof (s. Table 33)		12	-	70 (-22)	See DIN 4102-4: 2016-05, Table 10:19 to Table 10:23 and www.dataholz.de
		3	-	41 57	
		45	-	38 (-4) 55	according to the manufacturer
		67	-	(-8) 64	
		89	-	(-11) 49	
		10	-	(-9) 39 (-3)	
		11	-	45 (-3) 47	
		12	-	(-6) 40 (-6)	
		13	-	50 (-11) 53	
			-	(-9)	
			-		
			-		
Metal covering (s. Table 34)		12	-	63 (-24) 59	See DIN 4102-4: 2016-05, Table 10:19 to Table 10:23 and www.dataholz.de
		3	-	(-21) 71 (-31)	
		45	-	63 (-17) 58	according to the manufacturer
		67	-	(-14) 53 (-11) 53 (-10)	

Table 31: Abbreviations and material properties - flat roofs and roof terraces construction camp

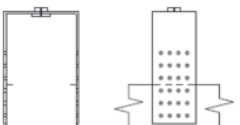
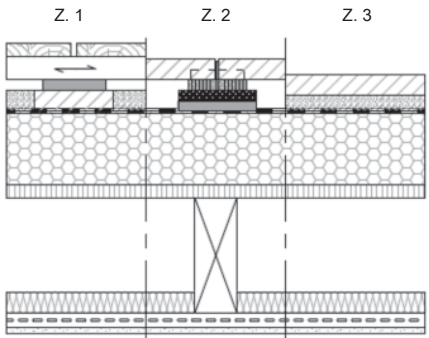
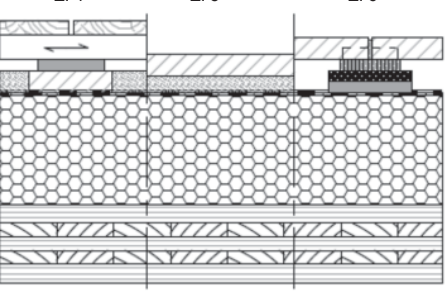
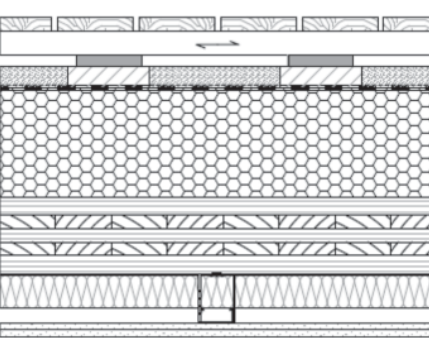
	Structural bearings as elastic storage, designed by the manufacturer to the specified natural frequency f_{0n}
concrete slabs	Concrete plates 400/400 mm, $m' \geq 90.0 \text{ kg / m}^2$, with about 7 mm cross joints on pedestals or grit as a coating.
flooring boards	Surface mounted from softwood or hardwood, with approximately 10 mm apart.
Laminated timber / glulam	Supporting structure Brettsperrholz- or board laminated wood elements.
roofing membrane	EPDM roofing membrane or roofing membrane KS as aquifer in following variations in thickness mm / mass in kg / m^2 : 1.5 / 1.7; 3/3 or 8/10
roof sheathing	Boards from softwood or hardwood
vapor barrier	Cold self-adhesive elastomer bitumen vapor barrier membrane with a specified thickness and mass, $s_d \geq 1500 \text{ m}$.
drainage element	Stable pressure, low drainage and water storage element from PC-polyolefin, $m' \geq 1.7 \text{ kg / m}^2$.
EPS	EPS 035 DAA ie Flachdämmplatte (150 kPa), $\rho \geq 72 \text{ kg / m}^3$.
filter fabric	<u>Geotextile thermally solidified polypropylene, used as a filter fleece on drainage elements.</u>
cavity damping	Fiber insulating material boards / mats of mineral, jute, hemp or wood, cellulose, cotton or sheep wool fibers having a longitudinal flow resistance of $5 \text{ kPa s / m} \leq r \leq 50 \text{ kPa s / m}$. Einblasdämmstoffe of cellulosic fibers according to DIN EN 15101-1 with a density $\rho = 40 - 50 \text{ kg / m}^3$ (space-filling), a longitudinal flow resistance of $5 \text{ kPa s / m} \leq r \leq 50 \text{ kPa s / m}^2$ and an additional Rieselschutzfolie below the wood joists.
Wood panel	Chipboard in accordance with DIN EN 312, OSB - laying plates according to DIN EN 300 or BFU-plates according to DIN EN 315 and DIN EN 13986 of the thicknesses of 18 mm to 25 mm, with open beamed ceiling, alternatively, 28 mm view formwork + 12 BFU mm - plate. Additional cladding of wood based panels made of gypsum panels or formwork view in the beam space are directly applied to the wood material board (without additional cavity).
Wood fiber or mineral fiber insulation board	Wood fiber or mineral fiber insulation panels for the exterior insulation of roof or ceiling, protected against weathering, insulation under cover, $\rho = 140$ to 180 kg / m^3 .
Squares	Squares of softwood or hardwood, each second bar by insulation in structural bolted 600 mm with a $\geq$.
battens	Battens from softwood or hardwood with terraces flooring boards on construction camp resting.
Lignatur	Lignatur LFE 160, 200 and 240
Lignatur acoustics	Lignatur LFE 120 and 240 Acoustics
Ligno block acoustics	Board plywood box member LIGNO block Q3 acoustic Z1
Ligno rib Acoustics	Cross-laminated rib member LIGNO rib Q3 acoustic Z1 having gravel filling
<u>Mineral bulk material</u> Mineral bulk material	Material for roofs as unbound bulk PUR / PIR
	Polyurethane roof insulating board to the outer insulation of roof or ceiling, protected against weathering, insulation under coverings, $m' \geq 4.77 \text{ kg / m}^2$.
Protection Mat	Water and nutrient storing synthetic fiber mat used as a protective layer under green roofs, $m' \geq 0.47 \text{ kg / m}^2$.
Grit / gravel	Unbound bed of gravel or grit, grit 5/8 with the specified bed height and mass per unit area.
Rock wool board	Permanently elastic pressure-resistant insulating board made of stone wool, $m' \geq 3 \text{ kg / m}^2$
Hilfsmittel zur akustischen Entkopplung	
(Knauf) 	For attaching CD profiles or wooden slats. Is equipped with a rubber molding for sound attenuation. Screw not thus pressing. f with a specified natural frequency f_{0n}
spring rail 	Spring rail 60 mm x 27 mm made of folded sheet metal for the elastic coupling of flexurally soft coverings. The Lochausstanzungen cause the spring action. Mounting mm with about 1 mm air in the screw, axle spacing $e \geq 500 \text{th}$

Tabelle 32: flat roof with roof terrace Sp.

Z.	1	2	3	4	5
	component	Thickness of base member in mm	Thick structure in mm	$L_{n,w}$ ($C_{tr, 50-2500}$) in dB	R_w ($C_{tr, 50-5000}$) in dB
1		≥ 140 EPS 035 DAA ie wood $25 \geq$ material board beams 220 80/220, $e \geq 625$ mm cavity damping spring rail, $e \geq 500$ ≥ 40 mm gypsum board, $m' \geq 10$ 28 kg / m ² 12.5	26 44 12 40 1.5 lin	31_a (19) 	64_a (-16)
2			40 40 12 1.5 col	38_a (20) 	52_a (-13)
3			40 30 1.5 con	44_a (5) 	70_a (-19)
4		≥ 200 EPS 035 DAA ie board 140 plywood / laminated timber, $m' \geq 68$ kg / m ²	26 44 12 40 1.5 lin	45_a (4) 	51_a (-6)
5			40 30 1.5 con	58_a (2) 	53_a (-6)
6			40 40 12 1.5 col	52_a (1) 	38_a (-5)
7		≥ 200 EPS 035 DAA ie board 140 plywood / laminated wood, $m' \geq 68$ kg / m ² mineral wool on CD profiles Direktschwing- suspension, $e \geq 750 \times 500$ 60 mm, $f_0 \leq 28$ Hz, CD-profile e 90 ≥ 500 mm gypsum board, $m' \geq 10$ kg / m ² plasterboard, $m' \geq 10$ kg / m ² 12.5 12.5	26 44 12 40 1.5 lin	31_a (23) 	72_a (-26)

forts e estimation Table 32: Flat roof with roof Terrace Sp.

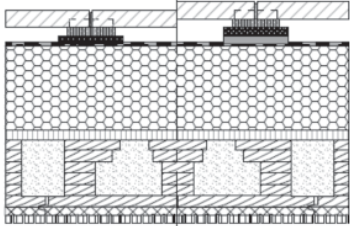
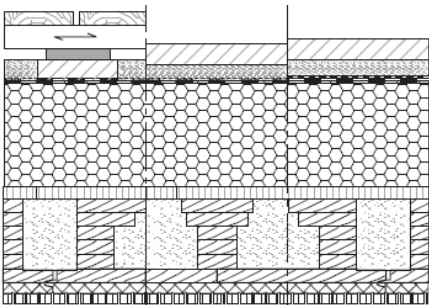
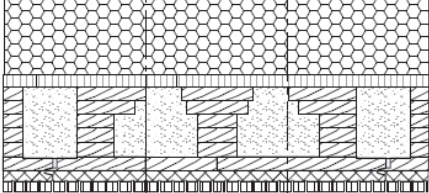
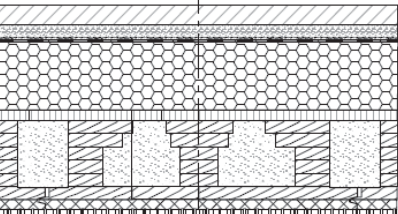
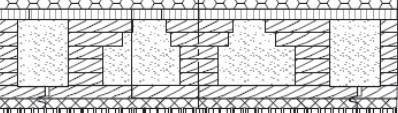
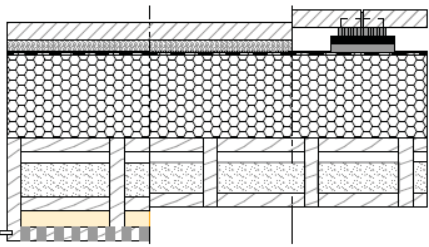
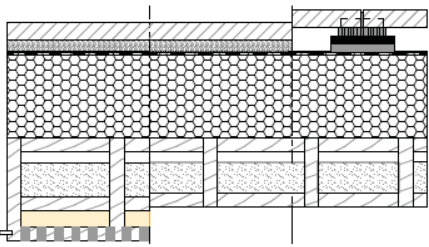
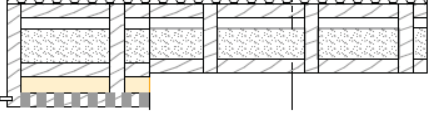
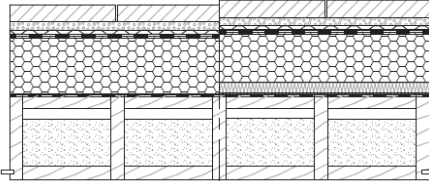
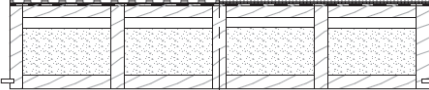
Z.	1	2	3	4	5
	component	Thickness of base member in mm	Thick structure in mm	$L_{n,w}$ ($C_{1,50-2500}$) in dB	R_w ($C_{tr,50-5000}$) in dB
8th	Z. 8 	Subsection 9 ≥ 200 EPS 035 DAA ie wood $22 \geq$ material board Ligno rib 196 acoustic filled with grit, $m' \geq 145 \text{ kg / m}$	40 40 1.5 concrete slab bearing of $\geq 20 \text{ Hz}$ roofing	43 _a (5)	51 _a (-7)
9			40 40 12 1.5 concrete slab bearing of $\geq 20 \text{ Hz}$ roofing	38 _a (6)	51 _a (-8th)
10	Z. 10 	Z. 11 ≥ 200 EPS 035 DAA ie wood $22 \geq$ material board Ligno rib 196 acoustic filled with grit, $m' \geq 145 \text{ kg / m}$	Z. 12 26 44 12 40 1.5 concrete slab bearing of $\geq 20 \text{ Hz}$ roofing	35 _a (14)	64 _a (-14)
11			40 30 1.5 concrete slab bearing of $\geq 40 \text{ kg / m}^2$	44 _a (9)	66 _a (-17)
12			40 30 5 1.5 concrete slab bearing of $\geq 40 \text{ kg / m}^2$	40 _a (11)	57 _a (-8th)
13	Z. 13 	Z. 14 ≥ 140 PUR / PIR DAA ie wood $22 \geq$ material board Ligno rib 196 acoustic filled with grit, $m' \geq 145 \text{ kg / m}$	40 30 1.5 concrete slab bearing of $\geq 40 \text{ kg / m}^2$	46 _a (7)	65 _a (-12)
14		≥ 140 EPS 035 DAA ie wood $22 \geq$ material board Ligno rib 196 acoustic filled with grit, $m' \geq 145 \text{ kg / m}$		45 _a (8th)	66 _a (-13)
15	Z. 15 	Z. 16 ≥ 200 EPS 035 DAA ie wood ≥ 240 EPS 035 DAA ie wood acoustic filled with grit, $m' \geq 107.5 \text{ kg / m}$	Z. 17 40 30 1.5 concrete slab bearing of $\geq 40 \text{ kg / m}^2$	48 _a (5)	65 _a (-12)
16		≥ 200 EPS 035 DAA ie 160 Lignatur filled with grit, $m' \geq 92.4 \text{ kg / m}$	40 30 1.5 concrete slab bearing of $\geq 40 \text{ kg / m}^2$	49 _a (5)	65 _a (-11)
17			40 40 12 1.5 concrete slab bearing of $\geq 20 \text{ Hz}$ roofing	44 _a (3)	49 _a (-8th)
18	Z. 18 	Z. 19 ≥ 140 PIR DAA that is a vapor 3 barrier, $m' \geq 3 \text{ kg / m}^2$ Lignatur filled with ≥ 200 Chippings, $m' \geq 139 \text{ kg / m}$	40 Concrete slabs grit, $m' \geq 31$ 20 kg / m^2 drainage element 10 roofing sheet, two-layer 8	47 _a (4)	61 _a (-9)
19		≥ 120 PIR DAA ie rock wool 25 3 plate vapor barrier, $m' \geq 3 \text{ kg / sqm}$ Lignatur filled with ≥ 200 Chippings, $m' \geq 139 \text{ kg / m}$		39 _a (14)	63 _a (-11)

Tabelle 33: flat roof (not accessible) Sp.

Z.	1	2	3	4
	component	Thickness of base member in mm	Thick structure in mm	R _w (C _{tr,50-5000}) in dB
1		≥ 140 EPS 035 DAA ie wood $25 \geq$ material board beams 220 80/220, e ≥ 625 mm cavity damping spring rail, e $\geq$ ≥ 40 500 mm gypsum board, m 28 ' ≥ 10 kg / m ² 12.5	50 1.5 Gravel, m ' ≥ 87.0 kg / m ²	70 _a (-22)
2	Z. 2 Z. 3	≥ 120 EPS 035 DAA 035 DAA ie $100 \geq$ EPS ie board plywood / 100 laminated wood, m ' ≥ 45 kg / m ²	1.5 roofing	41 _a
3			50 1.5 Gravel, m ' ≥ 87.0 kg / m ²	57 _a
4	Z. 4 Z. 5 Z. 6 ≥ 200	196 EPS 035 DAA ie Ligno acoustic block, m ' ≥ 63 kg / m ²	1.5 roofing	38 _a (-4)
5			50 1.5 Gravel, m ' ≥ 87.0 kg / m ²	55 _a (-8th)
6		≥ 200 EPS 035 DAA ie concrete $40 \geq$ slabs Ligno acoustic block, 196 m ' ≥ 63 kg / m ²	50 1.5 Gravel, m ' ≥ 87.0 kg / m ²	64 _a (-11)
7	Z. 7 Z. 8	≥ 100 Mineralfaserdämmplatte DAA DAA ie Mineralfaserdämmplatte ie Ligno acoustic block, m ' ≥ 63 kg / m ² ≥ 196	1.5 roofing	49 _a (-9)
8th		≥ 200 ≥ 196 EPS 035 DAA dh Ligno acoustic block, m ' $\geq$ 63 kg / m ²	80 0.6 25 5 1.5 of mineral wool, m ' ≥ 87.0 kg / m ²	39 _a (-3)
9	Subsection 9 Z. 10	≥ 200 EPS 035 DAA ie concrete $40 \geq$ slabs Ligno acoustic block, 196 m ' ≥ 63 kg / m ²	1.5 roofing	45 _a (-3)
10		≥ 200 EPS 035 DAA ie concrete 40 slabs memory protection mat 5 Ligno acoustic block, m ' ≥ 63 ≥ 196 kg / m ²		47 _a (-6)

forts e estimation Table 33: flat roof (not accessible)

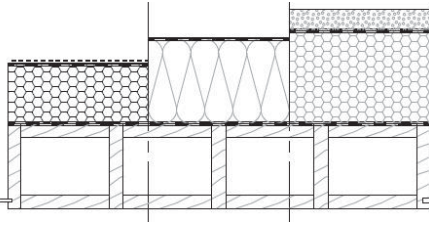
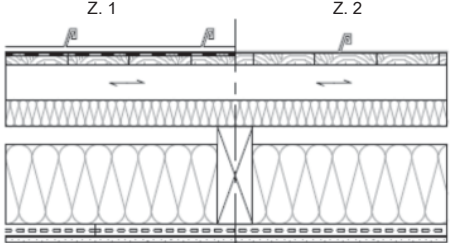
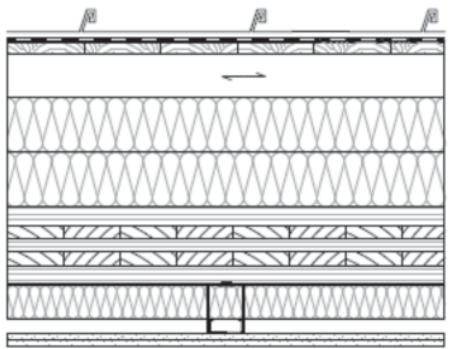
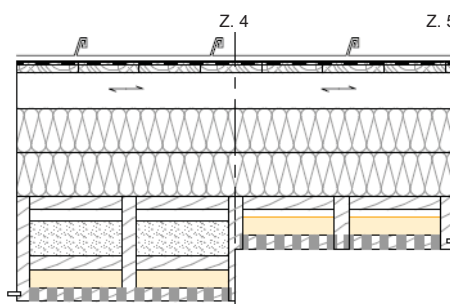
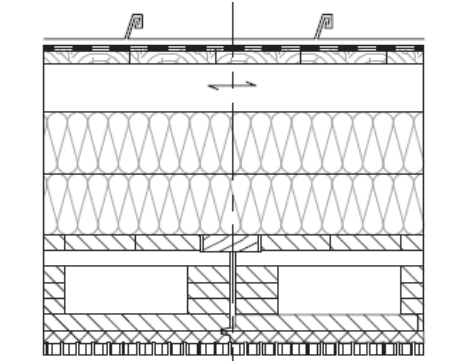
Sp. Z.	1			2	3	4
	component			Thickness of base member in mm	Thick structure in mm	R _w (C _{tr,50-5000}) in dB
11	Z. 11	Z. 12	Z. 13	140 PIR DAA that is a vapor barrier, 4 m '5 kg / m ² Lignatur, m' 39 kg / m ² <u>200</u>	2 Protective fleece, m '1 kg / m ² roofing sheet, two-layer 8th	40 _s (-6)
12				200 Mineralfaserdämmplatte vapor 4 barrier, m '5kg / m ² Lignatur, m' 39 kg / m ² <u>200</u>	8 roofing sheet, two-layer	50 _s (-11)
13				220 EPS 035 DAA that is a vapor 3 barrier, m '4 kg / m ² Lignatur, m' 39 kg / m ² 200	50 1.5 chipboard, m '75 kg / m ² roofing	53 (-9)

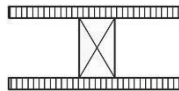
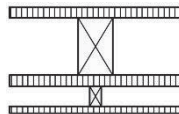
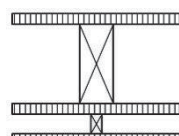
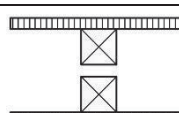
Table 34: flat sloping roof with Metalleindeckung Sp.

Z.	1	2	3	4
	component	Thickness of base member in mm	Thick structure in mm	R_w ($C_{tr, 50-5000}$) in dB
1		≥ 60 Fibreboards DAA dm beams 80/220, $e \geq 625$ mm cavity ≥ 220 damping spring rail, $e \geq 500$ mm gypsum board, $m' \geq 10$ ≥ 180 kg / m ²	0.7 Aluminum strips with double standing roofing 3 membrane roof 24 sheathing 80 <u>Timber, $e \geq 640$ mm</u>	63_a (-24)
2		28 12.5	0.7 Aluminum ribbons with double standing roof sheathing timber, $e \geq 640$ mm 24 80	59_a (-21)
3		≥ 100 Fibreboards DAD dm fibreboards DAD dm board plywood / laminated wood, $m' \geq 68$ kg / m ² void attenuation on CD profiles ≥ 140 Direktschwingabhänger, $e \geq 750$ x 500 mm, $f_0 \leq 28$ Hz, CD-profile, $e \geq 500$ mm gypsum board, $m' \geq$ ≥ 60 10 kg / m ² plasterboard, $m' \geq 10$ kg / m ² 90 12.5 12.5	0.7 Aluminum ribbons with double standing roofing roof 3 sheathing timber, $e \geq 640$ mm 24 80	71_a (-31)
4		≥ 100 Fibreboards DAD dm fibreboards DAD dm Lignatur acoustic filled with grit, $m' \geq 50$ kg / m m' $\geq$ 107.5 kg / m ≥ 240	0.7 Aluminum ribbons with double standing roofing roof 3 sheathing timber, $e \geq 640$ mm 24 80	63_a (-17)
5		≥ 100 Fibreboards DAD dm fibreboards DAD dm Lignatur acoustics, $m' \geq 57.5$ kg / m ≥ 120		58_a (-14)
6		≥ 100 Fibreboards DAA DAA ie fibreboards ie Ligno block, m' ≥ 63 kg / m ² ≥ 196	0.7 Aluminum ribbons with double standing roofing roof 3 sheathing timber, $e \geq 640$ mm 24 80	53_a (-11)
7		≥ 100 Mineralfaserdämmplatte DAA DAA dm dm ≥ 100 Mineralfaserdämmplatte Ligno block, $m' \geq 63$ kg / m ² ≥ 196		53_a (-10)

6.2.1 _ source directory component catalog flat roofs and roof terraces

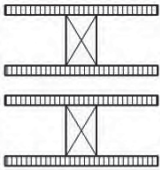
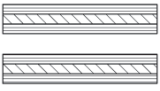
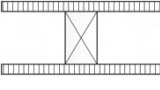
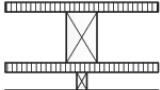
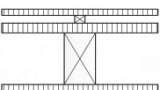
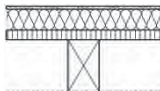
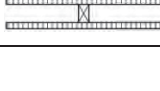
Bibliography of acoustical measurements	
Designation of the measured value	Origin of reading
a	Château Vieux-Hellwig C., Bacher S., A. Rabold, sound insulation of flat roofs in timber construction - airborne and impact sound insulation of flat roofs and roof terraces, research project ift Rosenheim, in progress
b	Measurements on behalf of binderholz and Saint-Gobain RIGIPS Austria by accredited testing laboratories

6.3 _ Component Catalog walls

Table 35: Aufbautenübersicht walls							
builds ell	row	sound insulation	Spectrum	Fire protection			
		dimension R_w	adjustment value ($C_{50-5000}$				
		in dB	in dB				
interior walls	table 39		123456789	38	(-, -) (-, -)	See DIN 4102-4: 2016-05, Tables 6.10 to 9.10 and www.dataholz.de	
				42	(-, -) (-, -)		
				34	(-, -) (-, -)		
				41	(-, -) (-, -)		
				44	(-, -) (-, -)		
				36	(-, -) (-2		
				43	-10) (-, -)		
				47	(-, -)		
				47			
			10	47			
			11	43			
			12	46			
			13	54			
			14	54			
		15	54	(-, -)			
		16	56	(-, -)			
table 40		123	32	(-1, -2)	see www.dataholz.de		
			38	(-0; -5)			
		45	47	(-1, -9) (-,			
			52	-)			
party walls	table 41		1234567	59	(-8, -20),	See DIN 4102-4: 2016-05, Tables 6.10 to 9.10 and www.dataholz.de	
				63	(-8, -22) (-,		
				60	-) (-13, -27)		
				64			
				58	(-, -)		
				61	(-, -)		
				60	(-, -)		
				89	66		(-, -)
		60		(-, -)			
	table 42		12	62	(-3, -16)		see www.dataholz.de
				67	(-13, -28)		
			345	57	(-1 -10)		
			61	(-2, -11)			
		67	(-8, -22)				

See DIN 4102-4: 2016-05, Tables 6.10 to 9.10 and
www.dataholz.desee
www.dataholz.deSee DIN 4102-4: 2016-05, Tables
6.10 to 9.10 and
www.dataholz.de

see www.dataholz.de

Continued Table 35: Aufbauartenübersicht Wände					
		sound insulation dimension R_w		Range adjustment value ($C_{50-5000}$; $C_{tr 50-5000}$)	
building type	row	in dB	in dB	Fire protection	
building partitions	table 43	 1 2 71 3 4 70 5 75 6 7 72 8 9 66 10 66 67 69 67 74	(-16, -30) (-12, -26) (-17, -30) (-15, -29), (-2, -8) (-2, -8) (-2, -10) (-2-9) (-3, -14) (-7, -19)	See DIN 4102-4; 2016-05, Table 10.6 to 10.9 and www.dataholz.de	
	table 44	 1 2 68 3 75 75	(-2, -13) (-3-14) (-3; -14)	See www.dataholz.de	
exterior walls	table 45	 1 2 37 3 37 41	(-, -) (-1, -5) (-, -)	See DIN 4102-4; 2016-05, Tables 6.10 to 9.10 and www.dataholz.de	
	table 45	 4 5 47 52	(-2, -12) (- -22)		
exterior walls	table 45	 6 7 37 8 9 44 10 52 44 47	(-, -) (-, -) (-, -) (-, -) (-3; -11)	See DIN 4102-4; 2016-05, Tables 6.10 to 9.10 and www.dataholz.de	
	table 45	 11 45 12 50 13 52 14 44 15 45 16 47 17 52 18 50 19 50 20 56	(-0; -8) (1 -10) (-4, -15) (-, -) (-, -) (-1, -9) (-1 -10) (-1, -9) (-, -) (-0-6)		
exterior walls	table 45	 21 55 22 48 23 49	(-1; -7) (-6, -15), (-2, -12)	See DIN 4102-4; 2016-05, Tables 6.10 to 9.10 and www.dataholz.de	
	table 45				

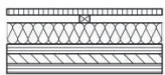
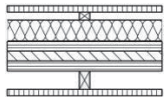
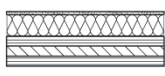
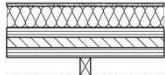
Continued Table 35: Außenwandübersicht Wärmehaare					
Bauteil	row	sound insulation		Spectrum	Fire protection
		dimension R_w	in dB	adjustment value ($C_{50-5000}$ $C_{tr 50-5000}$) in dB	
exterior walls		12	49 44	(-3, -14) (-1, -8)	see www.dataholz.de
		34	55 59	(-8 -21) (-6, -18)	
		5	39	(-1, -5)	
		6	57	(-2, -13)	

table 3 6: abbreviations and product specification - Walls

bra	(Dimensions and static depending on the wall type) timber frame made of solid wood, alternatively joists C
	A bhängertyp according to DIN EN 13964 for attaching CD profiles CD
	C -Wandprofil with a sheet thickness of 0.6 mm according to DIN EN 14195
C W	C-wall profile having a sheet thickness of 0.6 mm according to DIN EN 14195 in conjunction with DIN 18182-1
e BP	Expanded perlite insulation board in accordance with DIN EN 13169 including EBP / MW EPS
	Polystyrene foam to DIN EN 13163 FS
	Spring rail FZ
	Fiber cement board in accordance with DIN EN 12467
GF	Gypsum fiber board according to DIN EN 15283-2, with $m' \geq 13.75 \text{ kg / m}$, based on 12.5 mm plate thickness GK
	Gypsum board according to DIN EN 520 in conjunction with DIN 18180, with $m' \geq 8.5 \text{ kg / m}^2$, related to 12.5 mm plate thickness, processed in accordance with DIN 18181
GKF	Gypsum board type F (Fireproof panel) according to DIN EN 520 in conjunction with DIN 18180, with $m'm^2 \geq 10 \text{ kg / m}^2$, based on 12.5 mm plate thickness, processed in accordance with DIN 18181 HW
	Chipboard in accordance with DIN EN 312, OSB laying plates according to DIN EN 300 or BFU-plates according to DIN EN 315 and DIN EN 13986: $\rho \geq 600 \text{ kg / m}^3$, with $m' \geq 9.6 \text{ kg / m}^2$ KF
	Klickfix Direktbefestiger of C-wall profiles, acoustically decoupled L
	Battens horizontally or vertically mounted L-SB
	Battens horizontally or vertically on swing bracket fixed LS
	ventilated air layer or unventilated
MDF	medium density fibreboard according to DIN EN 622-5 and DIN EN 13986
MH	solid wood elements made of laminated timber, laminated timber wood or laminated wood, $\rho \geq 460 \text{ kg / m}^3$, alternatively hollow box elements NFS
	Closed molds or trays of wood and wooden materials, for example, groove and tongue formwork, ground cover formwork, wood planks OSB
	Chipboard panels of directed wood chips according to DIN EN 300 PU
	Rigid polyurethane foam in accordance with DIN EN 13165 including PUR and PIR
plaster	- lime plaster - Resin plaster according to DIN 18558 - insulating plaster
WH WTH	- Fiber insulating material boards / mats of mineral, jute, hemp, wood, cellulose or coconut fibers having a longitudinal flow resistance of $5 \text{ kPa s / m}^2 \leq r \leq 50 \text{ kPa s / m}^2$ - Einblasdämmstoffe of cellulosic fibers according to DIN EN 15101-1 ρ to the density = 40 - 50 kg / m³ (space filling) and a longitudinal flow resistance of $5 \text{ kPa s / m}^2 \leq r \leq 50 \text{ kPa}$
SP	Chipboard in accordance with DIN EN 312 and DIN EN 13986 $\rho, \geq 700 \text{ kg / m}^3$ SWP solid
wood pane	according to DIN EN 13353 and DIN EN 13986 WS-S weather protective clothing / weather
protection shell	WW wood wool board (formerly HWL) according to DIN EN 13168 XPS
	Extruded polystyrene according to DIN EN 13164 ZSP
	Cement bonded particle boards in accordance with DIN EN 634-2 and DIN EN 13986

Table 37: Insulation materials used - Walls column

row	1	2
	abbreviation	Requirement
1	MW	Mineral wool according to DIN EN 13162 with a longitudinal flow resistance of 5 kPa s / m r 50 kPa s / m
2	WF	Wood fiber according to DIN EN 13171 with a longitudinal flow resistance of 5 kPa s / m r 100 kPa s / m
3	CF	Einblasdämmstoffe of cellulose fibers according to DIN EN 15101-1 mit density = 40 - 50 kg / m³ (space filling) and a longitudinal flow resistance of 5 kPa s / m r 50 kPa
4	HF	Hemp fiber having a longitudinal flow resistance of 5 kPa s / m r 100 kPa s / m
5	KF	Coconut fiber having a longitudinal flow resistance of 5 kPa s / m r 100 kPa s / m
6	JF	Jute with a longitudinal flow resistance of 5 kPa s / m r 100 kPa s / m

table 3 8: Tools for the acoustic decoupling of the room-side facings column

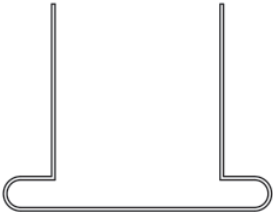
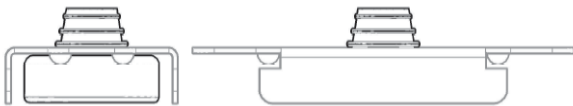
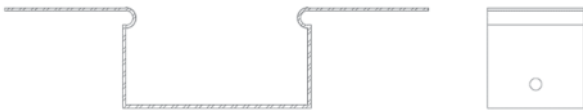
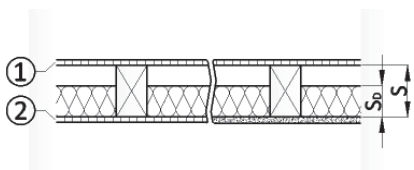
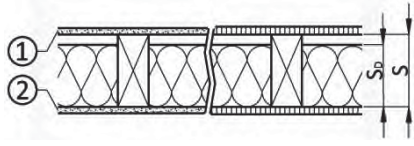
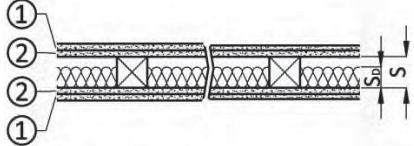
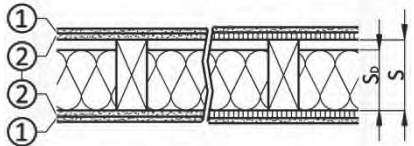
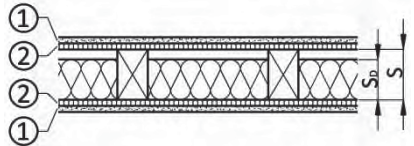
row	1	2
	views	application Description
Federschiene		
1		Component for acoustic decoupling of flexurally soft gypsum, gypsum fiber or wood based panels made of folded sheet metal (0.5 mm - 0.6 mm thick). Lochausstanzungen in the flange effect spring action. Spring bar: 27 mm x 60 mm center distance: $e \geq 415$ mm Maximum Load: see manufacturer's instructions
Schwinghanger		
2		Component for acoustic decoupling of flexurally soft gypsum, gypsum fiber or wood based panels made of folded sheet metal (0.5 mm - 0.6 mm thick). Bend in the flanges causes spring action. Maximum Load: see manufacturer's instructions
Aluprofil		
3		C-Wandprofil having a sheet thickness of 0.6 mm according to DIN EN 14195 in conjunction with DIN 18182-1. Furring completely separated from the outer wall.
Direktbefestigung (plasterboard click-Fix Direktbefestiger for C-wall profile, acoustically decoupled)		
4		Abhängertyp for acoustic decoupling and attachment of wooden battens or CDProfilen with an integrated vibrating element for sound decoupling; Maximum Load: 0.4 kN per hangers; more details from the manufacturer
Befestigungsclip		
5		Abhängertyp for acoustic decoupling and mounting of CD profiles; more details from the manufacturer

table 3 9: interior walls Holztafelbau column

row	1 cut horizontally	2		3	4
		construction details		Planking / Clothing	R_w (C; C 50-5000)
		insulation thickness S_D Shell distance S Holzständer b/h mm			
1		$S_D \geq WH \geq 40$ $S b/h \quad 60 \ 60/60$		$\geq 12.5 \geq 12.5$ GK GK	38_a (-3, -)
2				$\geq 12.5 \geq 12.5$ GF GF	42_a (-1; -)
3				$\geq 15 \geq 15$ HW HW	34_a (-2, -)
4		$S_D \quad WH \geq 120 \geq$ $S b/h \quad 140 \ 60/140$		$\geq 12.5 \geq 12.5$ GK GK	41_a (-2, -)
5				$\geq 12.5 \geq 12.5$ GF GF	44_a (-2, -)
6				$\geq 15 \geq 15$ HW HW	36_a (-2, -)
7		$S_D \geq WH \geq 40$ $S b/h \quad 60 \ 60/60$		$\geq 12.5 \geq 12.5$ GK GK	43_a (-1; -)
8th				$\geq 10 \geq 12.5$ GF GF	47_a (-2, -)
9		$S_D \quad WH \geq 120 \geq$ $S b/h \quad 140 \ 60/140$		$\geq 10 \geq 12.5$ GF GF	47_a (-2, -)
10				$\geq 10 \geq 15$ GF HW	47_a (-2, -)
11				$\geq 9.5 \geq 15$ GK HW	43_a (-2, -)
12		$S_D \geq WH \geq 80$ $S b/h \quad 100 \ 60/100$		≥ 12.5 GKF $\geq$ 12 HW	46_c (-2, -2)
GF Plasterboard according to Table 36 Gypsum board GK according to Table 36 Wood material board HW according to Table 36 WH Insulating fiber material according to Table 36, materials according to Table 37 having the specified thickness b/h Width (60-100 mm) x height (minimum value) of the wood stud, center distance $E \geq 600$ mm to Table 36					

continued u ng Table 39: interior walls Holztafelbau u column

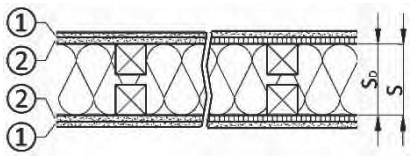
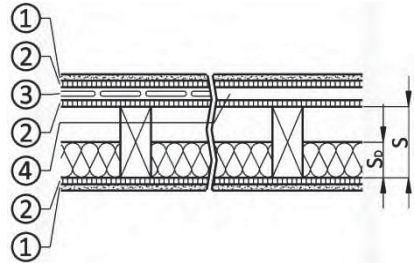
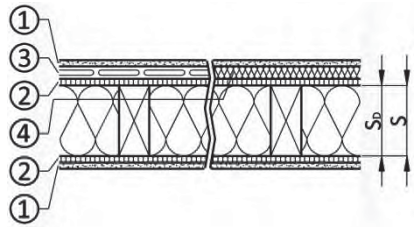
row	1 cut horizontally	2 construction details		3	4
		insulation thickness S_D Shell distance S Holzständer b/h mm	Planking / Clothing mm	R_w (C; C 50-5000) dB	
13		$S_D \geq 140 \geq WH$ $S b/h$ 140 2 x 60/60 60/140 stem Rähm continuously	$GK \geq 10 \geq 13$ HW	54_a (-2, -)	
14			$\geq 10 \geq 12.5$ GF GF	54_a (-2, -)	
15		$S_D \geq 70 \geq 140$ $S b/h$ WH 60/140	$GK \geq 12.5 \geq 13 \geq 27$ FS HW ≥ 25 LS	54_a (-3, -)	
16		$S_D \geq 140$ WH ≥ 140 $S b/h$ 140 60/140	$GK \geq 12.5 \geq 13 \geq 27$ FS HW ≥ 25 WH	56_a (-5 -)	
FS	False wall on the spring rail 27 mm according to Table 36 with insulation according to Table 37; Center distance $e \geq 400$ mm				
GF	gypsum fiber board according to Table 36 Gypsum board according to Table 36 Wood material board according to Table 36				
GK	air layer				
HW					
LS					
WH	Insulating fiber material according to Table 36, materials of Table 37, with the specified thickness b/h Width (60-100 mm) x height (minimum value) of the wood stud, center distance $E \geq 600$ mm to Table 36				

table 4 0: internal walls of solid timber column

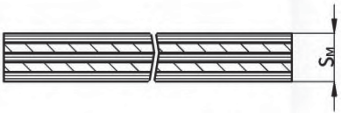
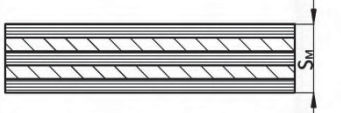
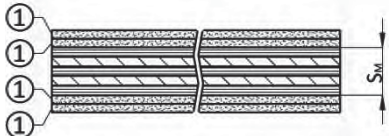
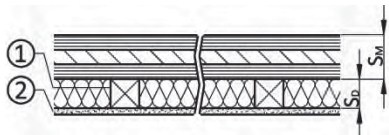
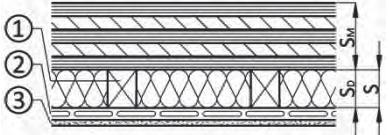
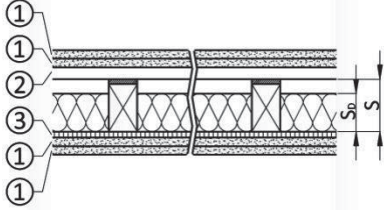
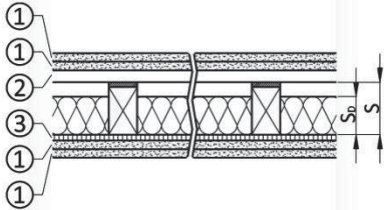
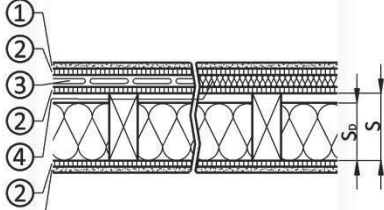
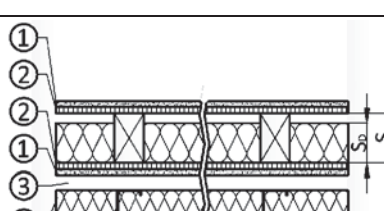
row	1 cut horizontally	2 construction details		3	4
		insulation thickness S_D Shell distance S Solid timber member S_M		Planking / Clothing	R_w (C; C 50-5000)
		mm		mm	dB
1		S_D - S_{SM} - ≥ 80 MH		-	32_b (-1, -1)
2		S_D - S_{SM} - ≥ 140 MH		-	38_n (-0 -0)
3		S_D - S_{SM} - ≥ 80 MH		≥ 18 GF	47_n (-1, 0)
4		S_D ≥ 60 WH S_{SM} - ≥ 90 MH		$\geq 60 \geq 12.5$ L GK	47_k (-1, -1)
5		S_D ≥ 80 WH ≥ 80 S_{SM} ≥ 135 MH		$L \geq 80 \geq 27 \geq$ 12.5 GK FS	52_g (-, -)
FS False wall on the spring rail 27 mm according to Table 36 with insulation according to Table 37; Center distance $e \geq 400$ mm; Plasterboard according to Table 36 Gypsum board according to Table 36 GF Facing panel battens having the above thickness, $e \geq 600$ mm WH GK L Insulating fiber material according to Table 36, materials of Table 37, with the specified thickness MH solid wood element according to Table 36, with the indicated thickness					

Table 41: Party walls Holztafelbau column

row	1	2	3	4
	cut horizontally	construction details		R _w (C; C ₅₀₋₅₀₀₀) dB
		insulation thickness S _D Shell distance S Holzständer b / h mm	Planking / Clothing mm	
1		S _D 80 WH S _b / h 100 60/100	15 GKF 35 CD + C 12 H	59 _c (-5, -8)
2		S _D 80 WH S _b / h 100 60/100	18 GKF 35 CD + KF 12 HW	63 _c (-3, -8)
3		S _D WH 120 S _b / h 140 60/140	12.5 GK HW 13 27 FS 25 WH	60 _a (-5 -)
4		S _D 80 WH S _b / h 100 60/100	12.5 GKF 12 HW 30 LS 60 75 WH CW	64 _c (-8, -13)
CD + CD + Mounting clip 27 x 60 mm CD-profile (total thickness of 35 mm) according to Table 36 Direktbefestiger sound-insulated with 27 mm x 60 CD-profile (total thickness of 35 mm) according to Table 36 C-KF CW C-Wandprofil according to Table 36 FS False wall on the spring rail 27 mm according to Table 36 with insulation according to Table 37; E center distance 400 mm plasterboard according to Table 36 plasterboard type F according to Table 36 Wood material board according to Table 36 GK air layer GKF HW LS WH Insulating fiber material according to Table 36, materials of Table 37, with the indicated thickness bra Width (60-100 mm) x height (minimum value) of the wood stud, center distance e 600 mm according to Table 36				

continued using Table 41: Flat partitions Holztafelbau column

row	1	2	3	4
	cut horizontally	construction details		R_w (C; C ₅₀₋₅₀₀₀) dB
		insulation thickness S_o Shell distance S Holzständer b / h mm	Planking / Clothing mm	
5		S_o 40 WH $S_{b/h}$ 105 80/80	12.5 GK 13 SP 27 25 FS LS	58 _a (-4 -)
6		S_o 60 WH $S_{b/h}$ 100 60/100	10 GF 12.5 GF 27 FS 25 WH	61 _a (-4 -)
7		S_o 60 WH $S_{b/h}$ 100 60/100	10 GF 12.5 GF 27 FS 25 WH	60 _a (-3, -)
8th		S_o 60 WH 140 2 x $S_{b/h}$ 60/60 60/60 handle 2 x separated Rähm	10 GF 12.5 GF 20 LS 12.5 GF 20 LS	66 _{a,d} (-3, -)
9		S_o 140 WH 140 2 x $S_{b/h}$ 60/60 60/140 stem Rähm continuously	12.5 GK HW 13 27 FS 25 WH	60 _a (-4 -)
FS	False wall on the spring rail 27 mm according to Table 36 with insulation according to Table 37; E center distance 500 mm			
GF	gypsum fiber board according to Table 36 Gypsum board according to Table 36 Wood material board according to Table 36			
GK	air layer			
HW				
LS SP				
WH	Clamping plate according to Table 36			
	Insulating fiber material according to Table 36, materials of Table 37, with the specified thickness b / h			
	Width (60-100 mm) x height (minimum value) of the wood stud, center distance e 600 mm according to Table 36			

Table 42: Party walls Massivholz bau column

row	1 cut horizontally	2	3	4
		construction details		R_w (C; C ₅₀₋₅₀₀₀) dB
		insulation thickness S_D Shell distance S Solid timber member S_M mm	Planking / Clothing mm	
1		S_D 75 WH SS_M 85 90 MH	12.5 GKF 75 CW	62 _m (-2, -3)
2		S_{M1} 90 MH	15 GKF 50 L-SB 40 WH	67 _m (-6, -13)
3		S_D WH 50 60 SS_{M1} 90 MH 100 S_{M2} MH	12.5 GKF	57 _m (-2, -1)
4		S_D WH 50 SS_M 60 90 MH	! 12.5 GKF	61 _m (-2, -2)
5		S_{M1} 100 MH S_{M2} 90 MH	50 WH ₁ 10 LS 50 WH 60 L-SB 12.5 GKF	67 _m (-3, -8)
CW C-Wandprofil according to Table 36 GKF plasterboard type F according to Table 36 air LS layer L-SB Wooden battens on swing bracket according to Table 36 with insulating material in accordance with Table 37, e 600 mm fiber insulation according to Table 36, materials according to Table 37 having the specified thickness fiber insulation according to Table 36, materials according to Table 37 having the specified thickness; ! 18 kg / m³ MH solid wood element according to Table 36, with the indicated thickness				

Table 43: Building partitions Holztafelbau

column row	1 cut horizontally	2	3	4
		construction details		R_w (C; C ₅₀₋₅₀₀₀) dB
		insulation thickness S_D Shell distance S Holzständer b / h mm	Planking / Clothing mm	
1		S_D $WH \geq 120 \geq$ $S \text{ b / h}$ $120 \geq 60/120$	$\geq 12.5 \text{ GKF} \geq 2 \times$ $18 \text{ GKF} \geq 45 \text{ LS}$	71_e (-8, -16)
2			$\geq 12.5 \geq 2 \times 15$ $GF \text{ GF} \geq 40 \text{ LS}$	70_b (-2, -12)
3		S_D $WH \geq 120 \geq$ $S \text{ b / h}$ $120 \geq 60/120$	$\geq 2 \times 12.5 \text{ GF} \geq 15$ $ZSP \text{ } 100 \text{ LS}$	75_a (-9, -17)
4			$\geq 2 \times 12.5 \text{ GF} \geq 15$ $\geq 35 \text{ ZSP LS}$	72_a (-6, -15)
5		S_D $\geq 60 \geq 60 \geq$ $S \text{ b / h}$ $WH \text{ } 60/60$	$\geq 12.5 \text{ GKF} \geq 2 \times$ $18 \text{ GKF} \geq 60 \geq 40$ $MW \text{ LS}$	66_e (-3, -2)
6			$\geq 12.5 \geq 2 \times 15$ $GF \text{ GF} \geq 60 \geq$ 45 MW LS	66_e (-3, -2)
7		S_D $85 \text{ WH } 85$ $S \text{ b / h}$ $60/85$	$\geq 18 \text{ GKF} \geq 2 \times 18$ $\text{GKF} \geq 2 \times 30 \text{ MW}$ $\geq 50 \text{ LS}$	67_i (-2, -2)
GF Plasterboard according to Table 36 plasterboard GKF type F according to Table 36 MW Mineral wool according to Table 37; Insulation on supporting structure fixed air layer LS WH ZSP Insulating fiber material according to Table 36, materials of Table 37, with the specified thickness of cement particle board according to Table 36 b / h Width (60-100 mm) x height (minimum value) of the wood stud, center distance $e \geq 600 \text{ mm}$ (1-4 line) or $e = 313 \text{ mm}$ (line 5-7) of Table 36				

continued u ng Table 43: Building Partitions H olztafelbau column

row	1	2	3	4
	cut horizontally	construction details		R_w (C; C ₅₀₋₅₀₀₀) dB
		insulation thickness S_D Shell distance S Holzständer b / h mm	Planking / Clothing mm	
8th		S_D 60 WH S_b / h 60 60/60	15 GF 12.5 GF 2 x 15 GF 60 45 LS WTH	69 _e (-3, -2)
9		S_D 60 WH S_b / h 60 60/60	15 GKF 18 GKF 160 WTH 5 LS	67 _e (-2, -3)
10		S_D WH 35 S_b / h 50 60/50	12.5 GF 15 GF 50 140 WTH LS	74 _e (-6, -7)
GF Plasterboard according to Table 36 GKF LS plasterboard type F according to Table 36 air WH layer WTH Insulating fiber material according to Table 36, materials of Table 37, with the specified thickness fiber insulation according to Table 36, materials according to Table 37 having the specified thickness; Insulation on supporting structure fixed b / h Width (60-100 mm) x height (minimum value) of the wood stud, center distance e 600 mm (line 10) and E = 313 mm (line 8, 9) according to Table 36				

Table 44: Building partitions Massivholzba u column

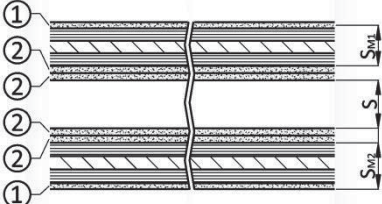
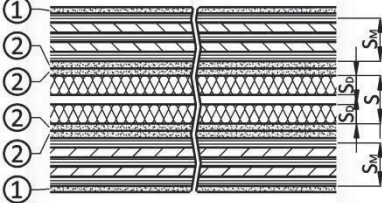
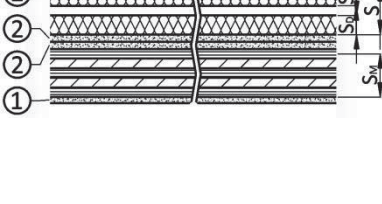
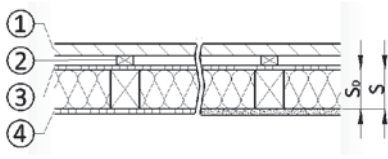
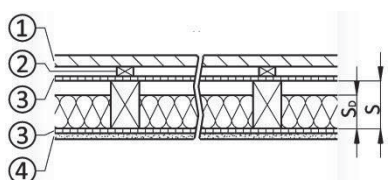
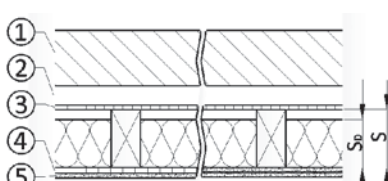
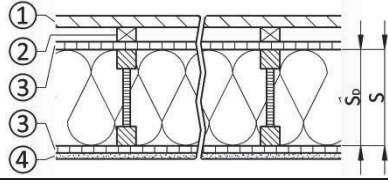
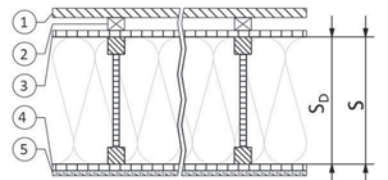
row	1	2	3	4
	cut horizontally	construction details		R_w (C; C ₅₀₋₅₀₀₀) dB
		insulation thickness S_D Shell distance S Solid timber member S_M mm	Planking / Clothing mm	
1		S_D - 100 84 84 SS_{M1} OSB OSB S_{M1}	12.5 GK 15 GF	68 _H (-1, -2)
2		S_D 2 x 40 WTH SS_M 100 100 MH	12.5 GKF 15 GF	75 _H (-2, -3)
3		S_D 40 WTH SS_M 100 84 OSB	12.5 GK 15 GF	75 _H (-2, -3)
GK Gypsum board according to Table 36 plasterboard GKF type F according to Table 36 Gypsum board GF according to Table 36 OSB Laying sheets of wood shavings oriented in accordance with DIN EN 300 Solid wood element according to Table 36, with the specified thickness fiber MH insulation according to Table 36, Materials according to Table 37 having the specified thickness; fixed insulation on supporting structure WTH				

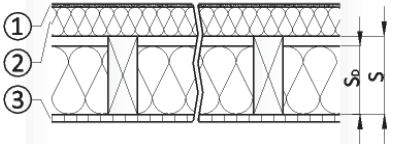
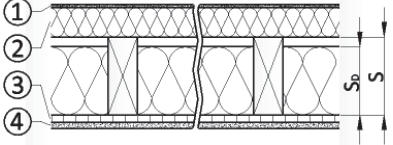
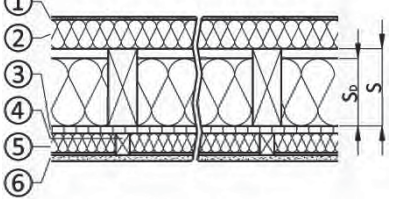
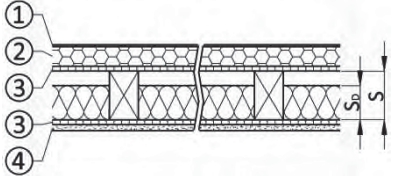
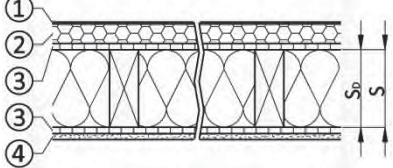
table 4 5: outer walls Holztafelbau column

row	1	2	3	4
	cut horizontally	construction details		R _w (C _{tr} ; C _{tr} 50-5000) dB
		insulation thickness S _D Shell distance S Holzständer b / h mm	Planking / Clothing mm	
1		S _D ≥ WH ≥ 60 S b / h 100 60/100	SP ≥ 10 o. O ≥ 18 NFS. ≥ 4 FZ	37 _a (-, -)
2		S _D ≥ 140 WH ≥ S b / h 160 60/160	≥ 15 HW	37 _f (-4, -5)
3		S _D ≥ 140 WH ≥ S b / h 160 60/160	≥ 16 ≥ 19 HW MDF	41 _a (-5 -)
4		S _D ≥ 140 WH ≥ S b / h 160 60/160	HW ≥ 15 ≥ 45 ≥ 40 L WH ≥ 9.5 GK	47 _f (-7; 12)
5		S _D ≥ 160 WH ≥ S b / h 160 60/160	≥ 16 ≥ 19 HW MDF ≥ 27 ≥ 30 L FS o. ≥ 27 WH ≥ 12.5 GF	52 _a (-14, -22)
FS FZ False wall on the spring rail 27 mm according to Table 36. Table 37 Insulation according fiber cement boards according to Table 36 Gypsum board according to Table 36 Gypsum board according to Table 36 Wood material board according to Table 36				
GF GK Facing layer on wooden battens with insulation according to Table 37, e ≥ 600 mm MDF board according to Table 36 to Table 36 closed formwork chipboard according to Table 36				
HW L Insulating fiber material according to Table 36, materials of Table 37, with the specified width thickness (60-100 mm) x height (minimum value) of the wood stud, center distance E ≥ 600 mm to Table 36				
MDF				
NFS SP				
WH b / h				

continued u ng Table 45: exterior walls wooden panel construction column

row	1 cut horizontally	2	3	4
		construction details		R_w (C_{tr} ; $C_{tr\ 50-5000}$) dB
		insulation thickness S_D Shell distance S Holzständer b / h mm	Planking / Clothing mm	
6		S_D 80 WH S_b / h 80 60/80	WS-S 20 10 L SP o. 18 NFS o. 4 FZ 10 SP o. O 18 NFS. GK 12.5	37 _a (-, -)
7		S_D 70 WH S_b / h 100 60/100	WS-S 20 10 L H 10 GF o. GK 12.5	44 _a (-, -)
8th		S_D WH 100 S_b / h 120 60/120	115 M-VS 40 LS 6 HW 12 HW o. GK 12.5 ! 9.5 GK	52 _a (-, -)
9		S_D 200 200 200 WH S_b / h joists	20 WS-S 30 16 L H GK 12.5	44 _a (-7, -)
10		S_D 300 300 300 WH S_b / h joists	WS-22 S 30 L 15 15 HW MDF GK 12.5	47 _i (-9 -11)
FZ GF Fiber cement boards according to Table 36 Gypsum GK HW board according to Table 36 Gypsum board L LS according to Table 36 M-VS Wood material board according to Table 36, the maximum plate thickness of 16 mm facing layer on MDF wooden battens with insulation according to Table 37, e 600 mm air layer NFS SP WH Masonry furring MDF board according to Table 36 to WS-S Table 36 closed formwork chipboard according to Table 36 Insulating fiber material according to Table 36, materials of Table 37, with the specified thickness weather clothing shawls / (z. B. ground cover formwork) b / h Width (60-100 mm) x height (minimum value) of the wood stud, center distance e 600 mm according to Table 36				

continued u ng Table 45: exterior walls wooden panel construction column

row	1	2	3	4
	cut horizontally	construction details		R_w $(C_{tr}; C_{tr, 50-5000})$ dB
		insulation thickness S_o Shell distance S Holzständer b/h mm	Planking / Clothing mm	
11		$S_o \geq 140$ $WH \geq 160$ $S b/h \geq 60/160$	≥ 8 plaster ≥ 60 WF ₁ ≥ 15 HW	45 _f (-6, -8)
12		$S_o \geq 140$ $WH \geq 160$ $S b/h \geq 60/160$	≥ 8 plaster ≥ 60 WF ₁ $\geq 15 \geq 12.5$ HW GF	50 _f (-5, -10)
13		$S_o \geq 140$ $WH \geq 160$ $S b/h \geq 60/160$	≥ 8 plaster ≥ 60 WF ₁ $HW \geq 15 \geq 45$ ≥ 40 L WH ≥ 12.5 GF	52 _f (-5, -15)
14		$S_o \geq 70 \geq 100$ $S b/h \geq WH \geq 60/100$	≥ 4 plaster 20-40 EPS ≥ 14 $HW \geq 12.5$ GK	44 _a (-, -)
15		$S_o \geq 160$ $WH \geq 160$ $S b/h \geq 60/160$	≥ 4 plaster 20-40 EPS ≥ 13 ≥ 12.5 SP GK	45 _a (-6, -)
EPS Polystyrene hard foam panels, application WAB, $\rho \geq 15 \text{ kg / m}^3$ gypsum fiber board according to Table 36 Gypsum board according to Table 36 GF GK Wood material board according to Table 36, the maximum plate thickness of 16 mm facing layer on wooden battens with insulation according to Table 37, $e \geq 600 \text{ mm}$ external plaster with reinforcement, $m \geq 8 \text{ kg / m}^2$ according to Table 36 to Table 36 chipboard HW L Wood fiber insulating material by wet process; $\rho = 210 \text{ kg / m}^3$ plaster Insulating fiber material according to Table 36, materials of Table 37, with the specified width thickness (60-100 mm) x height (minimum value) of the wood stud, center distance $E \geq 600 \text{ mm}$ to Table 36 SP WF₁				

continued u ng Table 45: exterior walls Holzt af Elbau column

row	1	2	3	4
	cut horizontally	construction details		R_w (C tr; C tr 50-5000) dB
		insulation thickness S_D Shell distance S Holzständer b / h mm	Planking / Clothing mm	
16		S_D $WH \geq 120 \geq$ $S b / h$ $120 \geq 120$	$\geq 7 \geq 160$ plaster $WF \geq 12$ ≥ 12.5 HW GKF	47_c (-7, -9)
17		S_D $\geq 160 WH \geq$ $S b / h$ $160 \ 60/160$	≥ 8 plaster $\geq$ 100 WF_2 $\geq 15 \geq 12.5$ HW GF	52_f (-5, -10)
18		S_D $\geq 140 \geq 160 WH$ $S b / h$ handle 2 x 60/78 60/160 continuously Rähm	≥ 8 plaster $\geq$ 60 WF_1 ≥ 15 HW	50_f (-4, -9)
19		S_D $\geq 140 \geq 160 WH$ $S b / h$ handle 2 x 60/60 60/160 continuously Rähm	$\geq 6 \geq 60$ plaster $WF \geq$ $15 \geq 12.5$ HW GK	50_a (-4 -)
20		S_D $\geq 140 \geq 160 WH$ $S b / h$ handle 2 x 60/78 60/160 continuously Rähm	≥ 8 plaster $\geq$ 100 WF_2 ≥ 15 HW $\geq 2 \times 12.5$ GF	56_f (-4, -6)

GF GK
GKF
plaster
HW
WF WF₁
WF₂
WH

Plasterboard according to Table 36 to Table 36
36 plasterboard plasterboard type F
according to Table 36
Wood material board according to Table 36, the maximum plate thickness of 16 mm with external plaster
reinforcement, $m \geq 8 \text{ kg} / m^2$ according to Table 36 insulating material made of wood fiber according to
Table 37 having the specified thickness of wood fiber insulating material by wet process; $\rho = 210 \text{ kg} / m^3$ of
wood fiber insulating material by wet process; $\rho = 250 \text{ kg} / m^3$
Insulating fiber material according to Table 36, materials of Table 37, with the specified thickness b / h
Width (60-100 mm) x height (minimum value) of the wood stud, center distance $E \geq 600 \text{ mm}$ (row 16, 18-20) or $e = 833 \text{ mm}$ (line 17) according to
Table 36

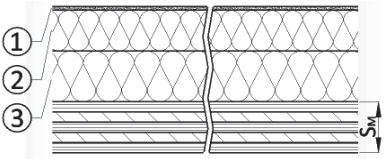
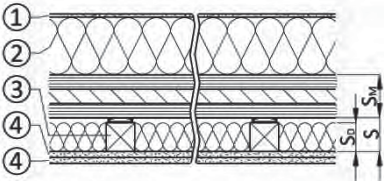
continued u ng Table 45: exterior walls wooden panel construction column

row	1	2	3	4
	cut horizontally	construction details		R_w $(C_{tr}; C_{tr, 50-5000})$ dB
		insulation thickness S_D Shell distance S Holzständer b/h mm	Planking / Clothing mm	
21		$S_D \geq 140 \geq 160$ WH $S b/h$ handle 2 x 60/78 60/160 continuously Rähm	≥ 8 plaster ≥ 60 WF 1 $HW \geq 15 \geq 45$ ≥ 40 L WH ≥ 12.5 GF	55_r (-5, -7)
22		$S_D \geq 200$ WH ≥ 200 200 $S b/h$ joists	≥ 8 plaster WF $\geq 60 \geq 15 \geq 60$ L HW $\geq$ WH ≥ 60 12.5 GK	51_r (-13, -15)
23		$S_D \geq 200$ WH ≥ 200 200 $S b/h$ joists	≥ 8 plaster WF $\geq 60 \geq 15 \geq 12.5$ HW GK	49_r (-9 -12)
GK GF Gypsum board according to Table 36 Gypsum HW L board according to Table 36 plaster Wood material board according to Table 36, an increase in the plate thickness up to 16 mm is allowed furring battens having WF WF 1 the above thickness, $e \geq 600$ mm external plaster with reinforcement, $m' \geq 8$ kg / m ² according to Table 36 insulating material made of wood fiber according to Table 37 having the specified thickness of wood fiber insulating material by wet process; $\rho = 210$ kg / m ³ WH Insulating fiber material according to Table 36, materials of Table 37, with the specified thickness b/h Width (60-100 mm) x height (minimum value) of the wood stud, center distance ≥ 600 mm to Table 36				

table 4 6: exterior walls Solid timber column

row	1	2	3	4
	cut horizontally	construction details		R_w (C_{tr} ; $C_{tr 50-5000}$) dB
		S _M mm	Planking / Clothing mm	
1		S _M ≥ 80 MH	≥ 40 WS-S ≥ 30 ≥ 30 L L ≥ 160 WF	49 _k (-7, -14)
2		S _M ≥ 90 MH	HW ≥ 19 ≥ 40 ≥ 22 L WF ₃ ≥ 140 WF	44 _k (-7 -8)
3		S _D ≥ WH ≥ 60 S _M 80 MH	≥ 40 WS-S ≥ 30 ≥ 160 L WF ≥ 60 ≥ 12.5 L GK	55 _k (-8 -21)
4		S _D WH ≥ 60 ≥ SS _M 70 ≥ 90 MH	HW ≥ 19 ≥ 40 ≥ 22 L WF ₃ ≥ 140 ≥ 60 WF L-SB ≥ 12.5 GF o. GK	59 _m (-11 -18)
GF GK Plasterboard according to Table 36 to Table 36 plasterboard plasterboard type F GKF according to Table 36 HW L Wood material board according to Table 36, m' ≥ 9.4 kg / m² L-SB Facing panel battens having the above thickness, e ≥ 600 mm wooden battens on swing bracket according to Table 36 with WF insulating material in accordance with Table 37, e ≥ 600 mm insulating material made of wood fiber according to Table 37 having WF₃ the specified thickness of insulation material from wood fiber according to Table 37 having the specified thickness, ρ = 240 kg / m³ fiber insulation according to Table 36, materials of Table 37, with the specified thickness weather protective clothing / cup (z. B. WH ground cover formwork) solid wood element according to Table 36, with the indicated thickness WS-S MH				

continued u ng Table 46: outer walls Massivholzbau column

row	1	2	3	4
	cut horizontally	construction details		R_w (C_{tr} ; $C_{tr 50-5000}$) dB
		Solid timber member S_M mm	Planking / Clothing mm	
5		$S_M \geq 100 \text{ MH}$	$\geq 7 \geq 60$ plaster WF_3 $\geq 100 \text{ WF}_4$	39_c (-5, -5)
6		S_D $WH \geq 60 \geq$ SS_M $70 \geq 90 \text{ MH}$	$\geq 6 \geq 120$ plaster $WF \geq$ 60 L-SB $\geq 12.5 \text{ GKF}$ o.GF	57_m (-7, -13)
GF GKF Plasterboard according to Table 36 plasterboard L-SB type F according to Table 36 cleaning Wooden battens on swing bracket according to Table 36 with insulating material in accordance with Table 37, $e \geq 600 \text{ mm}$ external plaster with $WF \text{ } WF_3$ reinforcement, $m^2 \geq 8 \text{ kg / m}^2$ according to Table 36 insulating material made of wood fiber according to Table 37 having the specified thickness of insulating material made of wood fiber bulk density = 257 kg / m^3 WF_4 Insulating material made of wood fiber bulk density = 160 kg / m^3 WH Insulating fiber material according to Table 36, materials of Table 37, with the specified thickness of solid wood element MH according to Table 36, with the indicated thickness				

6.3.1 _ References Component Catalog walls

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b	German Society for Wood Research (Information Service wood), see [19]
c	"Development and distribution of a practical handbook for sound insulation in the timber in accordance with the prior art" (Research Project); Timber Germany eV; 2018 (Research Report downloaded at www.informationsdienst-holz.de)
d	"More than just insulation - additional benefit of insulation material from renewable raw materials" (Research Project); Technical University of Rosenheim; in processing
e	Holtz, F. ; Rabold, A. ; Hessinger, J. ; Buschbacher, HP: Acoustic optimization of wood construction by improving the wall constructions, DGfH research report LSW lab for sound and heat Messtechnik GmbH (sponsored by AiF), 2004
f	Holtz, F. ; Rabold, A. ; Buschbacher, HP; Hessinger J. : Highly sound external components made of wood, DGfH research report LSW - Laboratory for sound and heat Messtechnik GmbH (funded by Holzabsatzfonds), 2003
G	Sound measurements at Müller BBM on behalf of the company Merk, Planegg 1995
H	Sound measurements in the laboratory for sound and Thermal Measuring on behalf of the company Finnforest Merk, Stephanskirchen
i	Sound measurements at the Institute of window technology on behalf of Knauf Gips KG, Stephanskirchen
k	Holtz, F. ; Rabold, A. ; Hessinger, J. ; Buschbacher, HP; Oechsle, O. ; Lagally, Th. : Acoustic characteristics of solid wood components, inventory and analysis, DGfH Research Report of the Laboratory of acoustic and thermal metrology 2001
l	Sound measurements in the laboratory for sound and Thermal Measuring commissioned by the Wood Marketing / DGfH on walls and roofs using cellular beams, Stephanskirchen 2004
m	Sound measurements at the Institute of window technology on behalf of the Binder Holz GmbH, Stephanskirchen
n	Sound measurements at the Institute of window technology on behalf of the research project vibroacoustics, see [21]

7 _ Appendix A

Verbal description and calculations, acoustic targets

A1 _ Verbal description of airborne sound insulation

As described in chapter 2 already shows the verbal description is of great importance of acoustic characteristics. To illustrate not only in the context of a legally binding description for the consumers but also to the quality level. The verbal description makes the layman the building acoustic performance of his building or his apartment accessible. Here, to be displayed on the perception in their own living rooms the effect of everyday noises from external utility units.

Thus, for. B. a party wall with a sound reduction of rated $R'_w = 55$ dB are characterized as follows:

"Loud conversations in the next room can be heard, but not understandable."

Note:

More verbal descriptions can be found in VDI 4100 [36] and the DEGA recommendation 103 "Sound insulation card" [34].

stuck in the terms "audible" and "understandable" valuable psychoacoustic statements about the quality of sound insulation. These ratings, however, are dependent on the existing noise level in their own living area. The higher this is, the lower the visibility of noise and calls from other functional units. So noise is for example the use from units less perceived in noisy neighborhoods than in quiet residential areas. Cause here is the coverage of the external noise by

results in the noise level in their own homes, which consists of the ambient noise (traffic noise). The same applies to internal sound sources (technical building equipment, household appliances, radio, etc.).

Thus, to assess the noise level is initially set them on their premises. This is during the day, depending on the area, traffic conditions and technical building services, between 20 dB (A) (quiet) and 30 dB (A) - 35 dB (A) (living spaces on roads with closed window).

Then the level is determined, which would occur without the background noise, only the transmission of noise from another working unit (z. B. loud music of the neighbors) via a separating member away. This level results from the transfer of the assessed separating member and its flanking elements. He is thus the smaller the better the sound insulation of the components.

The transmitted sound pressure level can be compared to the existing noise level now, to go to the verbal description of sound insulation. Fig. 7.1 provides this comparison graphically.

Depending on the difference between the two levels, the human ear is capable of this disturbing to hear the sounds and to understand or not to understand. In order to ensure confidentiality, it is necessary that the transmitted level is well below the basic noise. The following characteristic values may be mentioned for this sound level difference as confidentiality criterion [34], [35], [36]:

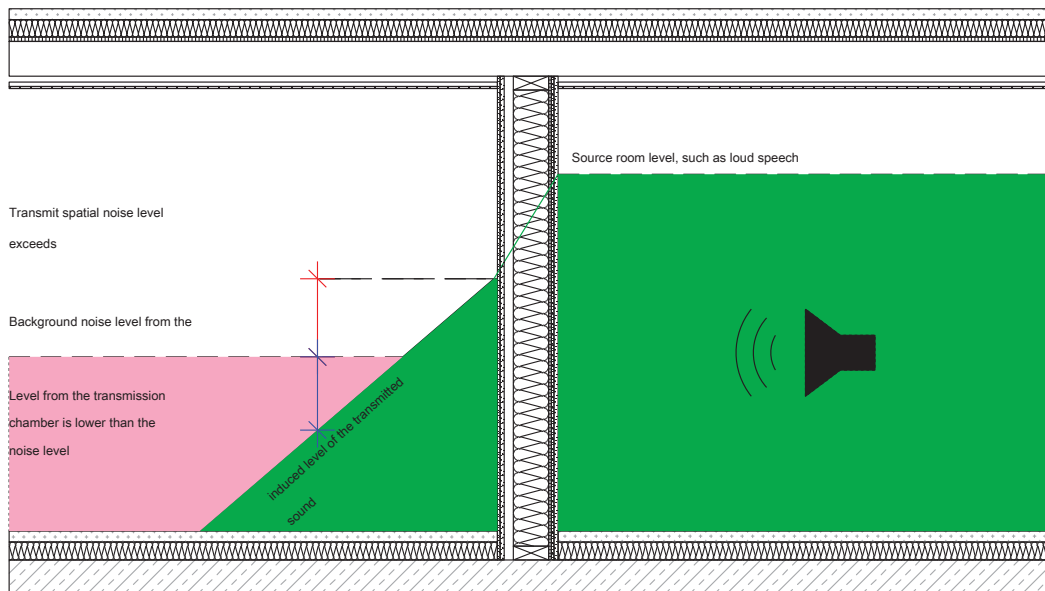


Figure 7.1.:

Comparison of the transmitted level (green) with the EXISTING where basic noise level (Pink)

15 dB: The transmitted level is 15 dB

below the basic noise level. Extraneous noises are audible.

audible:

The conversation in the foreign use unit can be perceived. Sometimes you can also identify who is speaking.

10 dB: Transferred language is not

ver stand and barely audible. The participants of a conversation can not be identified.

understandable:

The conversation is understandable with the content. There are sentences or sentence fragments identified.

7 dB: Transferred language is not

understandable, but still audible.

This approach also individual targets for noise control, depending on the make anticipated Ge räuschbelastung determine how this will be shown in the application example.

3 dB: Transferred language is generally

not understandable, but still audible. Lowermost limit of confidentiality requirements.

0 dB: Background level and Fremdgeräusche-

noise levels are equal. Language is still understandable and audible.

Note:

On the derivation and description of values incl. Range adjustment values for airborne sound insulation is omitted here. is the involvement of other spectra as described in Chapter 2, is not necessary for all components equally. An exception is the impact sound, which is explained in more detail in Appendix A2.

-10 dB: The foreign sounds are above the

Noise level. Language is properly understood and heard.

The above terms is attributed to the following meanings:

Example of use:

Empfangsraum (own four walls):

Living: $L \times B \times H = 5 \times 6 \times 2.5$ m, urban location, noise level: $L_{GE} = 25$ dB (A) in the receiving room reverberation time: $T_{0.5} = 0.5$ s Normal equipment of the rooms with a sofa and carpets. However, the reverberation time can in a very modern (reverberant) equipped rooms also rise unfavorable.

Source room (Neighbor): Kitchen: $L \times B \times H$

$= 4 \times 5 \times 2.5$ m

Noise source: loud speech, sound power level: $L_w \approx 82$ dB (A)

Note:

These are a sound power level. This must first be converted into a function room acoustics / reverberation time in a sound pressure level. Reverberation time in the source room: $T_s = 0.6$ s

Sabine formula according to:

$$A_s = 0.163 \frac{V_s}{T_s}$$

A_s : equivalent sound absorption area in the source room in m^2 V_s : Volume in the source room in m^3 T_s : Reverberation time in the source room in s

For the sound pressure level in the diffuse sound field arises:

$$L_s = L_w + 6 - 10 \log s$$

L_w : Sound power level of the noise source in dB (A) L_s : Sound pressure level of the noise source in the source room in dB (A) V_s : $4.0 \times 5.0 \times 2.5$ m = 50 m A_s : $0.163 \times (50 \text{ m}^3 / 0.6 \text{ sec}) = 13.6$ m L_s : $82 \text{ dB (A)} + 6 - 10 \log (13.6 \text{ m}^2) = 76.7 \text{ dB (A)}$

Partition wall in timber construction:

Result of a detailed forecast:

$$R'_{w-U_{\text{prog}}} = 56.5 \text{ dB}$$

In a common partition member surface by:

$$S = 4.0 \text{ m} \times 2.5 \text{ m} = 10 \text{ m}^2$$

Here the forecast uncertainty is peeled off to results on the safe side to obtain lying.

Calculation of the level in the receiving room without background level which is allowed through the partition:

$$L_e = L_s R'_{w-U_{\text{prog}}} + 10 \log \frac{A_s}{A_e} \left(\frac{1}{S} \right)$$

L_e : Sound pressure level in the receiving room caused by the transmission chamber in dB (A) L_s : Sound pressure level of the noise source in the source room in dB (A) S : common separating member area in m^2 A_e : Absorption area in the receiving room in m^2

Note:

At this point, the sound reduction can be reduced or increased by a spectrum adaptation term to the effect of the separator member to a particular excitation noise to characterize in more detail. Thus, the target values can be adjusted even more precisely on the nature of the exciting source.

$$A_e = 0.163 \frac{V_e}{T_e} \left(\frac{1}{T_e} \right) = 0.163 \frac{5 \text{ m}^3}{0.5 \text{ s}} \left(\frac{1}{0.5 \text{ s}} \right) = 24.45 \text{ m}^2$$

$$L_e = L_s R'_{w-U_{\text{prog}}} + 10 \log \frac{A_s}{A_e} \left(\frac{1}{S} \right)$$

$$= 76.7 \text{ dB (A)} - 56.5 \text{ dB} + 10 \log \frac{24.45 \text{ m}^2}{10 \text{ m}^2}$$

$$= 16.3 \text{ dB (A)}$$

Background noise:

$$L_{GE} = 25 \text{ dB (A)}$$

Receiving room level by neighbor noise:

$$L_e = 16.3 \text{ dB (A)}$$

Sound barrier as confidentiality criterion:

$$\Delta L = 8.7 \text{ dB (A)}$$

As listed on page 179 is assumed not to be understood that loud speech, but is still audible.

Conversely, the required sound insulation of the wall can be the same formulas for a given also

ΔL determined.

A2 _ derivation of targets for the impact sound

After a criterion for low frequencies of the sound level of protection and comfort BASE + was introduced in section 2.4, is now to be shown here, the basis on which these values are based. First, even have the question whether a relationship between the typically by which to assess the impact sound insulation blanket

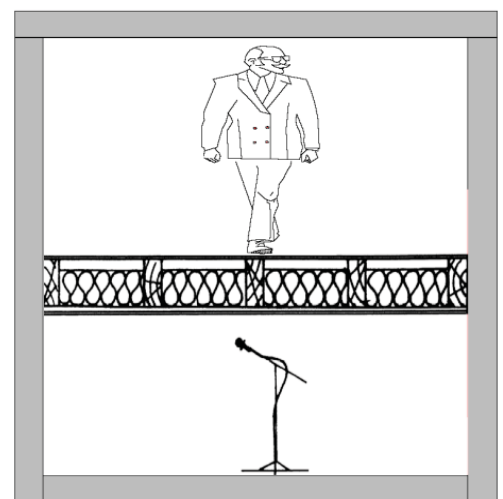
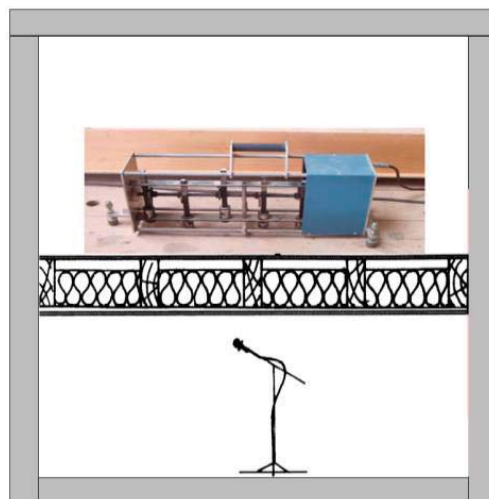
used rated normalized impact sound pressure $L_{n,w}$ and the perception of an impact sound generated by the inspection of covers is. In order to verify this relationship 7.3, the results are shown in Fig. Measurements with the standard hammer mechanism with measurement results of the impact sound transmissions ver when walking on different ceiling adjusted (to the measuring arrangement, see Fig. 7.2). For acoustically correct assessment

Fig. 7.2:

measurement of
Impact sound transmission of a
ceiling. Left:

Impact sound excitation by
the
Standard hammer mill. Right:

Excitation by committing the
ceiling.



tung was rated A-from the impact sound transmission in committing the ceiling of the reverberation and corrected maximum value of the impact sound level $L_{AFmax,n}$ educated. The individual points in Fig. 7.3, each of which represent the result of a ceiling structure, show a very poor correlation. This means that between the rated standard impact sound level $L_{n,w}$ and the A-weighted impact sound level $L_{AFmax,n}$ no clear connection

consists. Obviously calls for example, a ceiling with $L_{n,w} = 52$ dB with an $L_{AF,max,n} = 42$ dB (A) a similar perception of the transferred walking noises produced as a ceiling with $L_{n,w} = 37$ dB. It is thus evident that the $L_{n,w}$ is unsuitable as evaluation variable for the disturbance of walking noise.

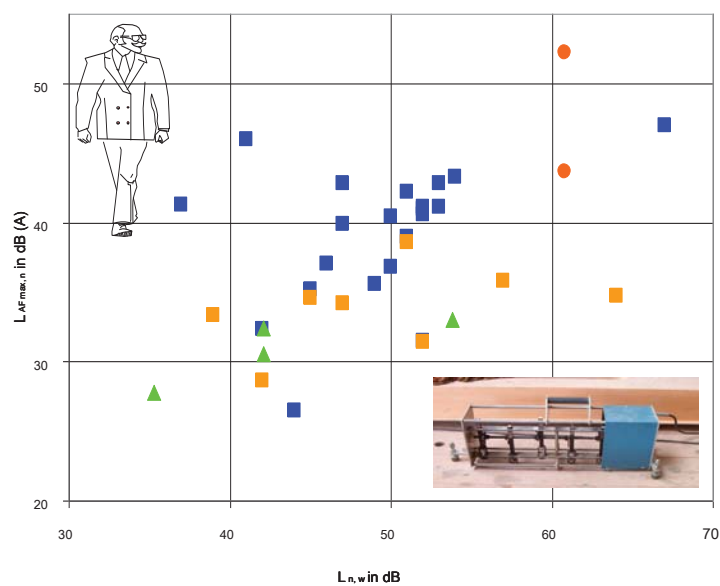


Figure 7.3.:

Correlation of $L_{n,w}$ and subjective feeling: relation between the rated standard impact sound level $L_{n,w}$ and the A-weighted impact sound level $L_{AFmax,n}$ when walking by wooden ceilings.

Blue squares: measurements in Rosenheim ift [32] orange squares: measurements on the TH Rosenheim [31] green triangles: measurements in the ceiling test stand Knauf, Iphofen [33].

Section 2.3 has already made clear that much of the noise energy at $L_{AF, max, n}$ in the frequency range below 100 Hz is transmitted. Thus, it is only logical to allow frequencies below 100 Hz with assessment included in the building acoustics Be, a measure of the quality to obtain a component. In Fig. 7.4, the ceilings are Fig. 7.3 again, but including the spectrum adaptation terms $C_{1, 50-2500}$ listed

wear. It now shows a significantly better correlation between the A-weighted sound levels occurs when walking on the ceiling and

DIN EN ISO 717-2 with $L_{n, w} + C_{1, 50-2500}$

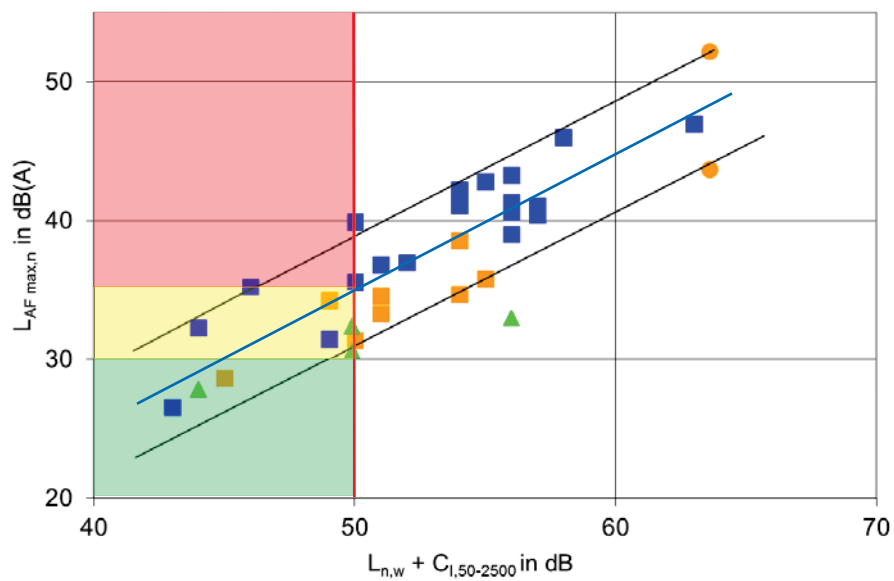
rated Hammer plant measurements. This will also be seen that the correlation shown in Fig. 7.3, weak less by the type of excitation with the standard hammer mechanism than by the incorrect evaluation on the $Be, L_{n, w}$ was caused.

A bb. 07.04:

Relationship between
the $L_{AF, max, n}$ and $L_{n, w} + C_{1, 50-2500}$

50-2500

for the derivation of target
values for the component
development



Laying down the targets for good sound insulation the subjective feeling is now the resident on past experience on the Störempfung considered. Usually, most people feel at an $L_{AF, max, n} > 35 \text{ dB (A)}$ is disturbed. So is the level which is caused by walking on a ceiling, well below 35 dB (A), it is assumed that the user is no longer

feels disturbed. This is according to Fig. 7.4 of ceiling with an $L_{n, w} + C_{l, 50-2500} < \text{reaches } 47 \text{ to } 53 \text{ dB}$. It became a $L_{n, w} + C_{l, 50-2500} < 50 \text{ dB}$ for the sound level of protection in section BASE + 2.4 derived. To achieve a more noticeable improvement, the improvement in L should $L_{AF, max, n}$ are 5 dB (A) - at approx. 3 This leads to an $L_{n, w} + C_{l, 50-2500} < 44 \text{ to } 50 \text{ dB}$, from which the COMFORT sound level of protection with $L_{n, w} + C_{l, 50-2500} < 47 \text{ dB}$ was derived.

A -Rating

dB (A)

approximately corresponds to the replication of human auditory perception.

The A rating reflects approximately against the disturbing effect of sound pressure levels in the human ear. There are perceived not all sound pressure level at each frequency equally disturbing. The trend high frequencies are perceived disturbing.

$\neq$

building acoustics review

$L_{n, w}; R_w$

corresponds to a comparison of the measured sizes building acoustic sound reduction and standard impact sound with a reference curve. Rated sizes carry the index "w".

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