KLH®

MADE FOR BUILDING
BUILT FOR LIVING

BUILDING PHYSICS

ORIGINAL 100% KLH® ORIGINAL

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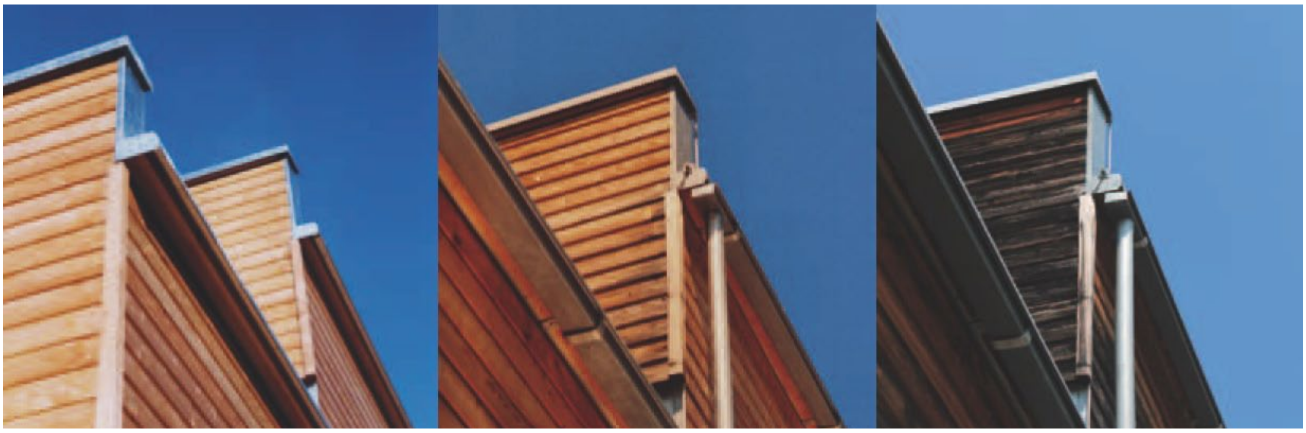
CONTENT

BUILDING PHYSICS

REQUIREMENTS FOR BUILDING PHYSICS

- Long-term prevention of building damage
- Thermal insulation and a comfortable indoor climate throughout the year
- Sound insulation against noise from outside and within the building
- Airtight building envelope
- Early detection of damage events
  (e.g., pipe bursts, damage to the building envelope)
  and the best possible preparation for the occurrence of such events

01 WOOD AND KLH®



Weathering timber façade [7.1]

PHYSICAL PROPERTIES OF KLH®

Wood is a unique, “living“ building material. Even after harvesting and processing, wood continues to respond significantly to its environment. When used correctly, wood and wood-based materials offer a wide range of applications that greatly contribute to both indoor comfort and ecological value creation.

DURABILITY

The durability of wood products is primarily ensured through their proper application and the associated wood protection measures. KLH® solid wood panels are mainly made from softwoods, primarily spruce. Their use is generally limited to Service Classes 1 and 2 in accordance with EN 1995-1-1. Increased exposure (Service Class 3) and special applications must be verified separately and require careful planning.

The requirements are based on an intended service life of at least 50 years, assuming appropriate design and maintenance. However, the documented service life of glued laminated timber products can exceed 100 years under suitable conditions.

WOOD SPECIES	European spruce (equivalent softwood species)
WOOD MOISTURE CONTENT AFTER PRODUCTION (EN 13183-2)	12% ± 2
SHRINKAGE PERPENDICULAR TO THE PLANE OF THE PANEL	0.24% of the thickness per 1% change in moisture content
SHRINKAGE IN THE PLANE OF THE PANEL	0.02% of the length per 1% change in moisture content
FIRE PERFORMANCE OF GLUED SOLID TIMBER PRODUCTS (COMMISSION DECISION 2005/610/EC)	Mean bulk density of wood ≥ 380 kg/m³ Euroclass D-s2, d0
KLH® - CLT ρ_u (LAB VALUE)	Density at 12% moisture content: 470 kg/m³
WATER VAPOUR DIFFUSION μ, SOFTWOOD (EN ISO 10456)	50 (dry) to 20 (moist) [-]
WATER VAPOUR DIFFUSION μ, CLT® (LAB VALUE)	300 (dry) to 25 (moist) [-]
THERMAL CONDUCTIVITY, λ (EN ISO 10456)	0.12 W/(m*K)
SPECIFIC HEAT CAPACITY, cp (EN ISO 10456)	1 600 J/(kg*K)
AIRBORNE SOUND INSULATION R_w FOR 60 MM KLH® - CLT	30 dB

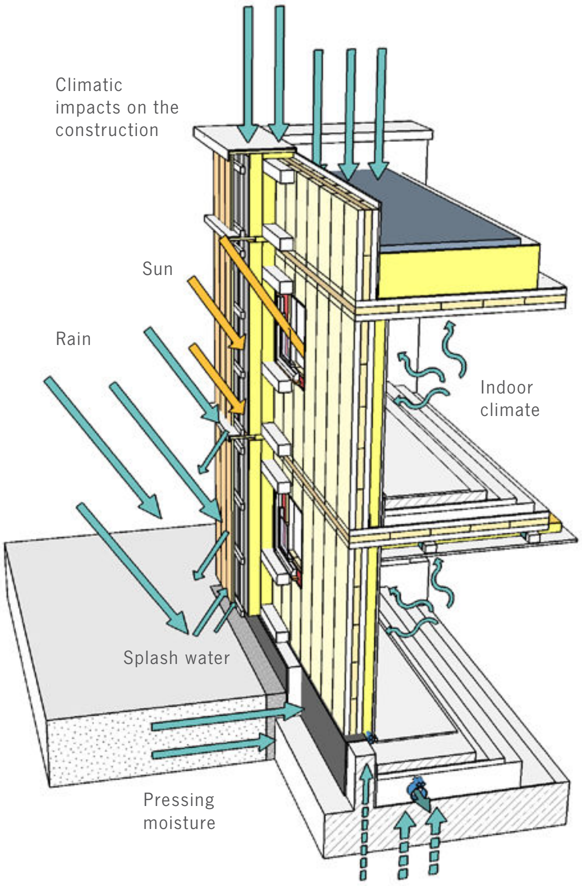
The information regarding service life must not be interpreted as a manufacturer's guarantee – it is intended solely as a guide for selecting the appropriate products in relation to the expected service life of the building.

STRUCTURAL WOOD PROTECTION

Priority should always be given to design-based (structural) wood protection. The advantages are clear: effectiveness throughout the entire service life (with minimal maintenance required), cost-efficiency, no use of environmentally harmful substances, and no special disposal requirements.

Design-based wood protection begins with the architectural design of the building. The three key areas of importance are: ROOF, FAÇADE and PLINTH. In particular, the roof and plinth areas offer a wide range of design options, but they can also be prone to errors if the fundamental construction requirements of timber are not properly considered. A durability risk assessment can help to identify key areas or certain care points, that need more attention. Proven solutions can be found in the KLH® construction brochures or specialised planning guides. Additional support is provided by relevant standards or research institutions specialising in timber construction (see bibliography).

FAÇADE SCHEME



SERVICE CLASS	AMBIENT CLIMATE		EQUILIBRIUM MOISTURE CONTENT OF MOST SOFT-WOODS	BUILDING OR STRUCTURAL TYPE
	TEMPERATURE	RELATIVE AIR HUMIDITY [a]		
1	20°C	≤ 65%	≤ 12%	Interior spaces of residential, educational, and administrative buildings
2	20°C	≤ 85%	≤ 20%	Interior spaces of utility buildings such as warehouses, riding arenas, and industrial halls, as well as sheltered structures not directly exposed to weather (rainfall angle ≥ 30°) [b]
3	-	> 85%	> 20%	Outdoor structures with design-based (constructive) wood protection

[a]The relative humidity in Service Classes 1 and 2 may exceed the specified values for a few weeks per year at most.
[b]In exceptional cases, sheltered components and components in enclosed spaces may also be classified as Service Class 3 (e.g, unheated ice rinks, halls containing moisture-laden goods).

Service Classes according to ÖNORM EN 1995-1-1 [7.2]

CHEMICAL WOOD PROTECTION AND COATINGS

Specific requirements may necessitate the use of chemical wood protection or coatings as supplementary measures. This includes applications such as

- Colour modification
- UV protection/protection against yellowing
- Temporary protection during construction
- Protection against moisture and fungal decay
- Insect protection
- Fire protection

For applications related to durability, the applicable wood preservative listings can be consulted. These specify the different Use Classes (UC 0 to 4) and the associated exposure risks.

The use of KLH® solid wood panels is generally limited to UC 0 and UC 1, which either do not require wood preservatives or only under certain regional conditions. Special applications in Use Class 2 (swimming pools, saunas, commercial kitchens, etc.) must be adapted to the relevant boundary conditions (controlled indoor climate, proper ventilation, and surface protection).

Application of white glazed surface

With coatings, surface quality also plays a crucial role in achieving the most uniform and consistent effect possible. During transport and on the construction site, additional measures are required to protect treated surfaces.

Rainwater absorption in unprotected end grain

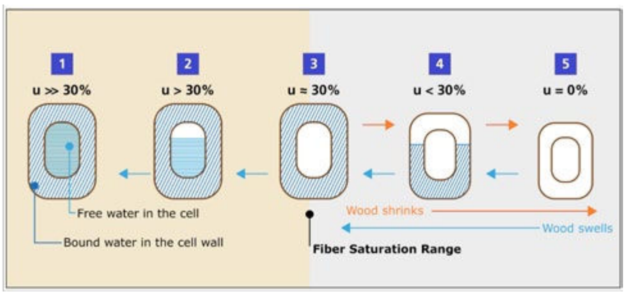
White glazed surface

02 MOISTURE PROTECTION

- Prevention of moisture damage caused by diffusion or unintended moisture accumulation in building components (poor ventilation, excessive construction moisture, etc.)
- Protection against external moisture (sealed building envelope, adequate protection of weather-exposed components, waterproofing of components near ground level)
- Smart building and sanitary systems (includes accessible pipe routing, inspection openings, and monitoring options)

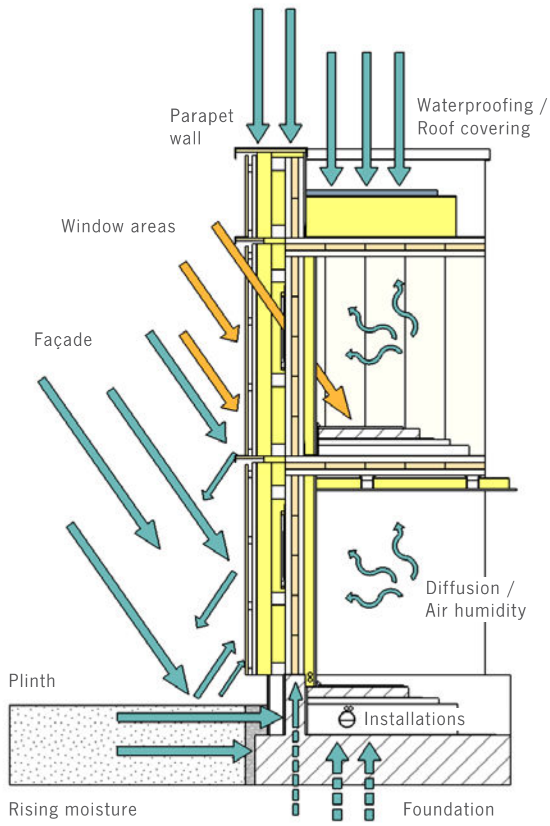
DIFFUSION

Both in U-value calculations and in the determination of the diffusion resistance, it is essential to account for the wood moisture content when dealing with timber. The material properties affected by this — thermal conductivity (λ) and water vapour diffusion resistance factor (μ) — are significantly influenced by the wood's moisture content.



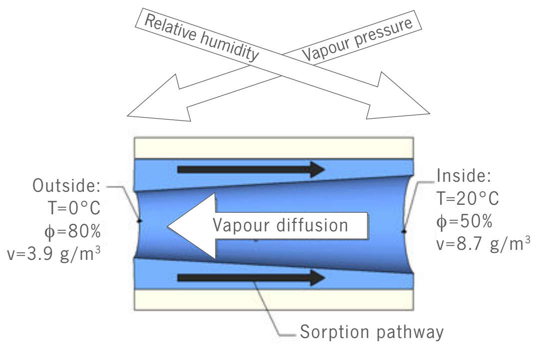
Schematic of a wood cell [7.3]

Wood behaves intelligently in this regard: as moisture levels rise, its water vapour diffusion resistance decreases, allowing absorbed moisture to be released back into the environment. During winter months, when indoor air humidity is low, the μ-value increases, which slows the transport of moisture into the building component. This effect, combined with wood's high capacity for moisture storage, directly benefits indoor comfort, as wood acts as a regulating layer for humidity within the building.



Effects on the façade

Diffusion is most relevant in cross-laminated timber (CLT) constructions within roof details. Thermal bridges can locally cause cooling in corner or connection areas, which may only dry out to a limited extent through the roof structure. Fasteners that penetrate the thermal insulation must either be thermally decoupled or assessed separately.



Moisture transport in wood [7.4]

EXTERNAL MOISTURE

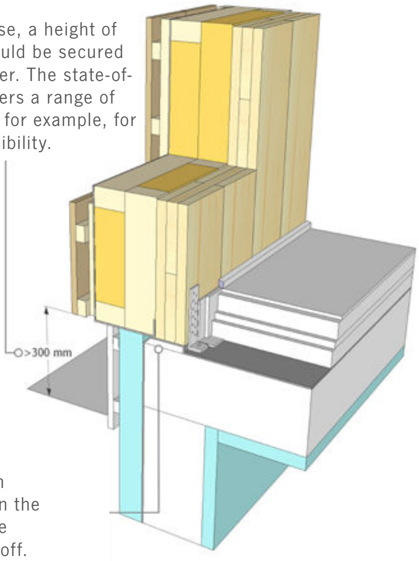
Wherever possible, external moisture should be managed through design-based wood protection (e.g., façade design); chemical wood protection and coatings may be used as a supplementary measure.

ROOF AREA

- Ensure robust rear-ventilated systems
- Check the waterproofing layers, include the vapour retarder or barrier as an emergency drainage layer
- Check connection details at edges and penetrations
- Verify drying potential (backward drying capability)
- Consider shading of critical areas (especially green roofs)
- Check for thermal bridges

PLINTH AREA

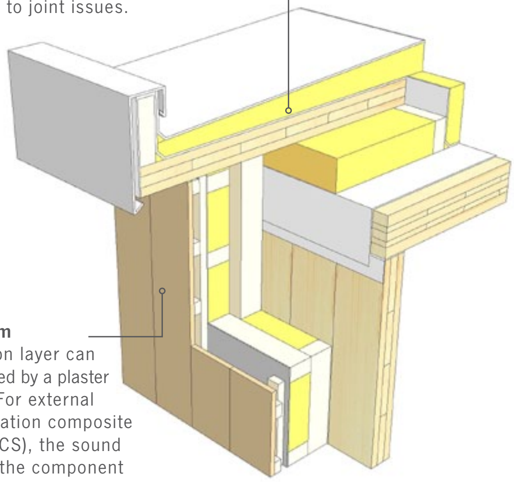
Splash water area
In the standard case, a height of at least 30 cm should be secured against splash water. The state-of-the-art product offers a range of adapted solutions, for example, for barrier-free accessibility.



Sealing layers
The transition from concrete to wood in the plinth area must be separated and set off.

FLAT ROOF WITH CANTILEVER

Roof overhang
A roof overhang should be separated from the rest of the construction due to its susceptibility to joint issues.



Façade system
The ventilation layer can also be replaced by a plaster base board. For external thermal insulation composite systems (ETICS), the sound insulation of the component must be considered.

The planning of the roof, façade, and base areas is of primary importance here, with the façade surface generally being the least critical and relevant mainly at transitions (e.g., balcony connections). The roof and base areas require a certain level of basic knowledge, careful consideration and should be guided by proven solutions.

PLINTH AREA

- Height
- Waterproofing
- Connection
- Offset/sill

For the connection details to the façade, the relevant standards and documentation provided by the component manufacturers must be consulted. If executed properly (in terms of materials, airtightness layers, overlaps, etc.), no further measures are required.

WET ROOMS AND INSTALLATIONS

For wet rooms and rooms with installations (water-carrying pipes), preventive measures must be taken to protect the wood structure. In typical use cases (residential or office use), moisture loads caused by elevated humidity should be regulated by the intended ventilation system (automatic or manual). For more demanding applications (such as swimming pools, saunas, or commercial kitchens), the components must be separately assessed and protected.

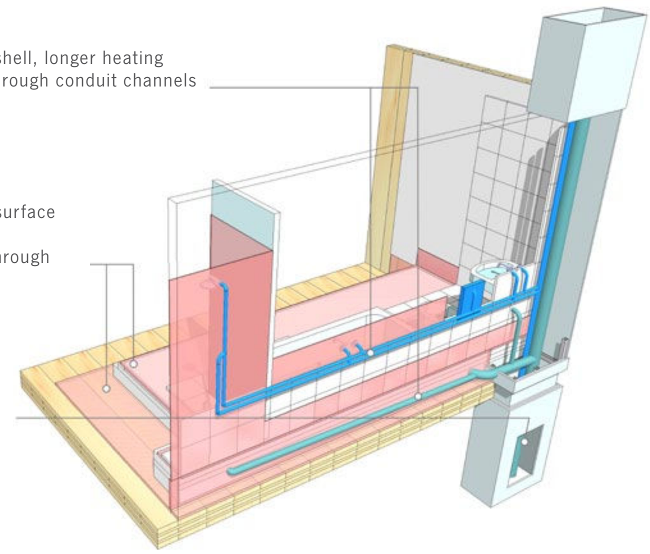
SEALING LAYERS

- A full-surface seal in accordance with standardised requirements (composite sealing, structural waterproofing) must always be applied in sanitary rooms.
- A second sealing layer with an all-around upstand (tub configuration) and a separate drainage point is recommended (weep hole).
- Unintentionally infiltrated moisture should be visibly drained off to protect the load-bearing timber structure.

Pipe routing
Mainly laid in the inner shell, longer heating pipes can be installed through conduit channels or on the ceiling.

Two sealing layers
1.Standard, behind the surface
2.On the KLH® floor, emergency drainage through shaft

Inspection possibility
Independent of the control by the user, external inspection can be carried out through the shaft access in the staircase.



PIPE ROUTING

- For pipe routing in the floor (without a second sealing layer), installation in conduit ducts or using a “pipe-in-pipe” system is recommended.
- Short, controllable pipe runs, as well as routing through walls and suspended ceilings, are preferable.

CONNECTIONS

- For connections and surface claddings, attention must be paid to permanently elastic joints and “compensation layers” for movement.
- Although the KLH® panel surface is very dimensionally stable due to the crosswise lamination, tiles and/or similar coverings should only be installed on the wooden surface with an appropriate compensation layer (to bridge movement).

MONITORING OPTIONS

- Passive monitoring, inspection openings at the critical and lowest points of the sealing layer, e.g. weep holes
- Simple, low cost, significantly increased operational safety and durability
- Active monitoring systems with moisture sensors are becoming increasingly common, with control via standard end devices (computer, smartphone)

03 THERMAL PROTECTION

Thermal protection is relevant throughout the entire year. There is a temperature range in which humans feel most comfortable, and this should be maintained indoors.

THE FUNDAMENTAL REQUIREMENTS FOR THE BUILDING ENVELOPE

- Low thermal conductivity
- Convection tightness

Depending on the type of thermal protection (winter or summer), additional boundary conditions play a decisive role.

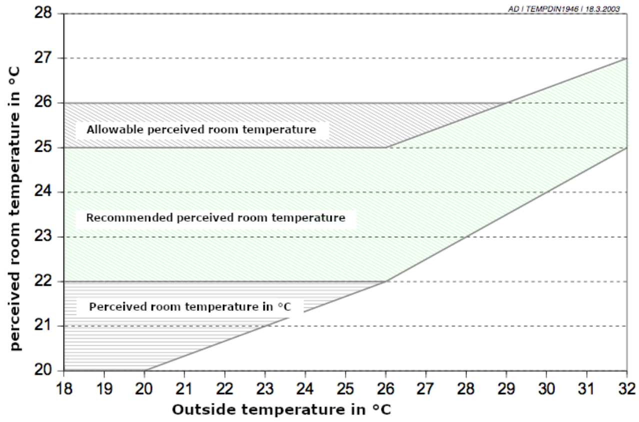
The relatively low thermal conductivity of spruce wood is standardised at 0.12 W/mK, although it can decrease to approximately 0.10 W/mK during the dry heating season.

WINTER THERMAL PROTECTION

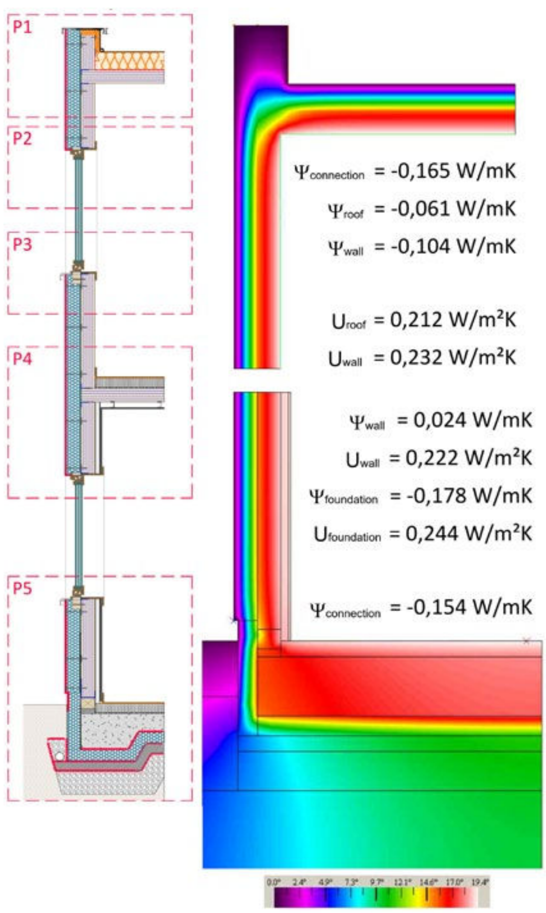
KEY INFLUENCING FACTORS

- Reduction of transmission losses (heat transfer through building components, heat escaping to the outside)
- Thermal energy from outside (solar energy through window surfaces)
- Supply of internal thermal energy (heating energy, household energy consumption)
- Convection losses, type of ventilation system

The primary parameter here is the so-called thermal transmittance, better known as the U-value.
The U-value is composed of the properties of the building component and its position within the building (the thermal transfer resistances $R_{s,inside}$ and $R_{s,outside}$ are variable).
The lower the U-value, the greater the resistance of the component to transferring heat to the colder area.



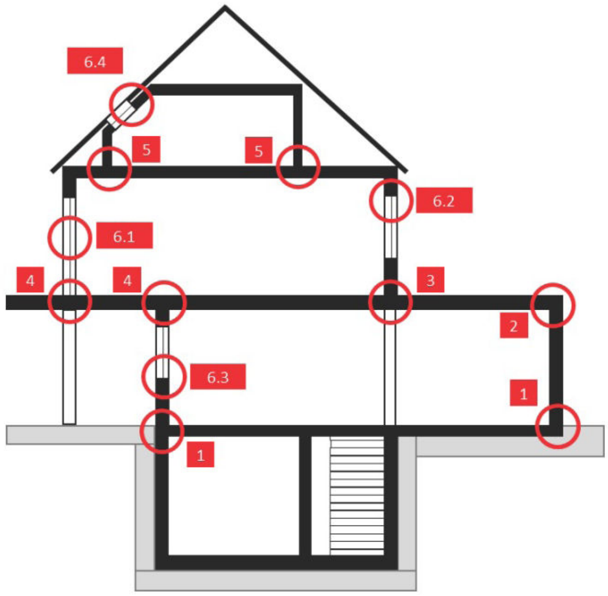
Recommended room air temperature as a function of the outside air [7.5]



Thermal bridges at passive house façades [7.6]

Example U-values for different construction assemblies can be found in the KLH® data sheets. For modified insulation thicknesses, the values can be calculated as shown in the following example. It should be noted that changing the insulation thickness not only affects the U-value, but can also impact sound insulation performance.

The influence of convection with respect to various building standards is explained in more detail in the chapter on airtightness.



Thermal bridges of the building envelope [7.7]

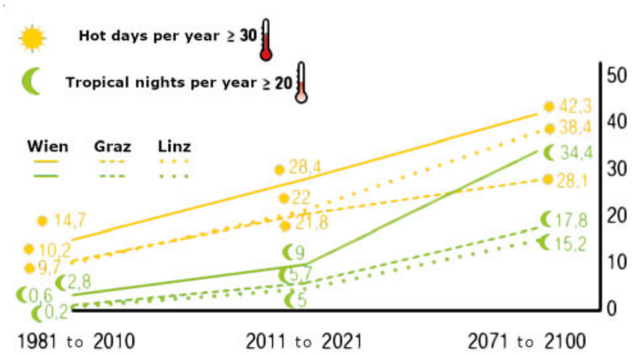
	d in [m]	λ in [w/(mk)]
KLH®	0.10	0.12
INSULATION	0.20	0.04

$$U = \frac{1}{R_{si} + \Sigma\left(\frac{d_i}{\lambda_i}\right) + R_{se}} = \frac{1}{0,13 + \left(\frac{0,1}{0,12} + \frac{0,2}{0,04}\right) + 0,04} = 0,167 \frac{W}{m^2K}$$

HWB in kWh/(m²·a)	Category		Heating oil equivalent in l/a
≤ 10	A++	Passive House	200–300[a]
≤ 15	A+	Low(er)-Energy House	400–700[a]
≤ 25	A		
≤ 50	B	Low-Energy House	1000–1500[a]
≤ 100	C	Target value according to building regulations 2008	1500–2500[a]
≤ 150	D	Old, non-renovated buildings	> 3000[a]
≤ 200	E		
≤ 250	F		
> 250	G		

Heating energy consumption [7.8]

Energy consumption which depends on thermal protection is expressed in kWh/(m²*a) and used to classify buildings into corresponding energy efficiency classes. In addition to passive characteristics, active building technologies (such as heat recovery systems, photovoltaic systems, etc.) can also be considered.



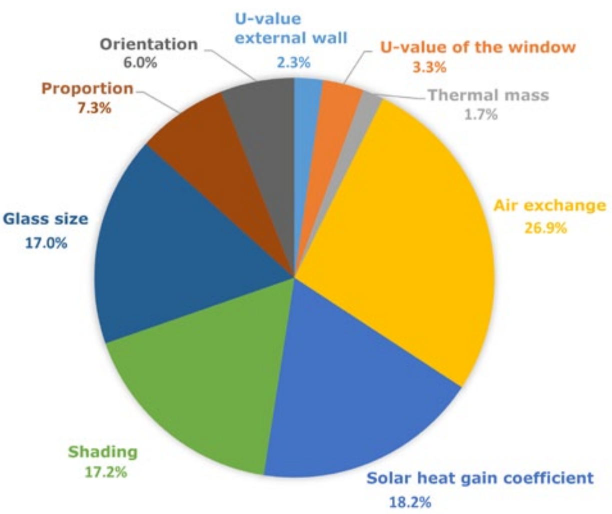
Increase in hot days and tropical nights [7.9]

Due to global changes in climatic conditions, the trend is moving toward higher temperatures. The number of days with extreme heatwaves is expected to increase, placing greater emphasis on summer thermal protection.

SUMMER THERMAL PROTECTION

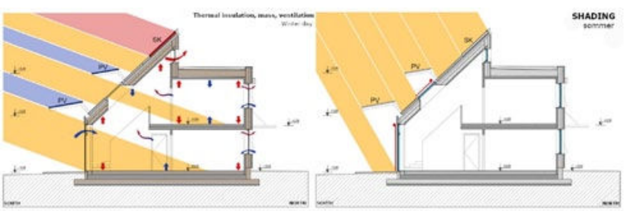
Summer thermal protection requires proper planning and a holistic consideration of the three key aspects:

- Loads
- Ventilation
- Construction type



Factors influencing summer overheating, avoidance of summer overheating [7.10]

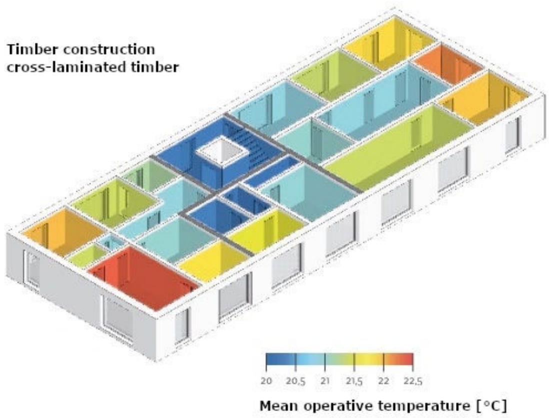
In the context of summer thermal protection, the term "loads" refers primarily to the penetration of solar energy through window surfaces, as well as internal heat sources. The share of heat transmission through insulated, opaque building components is relatively low, but should not be underestimated – especially in cases such as black flat roof membranes.

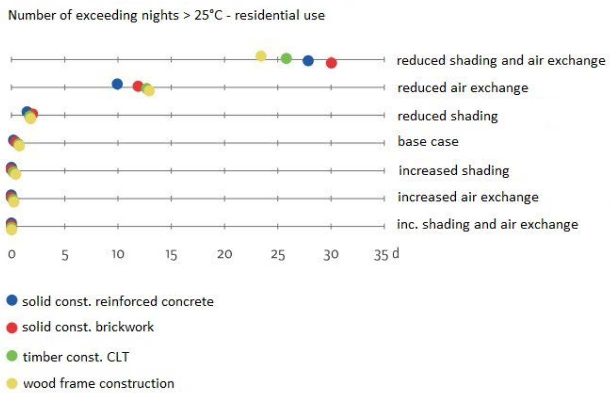


Solar active house, use of solar radiation [7.11]

Simulation example of a typical living space with southern orientation

Not explicitly mentioned here, but also worth noting, is the colour scheme of the building envelope. As already indicated with regard to flat roof membranes, dark surfaces have a higher radiation absorption. If we disregard the static factors already determined by architecture, usage, and component requirements, then it is primarily user-dependent aspects such as shading and air exchange that are decisive for summer comfort.





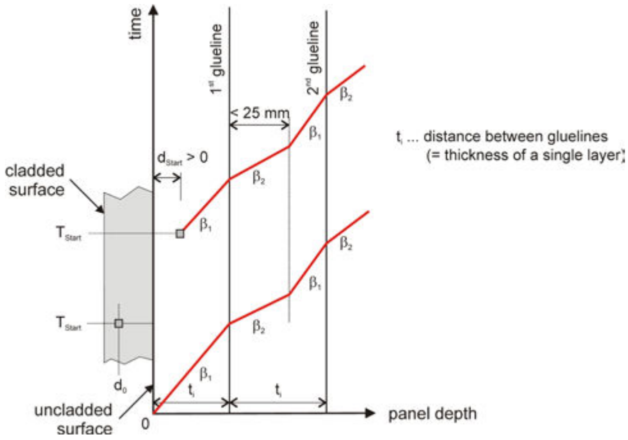
Simulation of indoor room temperature [7.12]

The goal of planning for summer thermal protection should be to create a pleasant indoor climate, which can be achieved through natural night-time ventilation (e.g., window ventilation or a structured ventilation concept). Cooling by means of technical systems with high energy consumption, on the other hand, does not represent a sustainable approach to design.

04 FIRE PROTECTION

Fire protection in timber construction is assessed according to the Eurocode based on the time-dependent charring process and the reduced properties of the wood. One of two methods must be applied:

- the "reduced cross-section method" (also known as the simplified or d_0 method), or
- the "reduced properties method" (a more precise approach, depending on the available data).



Burn-off behaviour with and without cladding, ETA-06/0138

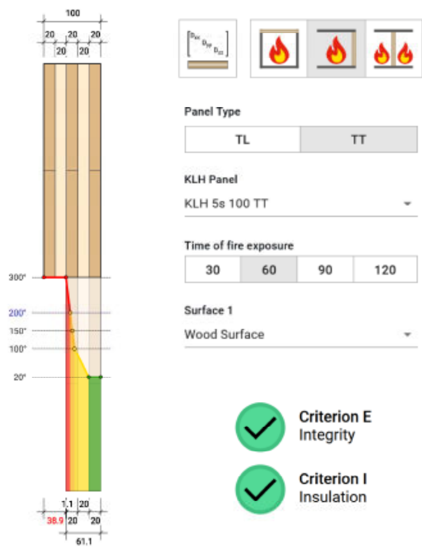
STRUCTURAL FIRE DESIGN WITH KLH®

PROPERTIES OF THE BASE MATERIAL	
KLH® solid wood element (spruce)	D-s2, d0
Reaction to fire (medium contribution)	D
Smoke production (visible smoke)	s2
Flaming droplets (none)	d0

KLH® offers a calculation tool called KLHdesigner, which determines precise values based on the ETA-06/0138. This tool provides information on the following properties:

RESIDUAL CROSS-SECTION IN VARIOUS FIRE SCENARIOS

- Fire duration
- Wall, one-sided fire exposure
- Wall, two-sided fire exposure
- Ceiling, fire exposure from below
- Various surface conditions (exposed, cladded, facing formwork)



KLHdesigner, cross-section in case of fire

RESIDUAL LOAD-BEARING CAPACITY IN THE EVENT OF FIRE

- Membrane action
- Plate action
- Basis for the KLH® design software in case of fire

Investigations on the fire behaviour of wall-ceiling connections [7.13]

MEETING THE E AND I CRITERION

More detailed information on the design principles using KLH® software can be found in the help files and in ETA-06/0138. For claddings, the relevant installation and processing guidelines must be observed.

STRUCTURAL FIRE PROTECTION

In addition, constructive measures (such as fire-separating building components, penetrations, and fire protection systems) as well as the provisions of current building codes and regulations must be observed. These fire protection measures are best referenced from relevant literature on fire safety in timber construction or obtained through a specialised technical consultancy.

Due to the region-specific requirements, there are no universally applicable concepts or solutions. Component-specific, tested or calculated fire protection serves as the basis for the required measures.

CONSTRUCTIVE DETAIL POINTS

(Openings/Shafts/Fire Stops)

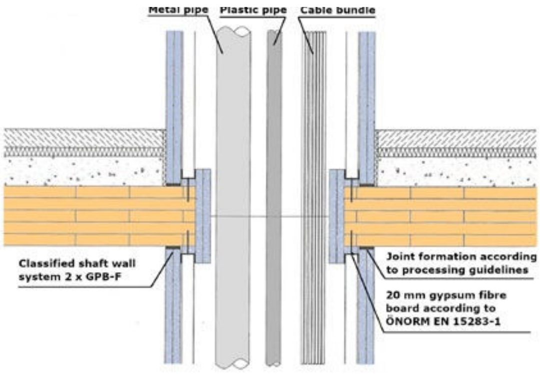
Constructive detail points must be sealed or protected according to the required fire resistance of the building component. This can be achieved using various claddings, insulation materials, shaft systems, or approved firestop systems.

JOINT DESIGN/SEALING

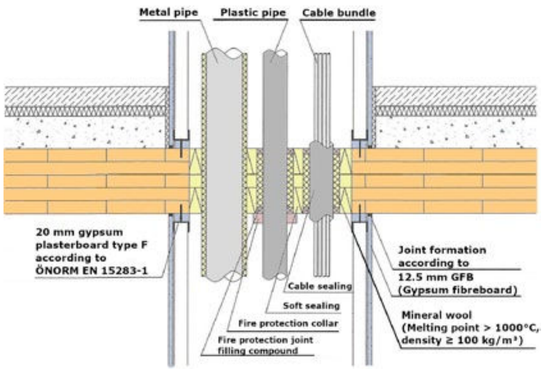
Joints between fire protection-relevant areas and building components must be sealed accordingly. This is achieved either by using fire-retardant materials, or the intended construction details already provide sufficient safety.

PROTECTION OF CONNECTION ELEMENTS

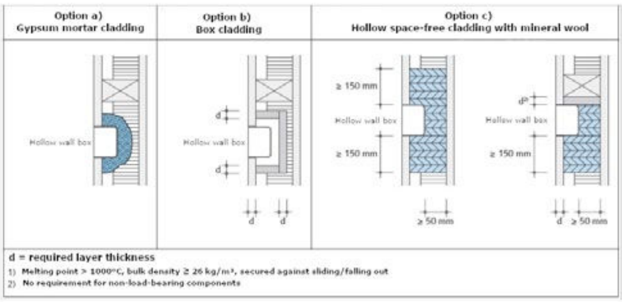
The relevant fasteners must either be located in a protected position for the required fire resistance duration, or be safeguarded by additional measures.



Shaft construction type A, fire stops for timber constructions [7.14]



Shaft construction type B, fire stops for timber constructions [7.14]



Encasing of hollow wall boxes [7.15]

For many detail points, system components (such as fire protection boxes or preformed blocks) already exist that meet the required fire protection standards.

Additional measures may include intumescent coatings or reactive fire-resistant materials.

05 SOUND INSULATION

KEY PARAMETERS IN SOUND INSULATION

The sound level (intensity of a sound source) and the sound insulation value of building components are expressed in decibels [dB]. This logarithmic scale measures changes in air pressure caused by sound waves and is added or subtracted energetically. Note for comparing values: An increase of 3 dB corresponds to the addition of a second sound source of equal intensity. An increase of 10 dB would represent a doubling of perceived loudness.

ADDITION AND SUBTRACTION OF SOUND LEVELS

Addition

$$L_{p,ges} = 10 \cdot \log \sum_{j=1}^{n} 10^{0,1 \cdot L_{p,j}}$$

Subtraction

$$L_{p,1} = 10 \cdot \log \left[10^{0,1 \cdot L_{p,ges}} - \sum_{i=2}^{n} 10^{0,1 \cdot L_{p,i}} \right]$$

An important aspect of sound insulation in buildings is the individual perception of the occupants. Standards and guidelines are based on average single-number ratings intended to cover a typical range of sound sources. However, personal expectations can differ significantly from these specifications.

AIRBORNE SOUND INSULATION

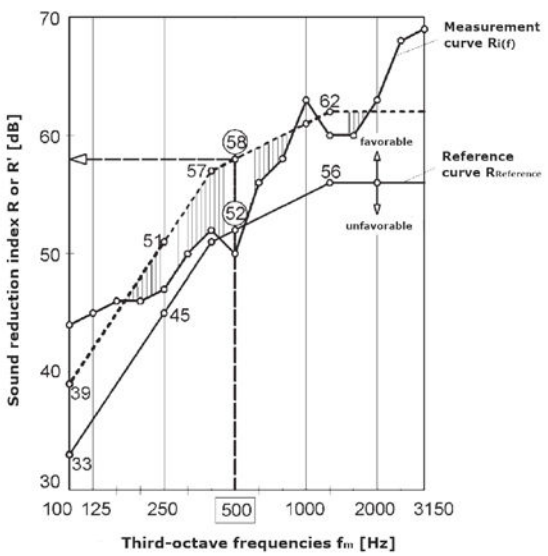
Airborne sound is generated by typical sources such as speech, music, or traffic noise. For building components, airborne sound insulation is generally expressed using the sound reduction index R_w. In the installed and combined condition, the standardised level difference $D_{nT,w}$ is used. This measurement also takes into account flanking transmission, openings, and room geometry.

	SOUND SOURCE	SOUND PRESSURE LEVEL L_p [dB]
1	Hearing threshold	0
2	Quiet rustling of leaves	15 to 20
3	Quiet residential area	30 to 40
4	Quiet conversation, quiet office	40 to 50
5	Normal conversation	50 to 60
6	Heavy road traffic	70 to 80
7	Shouting, screaming	80 to 85
8	Truck passing by	80 to 90
9	Printing works, pneumatic hammer at a distance of 10 m	90 to 100
10	Express train passing by	100 to 110
11	Boiler forge	110 to 120
12	Propeller plane at a distance of 3 m	120 to 130

Sound levels in our surroundings [7.16]

	EQUIVALENT CONTINUOUS SOUND LEVEL (LOWER LIMIT) [dB(A)]	EFFECT ON HUMANS
1	30 to 40	Sleep disorders
2	40 to 85	Communication disorders
3	45 to 85	Concentration disorders
4	45	Population reactions (20%)
5	60 to 85	Vegetative effects
6	65	Population reactions (30 to 70%)
7	85	Hearing impairment

Effects of noise [7.16]



Example for determining the airborne sound reduction index [7.16]

IMPACT SOUND INSULATION

Impact sound, also known as structure-borne sound, refers to noise generated by mechanical actions in adjacent units of use. It typically results from movement (walking, running) or from activities such as moving furniture, impact noise, or mechanical vibrations (e.g., fans, pumps). It is measured using the normalised impact sound level $L_{n,w}$ for individual components and the standard impact sound level $L_{nT,w}$ in the combined condition after installation.

GENERAL RULES FOR SOUND INSULATION

INTERSECTION WITH STRUCTURAL DESIGN

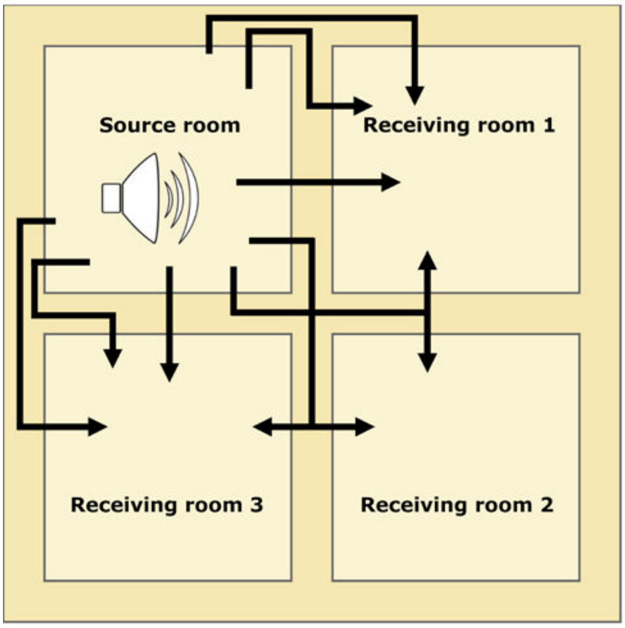
- Coordination with structural design is required.
- Structural solutions that are advantageous for statics (e.g., continuous ceilings and walls, rigid connections, a high number of load-bearing components) often have negative effects on sound insulation.
- A collaborative planning process is essential.

SEPARATION OF UTILISATION UNITS

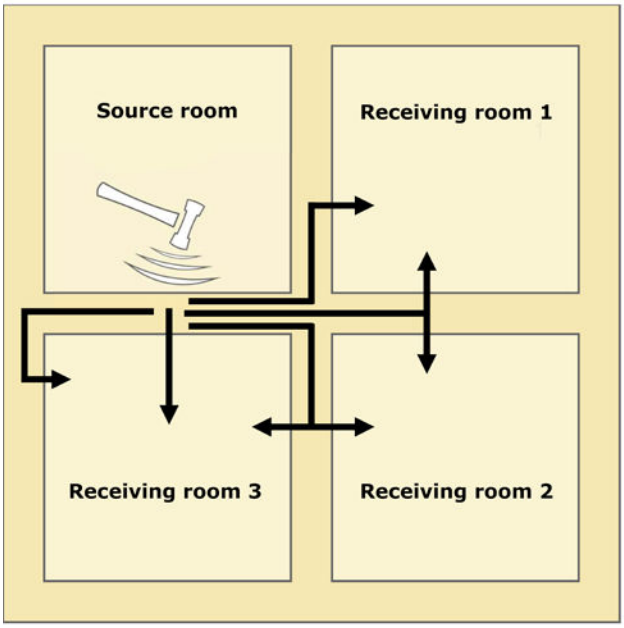
- Linked to structural design (connection elements)
- Effective separation of critical connection points
- Elastic support, separation joints, multi-layer construction

PLAN FOR SAFETY MARGINS

- Do not design to the minimum (guideline) requirements
- Inform yourself about enhanced sound insulation and varying performance levels
- PBe aware that predictions cannot account for all conditions
- Include safety margins for greater reliability and user satisfaction



Secondary sound paths of airborne sound transmission



Secondary sound paths of impact sound transmission

SOUND INSULATION IN SOLID TIMBER CONSTRUCTION

Solid yet lightweight – welcome advantages in structural design can lead to more extensive measures in sound insulation. A wide range of solutions for partition components already exists, using both heavy and lightweight variants. Massive component combinations require relatively few layers. Lightweight assemblies need a greater variety of layers and greater separation between them.

To achieve the desired acoustic performance in the installed state, secondary sound paths play a crucial role. Rigid, continuous junctions result in high transmission and often need to be compensated by increased mass. Separation cuts in the components can provide significant improvements, which can be further optimised using various separation strips and resilient layers.

Floor test facility KLH®

Mockup, sound insulation strips

Wall-floor connection

Spot measurement

COMPONENT VALUES

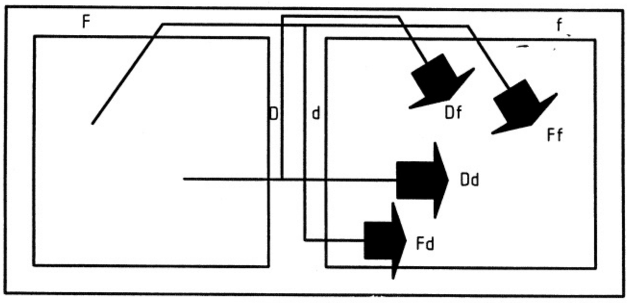
R_w	Rated Sound Reduction Index (represents the single-number value from laboratory measurement, as R'_w including flanking transmission)
$D_{nT,w}$	Rated Standard Level Difference (includes the dimensions and flanking elements of the room)
$L_{n,w}$	Rated Normalised Impact Sound Pressure Level (represents the single-number value from laboratory measurement, as $L'_{n,w}$ including flanking transmission)
$L'_{nT,w}$	Rated Standard Impact Sound Pressure Level (takes into account flanking paths and room geometry)

FLANKING/JOINT SOUND REDUCTION INDEX

$R_{i,j}$	Flanking Sound Reduction Index (indicates the level of insulation provided by the specific flanking condition)
$K_{i,j}$	Joint Sound Reduction Index (a key component of flanking insulation, describes the connection or joint primarily responsible for sound transmission)

The weakest value has the greatest influence. Due to the large number of possible combinations involving connectors, layer assemblies, and material properties, only previously tested combinations can be predicted with a high degree of certainty. Accordingly, less well-known combinations are assigned safety margins.

Currently, there are no simple standards for evaluating sound insulation in solid timber construction. However, relevant literature and consultation with specialised institutes and engineering offices are already available. Computer predictions are becoming increasingly reliable.



Identification of sound paths

$$R_{Ff,w} = \frac{R_{F,w} + R_{f,w}}{2} + \Delta R_{Ff,w} + K_{Ff} + 10 \lg \frac{S_s}{l_o l_f} \quad \text{dB}$$

$$R_{Fd,w} = \frac{R_{F,w} + R_{s,w}}{2} + \Delta R_{Fd,w} + K_{Fd} + 10 \lg \frac{S_s}{l_o l_f} \quad \text{dB}$$

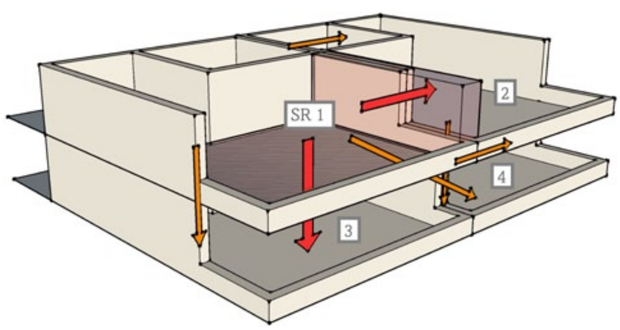
$$R_{Df,w} = \frac{R_{s,w} + R_{f,w}}{2} + \Delta R_{Df,w} + K_{Df} + 10 \lg \frac{S_s}{l_o l_f} \quad \text{dB}$$

Calculation of secondary sound paths

$$R'_w = -10 \lg \left[10^{-R_{Dd,w}/10} + \sum_{F=f=1}^{n} 10^{-R_{Ff,w}/10} + \sum_{f=1}^{n} 10^{-R_{Df,w}/10} + \sum_{F=1}^{n} 10^{-R_{Fd,w}/10} \right]$$

Summation of transmission paths

In addition to the direct transmission paths, it is important to pay enough attention to all other possibilities (flanks, shafts, external components, etc.).



Typical transmission paths to other units

06 AIRTIGHTNESS

KLH® 3s panels can be considered airtight components from a panel thickness of 60 mm. However, depending on the surface finish and connection quality, additional measures may be necessary to achieve the desired air exchange rate in the building.

To achieve a higher airtightness standard (e.g., low-energy building, passive house), appropriate sealing measures (such as joint taping or full-surface membranes) must be provided. The required airtightness of the building envelope to prevent moisture damage can, in many cases, also be achieved without these additional measures. However, for critical construction details, a building physics assessment should be carried out or tested standard details should be used.

In order to also cover the recommended airtight joint taping at various component connections, a sample element with different situations was tested.

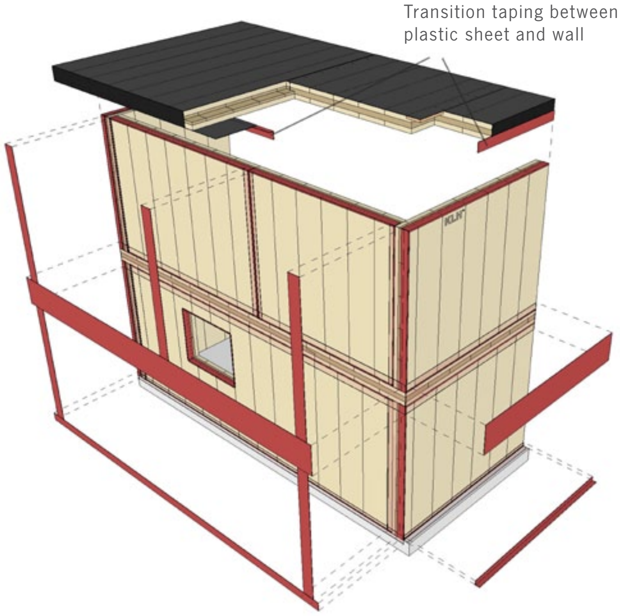
In the test result according to EN 12214, with a test pressure difference range of Δp 50 – 1000 Pa, the equivalent leakage area is the most illustrative parameter.

A_L = 1.484 mm²

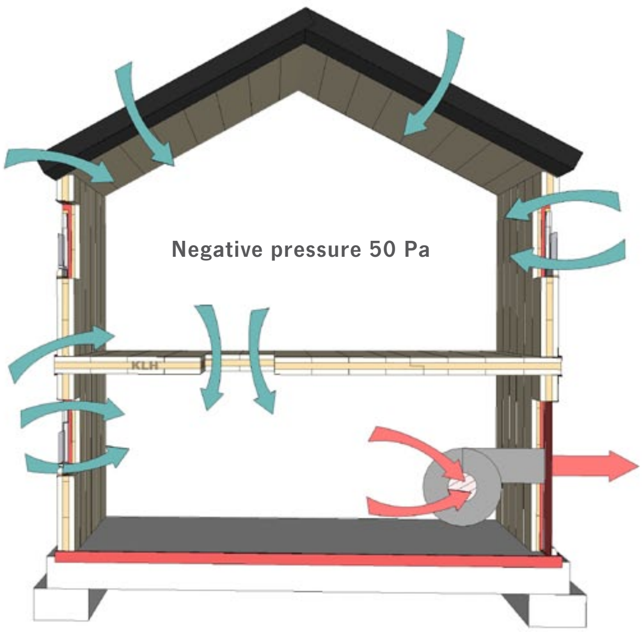
The equivalent leakage area (A_L) describes the area of an opening (e.g., a drilled hole) in an otherwise airtight reference body (e.g., a steel plate), through which the same air volume flow would occur at a pressure difference of Δp = 10 Pa as in the actual tested specimen.

The classification according to EN 12207 results in the best possible class for the test specimen:

Class 4 (lowest reference leakage, Q_{100} = 0.75 m³/hm)



Recommended design without airtight membrane



Principle of building envelope test

To establish a reference to common building measurements using the Blower Door Test and test results according to EN 13829, the air change rate n_{50} was derived from the results.

$$n_{50} = 0{,}02185 \times \frac{\text{Sum of the element surface areas}}{\text{Gross volume}} \quad [h^{-1}]$$

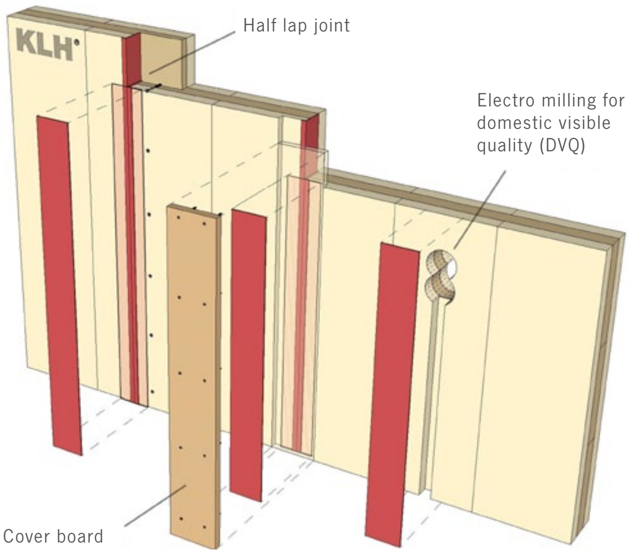
Test Report No.: B14.851.001.111 dated 25 July 2014

In addition to the air change rate and the associated airtightness class, airtightness also serves other important functions. In multi-unit residential buildings, the individual units must also be constructed airtight with respect to each other. The primary goal here is to prevent odour transmission and to ensure smoke-tightness. Major leaks also have a direct impact on sound insulation and can significantly reduce its effectiveness.

Leaks can also become an issue in relation to moisture. Unwanted convection can be especially problematic if it leads to slow condensation within building components. This includes areas such as wall-to-roof transitions, penetrations in the building envelope, and lintel zones. An increased air change rate does not necessarily cause structural damage, but it will result in a higher heating energy demand.

For sensitive projects, verifying the air change rate through building testing is recommended.

SCHEMATIC CONNECTION



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ADDITIONAL LITERATURE AND RESOURCES

01 WOOD AND KLH®

KLH® Brochures

https://www.klh.at/en/booklets/
https://www.klh.at/en/approvals-certificates/

Tested and Calculated KLH® Building Components
https://www.klh.at/en/tool-center/

Certified Timber Construction Components and Connections
https://www.dataholz.eu/en/index.htm

KLH® Detail Catalogue, 2019
https://www.klh.at/wp-content/uploads/2020/07/cad-details-2020-09-08-en.pdf

Cross-Laminated Timber (CLT) Information Sheet
https://informationsdienst-holz.de/publikationen/brettsperrholz-merkblatt

Publications on Timber Construction
https://informationsdienst-holz.de/publikationen

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https://informationsdienst-holz.de/publikationen/2-informationsdienst-holz-holzbau-handbuch/reihe-5-holzschutz/holzschutz-bauliche-massnahmen

Strategies for System-Compatible Installation of Building Services in Solid Timber Construction, 2014
https://repository.tugraz.at/publications/p9nnc-9jr78

Guideline for Plinth Connections in Timber Construction
https://www.holzforschung.at/en/knowledge-transfer/shop-downloads/

Moisture Management – Weather Protection During the Construction Phase
https://informationsdienst-holz.de/publikationen/feuchtemanagement-witterungsschutz-in-der-bauphase

Flat Roofs in Timber Construction
https://informationsdienst-holz.de/publikationen/2-informationsdienst-holz-holzbau-handbuch/reihe-3-bauphysik/flachdaecher-in-holzbauweise

Drying After Water Damage in Timber Construction
https://www.holzforschung.at/en/knowledge-transfer/shop-downloads/

Guideline – Restoration of Timber Structures Damaged by Flooding
https://www.holzforschung.at/en/knowledge-transfer/shop-downloads/

03 THERMAL PROTECTION

KLH® Components – Verified and Calculated with Ubakus (https://www.ubakus.de)
https://www.klh.at/en/tool-center/

Thermal Bridges
https://informationsdienst-holz.de/publikationen/2-informationsdienst-holz-holzbau-handbuch/reihe-3-bauphysik/waermebruecken

04 FIRE PROTECTION

Fire Protection Concepts for Multi-Story Buildings and Attic Extensions
https://informationsdienst-holz.de/publikationen/2-informationsdienst-holz-holzbau-handbuch/reihe-3-bauphysik/brandschutzkonzepte

Guideline Details for Component Connections in Building Classes 4 and 5
https://informationsdienst-holz.de/publikationen/leitdetails-fuer-bauteilanschluesse-gebaeudeklasse-4-und-5

Restoration After Fire Damage in Timber Construction
https://www.holzforschung.at/en/knowledge-transfer/shop-downloads/

05 SOUND INSULATION

Sound Insulation in Timber Construction – Basics and Preliminary Measurements
https://informationsdienst-holz.de/publikationen/2-informationsdienst-holz-holzbau-handbuch/reihe-3-bauphysik/schallschutz-im-holzbau

Tested and Calculated KLH® Components
https://www.klh.at/en/tool-center/

Certified Timber Construction Components and Joint Systems
https://www.dataholz.eu/en/index.htm

06 AIRTIGHTNESS

Wood Protection – Structural Measures
https://informationsdienst-holz.de/publikationen/2-informationsdienst-holz-holzbau-handbuch/reihe-5-holzschutz/holzschutz-bauliche-massnahmen

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