CLT by Stora Enso

Building physics

THE RENEWABLE MATERIALS COMPANY

storaenso

Stora Enso Wood Products

Building Solutions

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Table of contents

Thermal protection **4**
- U-value of a CLT panel 6
- U-value of an insulated CLT panel 8
- U-value comparisons 10

Airtightness **14**
- Introduction 16
- Relevance of airtightness and windtightness 16
- Benefits of CLT regarding airtightness 18
- Technical aspects of airtightness 18
- Configurations and specific connections 18
- Summary 29
- References 29

Moisture **30**
- Introduction 32
- Reasons for moisture protection 33
- Diffusion 33
- Diffusion resistance factor and s d value 33
- Holzforschung Austria's expert opinion 34
- Significance of moisture and diffusion for CLT 36
- Sources 36

Component designs **38**
- External walls 40
- Internal walls 98
- Partition walls 120
- Floor slabs 154
- Roofs 166

1 Thermal protection

Thermal protection

U-value of a CLT panel **6**
U-value of an insulated CLT panel **8**
U-value comparisons **10**
Examples of the heat transfer coefficient of various wall systems 10

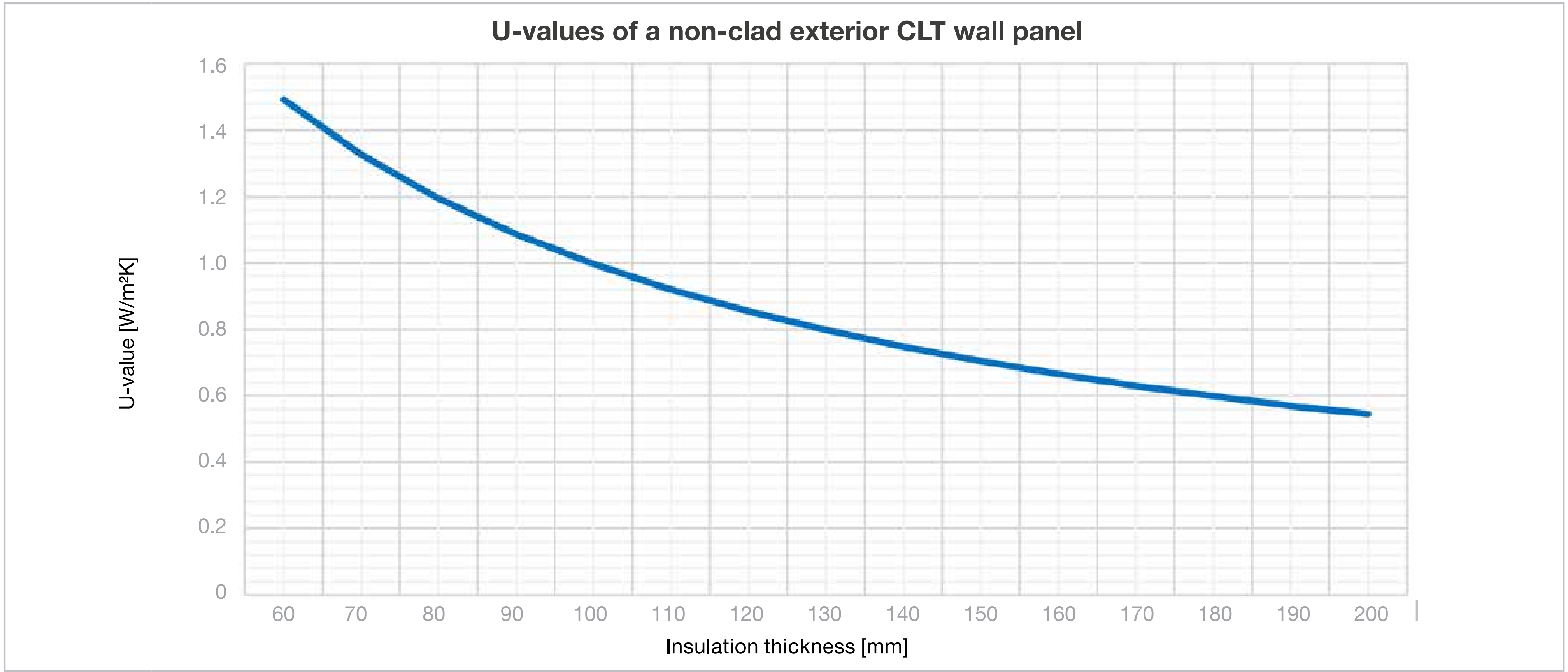
Thermal protection

The thermal performance of a component is determined by its U-value (thermal transmittance). The structure and orientation of the element, as well as the thermal conductivity λ of the materials contained must be known to calculate this value. The thermal conductivity of CLT is essentially determined by the bulk density and moisture content. According to the standard EN ISO 10456, the thermal conductivity λ of CLT is 0.12 W/mK.

U-value of a CLT panel

An external CLT wall panel with a thickness of 100 mm is used in the following example to demonstrate how to calculate the U-value. The calculation is taking the internal and external heat transfer coefficients into account.

Thermal transmittance	$U = \frac{1}{R_{si} + \sum \frac{d_i}{\lambda_i} + R_{se}}$
Heat transfer resistance	$R_{si} = 0.13 m^2K/W$ $R_{se} = 0.04 m^2K/W$
Thermal conductivity of CLT	$\lambda_{CLT} = 0.12 W/mK$
Thermal transmittance	$U_{CLT,100} = \frac{1}{0.13 m^2K/W + \frac{0.1 m}{0.12 W/mK} + 0.04 m^2K/W} = 0.997 W/m^2K$

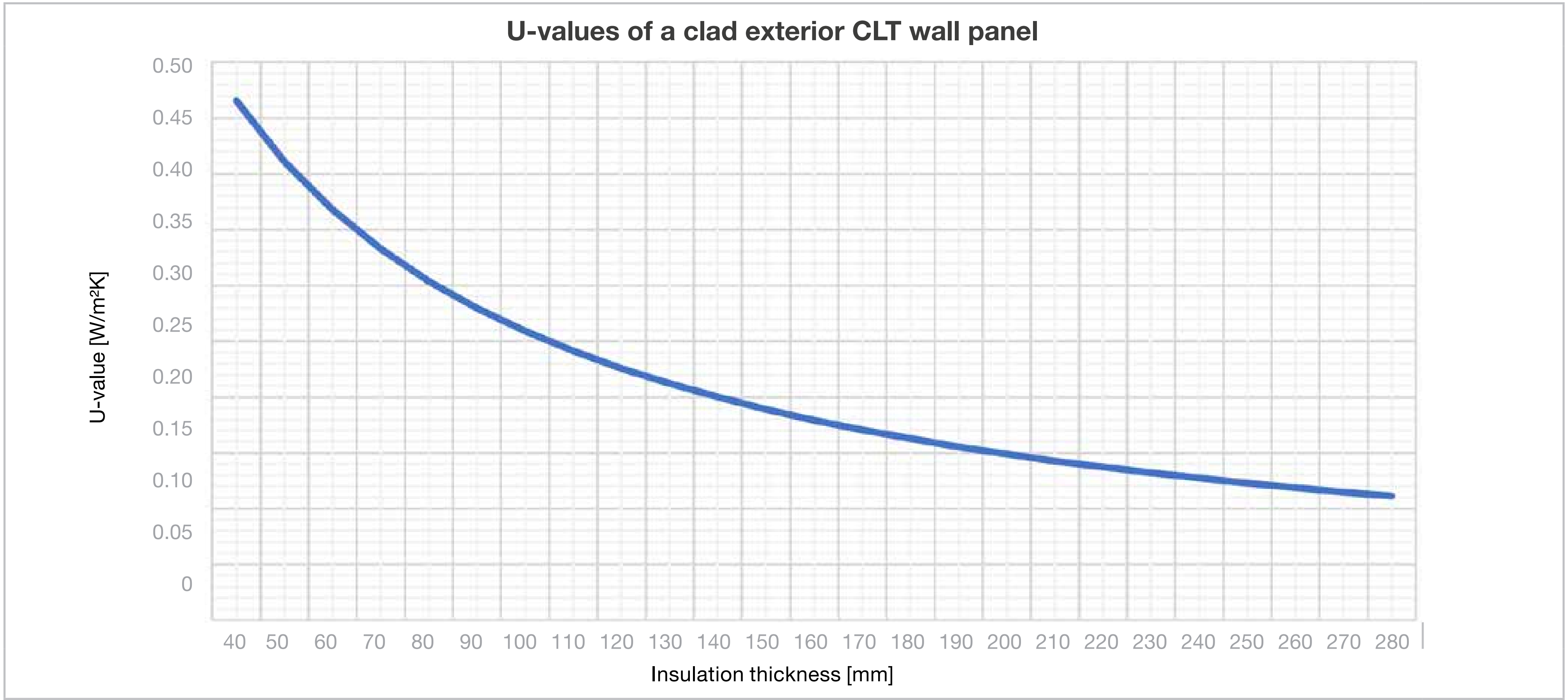

U-values of a non-clad exterior CLT wall panel
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
U-value [W/m²K]
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Insulation thickness [mm]

Thermal protection

U-value of an insulated CLT panel

The U-value of a 100 mm thick CLT panel combined with 160 mm mineral wool with thermal conductivity 0.035, is calculated as follows:

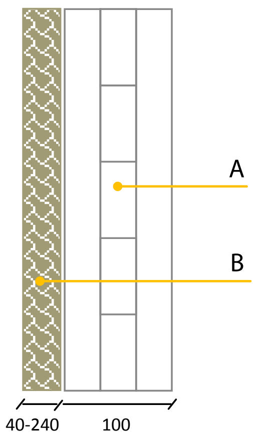
Thermal transmittance	$U = \frac{1}{R_{si} + \sum \frac{d_i}{\lambda_i} + R_{se}}$
Heat transfer resistance	$R_{si} = 0.13 m^2K/W$ $R_{se} = 0.04 m^2K/W$
Thermal conductivity of CLT	$\lambda_{CLT} = 0.12 W/mK$
Thermal conductivity of insulation	$\lambda_{insulation} = 0.035 W/mK$
Thermal transmittance	$U_{CLT,100} = \frac{1}{0.13 m^2K/W + \frac{0.1m}{0.12 W/mK} + \frac{0.16m}{0.035 W/mK} + 0.04 m^2K/W} = 0.179 W/m^2K$


U-values of a clad exterior CLT wall panel
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
U-value [W/m²K]
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280
Insulation thickness [mm]

U-value comparisons

1. Examples of the heat transfer coefficient of various wall systems

CLT by Stora Enso Example 1 — CLT 100 3s with mineral wool insulation				Estimated heat transfer values: R_{si} = 0.13 m²K/W | R_{se} = 0.04 m²K/W		
	Thickness [mm]	Material [–]	λ [W/(mK)]	Insulation thickness [mm]	Total thickness [mm]	U-value [W/m²K]
A	100	CLT by Stora Enso	0.12	–	–	–
B	40–240	mineral wool	0.035	40	140	0.47
			0.035	60	160	0.37
			0.035	80	180	0.30
			0.035	100	200	0.26
			0.035	120	220	0.23
			0.035	140	240	0.20
			0.035	160	260	0.18
			0.035	180	280	0.16
			0.035	200	300	0.15
			0.035	220	320	0.14
	exterior	interior	0.035	240	340	0.13



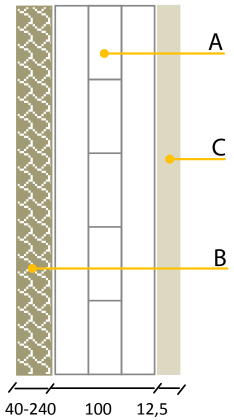
CLT by Stora Enso

Example 2 — CLT 100 3s with mineral wool insulation and plasterboard (12.5 mm)

Estimated heat transfer values:

R_{si} = 0.13 m²K/W | R_{se} = 0.04 m²K/W

	Thickness [mm]	Material [–]	λ [W/(mK)]	Insulation thickness [mm]	Total thickness [mm]	U-value [W/m²K]
A	100	CLT by Stora Enso	0.12	–	–	–
B	40–240	mineral wool	0.035	40	153	0.45
C	12.5	plasterboard	0.21	–	–	–
			0.035	60	173	0.36
			0.035	80	193	0.30
			0.035	100	213	0.26
			0.035	120	233	0.22
			0.035	140	253	0.20
			0.035	160	273	0.18
			0.035	180	293	0.16
			0.035	200	313	0.15
			0.035	220	333	0.14
	exterior	**interior**	0.035	240	353	0.13



Thermal protection

Timber frame

Example 3 — Plasterboard, OSB, mineral wool, battens and DHF board

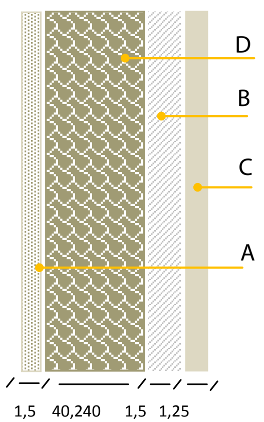
Estimated heat transfer values:

R_{si} = 0.13 m²K/W | R_{se} = 0.04 m²K/W

Solid wood battens calculated with:

b = 50 mm | e = 625 mm
λ = 0.13 W/mK

	Thickness [mm]	Material [–]	λ [W/(mK)]	Insulation thickness [mm]	Total thickness [mm]	U-value [W/m²K]
A	15	DHF board	0.1	–	–	–
B	15	OSB board	0.13	–	–	–
C	12.5	plasterboard	0.21	–	–	–
D	40–240	wooden battens with mineral wool in cavities	0.043	40	83	0.70
			0.043	60	103	0.53
			0.043	80	123	0.42
			0.043	100	143	0.35
			0.043	120	163	0.30
			0.043	140	183	0.27
			0.043	160	203	0.24
			0.043	180	223	0.21
			0.043	200	243	0.19
			0.043	220	263	0.18
	exterior	**interior**	0.043	240	283	0.16



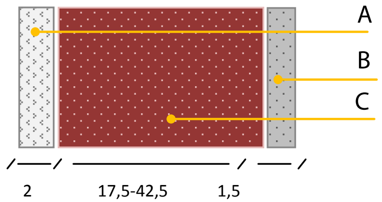
Brick and plaster

Example 4 — Plastering mortar, clay block and lime plaster

Estimated heat transfer values:

$R_{si} = 0.13\ m^2K/W$ | $R_{se} = 0.04\ m^2K/W$

Values were taken from the “PROTON 2011 product range” brochure (Wienerberger) and relate to the “PROTON flat clay block” product group.

	Thickness [mm]	Material [–]	λ [W/(mK)]	Insulation thickness [mm]	Total thickness [mm]	U-value [W/m²K]
A	20	lightweight plastering mortar	0.31	–	–	–
B	15	lime plaster	0.7	–	–	–
C	175–425	flat clay block	0.16	175	210	0.74
			0.12	240	275	0.44
			0.1	300	335	0.31
			0.09	365	400	0.23
	exterior	interior	0.09	425	460	0.20

2 Airtightness

Airtightness

Introduction **16**
Relevance of airtightness and windtightness **16**
Airtightness 16
Windtightness 17
Benefits of CLT regarding airtightness **18**
Technical aspects of airtightness **18**
Configurations and specific connections **18**
Summary **29**
References **29**

Airtightness

Introduction

The airtightness and windtightness of the building envelope and of individual building components (wall, floor and roof panels) is an essential requirement which has an impact on many aspects of the indoor climate, noise load, freedom from structural defect, indoor atmosphere and energy balance of buildings.

Together, the airtight layer (generally on the inside of the room) and the wind-tight layer (on the outside of the building) prevent an inadmissible flow of air through the structure. These layers are critical to the quality and durability of the building structure [1].

CLT's tried and tested panel design results in an airtight layer. An additional airtight membrane on the inside of the room is not generally required. This has a positive effect on the associated costs, helps avoid errors and construction defects, and reduces construction times and installation phases.

With other timber construction methods (e.g. timber frame building), an airtight layer (at the same time also a vapour barrier in the form of a membrane or butt-bonded OSB boards) must also be provided.

Relevance of airtightness and windtightness

1. Airtightness

Airtightness has an impact on the heat and humidity balance of a structure. The term "airtightness" refers to the prevention of convective flows, i.e. the penetration of structural components by air moving from inside to outside.

Inadequate airtightness can mean that air flows through the structure from inside to outside. The possible consequences [1] are:

- deposition of condensation in the structure
- reduced thermal protection
- low surface temperature

The associated hazards are:

- damage to the structure
- mould formation
- draughts (as a result of cooling of the indoor surface temperature)
- increased energy demand

The airtightness of Stora Enso's CLT has been tested by the Holzforschung Austria in 2012 and Technical University of Graz (Laboratory for building physics) in 2013 and 2014.

This airtightness test on CLT was carried out based on ÖNORM EN 12114:2000 [2] and covered the panel itself, a stepped rebate and a panel joint with a jointing board.

OUTCOME

"The panel joints and the CLT panel itself exhibit a high level of airtightness. The volumetric flow rates through the two joint variants and through the undisturbed surface lay outside the measurable range as a result of the high level of impermeability" [3] [8] [9].

Throughout its service life, CLT is exposed to different moisture conditions. Depending on the surface quality, it is produced with a relative timber moisture content of approx. 10 to 12%.

During the construction phase, due to the hygroscopic nature of wood, it absorbs building moisture, for instance, from bonded gravel fill, screed or plaster, thereby increasing its relative timber moisture content. The service life is also characterized by seasonal fluctuations in timber moisture content. Domestic ventilation can also dry out CLT during the winter months.

These fluctuations in CLT's timber moisture content are connected to changes in the shape of the wood (swelling or shrinkage), which, in extreme cases, can be manifested through cracks in the surface (too dry) or through an undulating surface (too damp).

To investigate the possible influence of these structural component loads on air permeability, changes in moisture content were simulated in the laboratory, and the air permeability of a CLT element was tested with varying levels of moisture content. The aim of the air permeability tests was to simulate CLT's long-term behaviour with respect to air permeability.

2. Windtightness

The windtightness of a building envelope is just as relevant as its airtightness. Inadequate windtightness can result in similar phenomena to those occurring with inadequate airtightness. One of the reasons for this is the cooling of the insulating layer.

The wind-tight layer on the outside of the building prevents outside air from penetrating the building components. The insulating layer is therefore protected, and the building components' insulating properties are not impaired [1].

The relevance of windtightness is shown by means of the following illustrations (taken from [1]).

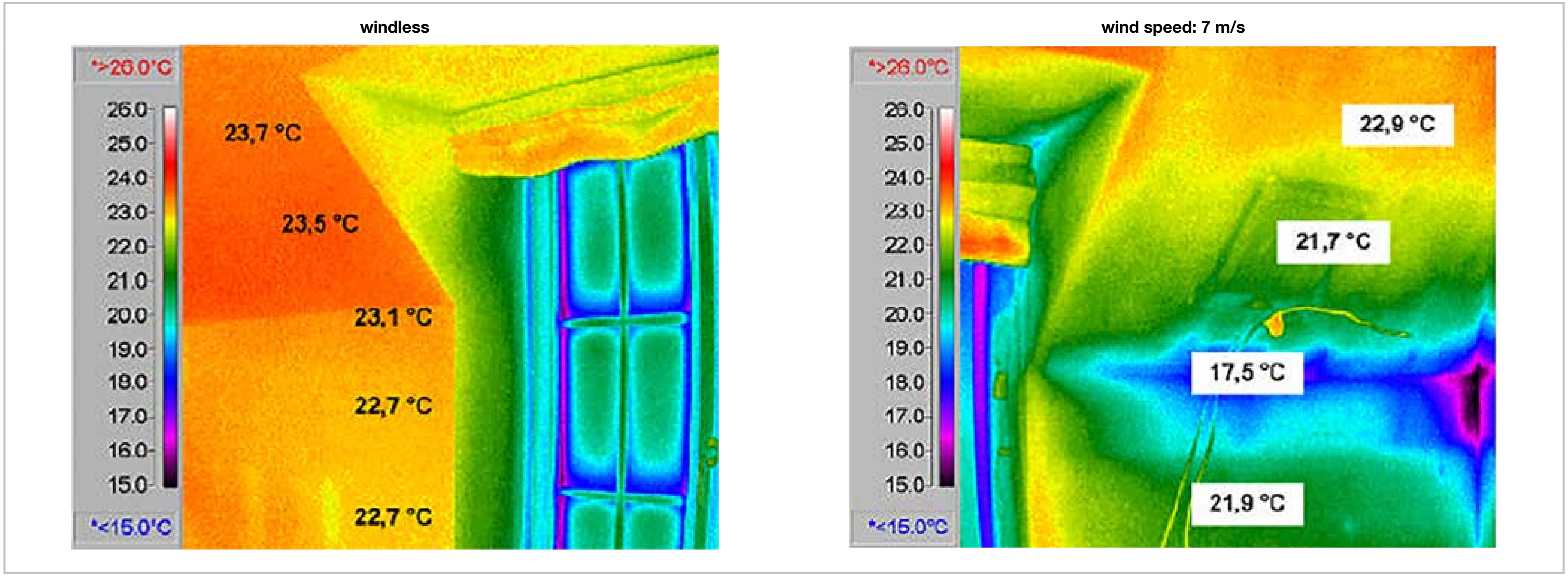


Illustration 1 – Thermographic images of a wall and roof connection at +3 °C outdoor temperature and +24 °C indoor temperature (taken from [1])

Airtightness

Benefits of CLT regarding airtightness

Large-format panels (up to 2.95 m × 16 m), therefore few building-component joints and thus fewer joints to be sealed. As a rule, no additional membranes are required on the inside of the room. Simple, reliable joint or butt joint sealing by means of compressible preformed gasket is possible.

Technical aspects of airtightness

The air change rate (n_{50} value) is used to measure a building's airtightness.

NOTE	
Air change rate	The air change rate n (unit: 1/h) is used to describe ventilation. It indicates how often a room's air volume is changed per hour.
n_{50} value	The n_{50} value is the air change which occurs if 50 Pa (pascals) under or over pressure are generated in the building.

If all CLT connections (corner joints, side joints, windows, etc.) are carried out properly, n_{50} values corresponding to the passive house standard (n_{50} = 0.6 1/h) can be achieved. ÖNORM B 8110-1:2008 [4] specifies permissible air change rates. Depending on the building type, a distinction is drawn between buildings without ventilation systems (n_{50} = 3 1/h), buildings with ventilation systems (n_{50} = 1.5 1/h) and passive houses (n_{50} = 0.6 1/h) [4]. "Ventilation systems" refers to monitored ventilation systems for living spaces.

Compliance with these n_{50} values is vital for the function of the respective building envelopes.

The air change rate is measured and evaluated using the blower door test. This blower door test is recommended to the end customer by Stora Enso to enable the quality and construction of a building to be evaluated.

In addition to the issue of airtightness, the subject of vapour diffusion behavior will also be examined briefly here: CLT is an excellent material for wall structures which are membrane-free and which allow diffusion.

When no membrane is fitted, it is important to bear in mind that the vapour diffusibility of the individual layers (insulation, plaster, etc.) increases towards the outside (as a rule of thumb: the outer layer should exhibit up to ten times greater vapour diffusibility). This enables condensation to be avoided in wall, floor and roof structures.

Diffusion behavior is expressed by means of the vapour diffusion resistance factor (μ) and the air layer thickness (s_d value) equivalent of diffusion.

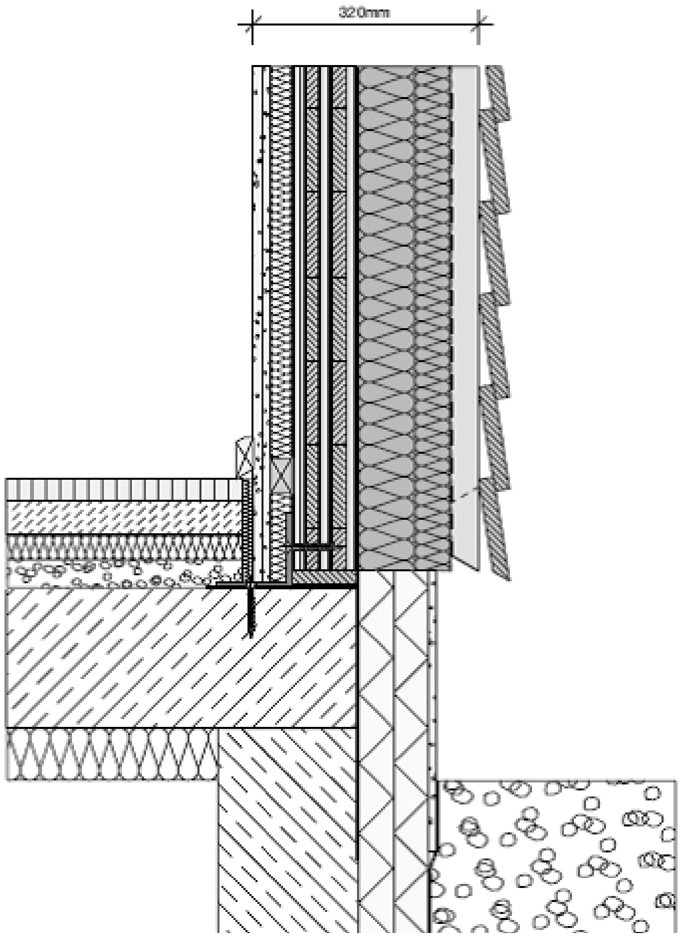
If the airtightness is inadequate, substantially higher levels of condensation can occur in the building components as a result of moist air flows through walls, floors and roofs than via condensation accumulating purely as a result of diffusion.

Configurations and specific connections

Compressed preformed gasket is mainly used to ensure an airtight seal at the connections of building components. Permanently flexible joint foams can also be used in some places. Self-adhesive tapes and tubular rubber seals are used more rarely (see item 4.g).

The configurations illustrated below show a few options for airtightness, though it should be noted that these are merely a few options among countless possible configurations [5] [6].

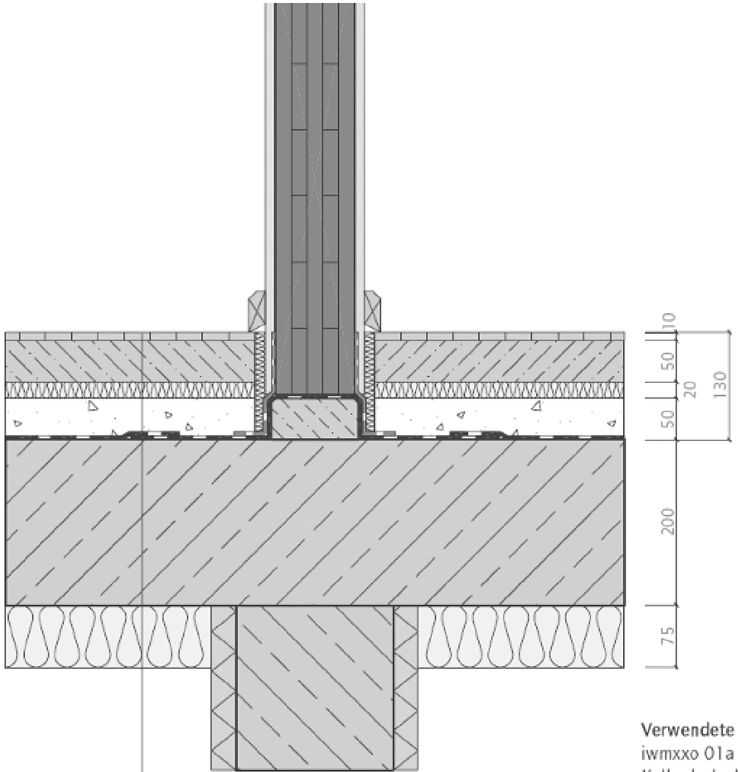
Plinth connection I



Connection of wall to cellar roof or concrete slab:

In addition to airtightness, moisture protection is another important factor in the plinth area.

Plinth connection II



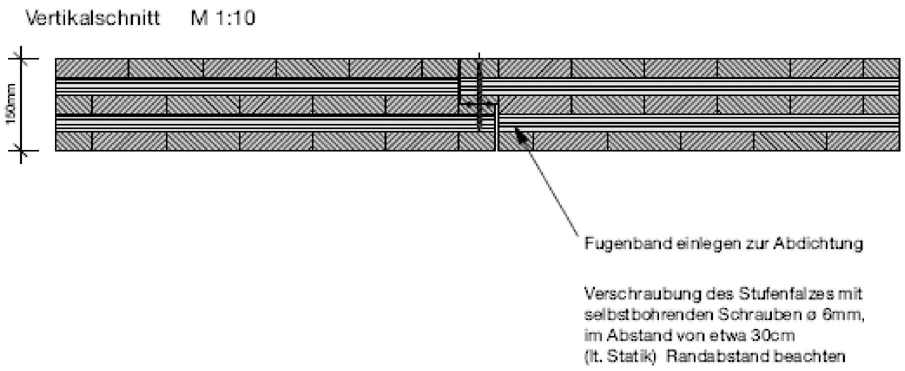
10	Bodenbelag Parkett
50	Zementestrich
	Trennlage lt. ÖN B 2232
20	Trittschalldämmung MW-T (s'< 30 MN/m)
50	Schüttung gebunden
	Feuchtigkeitsabdichtung
200	Stahlbetondecke
75	Wärmedämmung (R>2,1 m K/W)

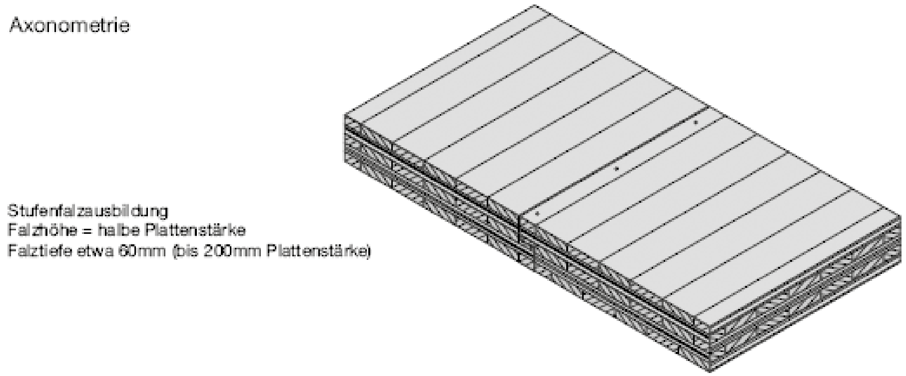
Verwendete Bauteile
iwmxxo 01a (tragend),
Kellerdecke laut Abbildung

Connection of internal wall to cellar roof or concrete slab:

In this configuration the same criteria have to be applied as in the case of the connection between the wall and cellar roof or concrete slab.

Wall and floor joint I

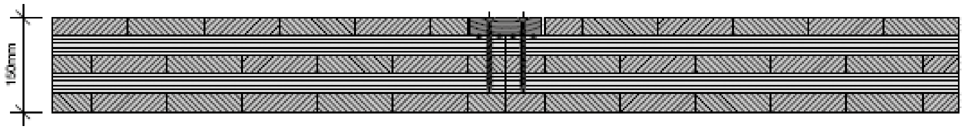




Stepped rebate connection:

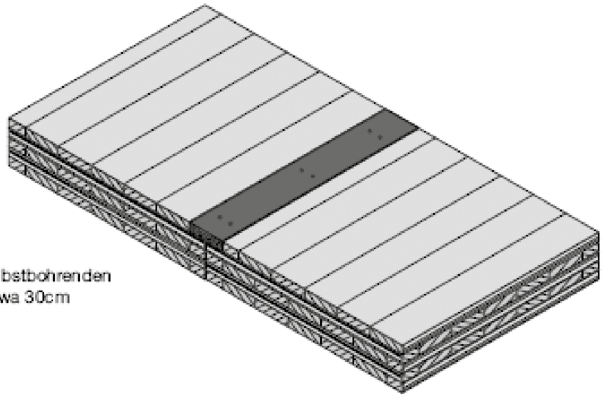
Both the longitudinal and transverse seals of the stepped rebate are important (see illustration above).

Wall and floor joint II



Fugenband einlegen zur Abdichtung

Axonometrie



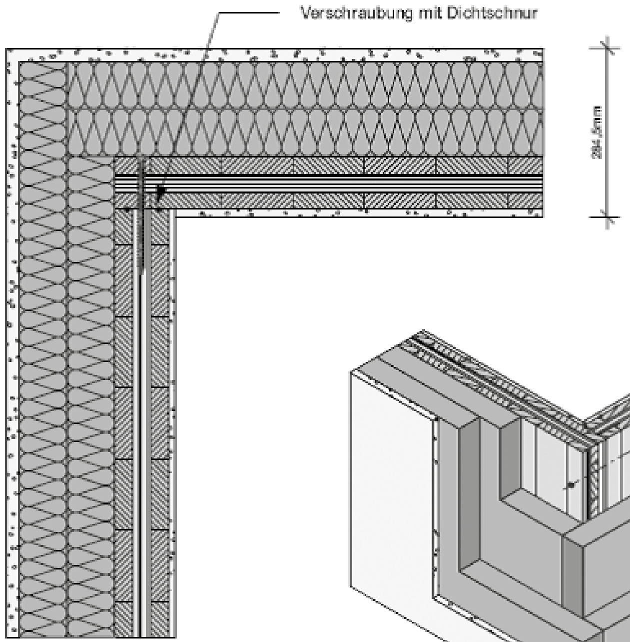
Verschraubung des Falzbrettes mit selbstbohrenden
Schrauben ø 6mm, im Abstand von etwa 30cm
(lt. Statik) Randabstand beachten

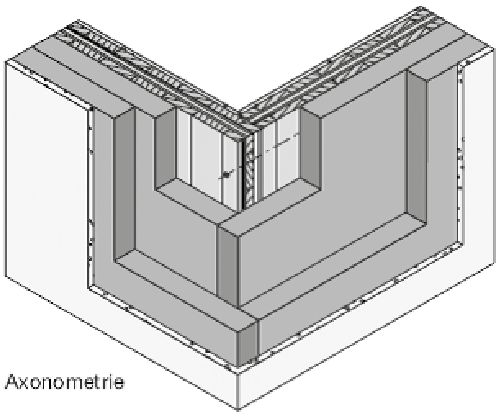
Kontaktfuge Element - Element:
Verlegung/ Montage erfolgt mit "Luft"
Toleranzmaß über die Gesamtbreite beachten

Jointing board connection:

The same procedure should be adopted for this connection as for a connection with a stepped rebate (see above).

Wall connection I





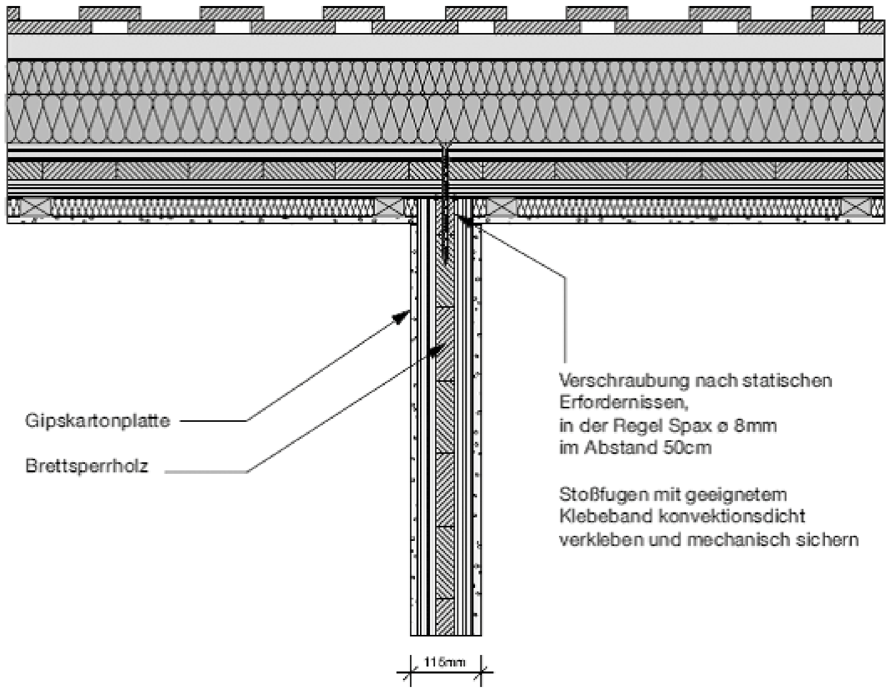
Axonometrie

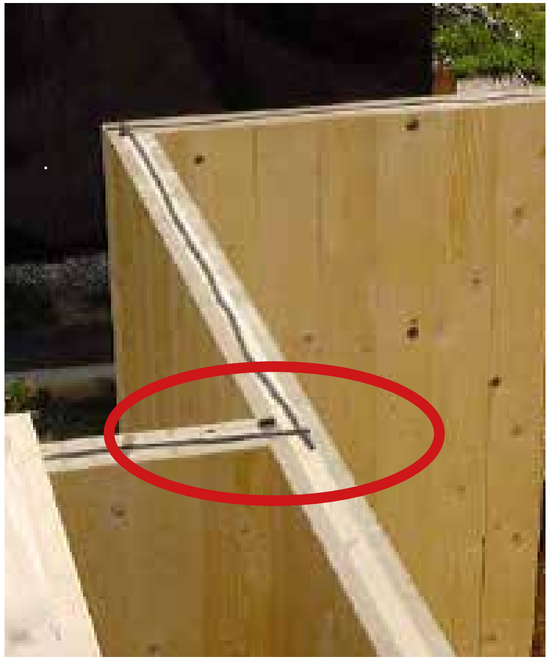
Corner joint:

With all horizontal and vertical seals, it is important to ensure a continuous joint seal (horizontal and vertical seals must be connected to each other).

Airtightness

Wall connection II

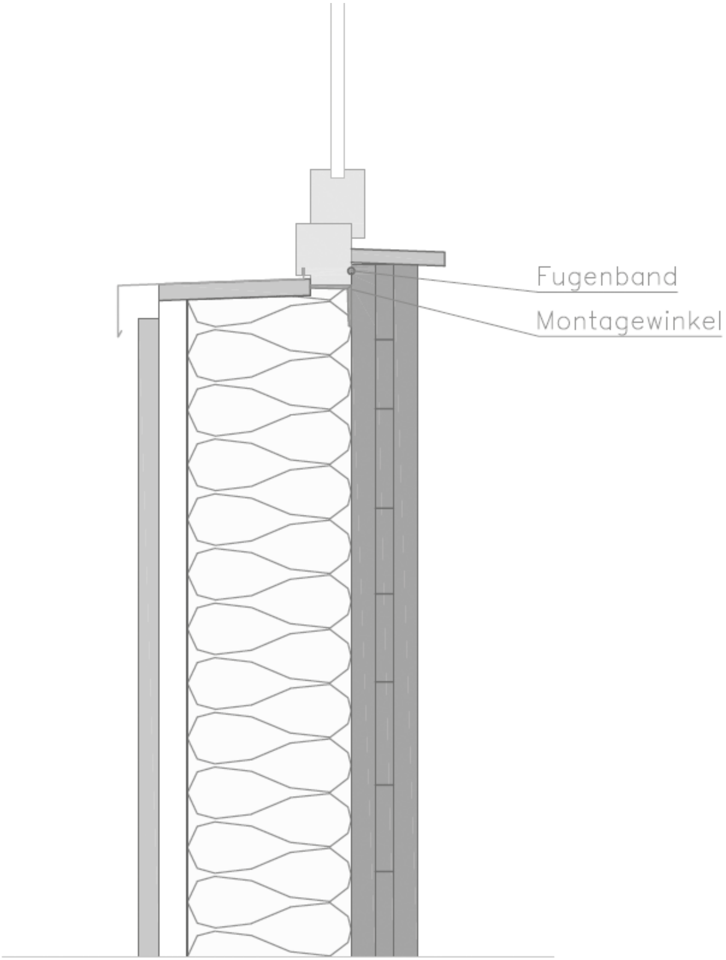




Connection of longitudinal wall to transverse wall:

The same procedure as for a corner joint must be adopted here.

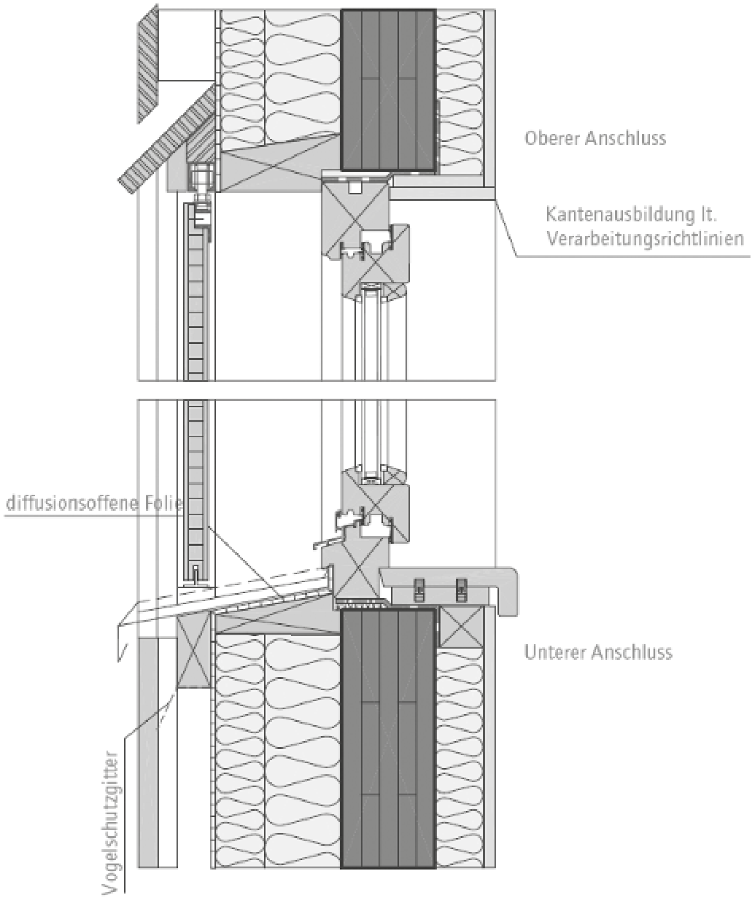
Window or door connection I



Connection of fitted window:

In this case the window frame is fitted on the CLT wall. The window connection must be made using a suitable sealing system (wall gasket “Compriband”, joint tape, etc.). It is important to ensure a proper, careful finish (precise corners, etc.).

Window or door connection II

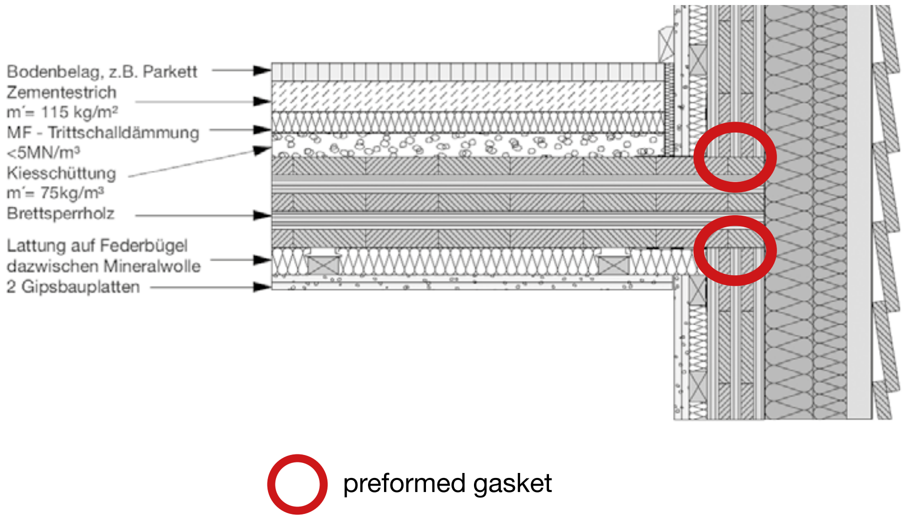


Connection of inserted window:

In this case the window frame is inserted into the CLT wall.

The window frame is inserted using wall gasket "Compriband" or a suitable PU foam. A soft-cell foam is recommended. It is important to ensure a proper, careful finish (precise corners, etc.).

Wall–floor–wall connection

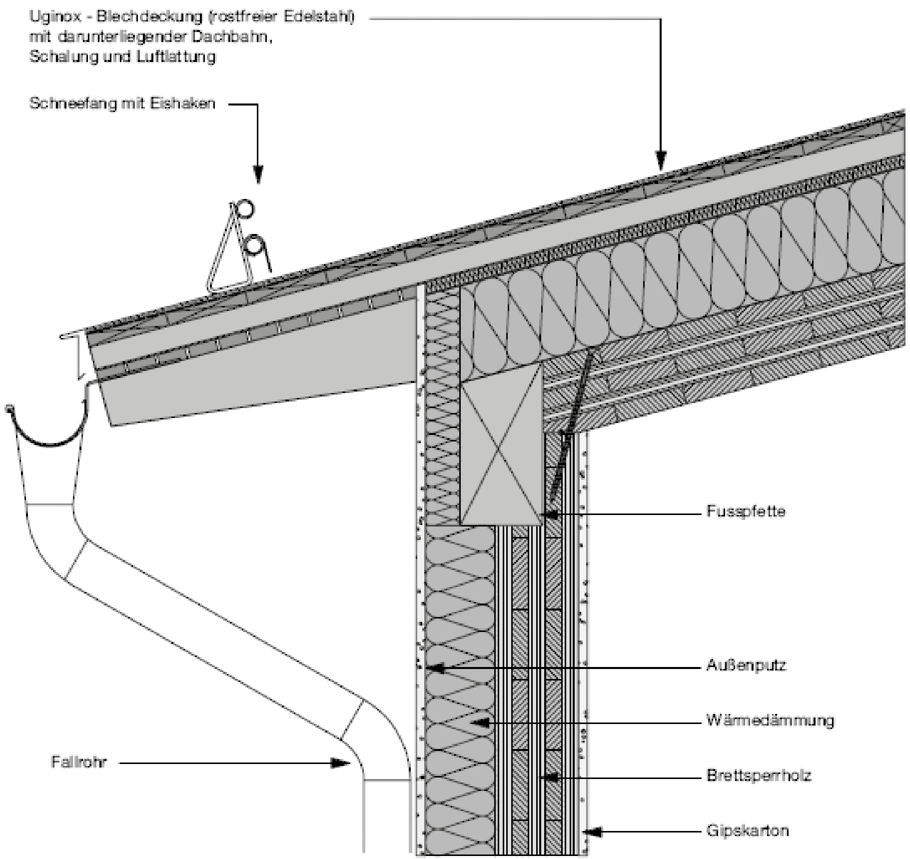


Connection of wall to floor:

The key contact surfaces are those of the upper and lower wall to the floor. Both contact surfaces must be connected so that they are airtight.

Airtightness

Wall–floor–wall connection



Connection of wall to roof panel or roof construction:

There are various ways of doing this. However, the wall panel should form a sealed unit with the roof panel. All openings and apertures must be connected in an airtight manner to the relevant contact surfaces.

Summary

Both airtightness and wind-tightness are key requirements for a high-quality building made with CLT.

In the various connection configurations, it is important to use a cohesive system regarding airtightness and wind-tightness, i.e. all the horizontal and vertical joints must form a sealed unit.

Openings in the CLT structure should be avoided, or a professional, airtight finish must be made.

This is the only way to avoid increased heat loss with all its consequences such as penetration of moisture into the structure, mould fungus formation and so forth.

For further information:

- www.storaenso.com
- www.dataholz.com

References

[1] **Riccabona Ch. and Bednar Th. (2008)**
Baukonstruktionslehre 4 [Building construction theory 4]; 7th edition
MANZ Verlag (Vienna)

[2] **ÖNORM EN 12114 (2000)**
Thermal performance of buildings. Air permeability of building components. Laboratory test methods
Austrian Standards Institute (Vienna)

[3] **Holzforschung Austria (2008)**
Test report; airtightness test on a panel with two different joint types

[4] **ÖNORM B 8110-1 (2008)**
Thermal protection in building construction. Requirements for thermal insulation and declaration of thermal protection of buildings and parts of buildings.
Austrian Standards Institute (Vienna)

[5] **Steindl R. (2007)**
Degree dissertation; Structural components for houses made of cross-laminated timber

[6] **www.dataholz.com**
Internet — Researched on 02/04/2009

[7] **ÖNORM EN 1026**
Windows and doors – Air permeability – Classification
Austrian Standards Institute (Vienna)

[8] **Technical University of Graz (2013)**
Air permeability test on a test object in accordance with ÖNORM EN 1026 and ÖNORM EN 12114

[9] **Technical University of Graz (2014)**
Air permeability test on a test object in accordance with ÖNORM EN 1026 and ÖNORM EN 12114

3

Moisture

Moisture

Introduction 32
Reasons for moisture protection 33
Room usability 33
Building heat insulation 33
Preserving the building structure 33
Diffusion 33
Diffusion resistance factor and s_d value 33
Diffusion resistance factor 33
s_d value 33
Holzforschung Austria's expert opinion 34
Significance of moisture and diffusion for CLT 36
Sources 36

Moisture

Introduction

Structural components and parts of buildings are not only exposed to thermal stress, but also to hygric stress. After the building has been completed, building components often still contain a considerable amount of building moisture.

Therefore, using CLT is advantageous, as the driest possible structures can be obtained by using this product.

Building components must be sufficiently protected from all types of moisture. Excessive moisture content **can reduce solidity and thermal insulation**. At the same time however, wood requires a minimum level of moisture (particularly in the case of visible panels) in order to reduce drying cracks.

Figure 1 shows the different effects of moisture which a building must be protected from.

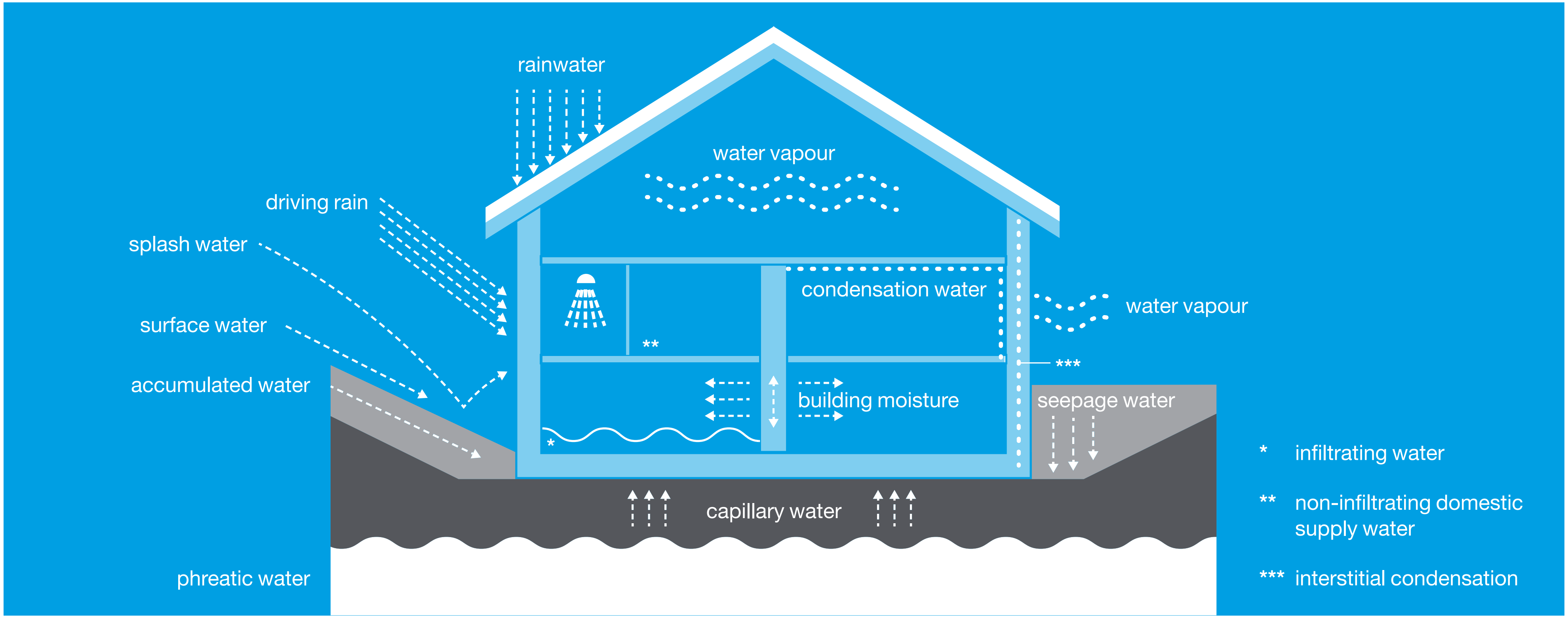


Fig. 1: Typical moisture conditions of a building (Fischer et al., 2008)

As the load-bearing structure and the insulation layer are clearly separate on CLT panels, the structural and physical aspects of the design can be considered separately. This means that if condensate were to be formed in the structure, the water droplets don't affect the bearing CLT as they form in the insulation, separated from the CLT. In a timber frame structure on the other hand, the droplets can affect the bearing studs as the entire surface area of the studs is in direct contact with the insulation, and thereby they are at risk of getting wet. CLT offers a further advantage in that, besides the load-bearing structure, it also has a significantly higher thermal mass in comparison to other wood construction systems. With 3 layers and more, CLT panels are airtight.

Reasons for moisture protection

For building owners and occupants, moisture protection is necessary or advisable for the following reasons:

1. Room usability

Rooms require a precisely defined indoor climate which means that uncontrolled levels of humidity must be avoided. Damp building materials can be the source of germs and odorous substances.

2. Building heat insulation

Increased moisture levels in the building means that the thermal conductivity of the building's materials increases, and more energy is required to heat the building. More energy is also required to remove damp air and condensation.

3. Preserving the building structure

Managing a building's exposure to moisture is essential for preserving the building's structure. Most structural damage can be traced back to the impact of water.

Diffusion

Diffusion is the movement of tiny single particles (atoms, ions, molecules), caused by the thermal self-motility (Brownian motion) of these tiny particles.

In line with heat flow, water vapour also flows:

- according to the drop in temperature from warm to cold
- or according to relative humidity from moist air to dry air.

This diffusion flow occurs in the air and also in porous building components containing air pockets. The more impermeable a building component, the greater its diffusion resistance. Damp materials are more permeable to water vapour diffusion.

Diffusion resistance factor and s_d value

4. Diffusion resistance factor

The water vapour diffusion resistance factor μ is used to measure the impermeability of a building material to diffusing water molecules. μ is a dimensionless quantity which indicates the factor by which a material's diffusion resistance increases in comparison to the reference value. Air is used as the reference value as it generally offers the least resistance to water vapour (μ = 1).

Only glass and metal can be considered impermeable to water vapour; all other materials are permeable to water vapour, even if diffusion resistance can be very high.

5. s_d value

The diffusion resistance factor μ alone is not enough to identify the impermeability to water vapour diffusion of a layer of material, rather than of the material itself. Both the type of material and the thickness of the layer must be known to understand the extent of resistance to water vapour diffusion.

Thus, the simplest definition to describe the resistance of a layer of material is derived from the product of the thickness of the layer and the diffusion resistance

Moisture

factor. Therefore, in building physics, the term “equivalent air layer thickness s_d” is used to measure the diffusion resistance of a layer of material.

$$s_d = \mu * d$$

The s_d value represents how thick a layer of air must be to have the same transmission resistance as the component.

CLT panels have different levels of diffusion resistance. This depends on the lamella thickness and the number of layers and adhesive joints.

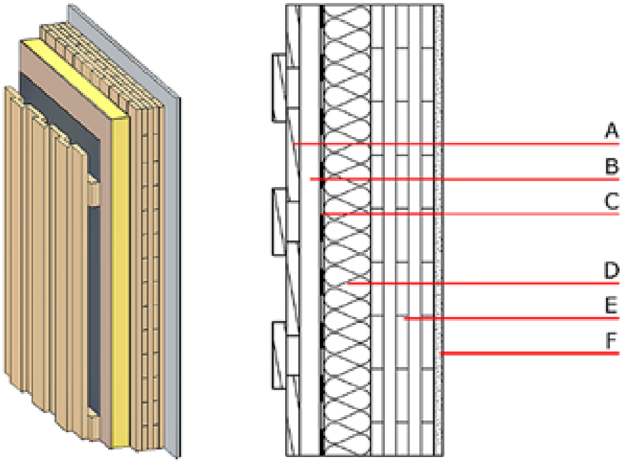
$$\sum s_d = \mu_1 * d_1 + \mu_2 * d_2 + \mu_3 * d_3 + \ldots + \mu_n * d_n$$

Holzforschung Austria’s expert opinion

Holzforschung Austria’s expert opinion reveals that a 3-layer CLT panel exhibits the same s_d value as that of a solid wood panel made of spruce with similar strength (+ 26 mm for the bonded joint on the CLT panel).

- Dependence of the material moisture content. The bonded joint’s μ value significantly decreases in damper test conditions. Porous cavities occur between the adhesive layers and capillary contacts between end grain and length grain wood. This enables faster moisture transport processes in humid climates compared with dry climates. However, this depends on the type of adhesive and the relative ambient humidity.
- The s_d value should be 5–10 m lower towards the surface compared to the middle of the structure. See example below (standard wall structure with ventilated façade).

Example: standard wall structure with ventilated façade



- plasterboard: s_d = 0.273 m
- cross-laminated timber: s_d = 3.9 m
- insulation: s_d = 0.25 m
- permeable layer: $s_d \leq$ 0.3 m

Material specifications relating to design – Layer structure
(from outside to inside, dimensions in mm)

	Thickness	Material	Thermal conductivity				Fire rating
			λ	λ (min.–max.)	ρ	C	EN
A	20.0		0.150	50	600	1.600	D
B	30.0		0.130	50	500	1.600	D
C							
D	50.0	wood wool insulation board	0.049	2–5	130	1.000	B
E	100.0	bonded solid wood (for ex. 5-layer cross-laminated timber)	0.130	50	500	1.600	D
F	13.0		0.320	21	1.000	1.100	A2

The structure is more impermeable towards the surface (calculated using the cross-laminated timber) and is therefore correct from a building physics point of view.

Moisture

Significance of moisture and diffusion for CLT

With 3 layers and more, CLT panels are “airtight” but not vapour proof. This means that CLT is permeable and the adhesive bonds form vapour barriers for the insulation plane. Just like any other construction system, CLT must be protected from permanent moisture.

CLT regulates the inside air. When there is higher ambient humidity, CLT absorbs the moisture and releases it again when the level of humidity decreases.

CLT can also be described as a moisture variable vapour barrier. It is more permeable in the summer, when temperatures are high and the air humid, than in the winter when temperatures are cold and the air is drier.

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4
Component designs

Component designs

External walls **40**
External wall — Variant 1 of 29 40
External wall — Variant 2 of 29 42
External wall — Variant 3 of 29 44
External wall — Variant 4 of 29 46
External wall — Variant 5 of 29 48
External wall — Variant 6 of 29 50
External wall — Variant 7 of 29 52
External wall — Variant 8 of 29 54
External wall — Variant 9 of 29 56
External wall — Variant 10 of 29 58
External wall — Variant 11 of 29 60
External wall — Variant 12 of 29 62
External wall — Variant 13 of 29 64
External wall — Variant 14 of 29 66
External wall — Variant 15 of 29 68
External wall — Variant 16 of 29 70
External wall — Variant 17 of 29 72
External wall — Variant 18 of 29 74
External wall — Variant 19 of 29 76
External wall — Variant 20 of 29 78
External wall — Variant 21 of 29 80
External wall — Variant 22 of 29 82
External wall — Variant 23 of 29 84
External wall — Variant 24 of 29 86
External wall — Variant 25 of 29 88
External wall — Variant 26 of 29 90
External wall — Variant 27 of 29 92
External wall — Variant 28 of 29 94
External wall — Variant 29 of 29 96

Internal walls **98**
Internal wall — Variant 1 of 11 98
Internal wall — Variant 2 of 11 100
Internal wall — Variant 3 of 11 102
Internal wall — Variant 4 of 11 104
Internal wall — Variant 5 of 11 106
Internal wall — Variant 6 of 11 108
Internal wall — Variant 7 of 11 110
Internal wall — Variant 8 of 11 112
Internal wall — Variant 9 of 11 114
Internal wall — Variant 10 of 11 116
Internal wall — Variant 11 of 11 118

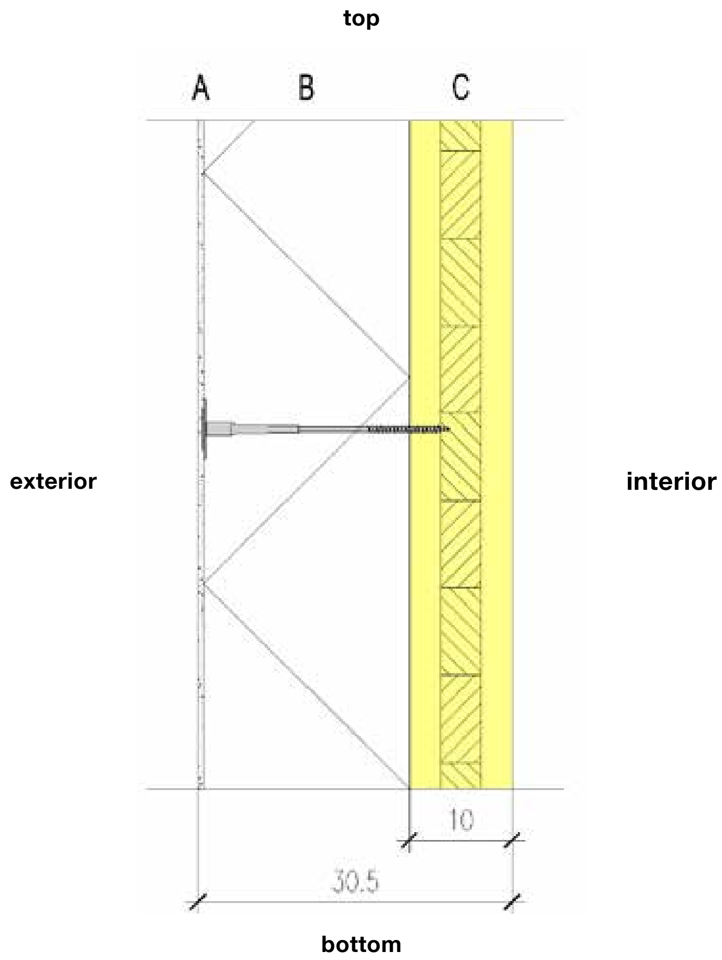
Partition walls **120**
Partition wall — Variant 1 of 17 120
Partition wall — Variant 2 of 17 122
Partition wall — Variant 3 of 17 124
Partition wall — Variant 4 of 17 126
Partition wall — Variant 5 of 17 128
Partition wall — Variant 6 of 17 130
Partition wall — Variant 7 of 17 132
Partition wall — Variant 8 of 17 134
Partition wall — Variant 9 of 17 136
Partition wall — Variant 10 of 17 138
Partition wall — Variant 11 of 17 140
Partition wall — Variant 12 of 17 142
Partition wall — Variant 13 of 17 144
Partition wall — Variant 14 of 17 146
Partition wall — Variant 15 of 17 148
Partition wall — Variant 16 of 17 150
Partition wall — Variant 17 of 17 152

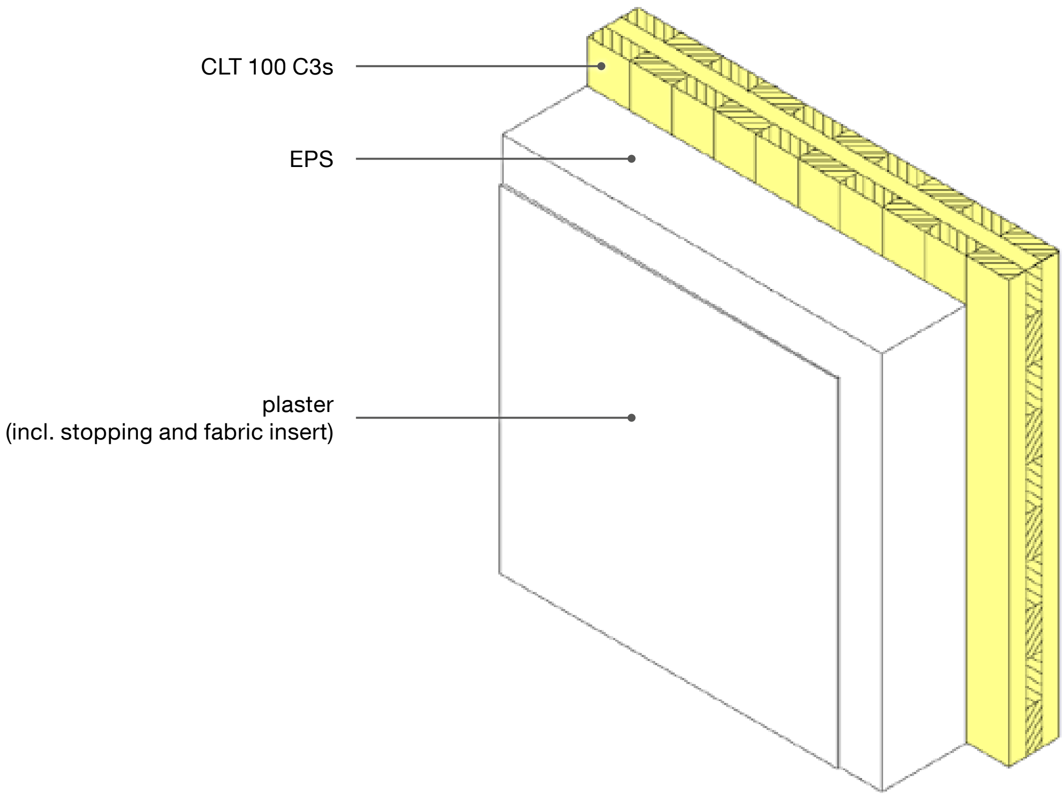
Floor slabs **154**
Floor slab — Variant 1 of 6 154
Floor slab — Variant 2 of 6 156
Floor slab — Variant 3 of 6 158
Floor slab — Variant 4 of 6 160
Floor slab — Variant 5 of 6 162
Floor slab — Variant 6 of 6 164

Roofs **166**
Roof — Variant 1 of 6 166
Roof — Variant 2 of 6 168
Roof — Variant 3 of 6 170
Roof — Variant 4 of 6 172
Roof — Variant 5 of 6 174
Roof — Variant 6 of 6 176

External walls

1. External wall — Variant 1 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.13**	**36**

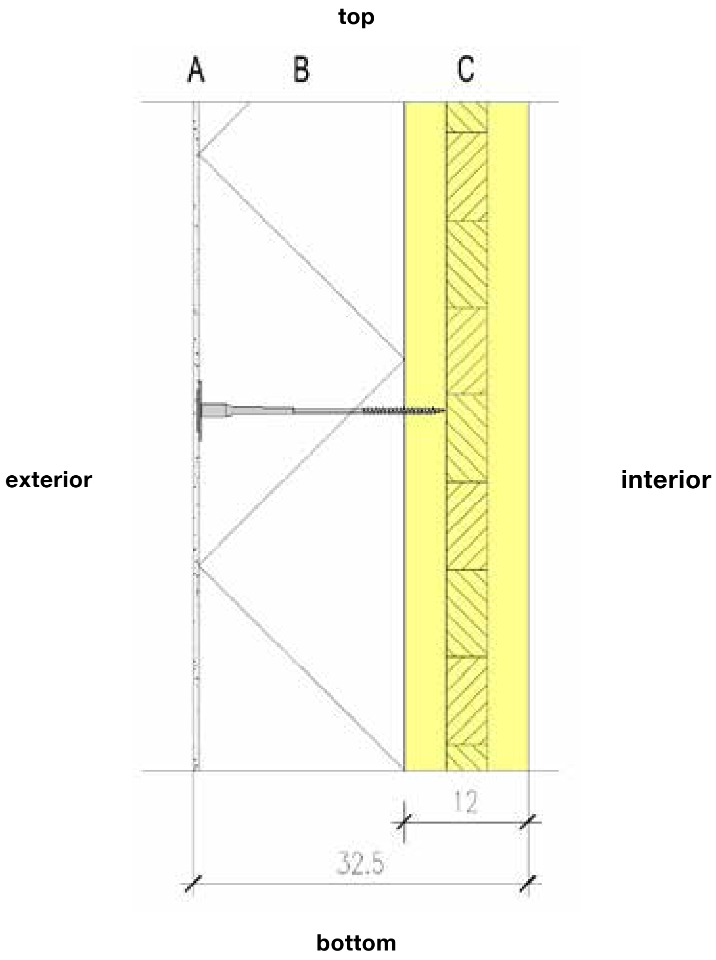
Component design

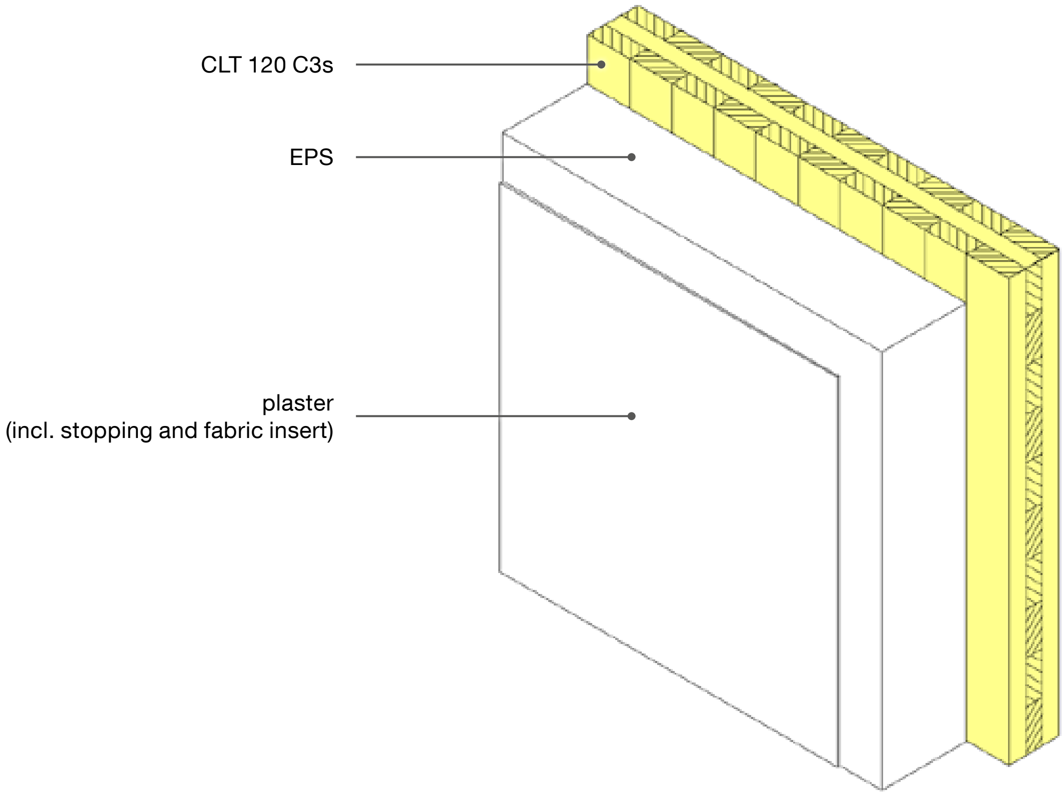
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	EPS	16, 20, 26	0.031	60	18	E
C	CLT 100 C3s	10	0.110	50	470	D

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 60	35	0.16	adequate	34.7	36	–
20	REI 60	35	0.13	adequate	34.8	36	–
26	REI 60	35	0.11	adequate	34.9	36	–

2. External wall — Variant 2 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.13**	**36**

Component design

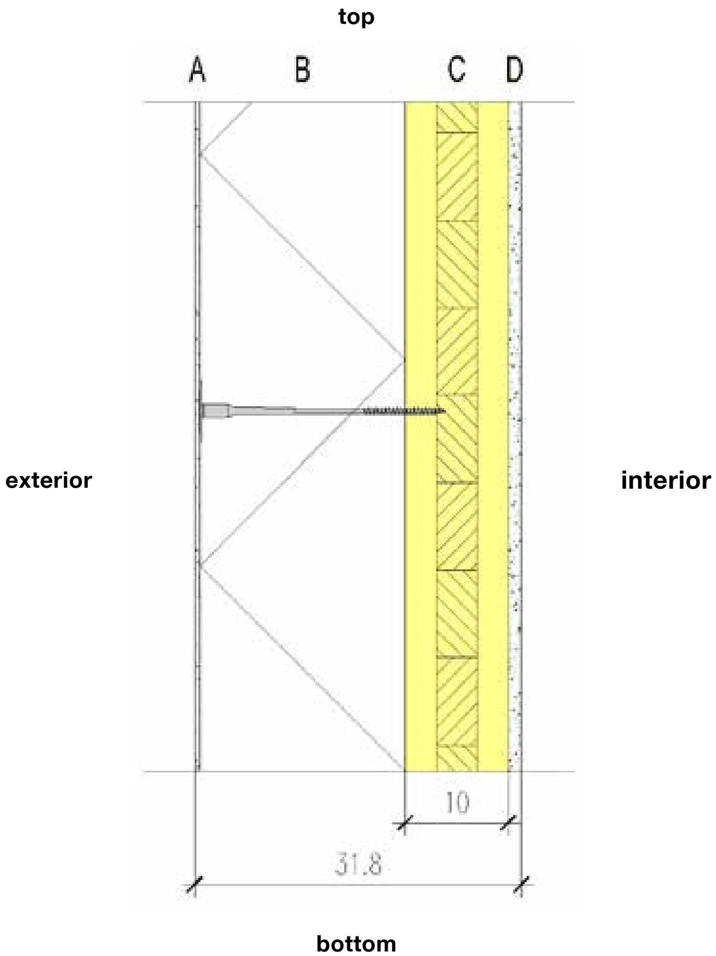
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	EPS	16, 20, 26	0.031	60	18	E
C	CLT 120 C3s	12	0.110	50	470	D

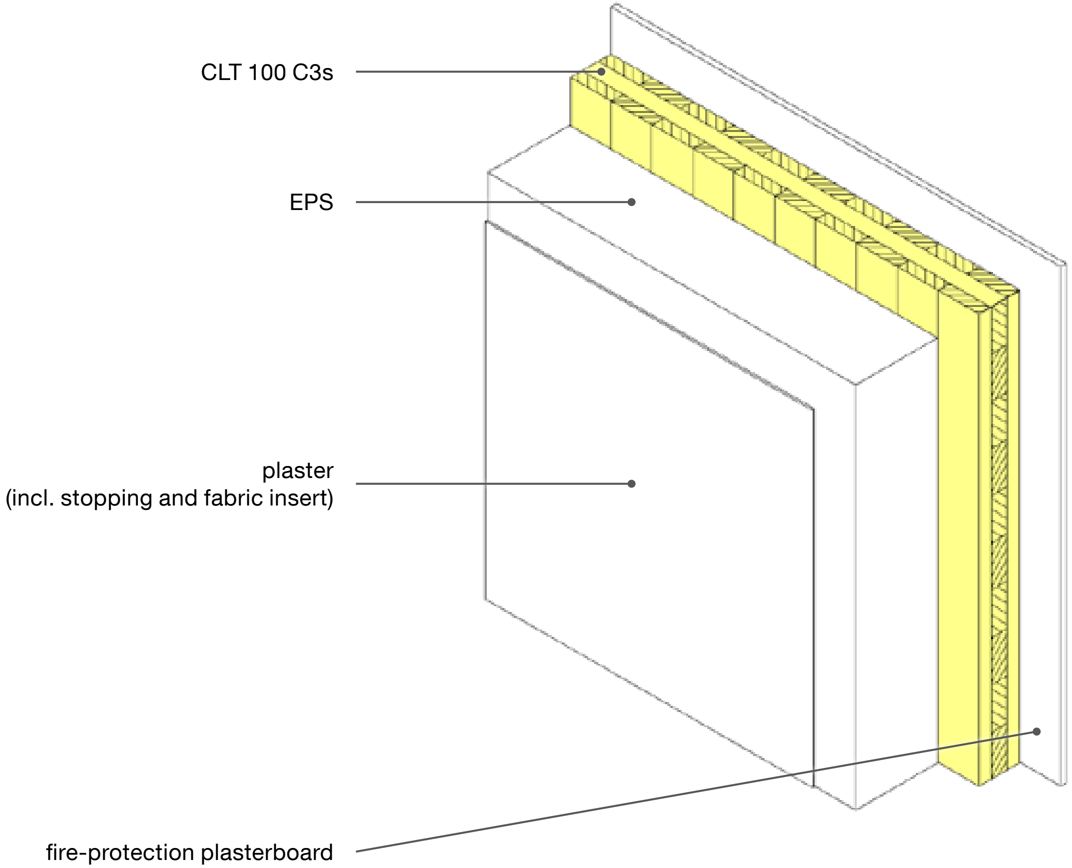
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.16	adequate	33.3	36	–
20	REI 90	35	0.13	adequate	33.4	36	–
26	REI 90	35	0.10	adequate	33.4	36	–

Component designs

3. External wall — Variant 3 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.13**	**37**

Component design

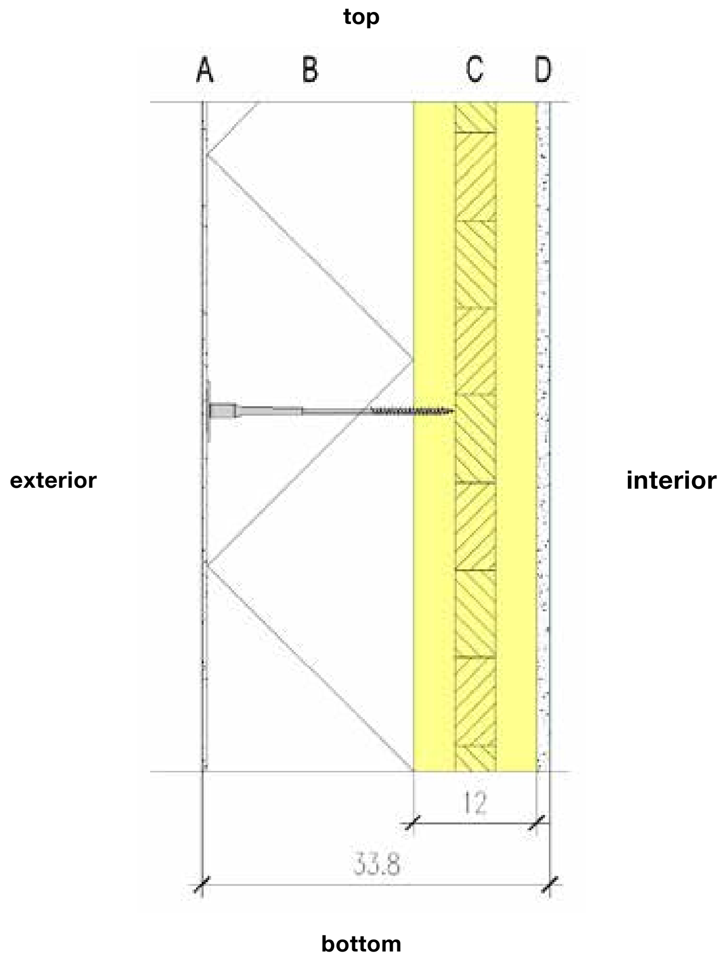
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	EPS	16, 20, 26	0.031	60	18	E
C	CLT 100 C3s	10	0.110	50	470	D
D	fire-protection plasterboard	1.3	0.250	—	800	A2

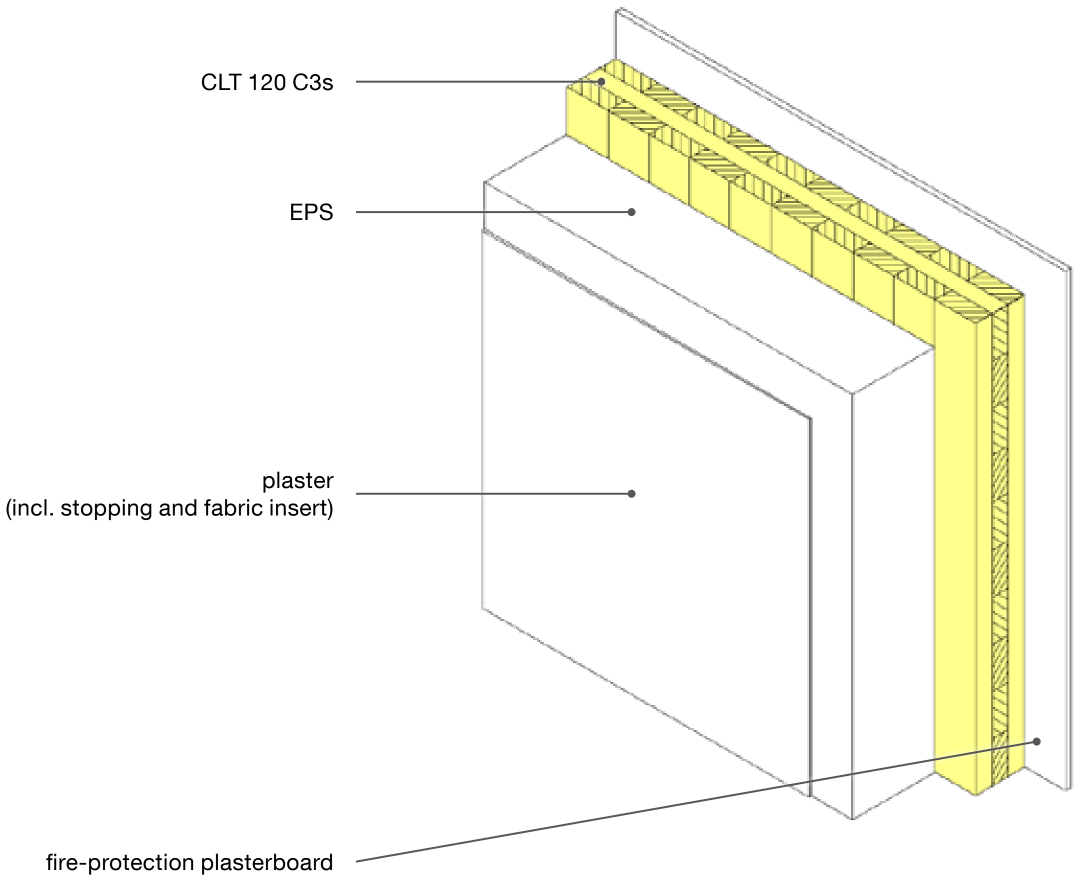
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.16	adequate	38.7	37	—
20	REI 90	35	0.13	adequate	38.8	37	—
26	REI 90	35	0.11	adequate	38.8	37	—

Component designs

4. External wall — Variant 4 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	0.13	37

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	EPS	16, 20, 26	0.031	60	18	E
C	CLT 120 C3s	12	0.110	50	470	D
D	fire-protection plasterboard	1.3	0.250	—	800	A2

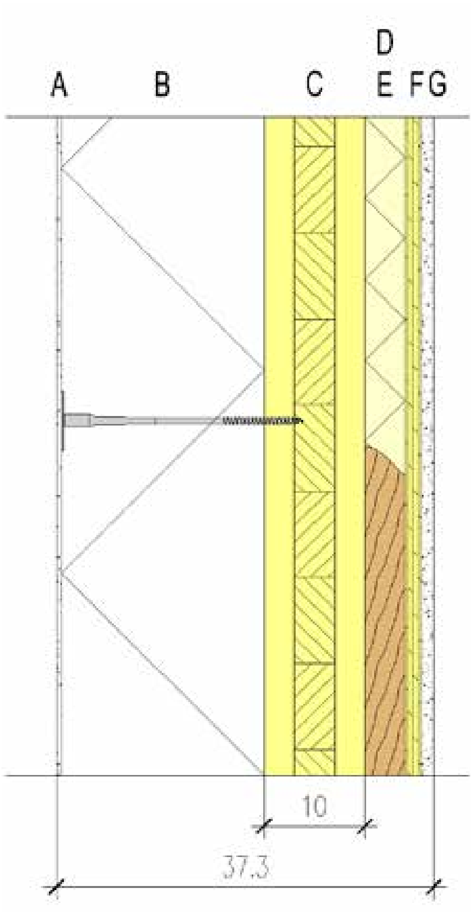
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.15	adequate	37.4	37	—
20	REI 90	35	0.13	adequate	37.4	37	—
26	REI 90	35	0.10	adequate	37.4	37	—

5. External wall — Variant 5 of 29

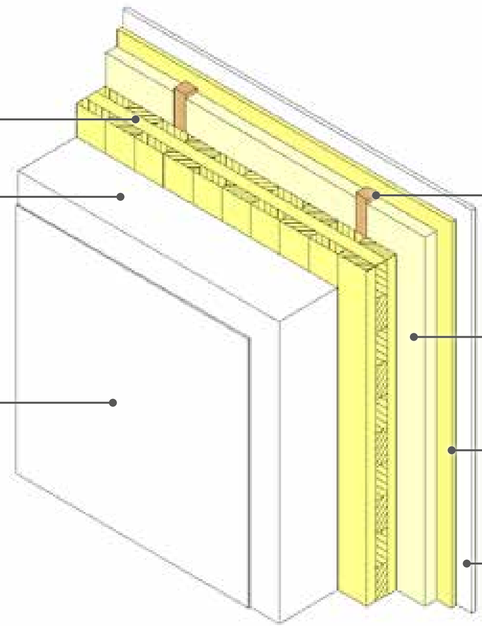
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.11**	**43**

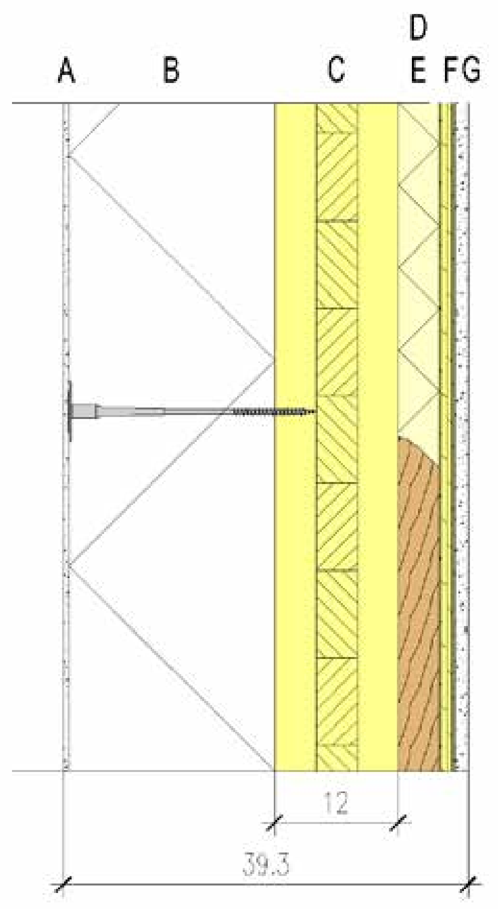
Component design

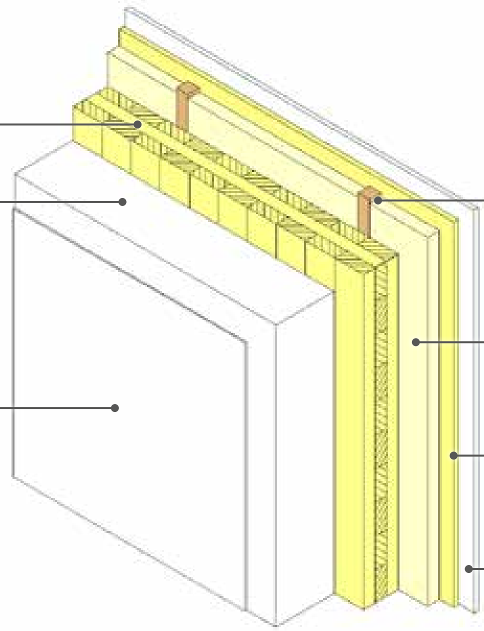
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	EPS	16, 20, 26	0.031	60	18	E
C	CLT 100 C3s	10	0.110	50	470	D
D	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
E	mineral wool	5	0.035	—	18	A1
F	OSB	1.5	0.130	200–300	600	B
G	fire-protection plasterboard	1.3	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 120	35	0.13	adequate	27.2	43	—
20	REI 120	35	0.12	adequate	27.2	43	
26	REI 120	35	0.11	adequate	27.2	43	—

6. External wall — Variant 6 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.11**	**43**

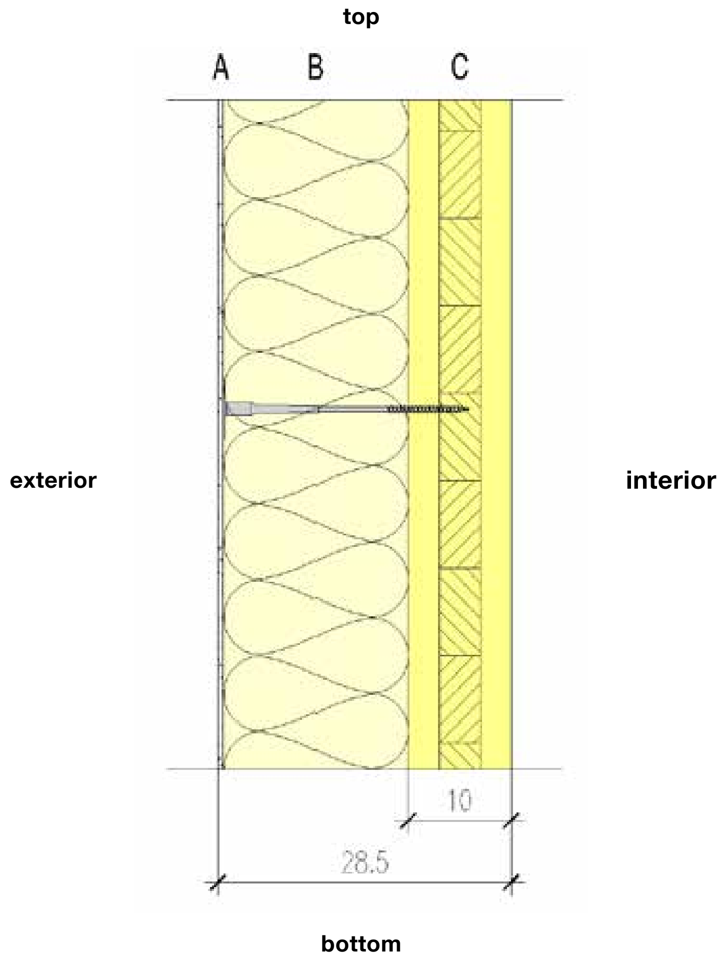
Component design

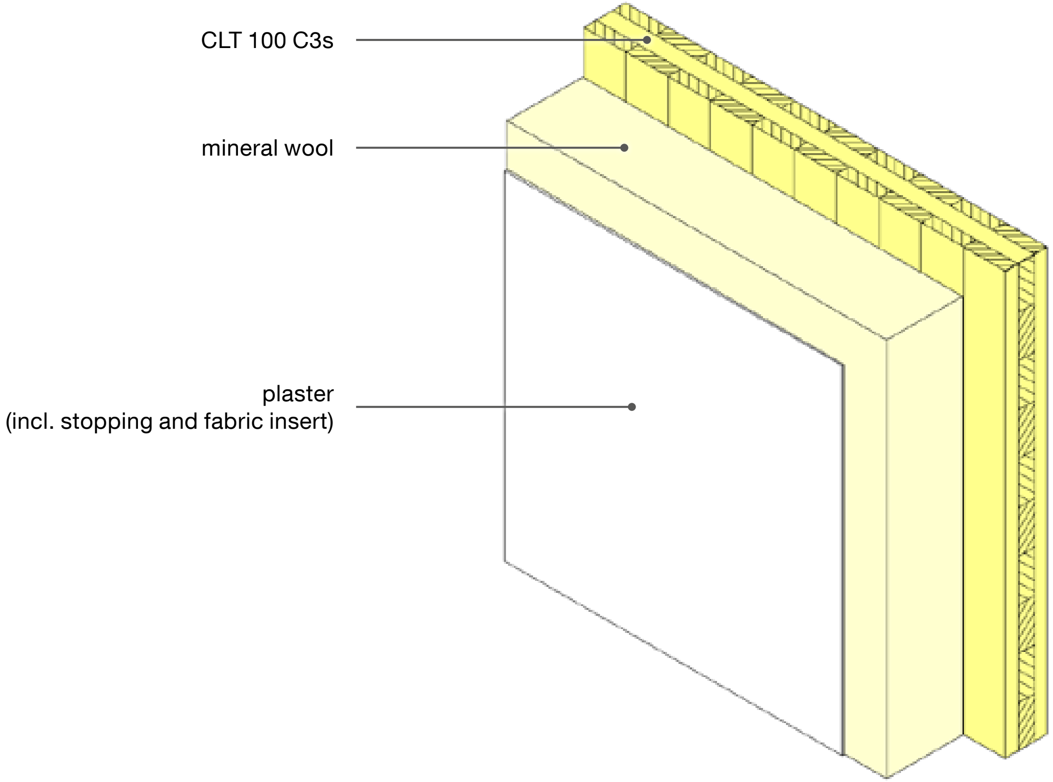
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	EPS	16, 20, 26	0.031	60	18	E
C	CLT 120 C3s	12	0.110	50	470	D
D	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
E	mineral wool	5	0.035	—	18	A1
F	OSB	1.5	0.130	200–300	600	B
G	fire-protection plasterboard	1.3	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 120	35	0.13	adequate	27.2	43	—
20	REI 120	35	0.11	adequate	27.2	43	—
26	REI 120	35	0.09	adequate	27.2	43	—

7. External wall — Variant 7 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.16**	**38**

Component design

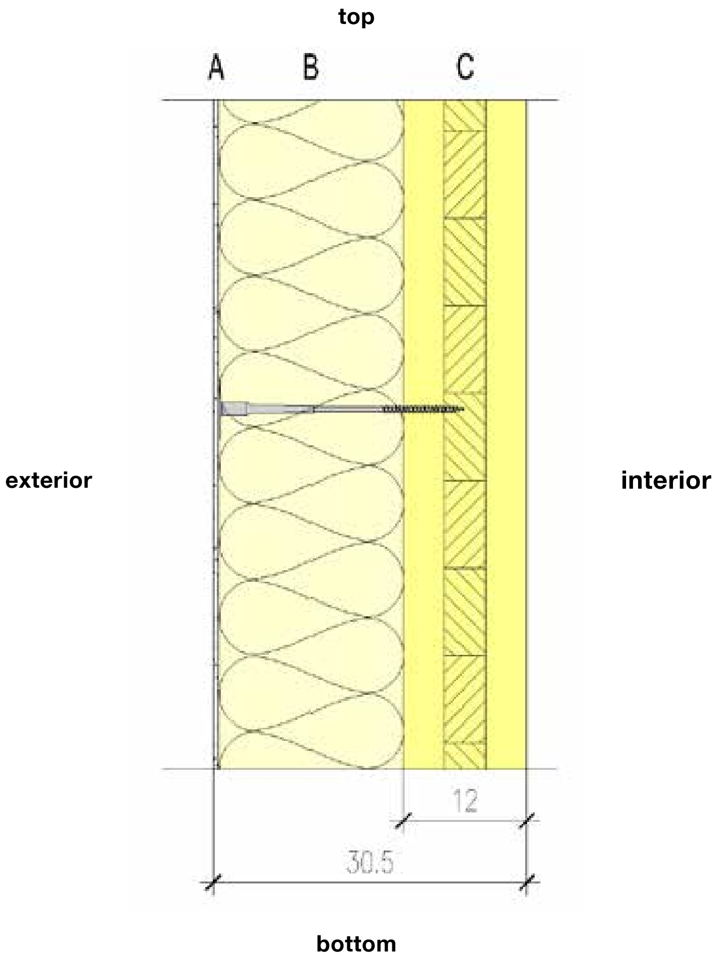
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	mineral wool	16, 18	0.035	1	18	A1
C	CLT 100 C3s	10	0.110	50	470	D

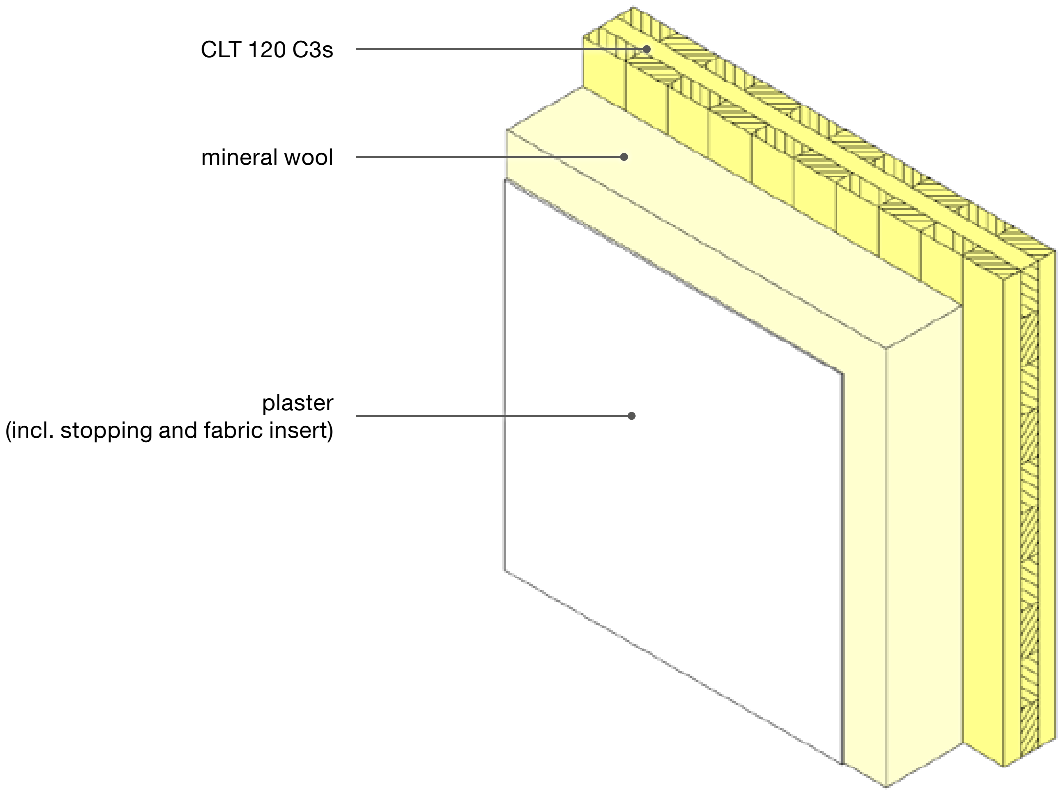
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 60	35	0.18	adequate	34.7	38	–
18	REI 60	35	0.16	adequate	34.7	38	–

Component designs

8. External wall — Variant 8 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.16**	**33.3**

Component design

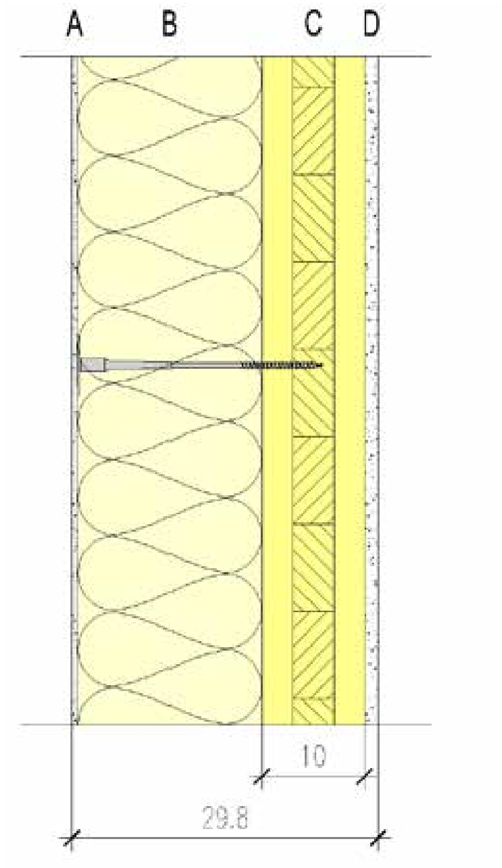
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	mineral wool	16, 18	0.035	1	18	A1
C	CLT 120 C3s	12	0.110	50	470	D

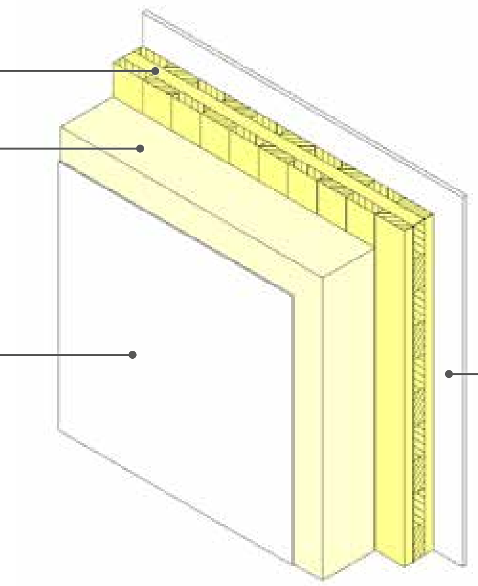
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 60	35	35	0.17	adequate	33.3	38
18	REI 60	35	35	0.16	adequate	33.3	38

Component designs

9. External wall — Variant 9 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.16**	**39**

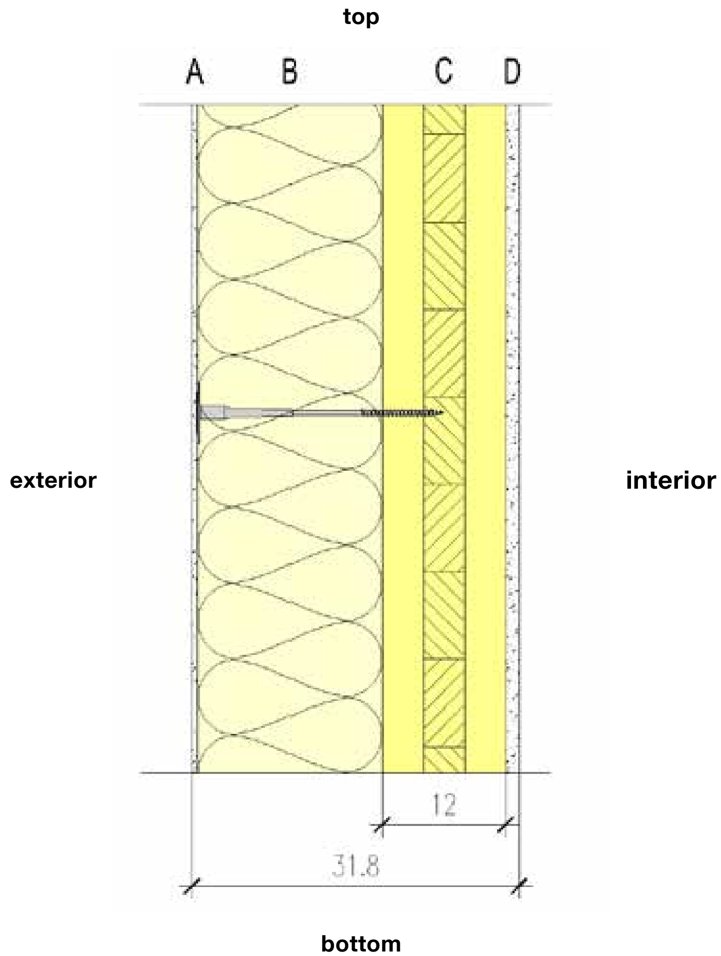
Component design

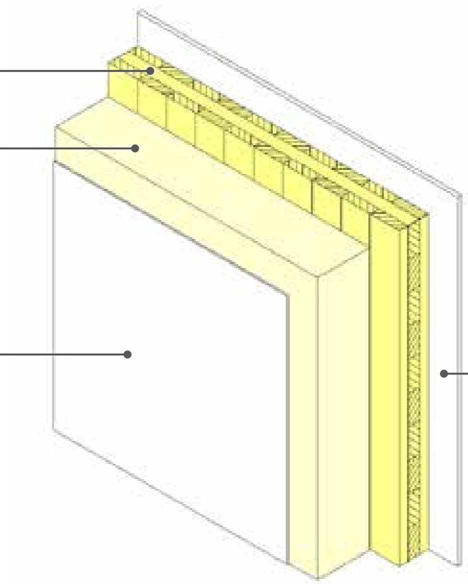
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	mineral wool	16, 18	0.035	1	18	A1
C	CLT 100 C3s	10	0.110	50	470	D
D	fire-protection plasterboard	1.3	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.18	adequate	38.7	39	—
18	REI 90	35	0.16	adequate	38.7	39	—

10. External wall — Variant 10 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	0.16	39

Component design

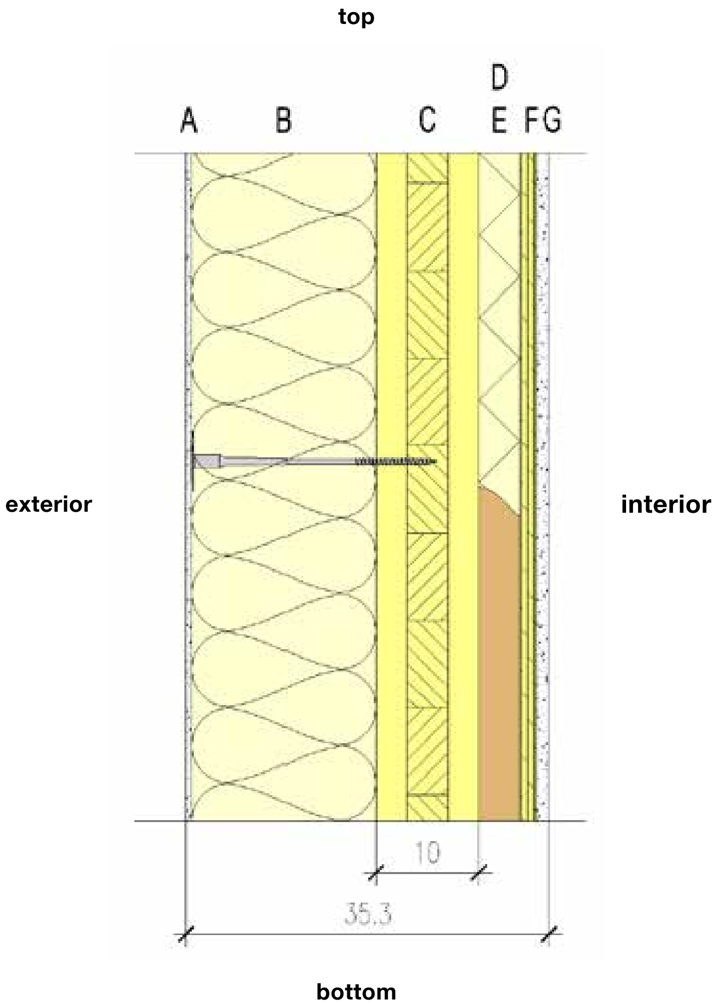
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	mineral wool	16, 18	0.035	1	18	A1
C	CLT 120 C3s	12	0.110	50	470	D
D	fire-protection plasterboard	1.3	0.250	—	800	A2

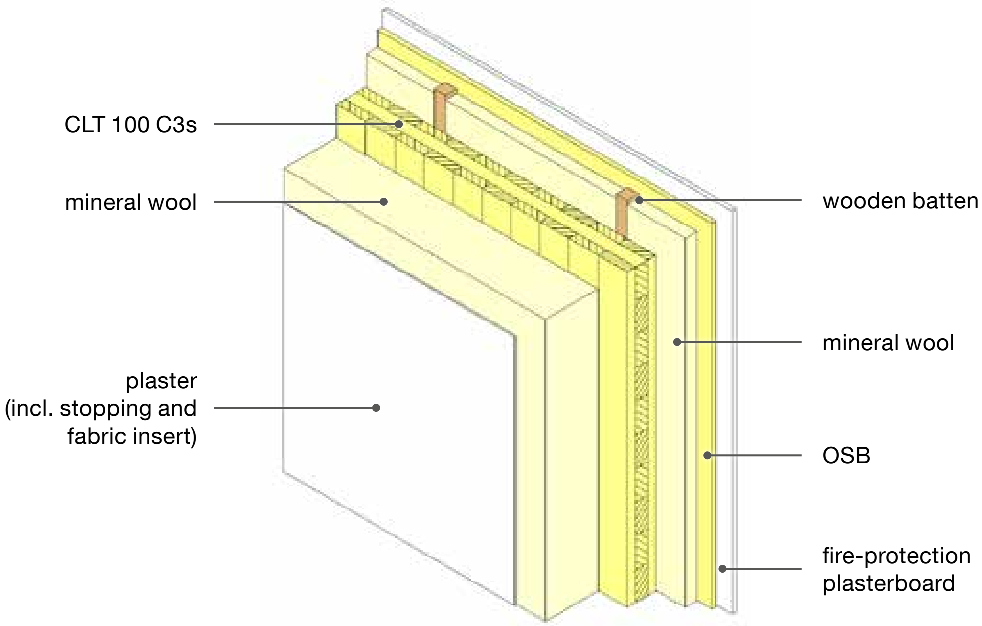
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.17	adequate	37.4	39	—
18	REI 90	35	0.16	adequate	37.4	39	—

Component designs

11. External wall — Variant 11 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	0.13	45

Component design

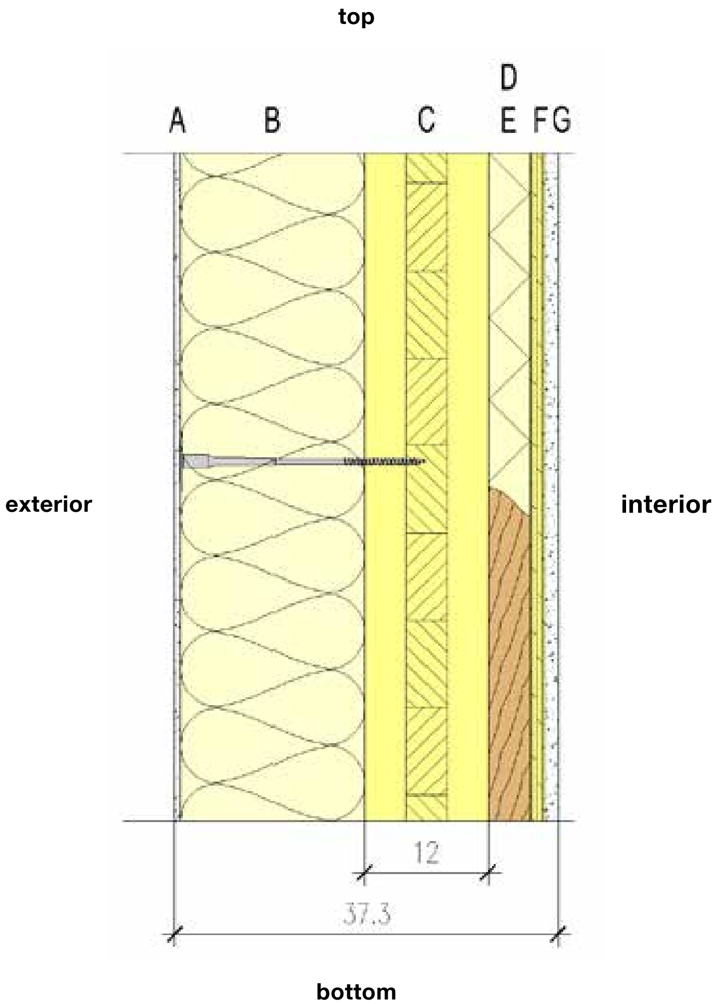
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	mineral wool	16, 18	0.035	1	18	A1
C	CLT 100 C3s	10	0.110	50	470	D
D	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
E	mineral wool	5	0.035	—	18	A1
F	OSB	1.5	0.130	200–300	600	B
G	fire-protection plasterboard	1.3	0.250	—	800	A2

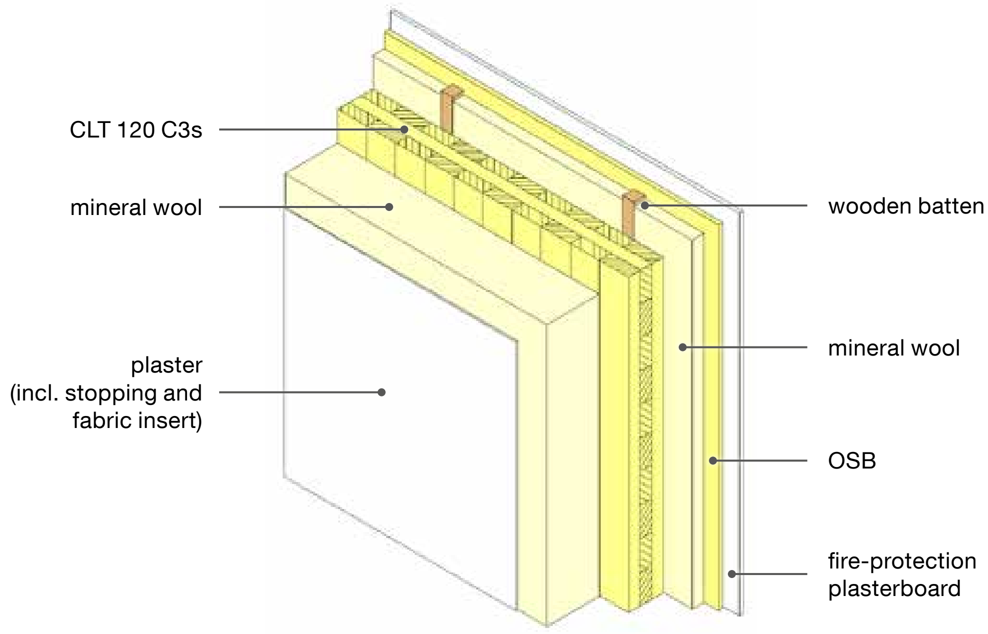
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 120	35	0.14	adequate	27.2	45	—
18	REI 120	35	0.13	adequate	27.2	45	—

Component designs

12. External wall — Variant 12 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.13**	**45**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	mineral wool	16, 18	0.035	1	18	A1
C	CLT 120 C3s	12	0.110	50	470	D
D	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
E	mineral wool	5	0.035	–	18	A1
F	OSB	1.5	0.130	200–300	600	B
G	fire-protection plasterboard	1.3	0.250	–	800	A2

Structural-physical analysis

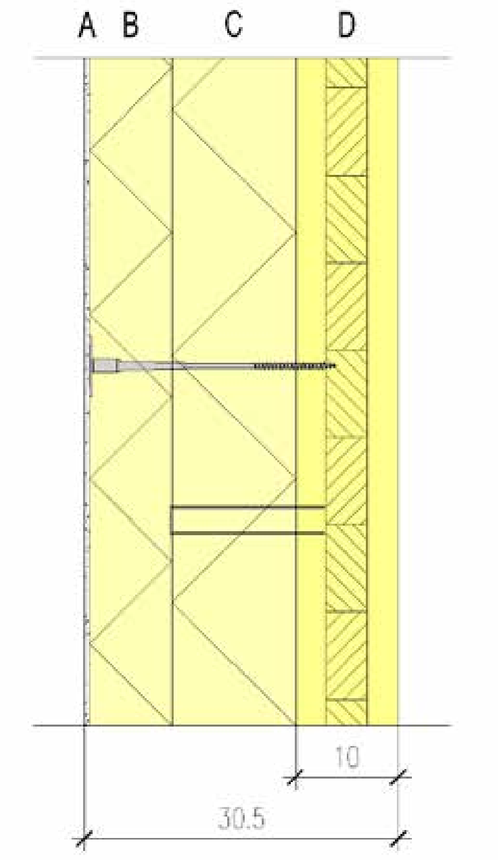
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 120	35	0.14	adequate	27.2	45	–
18	REI 120	35	0.13	adequate	27.2	45	–

Component designs

13. External wall — Variant 13 of 29

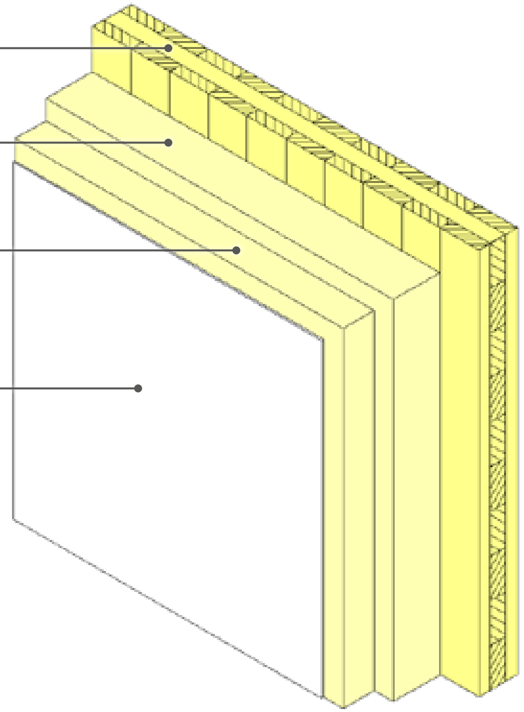
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	0.18	38

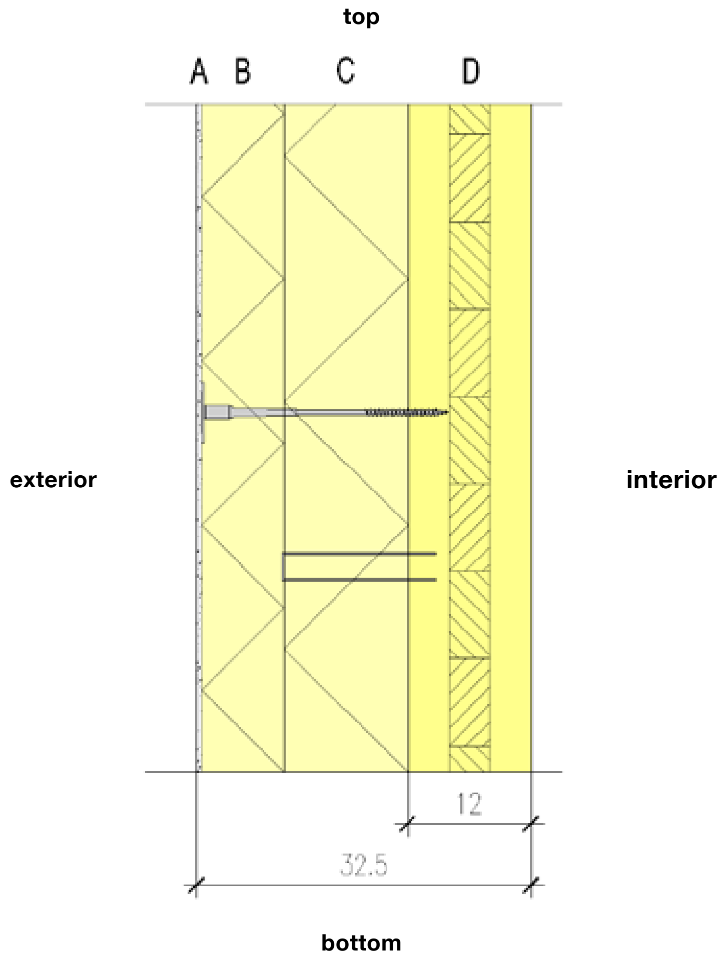
Component design

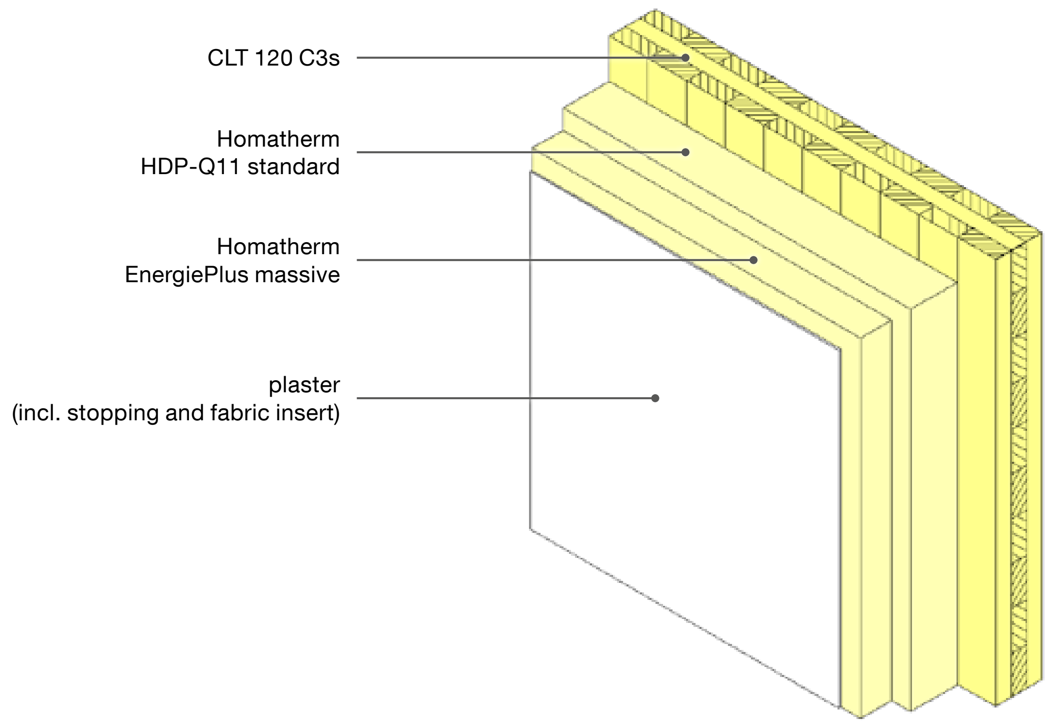
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	Homatherm EnergiePlus massive	8, 6	0.039	3	140	E
C	Homatherm HDP-Q11 standard	12, 10	0.038	3	110	E
D	CLT 100 C3s	10	0.110	50	470	D

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 60	35	0.21	adequate	34.6	38	–
20	REI 60	35	0.18	adequate	34.7	38	–

14. External wall — Variant 14 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.17**	**38**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	Homatherm EnergiePlus massive	8, 6	0.039	3	140	E
C	Homatherm HDP-Q11 standard	12, 10	0.038	3	110	E
D	CLT 120 C3s	12	0.110	50	470	D

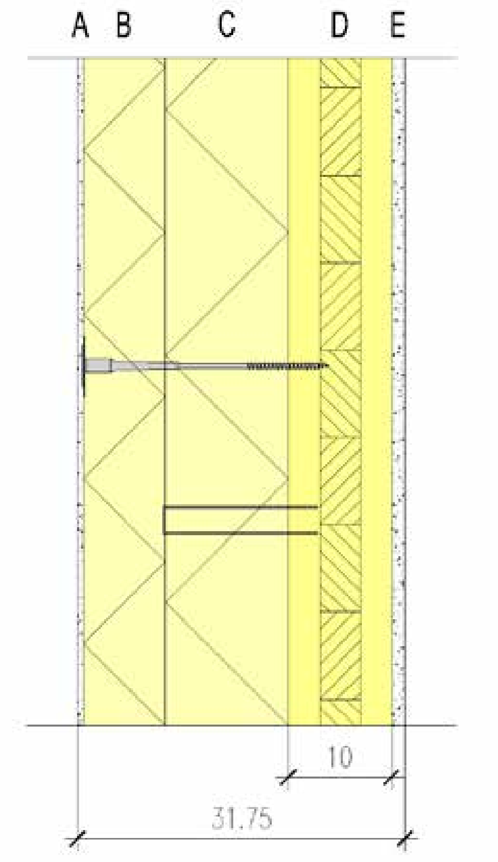
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 60	35	0.20	adequate	33.3	38	–
20	REI 60	35	0.17	adequate	33.3	38	–

15. External wall — Variant 15 of 29

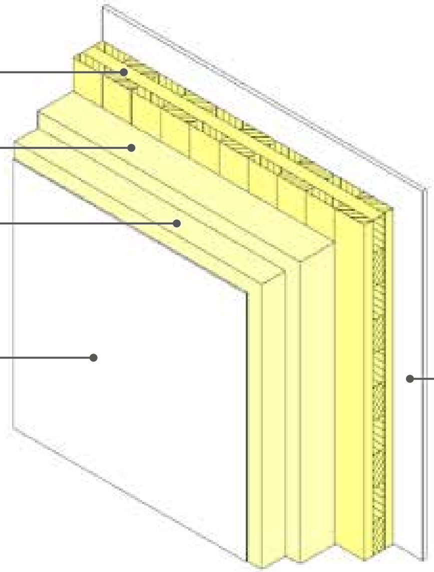
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.17**	**39**

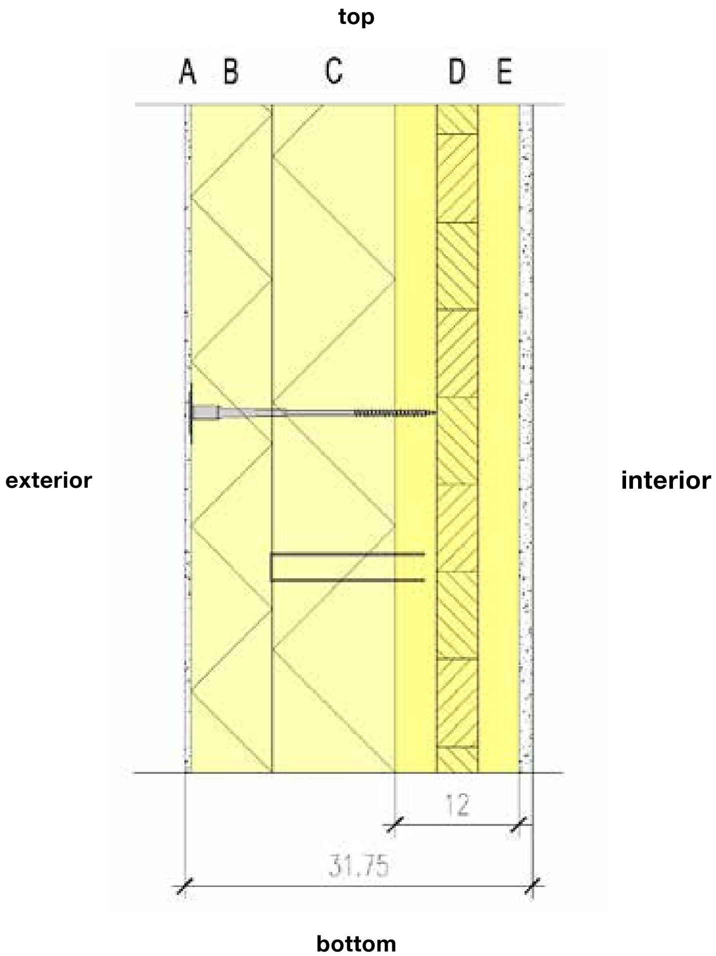
Component design

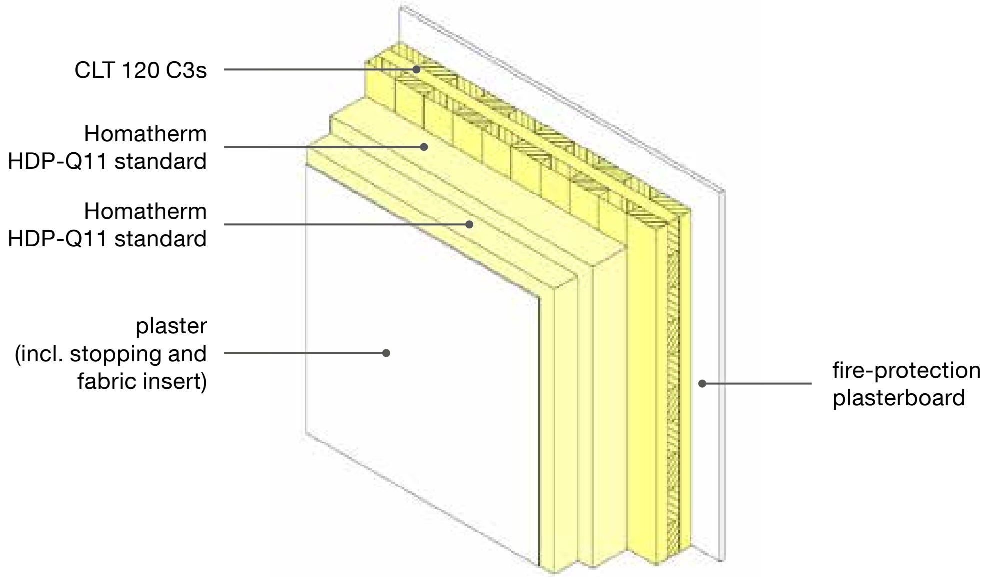
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	Homatherm EnergiePlus massive	8, 6	0.039	3	140	E
C	Homatherm HDP-Q11 standard	12, 10	0.038	3	110	E
D	CLT 100 C3s	10	0.110	50	470	D
E	fire-protection plasterboard	1.3	0.250	–	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.21	adequate	38.7	39	–
20	REI 90	35	0.17	adequate	38.7	39	–

16. External wall — Variant 16 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.17**	**39**

Component design

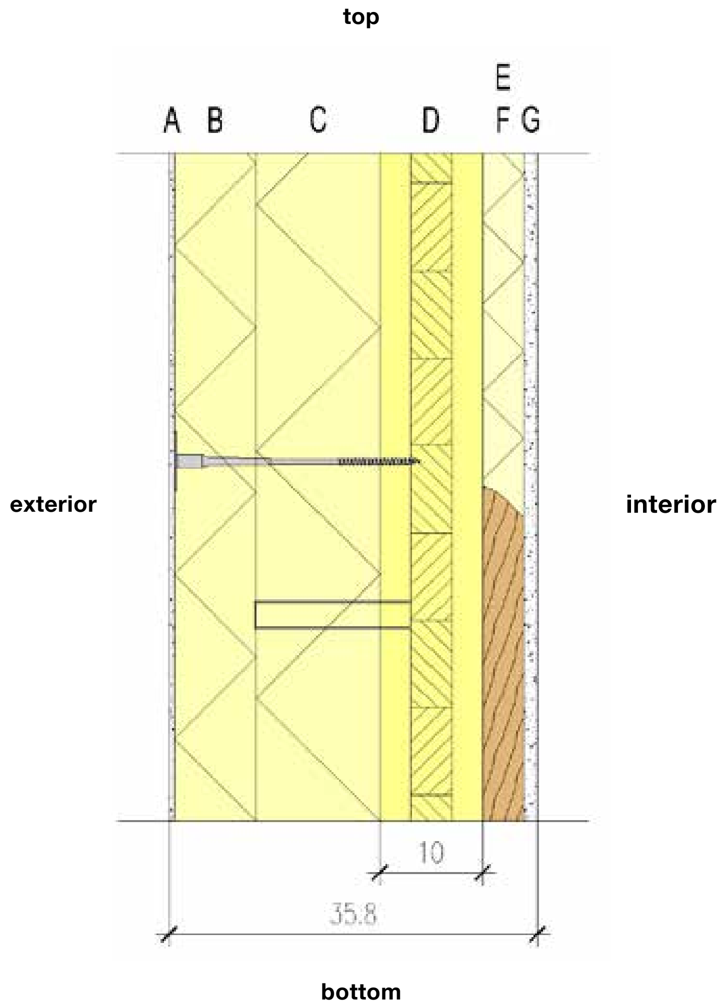
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	Homatherm EnergiePlus massive	8, 6	0.039	3	140	E
C	Homatherm HDP-Q11 standard	12, 10	0.038	3	110	E
D	CLT 120 C3s	12	0.110	50	470	D
E	fire-protection plasterboard	1.3	0.250	—	800	A2

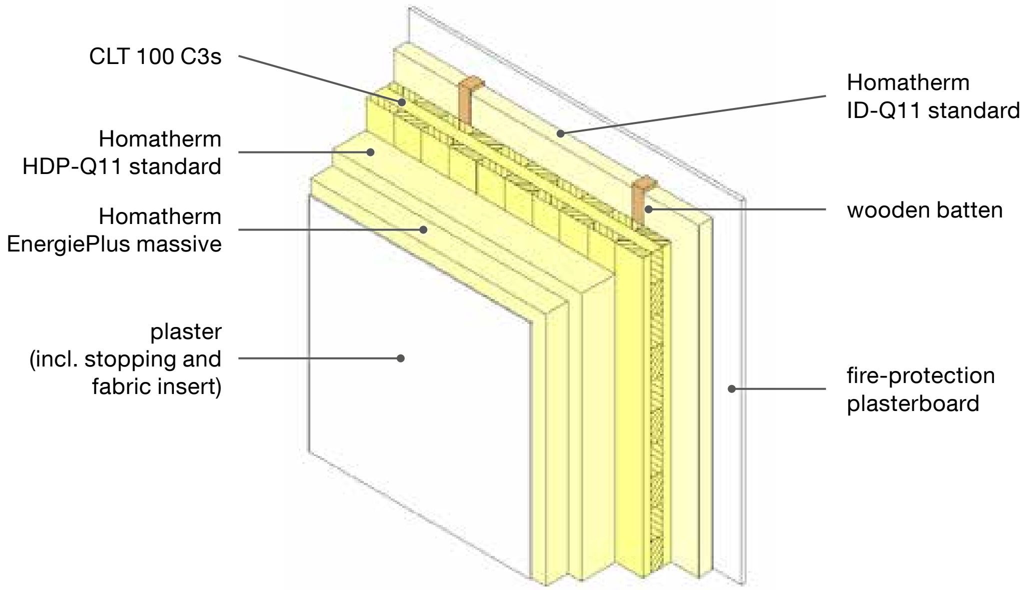
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.20	adequate	37.4	39	—
20	REI 90	35	0.17	adequate	37.4	39	—

Component designs

17. External wall — Variant 17 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	0.15	44

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	Homatherm EnergiePlus massive	8, 6	0.039	3	140	E
C	Homatherm HDP-Q11 standard	12, 10	0.038	3	110	E
D	CLT 100 C3s	10	0.110	50	470	D
E	wooden battens 50/40 | e = 62.5 cm	4	0.130	50	500	D
F	Homatherm ID-Q11 standard	4	0.038	3	110	E
G	fire-protection plasterboard	1.5	0.250	—	800	A2

Structural-physical analysis

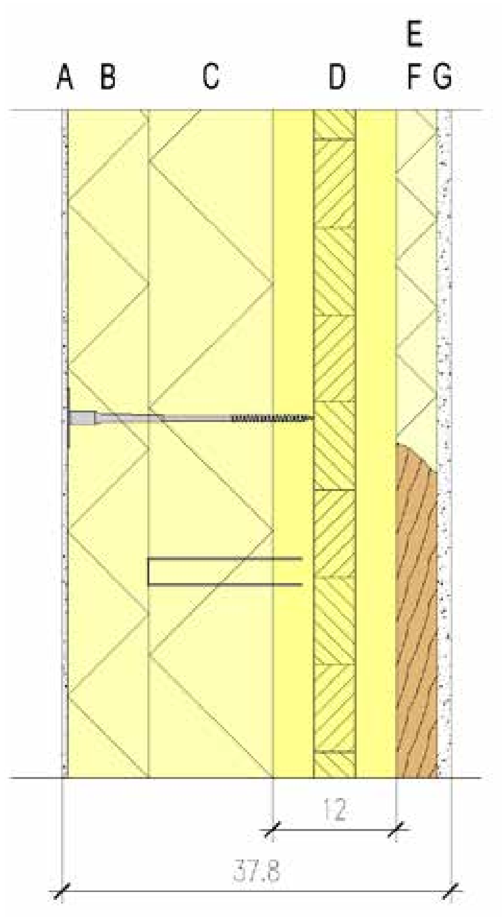
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 120	35	0.18	adequate	18.1	44	—
20	REI 120	35	0.15	adequate	18.1	44	—

Component designs

18. External wall — Variant 18 of 29

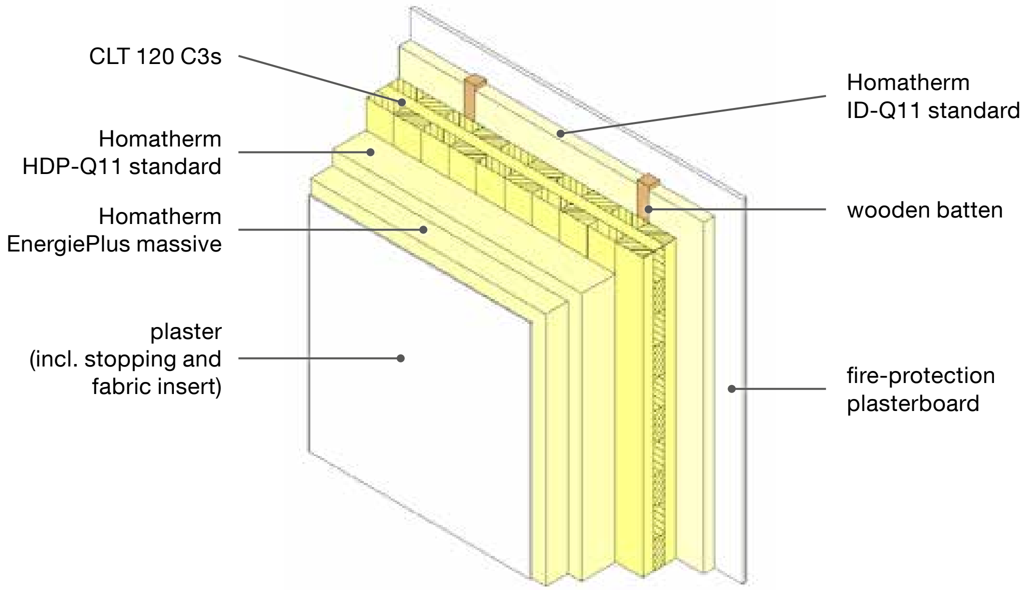
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.15**	**44**

Component design

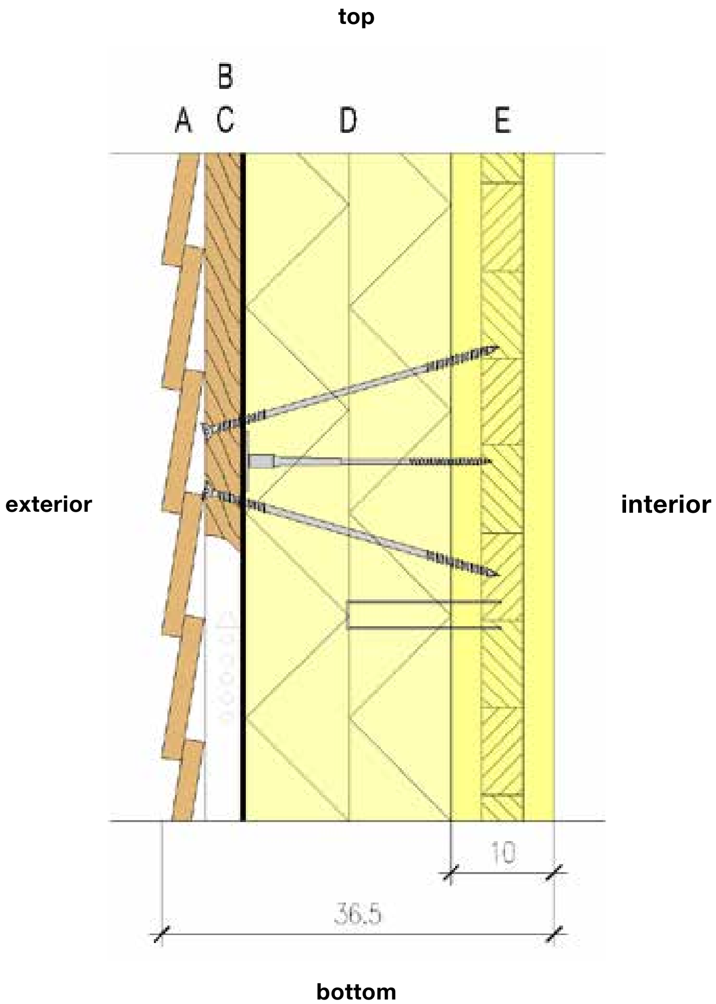
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	Homatherm EnergiePlus massive	8, 6	0.039	3	140	E
C	Homatherm HDP-Q11 standard	12, 10	0.038	3	110	E
D	CLT 120 C3s	12	0.110	50	470	D
E	wooden battens 50/40 | e = 62.5 cm	4	0.130	50	500	D
F	Homatherm ID-Q11 standard	4	0.038	3	110	E
G	fire-protection plasterboard	1.5	0.250	—	800	A2

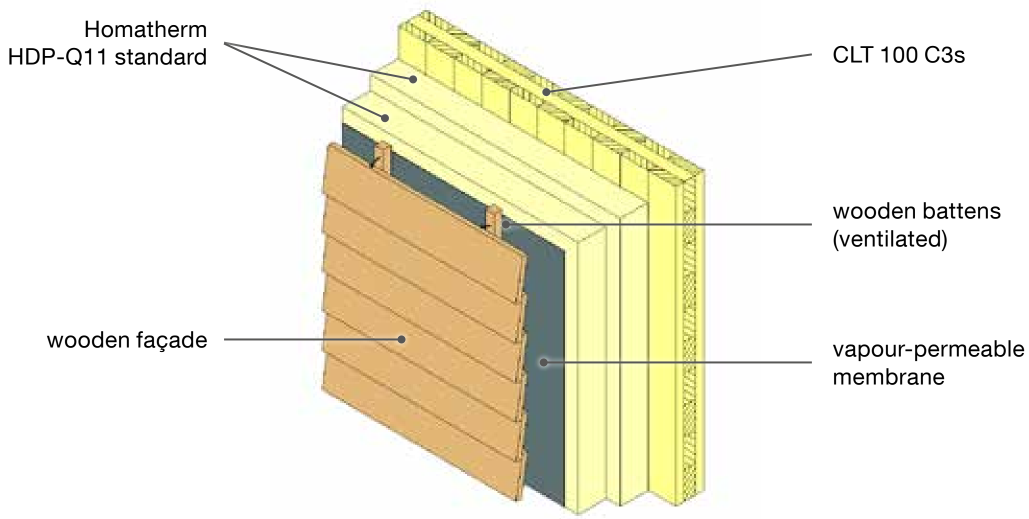
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 120	35	0.17	adequate	18.0	44	—
20	REI 120	35	0.15	adequate	18.0	44	—

Component designs

19. External wall — Variant 19 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.17**	**43**

Component design

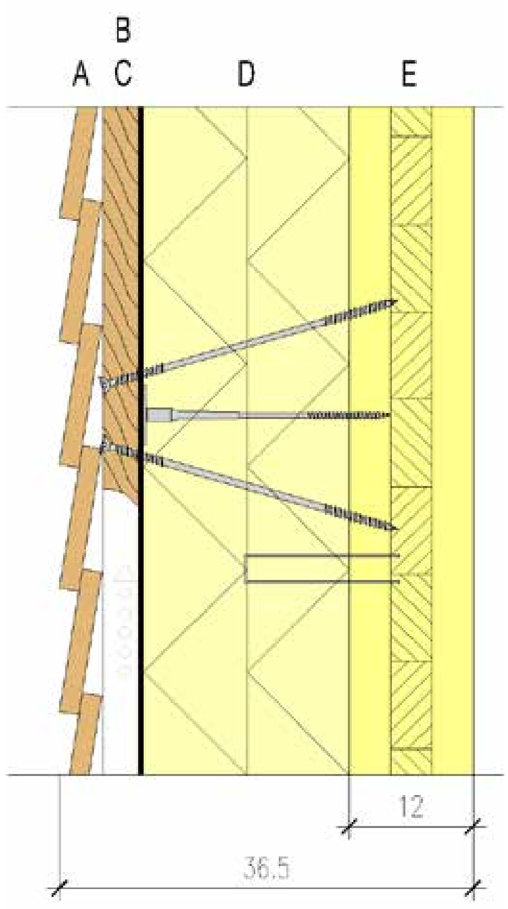
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	–	–	–	–	–
D	Homatherm HDP-Q11 standard (2 layers)	16, 20	0.038	3	110	E
E	CLT 100 C3s	10	0.110	50	470	D

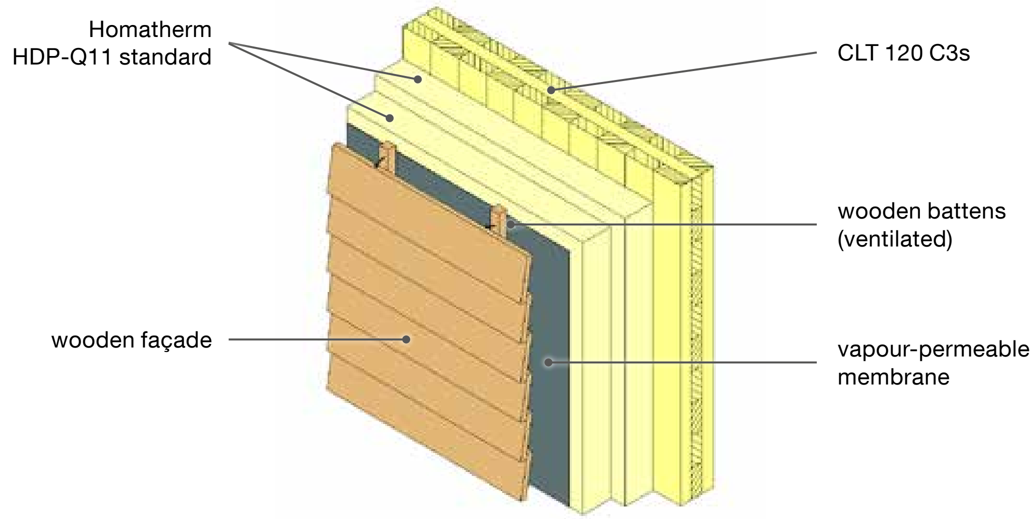
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 60	35	0.21	adequate	34.7	43	–
20	REI 60	35	0.17	adequate	34.8	43	–

Component designs

20. External wall — Variant 20 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.15**	**44**

Component design

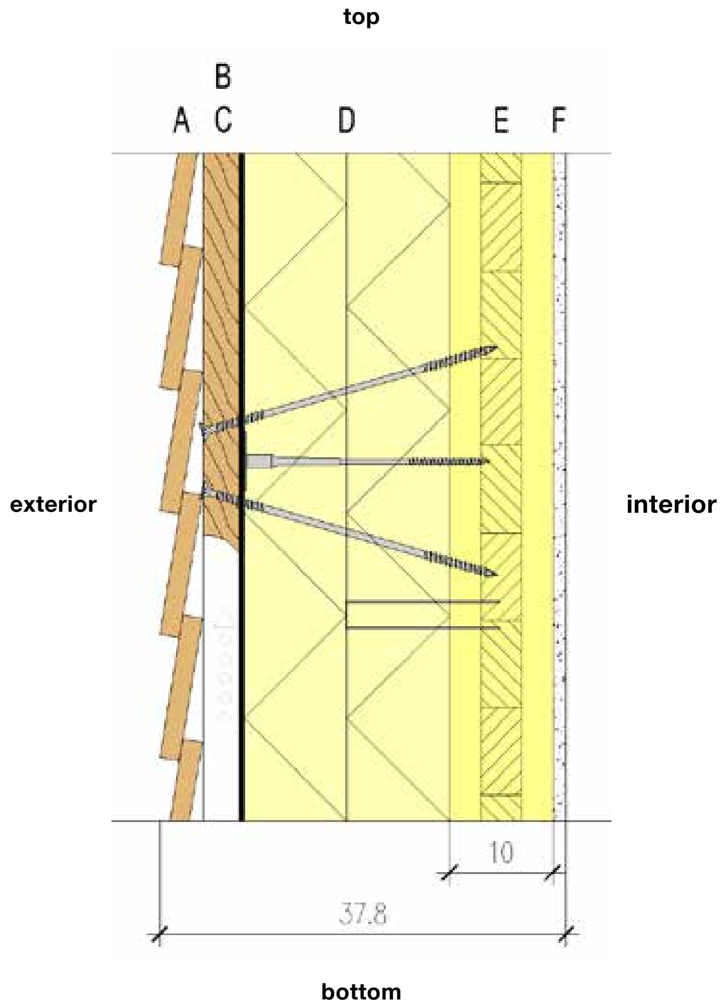
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	—	—	—	—	—
D	Homatherm HDP-Q11 standard (2 layers)	16, 18, 20, 24	0.038	3	110	E
E	CLT 120 C3s	12	0.110	50	470	D

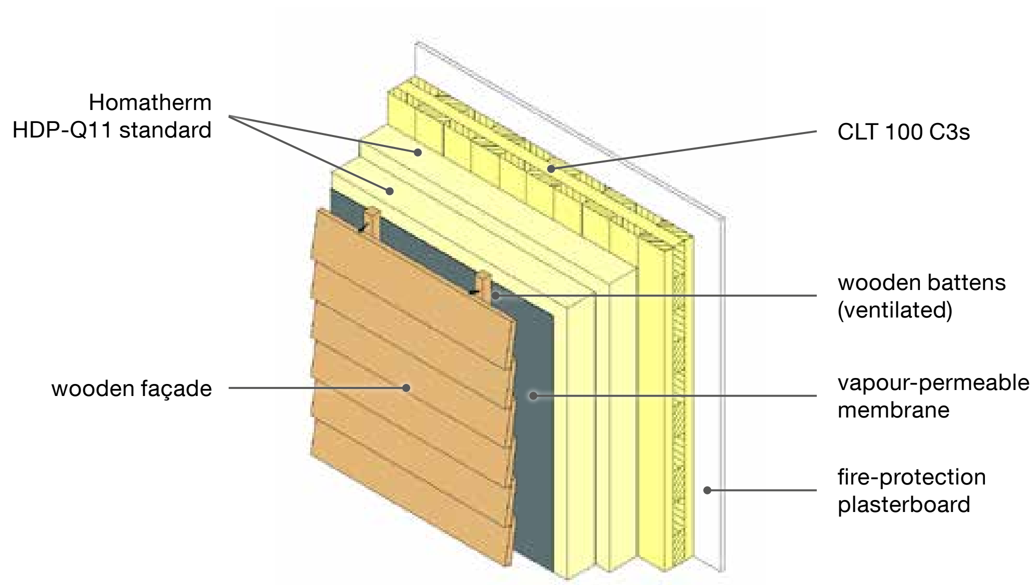
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 60	35	0.20	adequate	33.4	43	—
18	REI 60	35	0.18	adequate	33.4	43	—
20	REI 60	35	0.17	adequate	33.4	43	—
24	REI 60	35	0.15	adequate	33.4	44	—

Component designs

21. External wall — Variant 21 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	0.17	44

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	–	–	–	–	–
D	Homatherm HDP-Q11 standard (2 layers)	16, 20	0.038	3	110	E
E	CLT 100 C3s	10	0.110	50	470	D
F	fire-protection plasterboard	1.3	0.250	–	800	A2

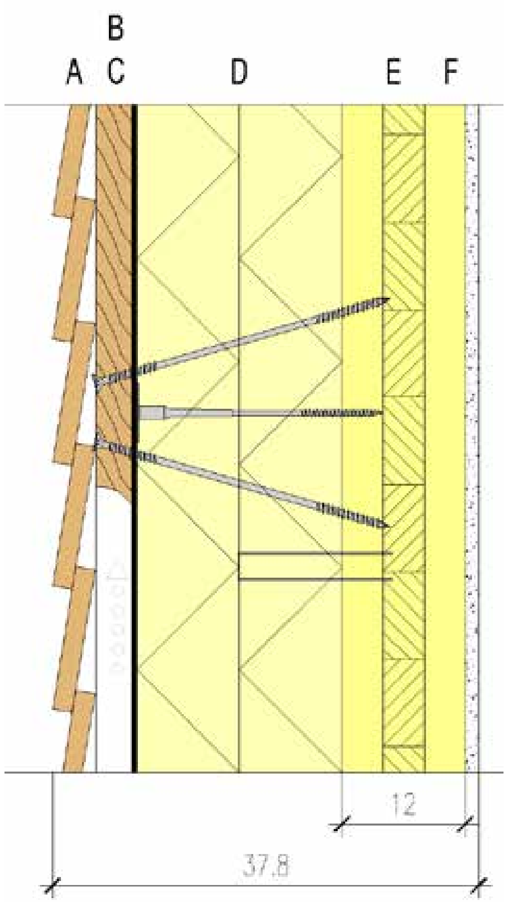
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.20	adequate	38.7	44	–
20	REI 90	35	0.17	adequate	38.8	44	–

22. External wall — Variant 22 of 29

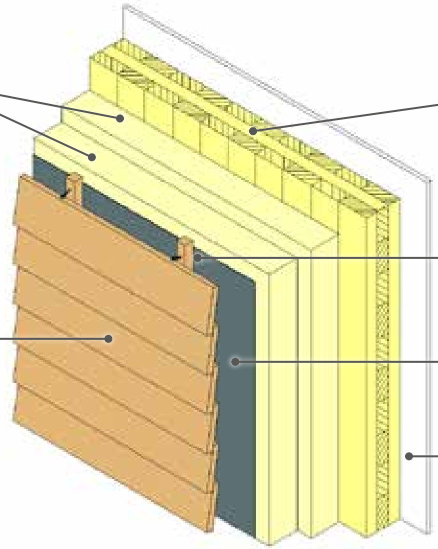
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m^2K)	Acoustic (R_w)
REI 90	0.17	44

Component design

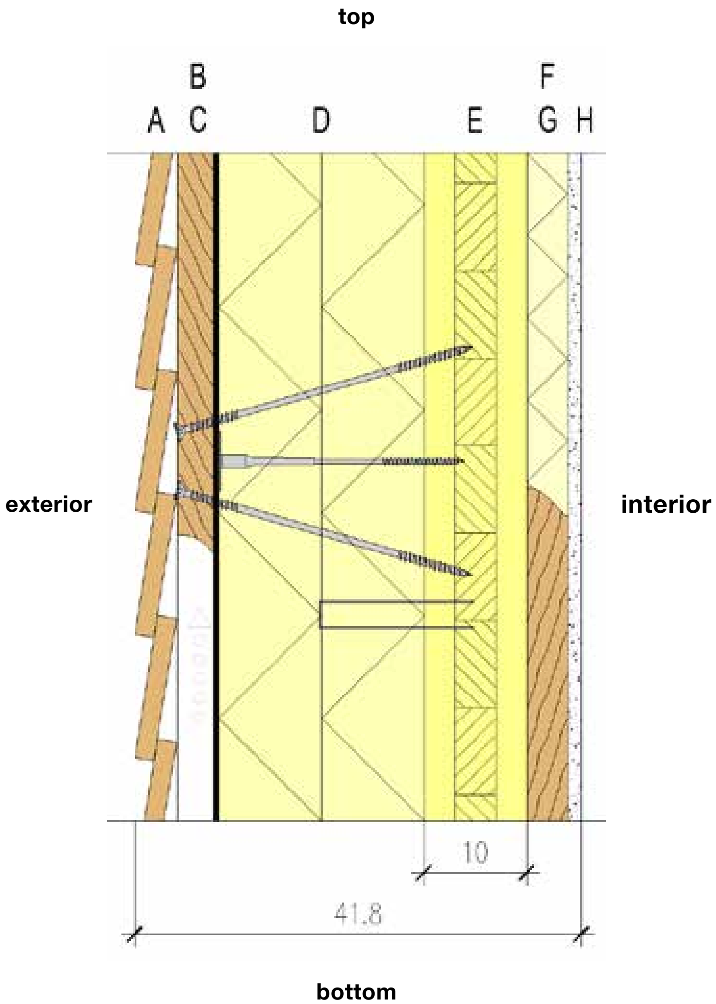
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m^3]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	–	–	–	–	–
D	Homatherm HDP-Q11 standard (2 layers)	16, 20	0.038	3	110	E
E	CLT 120 C3s	12	0.110	50	470	D
F	fire-protection plasterboard	1.3	0.250	–	800	A2

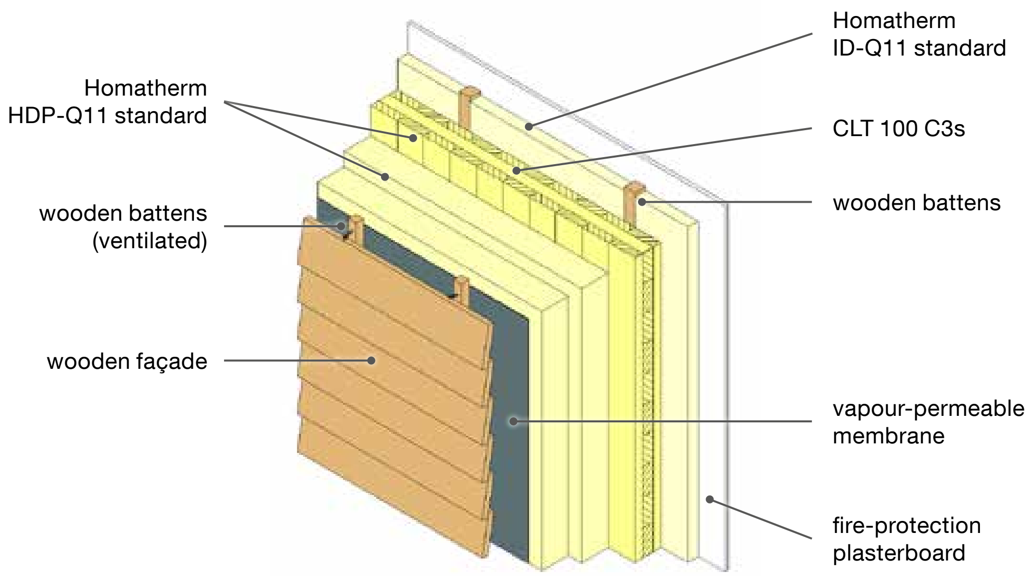
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m^2K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m^2]	R_w	$L_{n,w}$
16	REI 90	35	0.20	adequate	37.4	44	–
20	REI 90	35	0.17	adequate	37.4	44	–

Component designs

23. External wall — Variant 23 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.15**	**48**

Component design

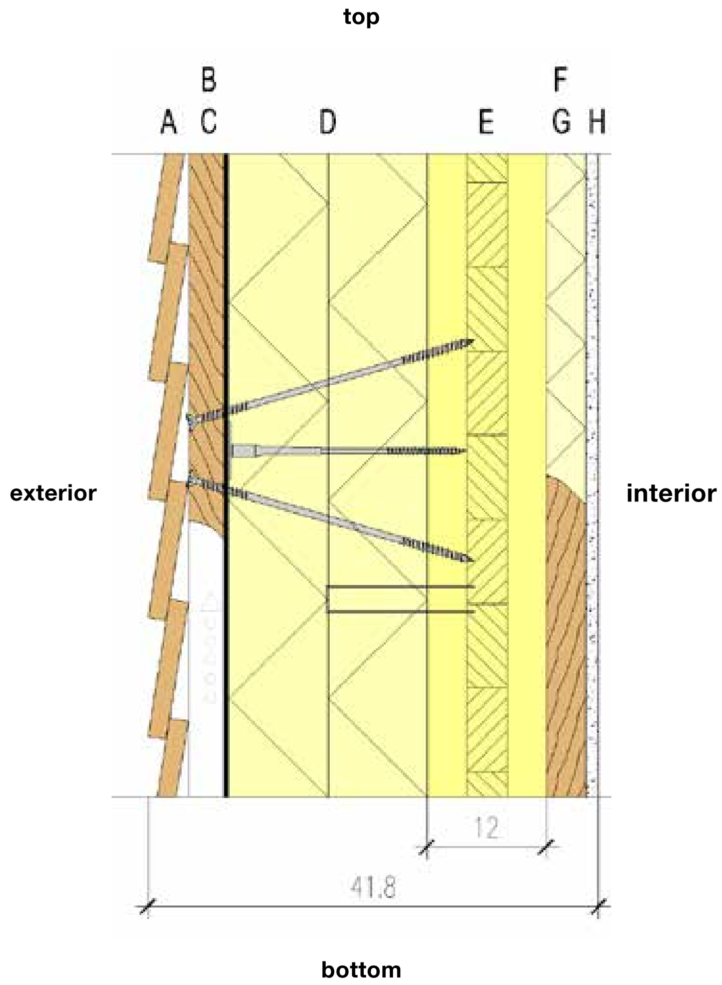
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	—	—	—	—	—
D	Homatherm HDP-Q11 standard (2 layers)	16, 20	0.038	3	110	E
E	CLT 100 C3s	10	0.110	50	470	D
F	wooden battens 50/40 | e = 62.5 cm	4	0.130	50	500	D
G	Homatherm ID-Q11 standard	4	0.038	3	130	E
H	fire-protection plasterboard	1.5	0.250	—	800	A2

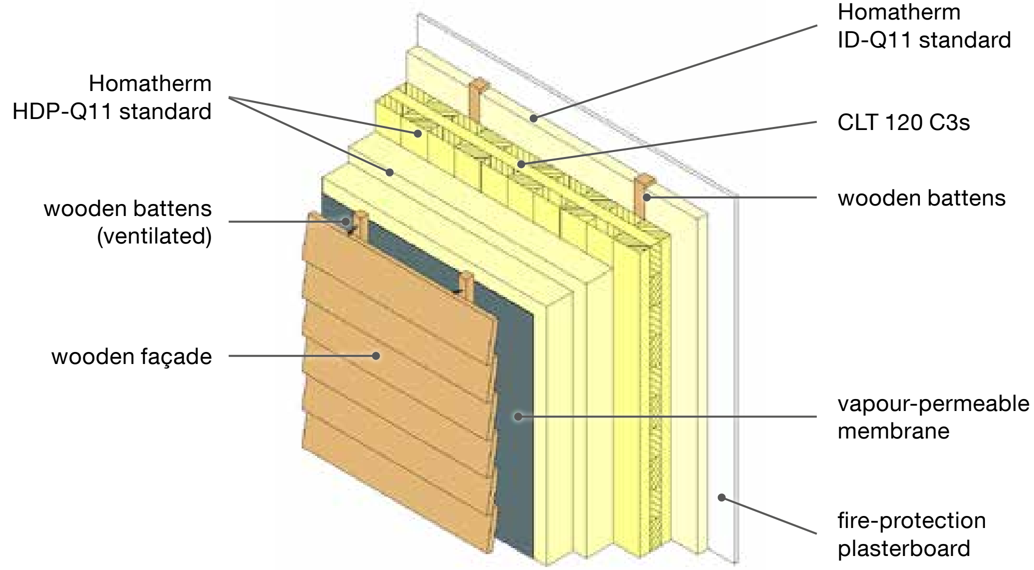
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 120	35	0.18	adequate	18.1	48	—
20	REI 120	35	0.15	adequate	18.1	48	—

Component designs

24. External wall — Variant 24 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.15**	**48**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	—	—	—	—	—
D	Homatherm HDP-Q11 standard (2 layers)	16, 20	0.038	3	130	E
E	CLT 120 C3s	12	0.110	50	470	D
F	wooden battens 50/40 | e = 62.5 cm	4	0.130	50	500	D
G	Homatherm ID-Q11 standard	4	0.038	3	110	E
H	fire-protection plasterboard	1.5	0.250	—	800	A2

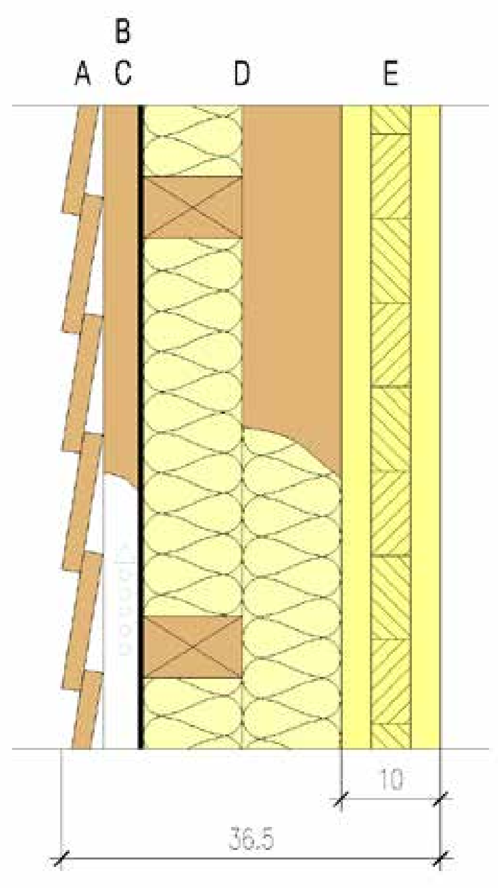
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 120	35	0.17	adequate	16.5	48	—
20	REI 120	35	0.15	adequate	16.5	48	—

25. External wall — Variant 25 of 29

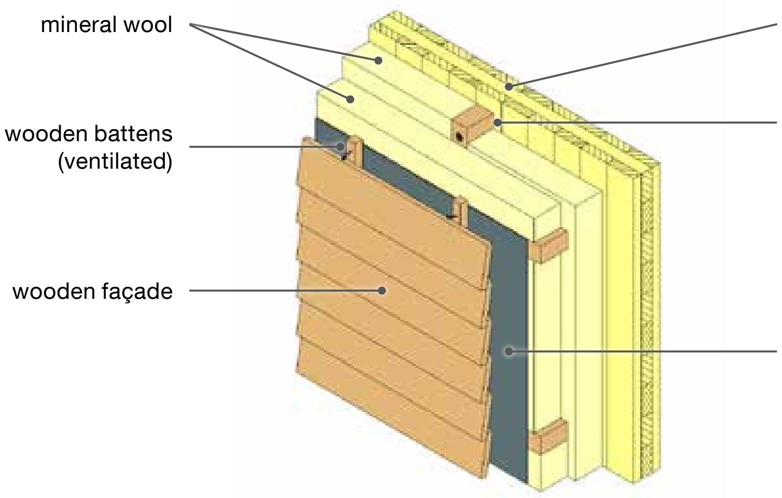
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.16**	**47**

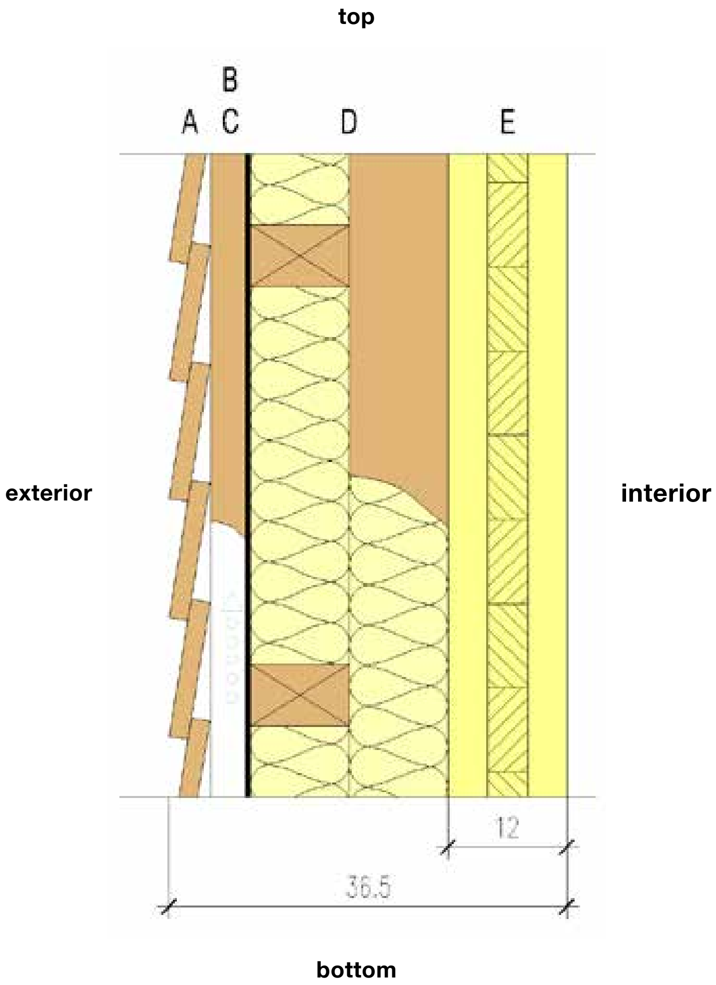
Component design

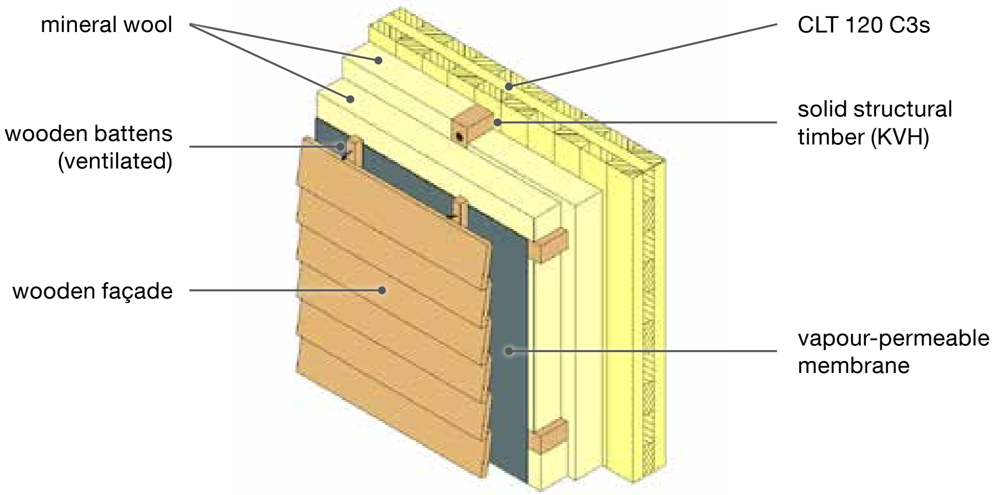
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	–	–	–	–	–
D	structural timber 6/x | e = 62.5 cm	16, 20, 26	0.130	50	500	D
D	mineral wool	16, 20, 26	0.035	1	18	A1
E	CLT 100 C3s	10	0.250	–	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 60	35	0.20	adequate	34.4	47	–
20	REI 60	35	0.16	adequate	34.7	47	–
26	REI 60	35	0.13	adequate	34.8	48	–

26. External wall — Variant 26 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.16**	**47**

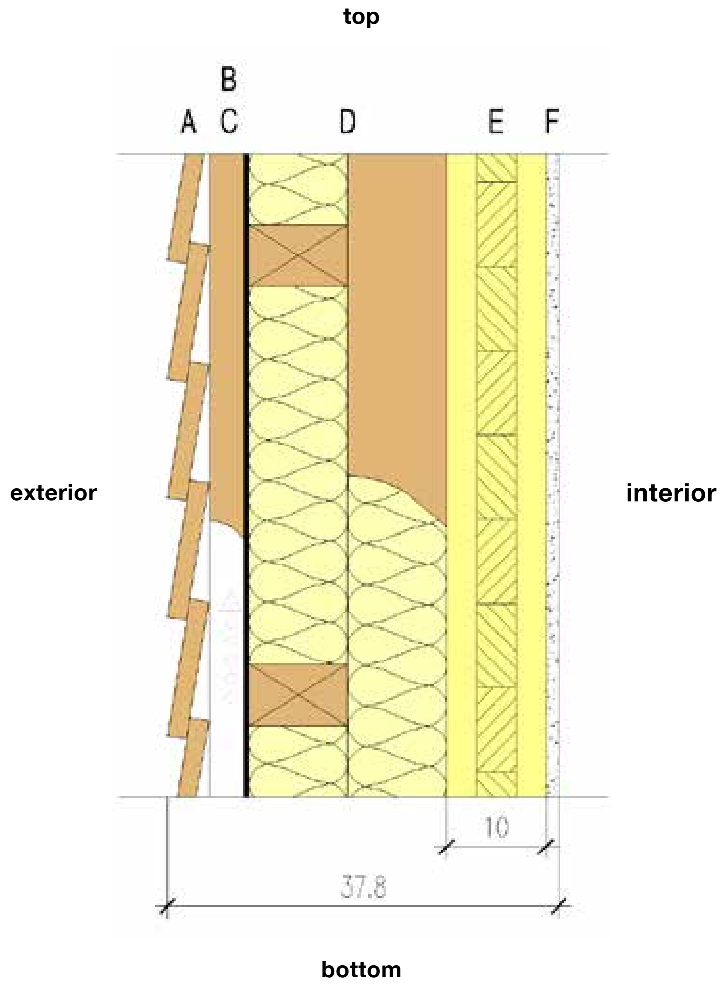
Component design

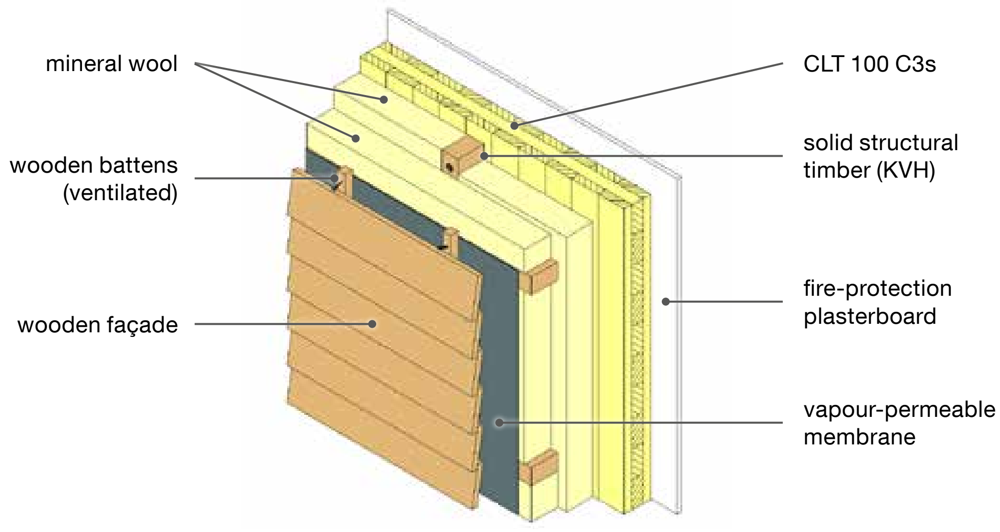
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	—	—	—	—	—
D	structural timber 6/x | e = 62.5 cm	16, 20, 26	0.130	50	500	D
D	mineral wool	16, 20, 26	0.035	1	18	A1
E	CLT 120 C3s	12	0.110	50	470	D

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 60	35	0.19	adequate	33.3	47	—
20	REI 60	35	0.16	adequate	33.4	47	—
26	REI 60	35	0.13	adequate	33.4	48	—

27. External wall — Variant 27 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.16**	**51**

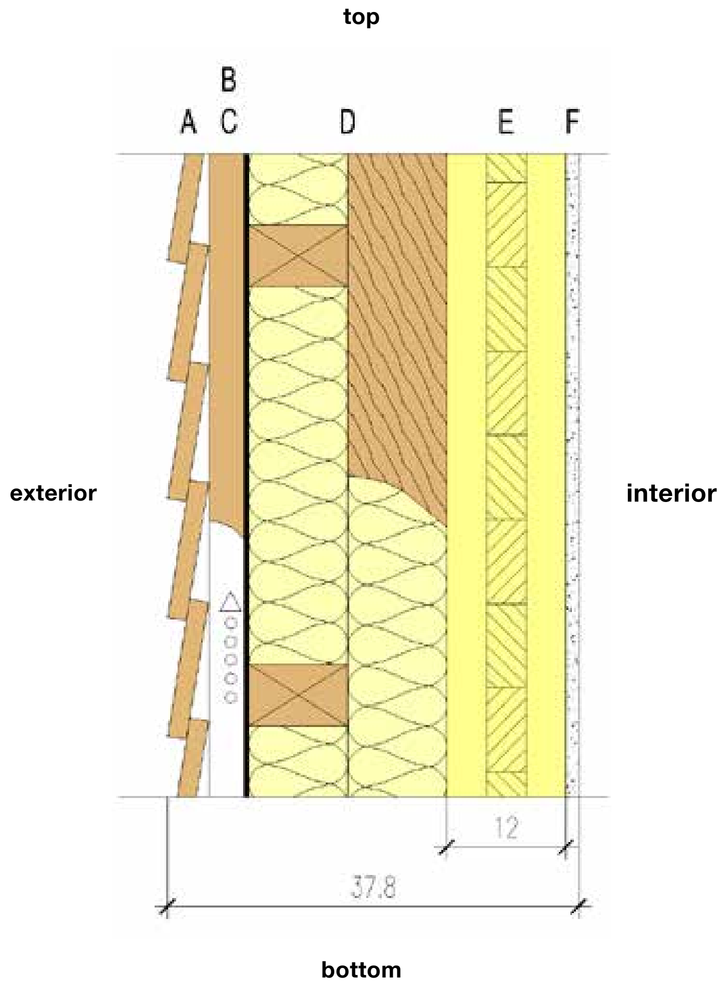
Component design

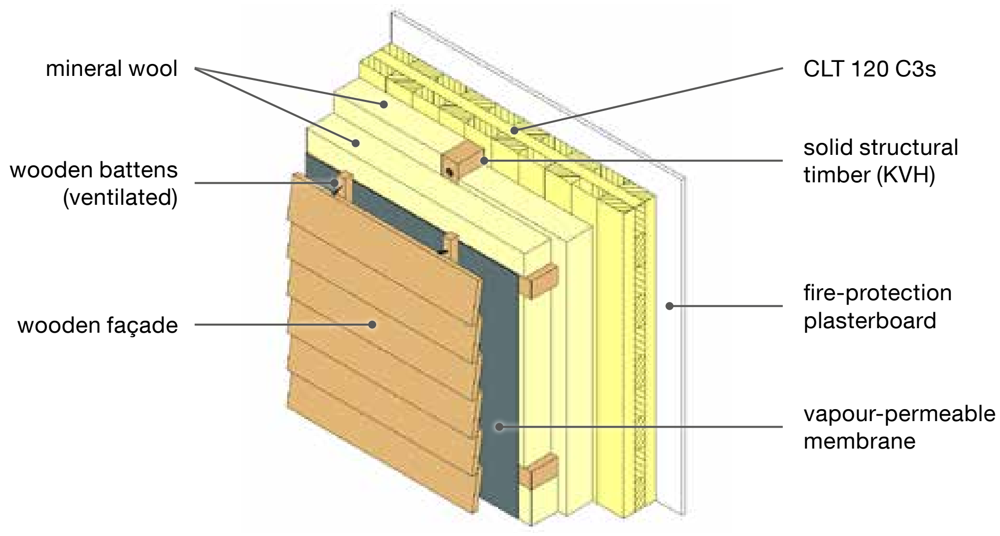
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	—	—	—	—	—
D	structural timber 6/x | e = 62.5 cm	16, 20, 26	0.130	50	500	D
D	mineral wool	16, 20, 26	0.035	1	18	A1
E	CLT 100 C3s	10	0.110	50	470	D
F	fire-protection plasterboard	1.3	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.19	adequate	38.7	51	—
20	REI 90	35	0.16	adequate	38.7	51	—
26	REI 90	35	0.13	adequate	38.8	52	—

28. External wall — Variant 28 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	0.16	51

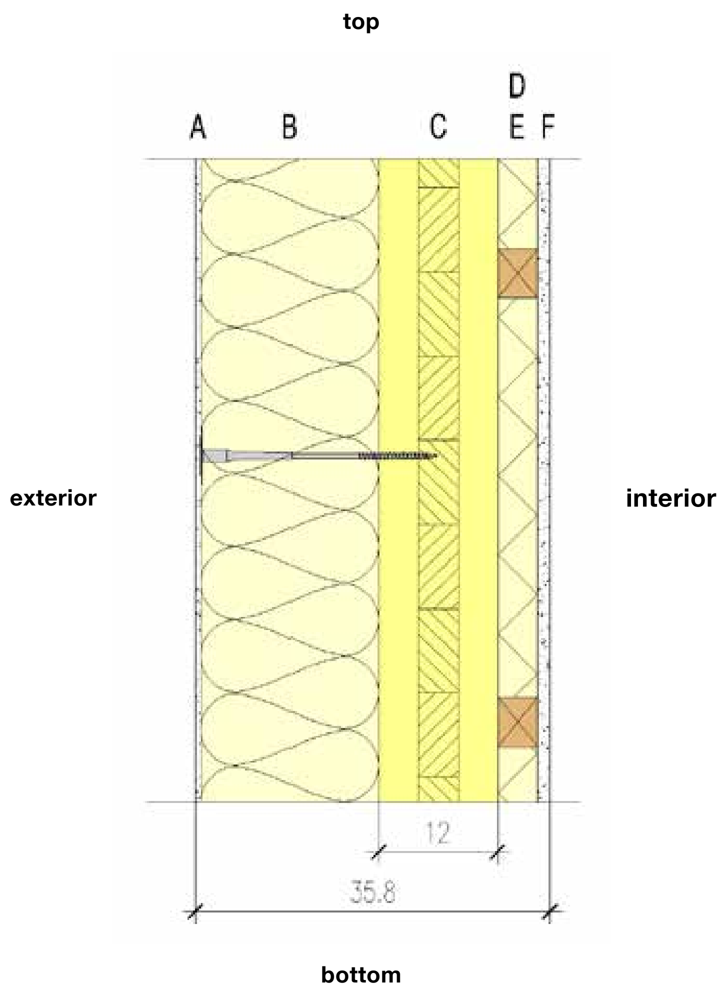
Component design

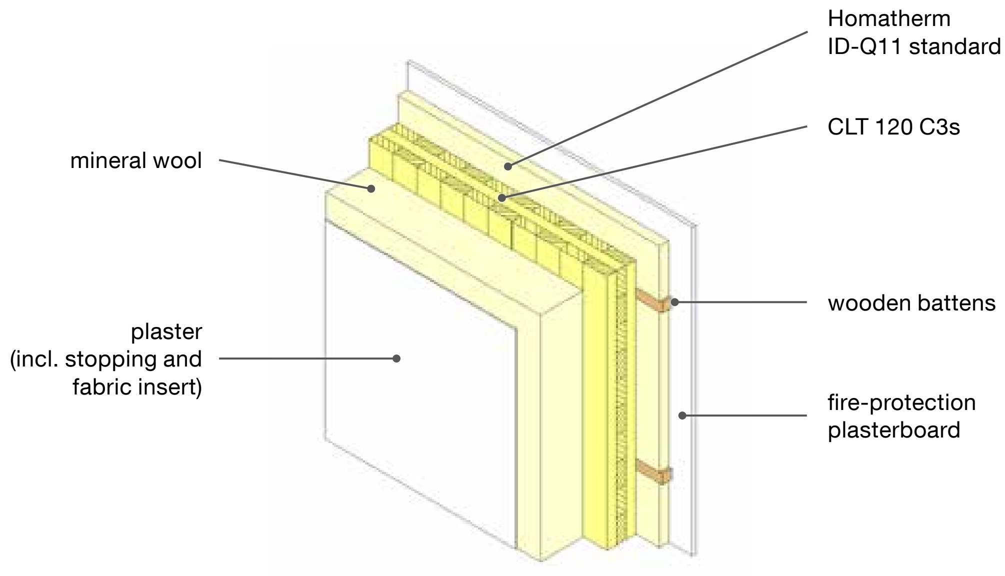
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	wooden façade	2.5	0.130	50	500	D
B	wooden battens (ventilated)	3	0.130	50	500	D
C	vapour-permeable membrane	—	—	—	—	—
D	structural timber 6/x | e = 62.5 cm	16, 20, 26	0.130	50	500	D
D	mineral wool	16, 20, 26	0.035	1	18	A1
E	CLT 120 C3s	12	0.110	50	470	D
F	fire-protection plasterboard	1.3	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
16	REI 90	35	0.19	adequate	37.4	51	—
20	REI 90	35	0.16	adequate	37.3	51	—
26	REI 90	35	0.13	adequate	37.4	52	—

29. External wall — Variant 29 of 29





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.14**	**44**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	plaster (incl. stopping and fabric insert)	0.5	1.000	10–35	2,000	A1
B	mineral wool	18	0.035	1	18	A1
C	CLT 120 C3s	12	0.110	50	470	D
D	wooden battens 50/40 | e = 62.5 cm	4	0.130	50	500	D
E	Homatherm ID-Q11 standard	4	0.038	3	130	E
F	fire-protection plasterboard	1.5	0.250	–	800	A2

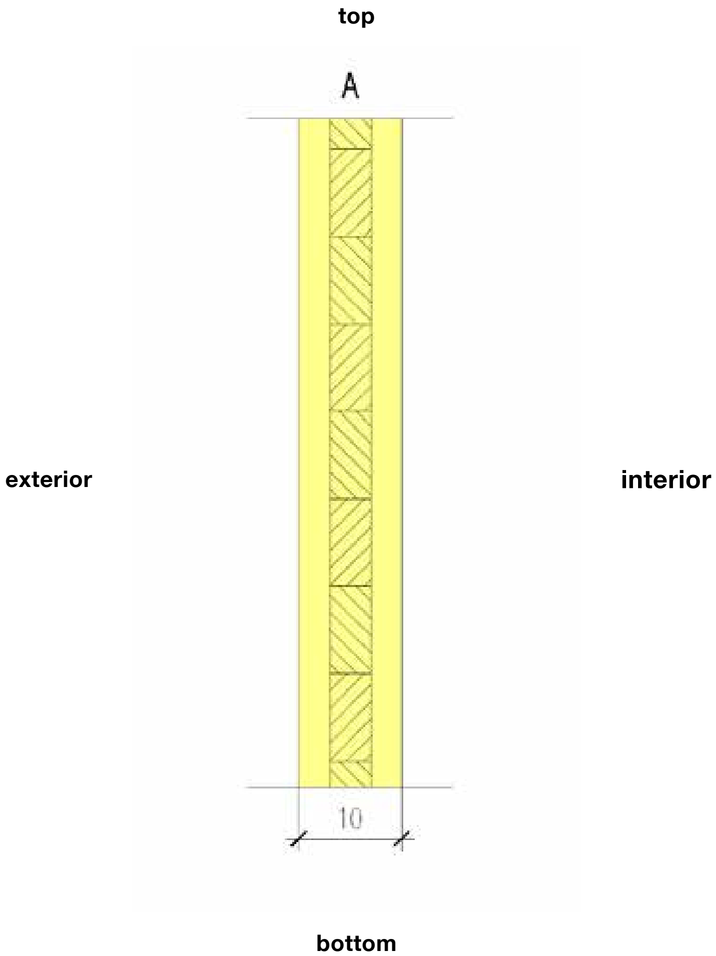
Structural-physical analysis

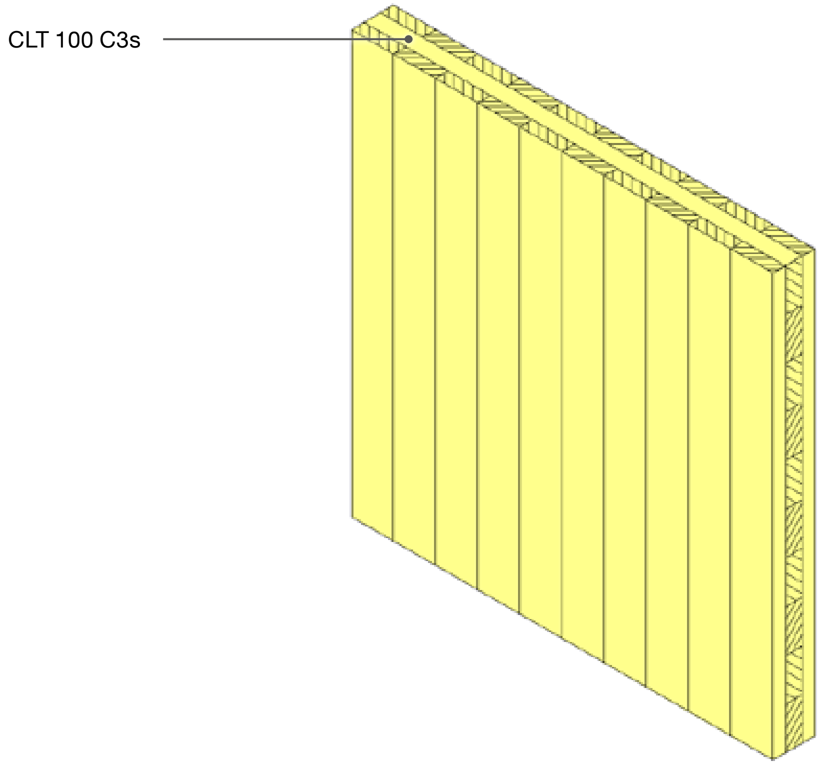
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
18	REI 120	35	0.14	adequate	16.3	44	–

Component designs

Internal walls

1. Internal wall — Variant 1 of 11





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	0.86	34

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	CLT 100 C3s	10	0.110	50	470	D

Structural-physical analysis

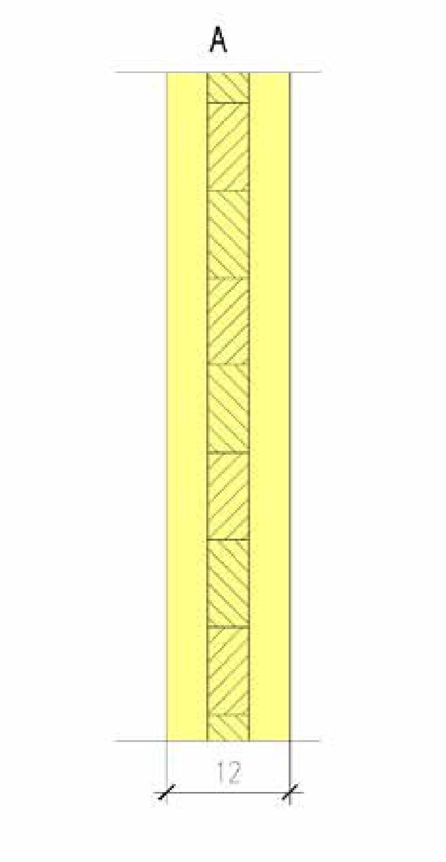
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
–	REI 60	35	0.86	adequate	29.6	34	–

Component designs

2. Internal wall — Variant 2 of 11

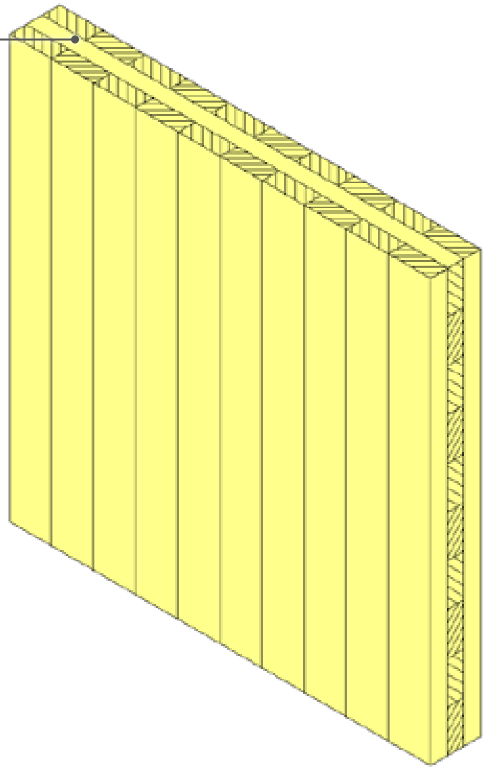
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	0.74	35

Component design

	Material	Thickness [cm]	λ [W/(mK)]	µ	ρ [kg/m³]	Flammability category
A	CLT 120 C3s	12	0.110	50	470	D

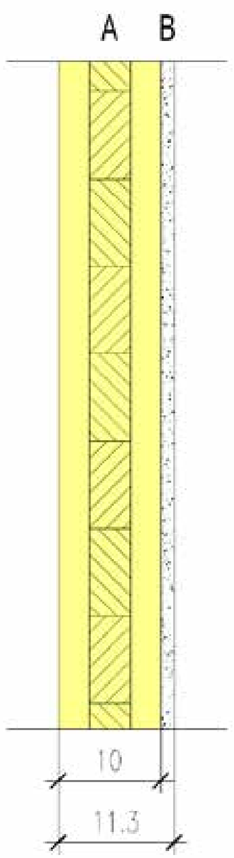
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
–	REI 60	35	0.74	adequate	31.1	35	–

3. Internal wall — Variant 3 of 11

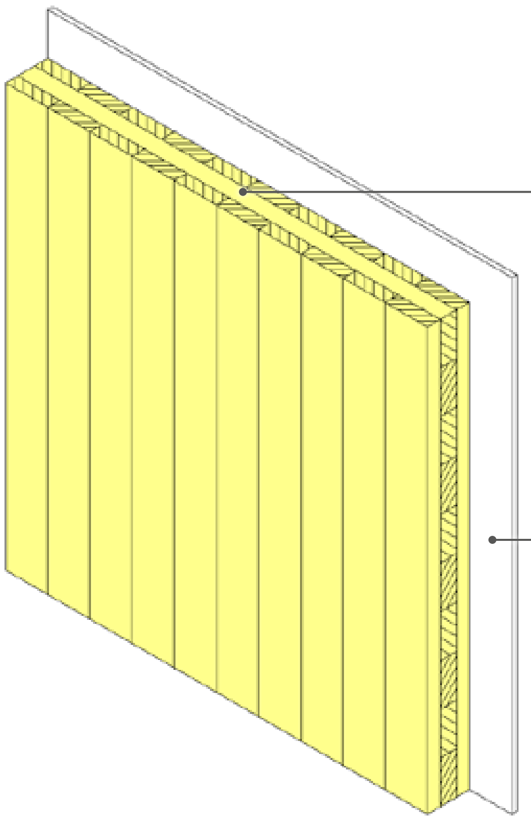
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.82**	**36**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	µ	ρ [kg/m³]	Flammability category
A	CLT 100 C3s	10	0.110	50	470	D
B	fire-protection plasterboard	1.3	0.250	–	800	A2

Structural-physical analysis

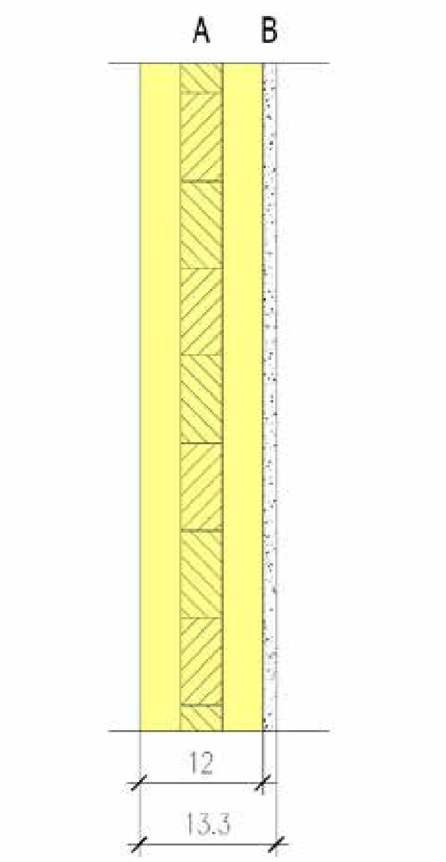
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
–	REI 90	35	0.82	adequate	34.5 (FPP) 30.0 (wood)	36	–

Component designs

4. Internal wall — Variant 4 of 11

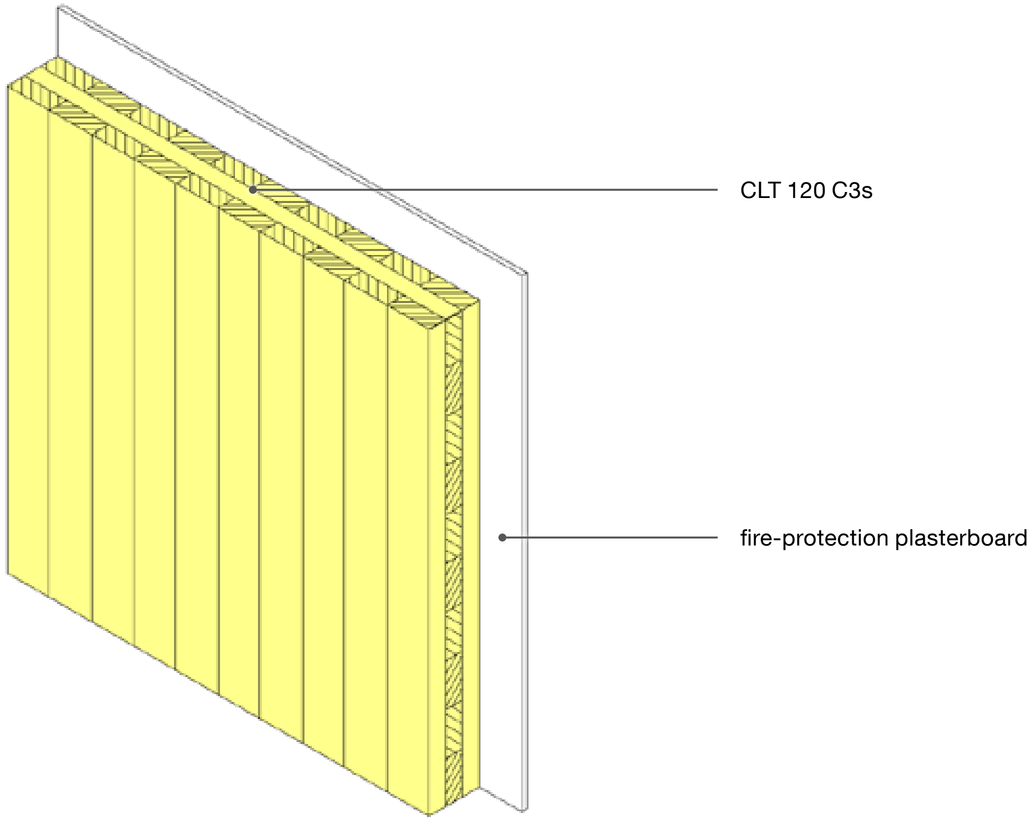
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	0.71	37

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	CLT 120 C3s	12	0.110	50	470	D
B	fire-protection plasterboard	1.3	0.250	–	800	A2

Structural-physical analysis

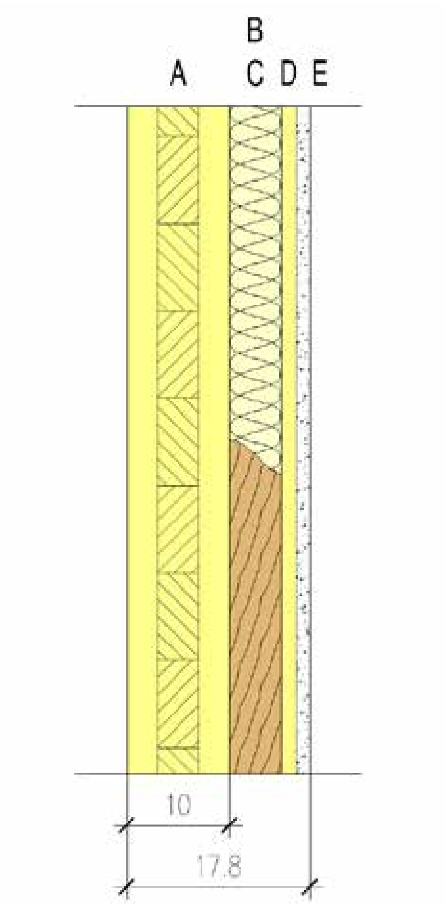
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
–	REI 90	35	0.71	adequate	36.0 (FPP) 31.4 (wood)	37	–

Component designs

5. Internal wall — Variant 5 of 11

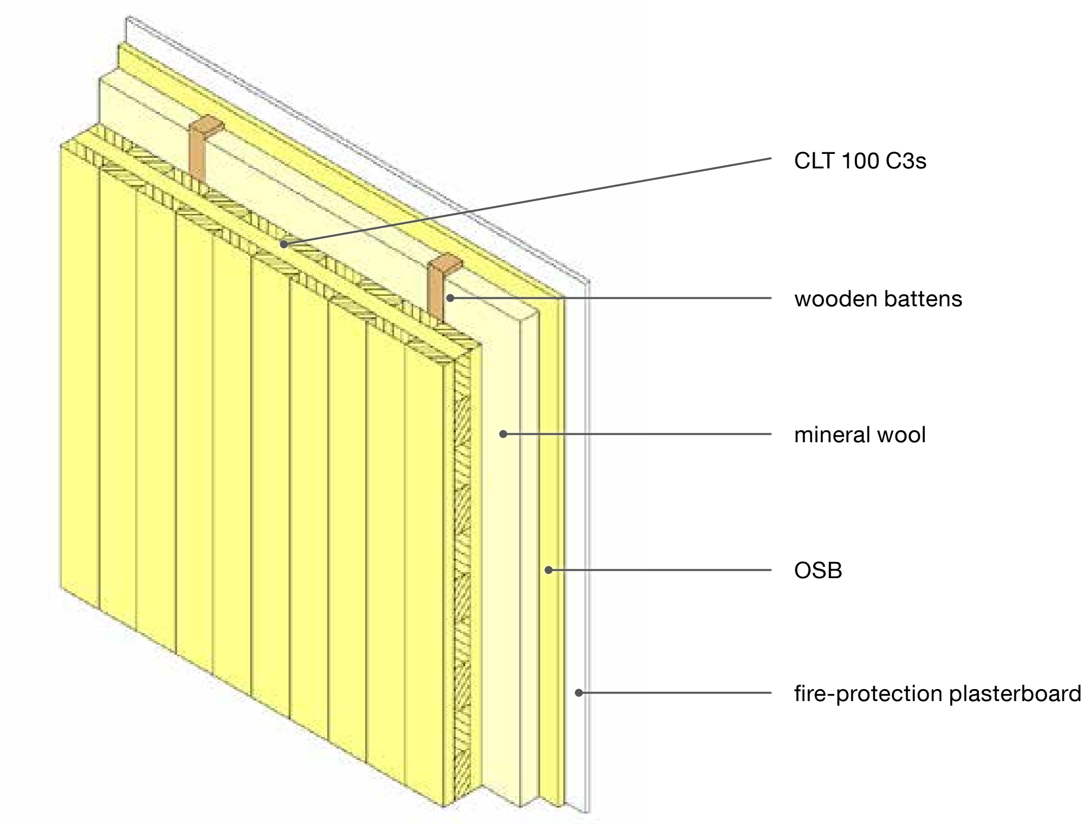
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.38**	**41**

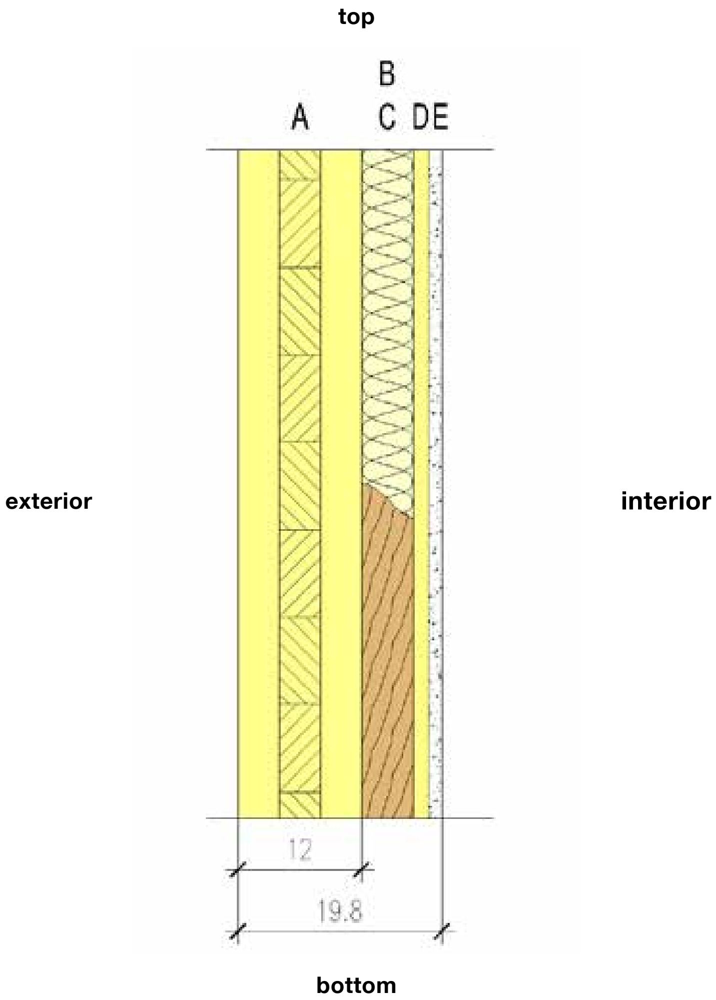
Component design

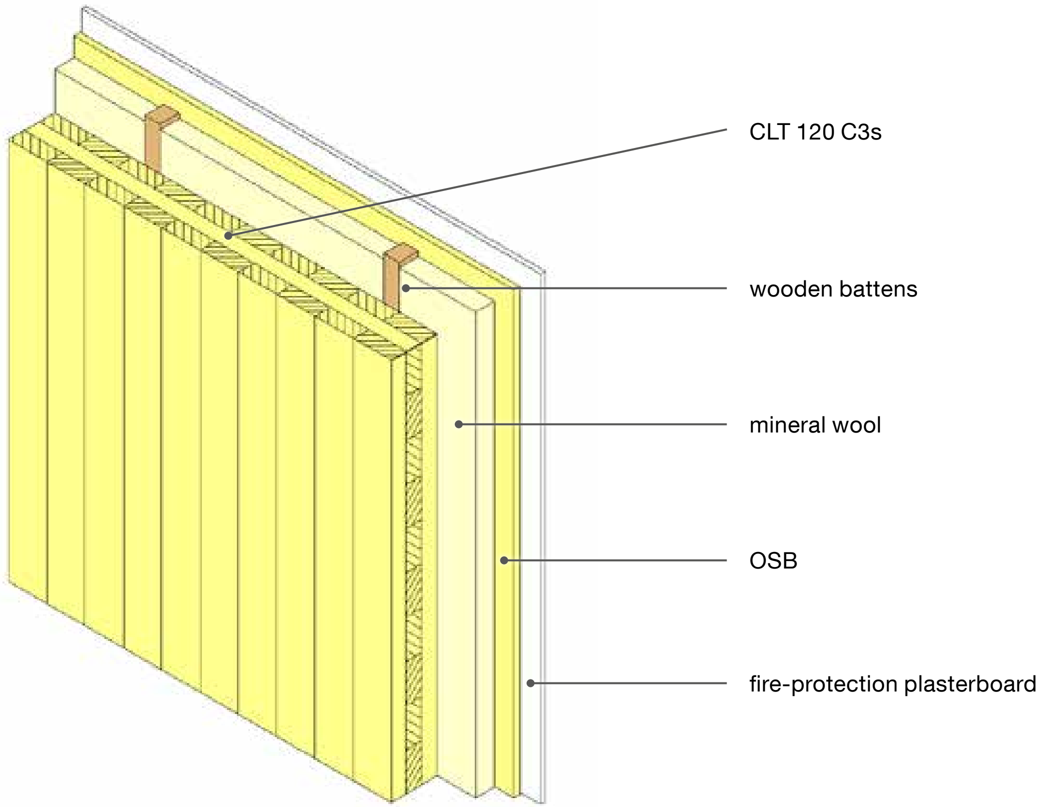
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	CLT 100 C3s	10	0.110	50	470	D
B	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
C	mineral wool	5	0.035	—	18	A1
D	OSB	1.5	0.130	200–300	600	B
E	fire-protection plasterboard	1.3	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
—	REI 120	35	0.38	adequate	27.2 (service cavity) 33.8 (wood)	41	—

6. Internal wall — Variant 6 of 11





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.36**	**41**

Component design

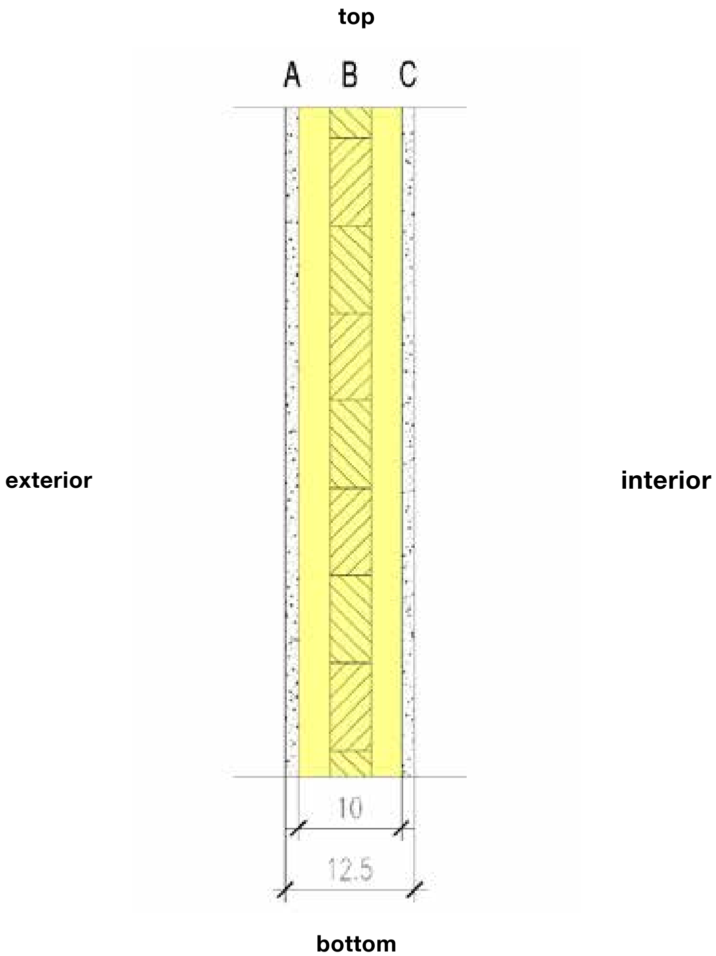
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	CLT 120 C3s	12	0.110	50	470	D
B	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
C	mineral wool	5	0.035	—	18	A1
D	OSB	1.5	0.130	200–300	600	B
E	fire-protection plasterboard	1.3	0.250	—	800	A2

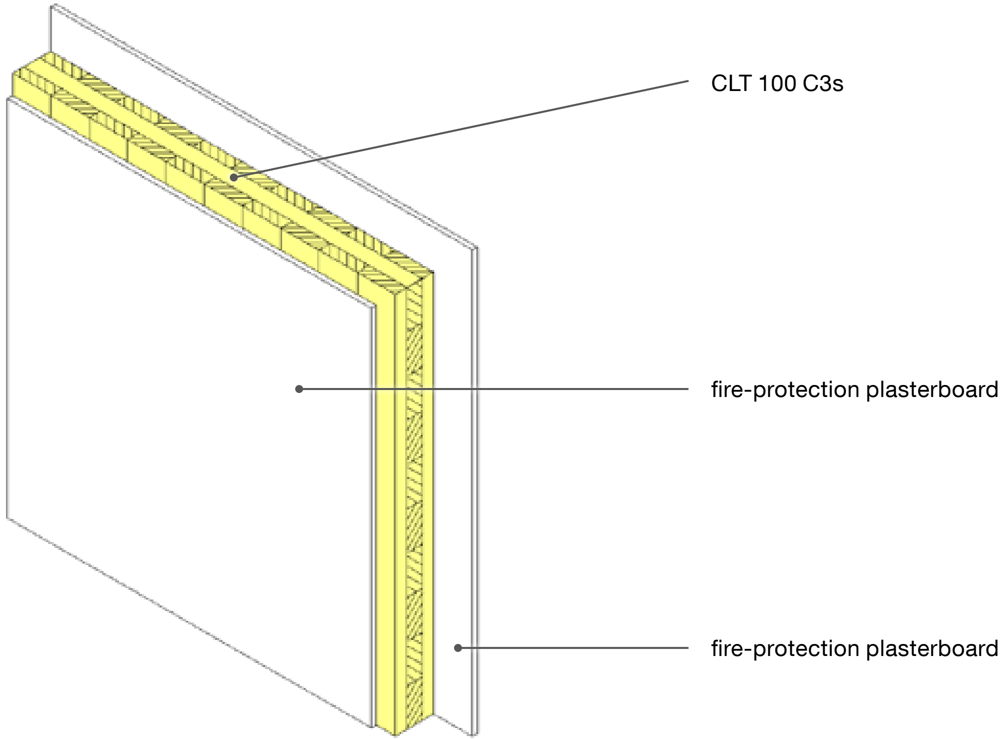
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
—	REI 120	35	0.36	adequate	27.2 (service cavity) 33.0 (wood)	41	—

Component designs

7. Internal wall — Variant 7 of 11





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.79**	**38**

Component design

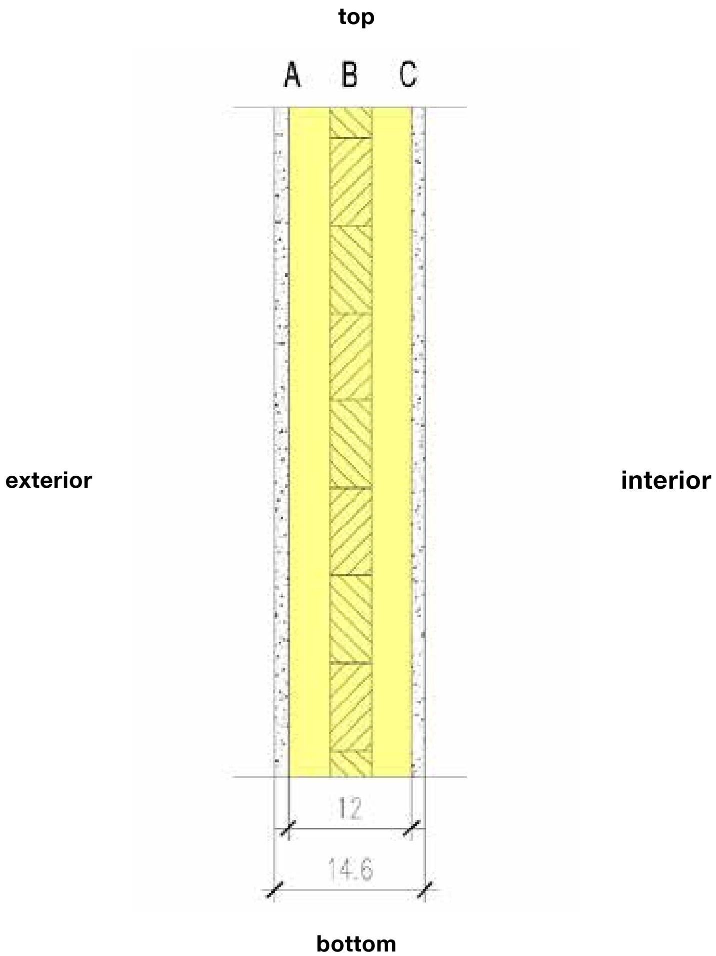
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	–	800	A2
B	CLT 100 C3s	10	0.110	50	470	D
C	fire-protection plasterboard	1.3	0.250	–	800	A2

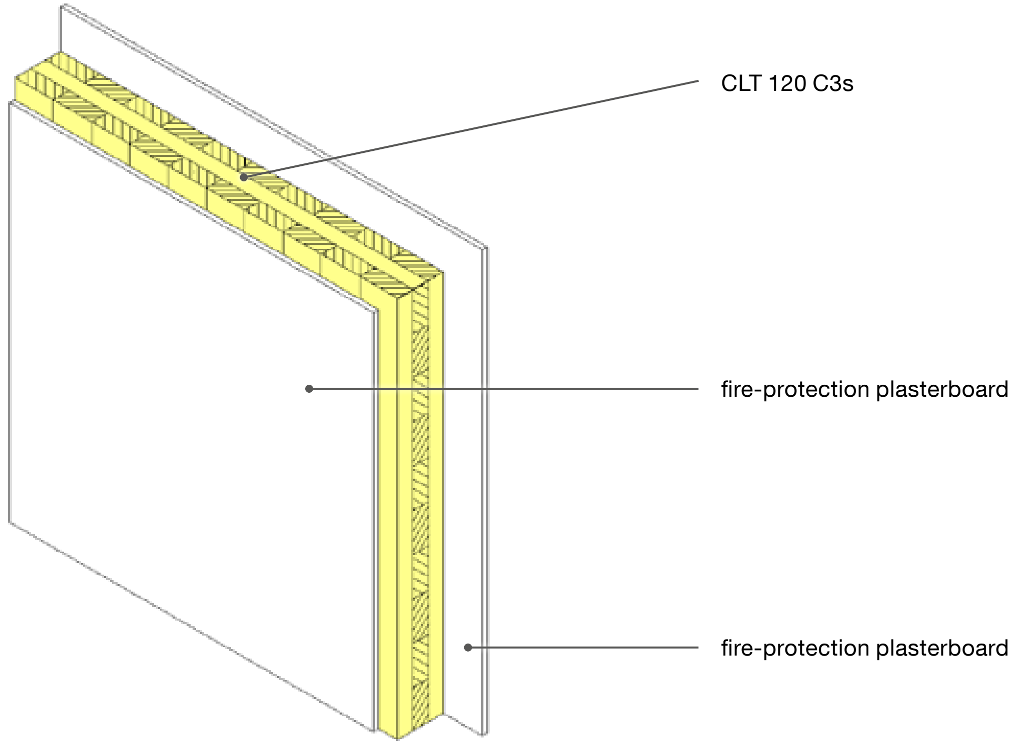
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
–	REI 90	35	0.79	adequate	35.0	38	–

Component designs

8. Internal wall — Variant 8 of 11





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	0.69	38

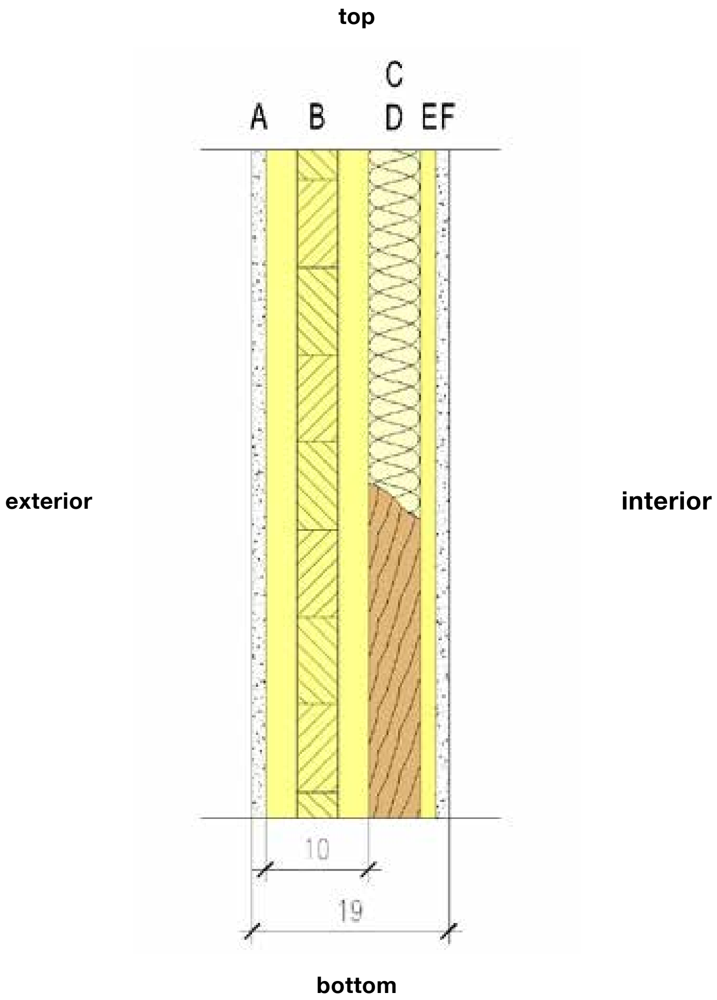
Component design

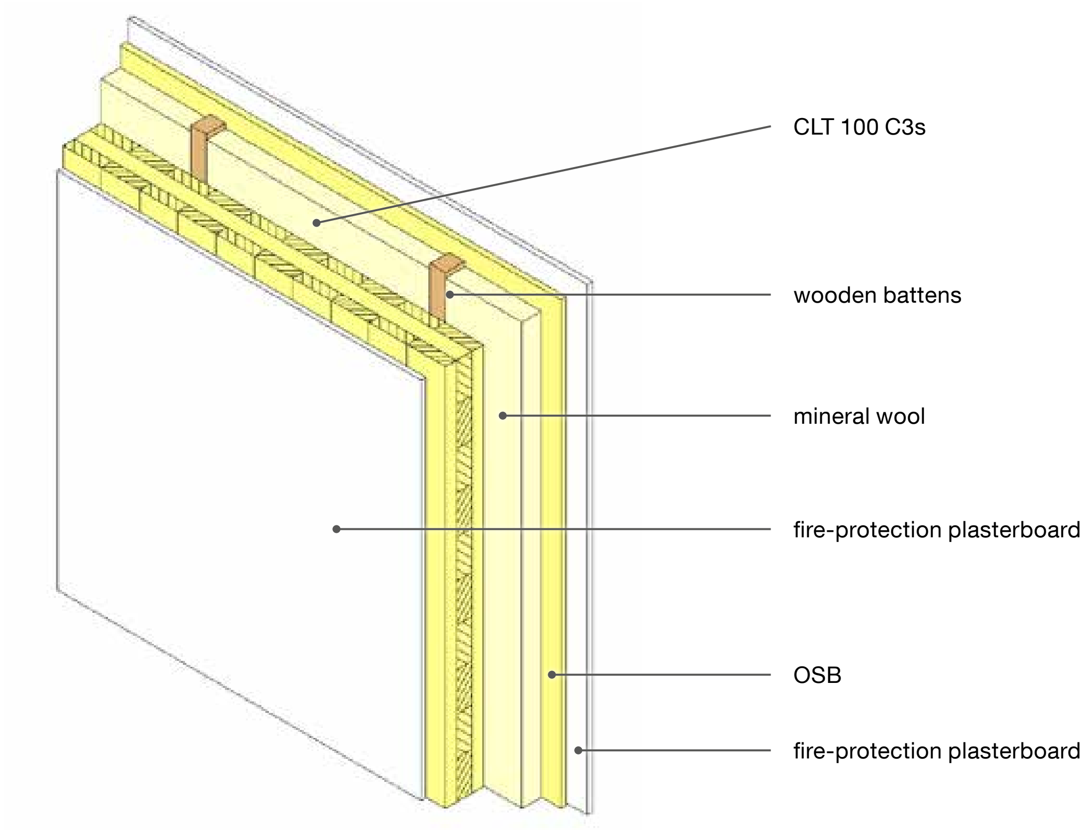
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	–	800	A2
B	CLT 120 C3s	12	0.110	50	470	D
C	fire-protection plasterboard	1.3	0.250	–	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
–	REI 90	35	0.69	adequate	36.2	38	–

9. Internal wall — Variant 9 of 11





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.38**	**42**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	—	800	A2
B	CLT 100 C3s	10	0.110	50	470	D
C	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
D	mineral wool	5	0.035	—	18	A1
E	OSB	1.5	0.130	200–300	600	B
F	fire-protection plasterboard	1.3	0.250	—	800	A2

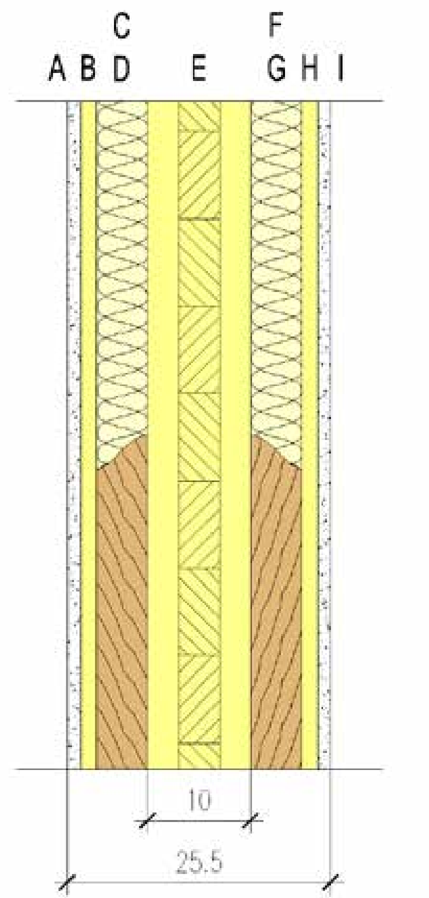
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
—	REI 120	35	0.38	adequate	27.1 (service cavity) 38.1 (wood)	42	—

10. Internal wall — Variant 10 of 11

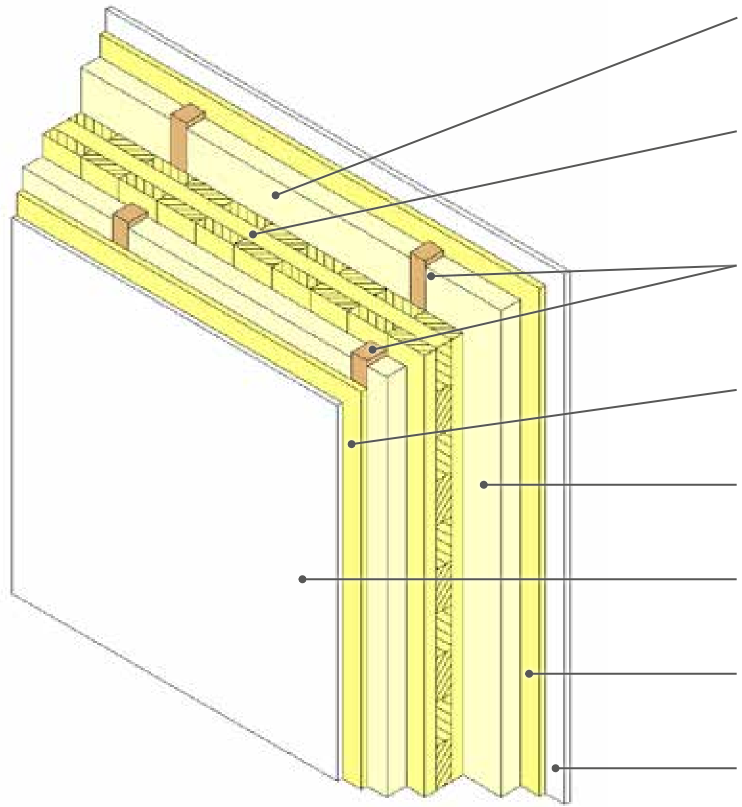
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.25**	**46**

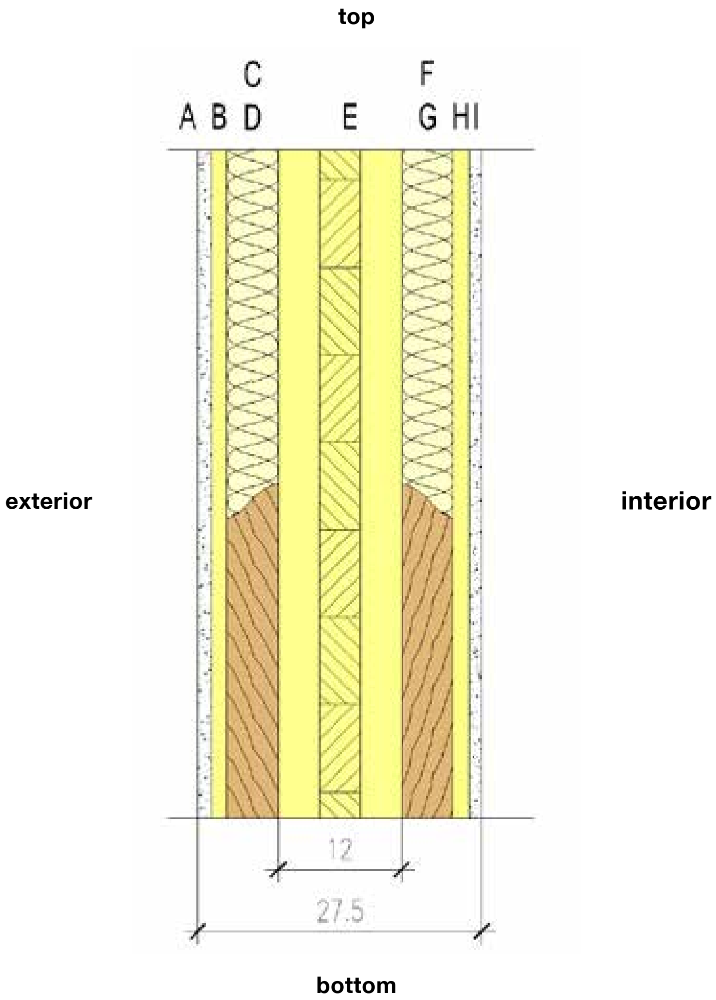
Component design

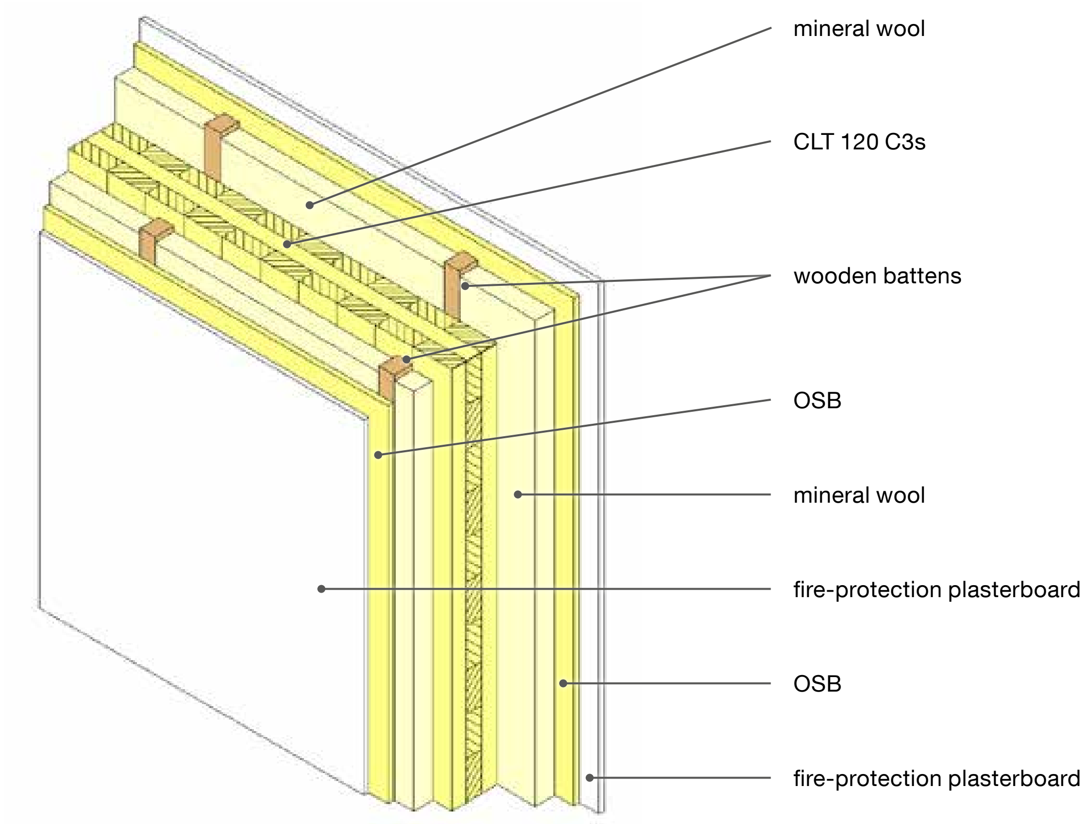
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	–	800	A2
B	OSB	1.5	0.130	200–300	600	B
C	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
D	mineral wool	5	0.035	–	18	A1
E	CLT 100 C3s	10	0.110	50	470	D
F	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
G	mineral wool	5	0.035	–	18	A1
H	OSB	1.5	0.130	200–300	600	B
I	fire-protection plasterboard	1.3	0.250	–	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
–	REI 120	35	0.25	adequate	27.2	46	–

11. Internal wall — Variant 11 of 11





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.24**	**46**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	–	800	A2
B	OSB	1.5	0.130	200–300	600	B
C	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
D	mineral wool	5	0.035	–	18	A1
E	CLT 120 C3s	12	0.110	50	470	D
F	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
G	mineral wool	5	0.035	–	18	A1
H	OSB	1.5	0.130	200–300	600	B
I	fire-protection plasterboard	1.3	0.250	–	800	A2

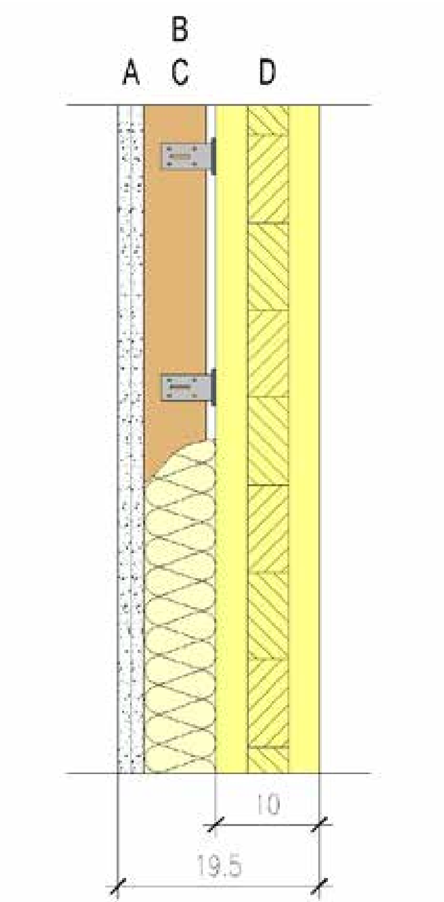
Structural-physical analysis

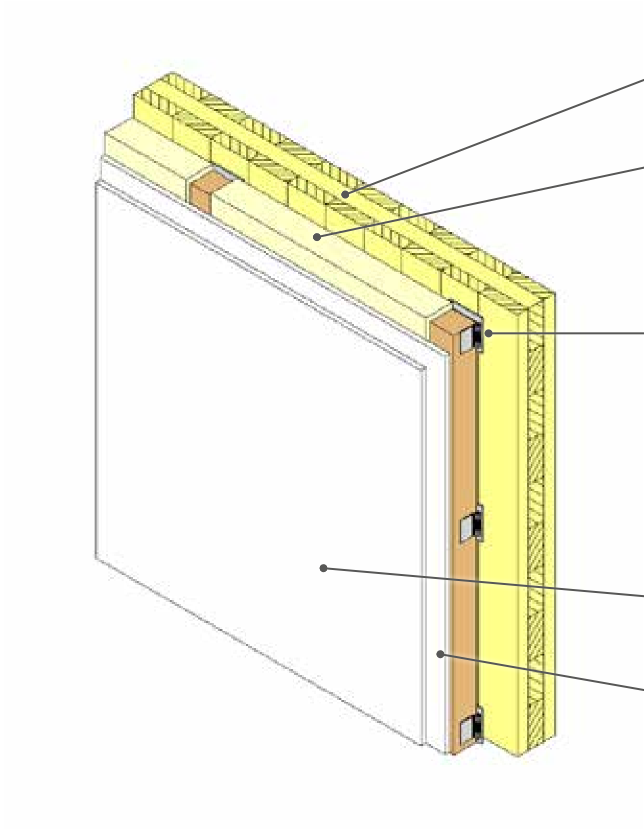
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
–	REI 120	35	0.24	adequate	27.2	46	–

Component designs

Partition walls

1. Partition wall — Variant 1 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	0.34	45

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	2.5	0.250	—	800	A2
B	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
C	mineral wool	7	0.035	—	18	A1
D	CLT 100 C3s	10	0.110	50	470	D

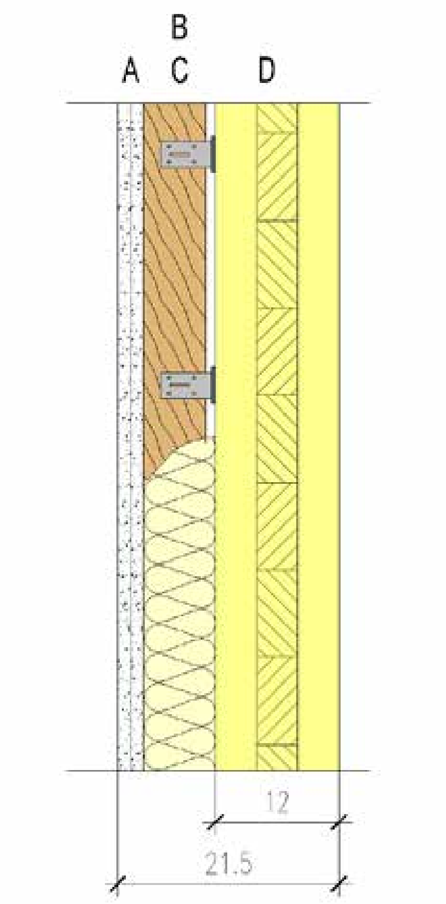
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
7	REI 60 EI 120	35	0.34	adequate	34.0	45	—

2. Partition wall — Variant 2 of 17

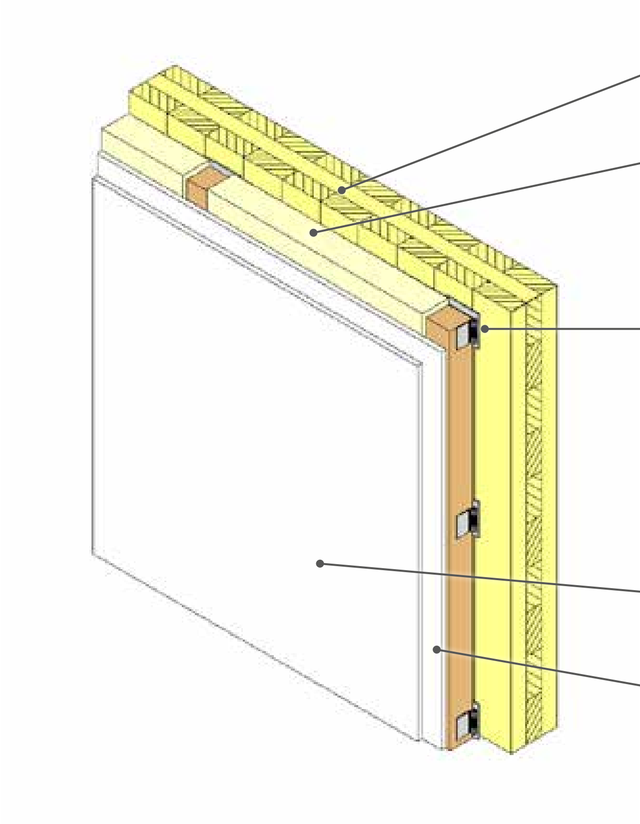
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.32**	**45**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	2.5	0.250	–	800	A2
B	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
C	mineral wool	7	0.035	–	18	A1
D	CLT 120 C3s	12	0.110	50	470	D

Structural-physical analysis

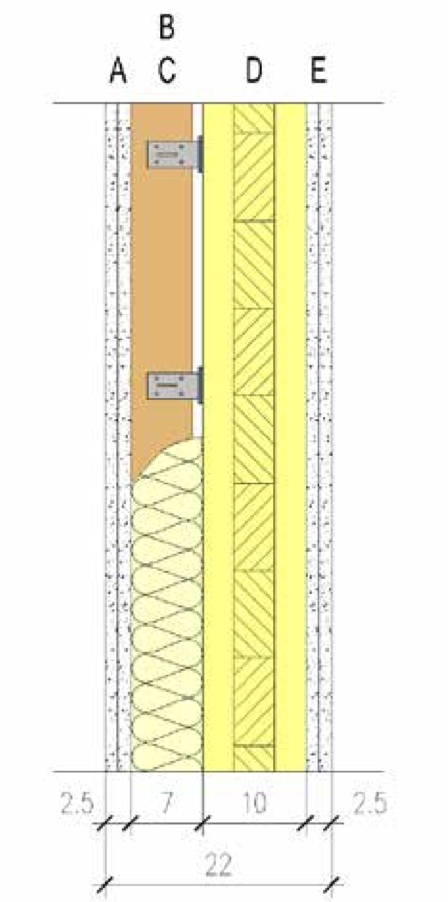
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
7	REI 60 EI 120	35	0.32	adequate	34.0	45	–

Component designs

3. Partition wall — Variant 3 of 17

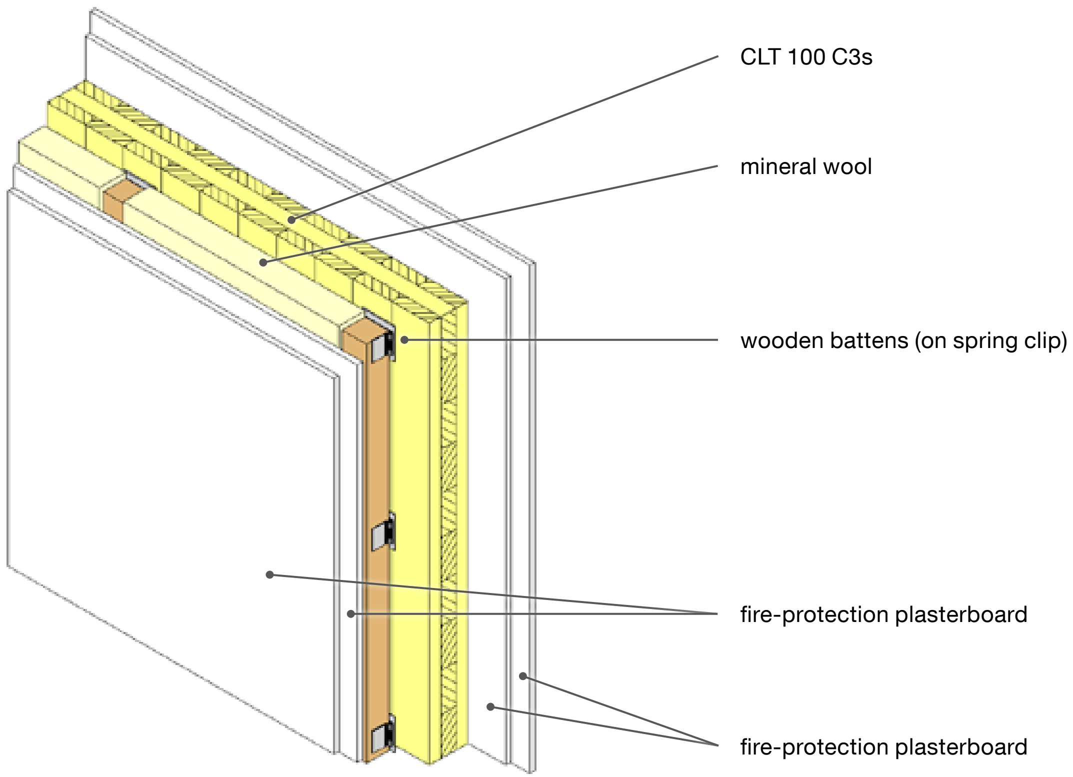
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.33**	**46**

Component design

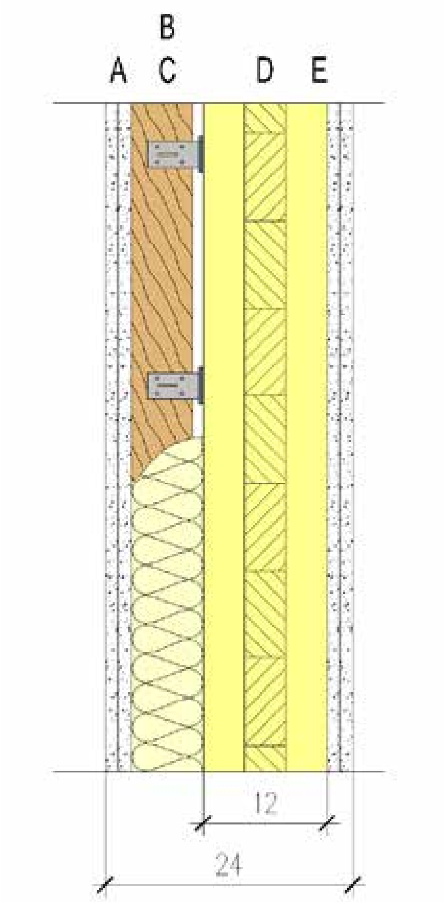
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	2.5	0.250	—	800	A2
B	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
C	mineral wool	7	0.035	—	18	A1
D	CLT 100 C3s	10	0.110	50	470	D
E	fire-protection plasterboard	2.5	0.250	—	800	A2

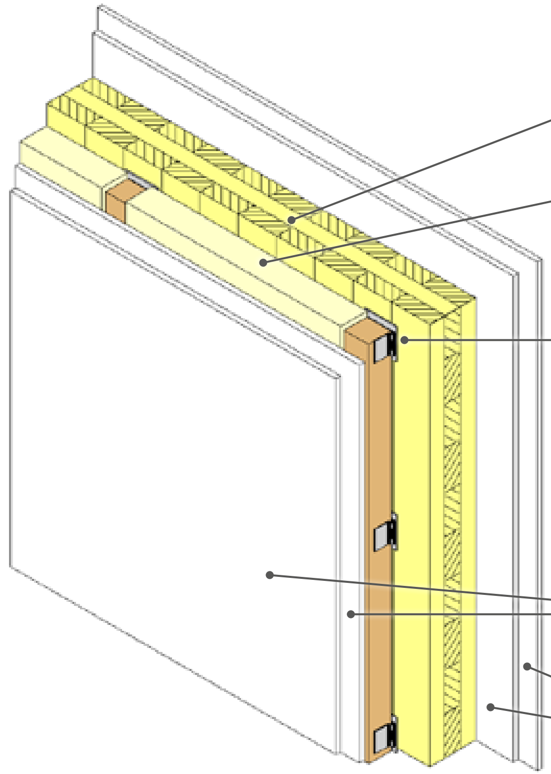
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
7	REI 90 EI 120	35	0.33	adequate	42.2	46	—

Component designs

4. Partition wall — Variant 4 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.31**	**46**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	2.5	0.250	—	800	A2
B	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
C	mineral wool	7	0.035	—	18	A1
D	CLT 120 C3s	12	0.110	50	470	D
E	fire-protection plasterboard	2.5	0.250	—	800	A2

Structural-physical analysis

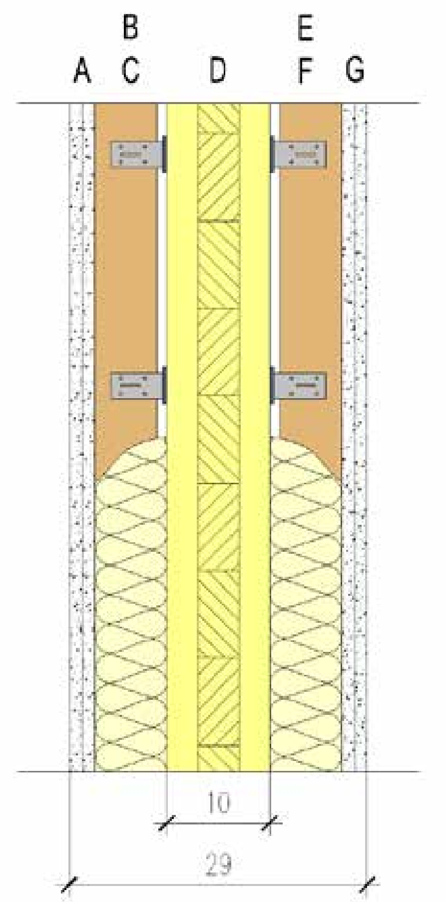
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
7	REI 90 EI 120	35	0.31	adequate	41.4	46	—

Component designs

5. Partition wall — Variant 5 of 17

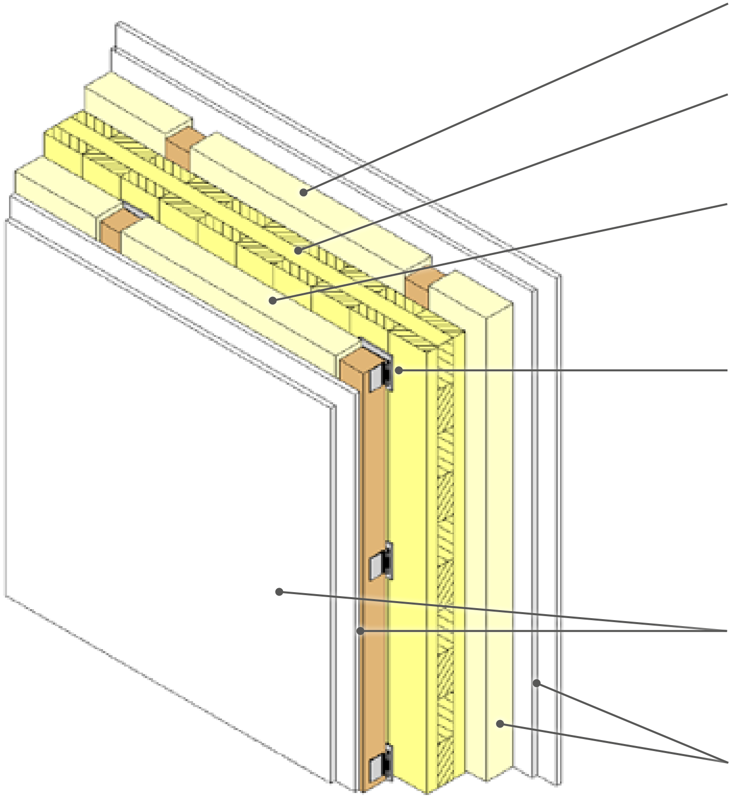
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.21**	**58**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	2.5	0.250	—	800	A2
B	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
C	mineral wool	7	0.035	—	18	A1
D	CLT 100 C3s	10	0.110	50	470	D
E	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
F	mineral wool	7	0.035	—	18	A1
G	fire-protection plasterboard	2.5	0.250	—	800	A2

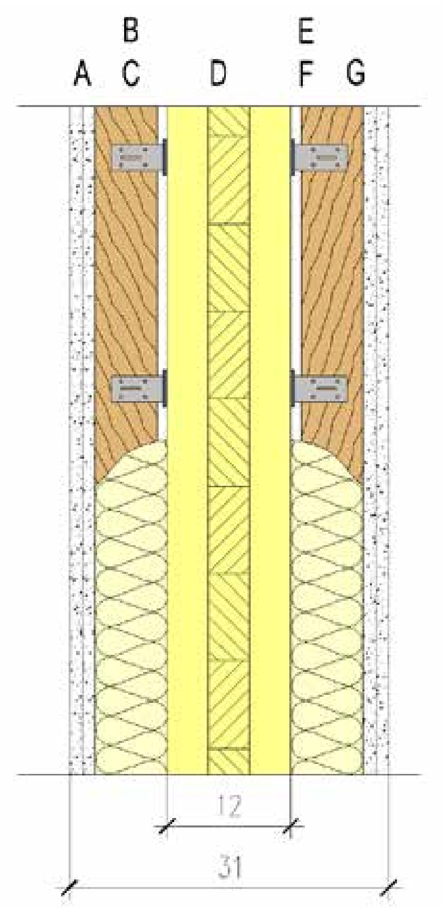
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
2 × 7	REI 120	35	0.21	adequate	22.8	58	—

6. Partition wall — Variant 6 of 17

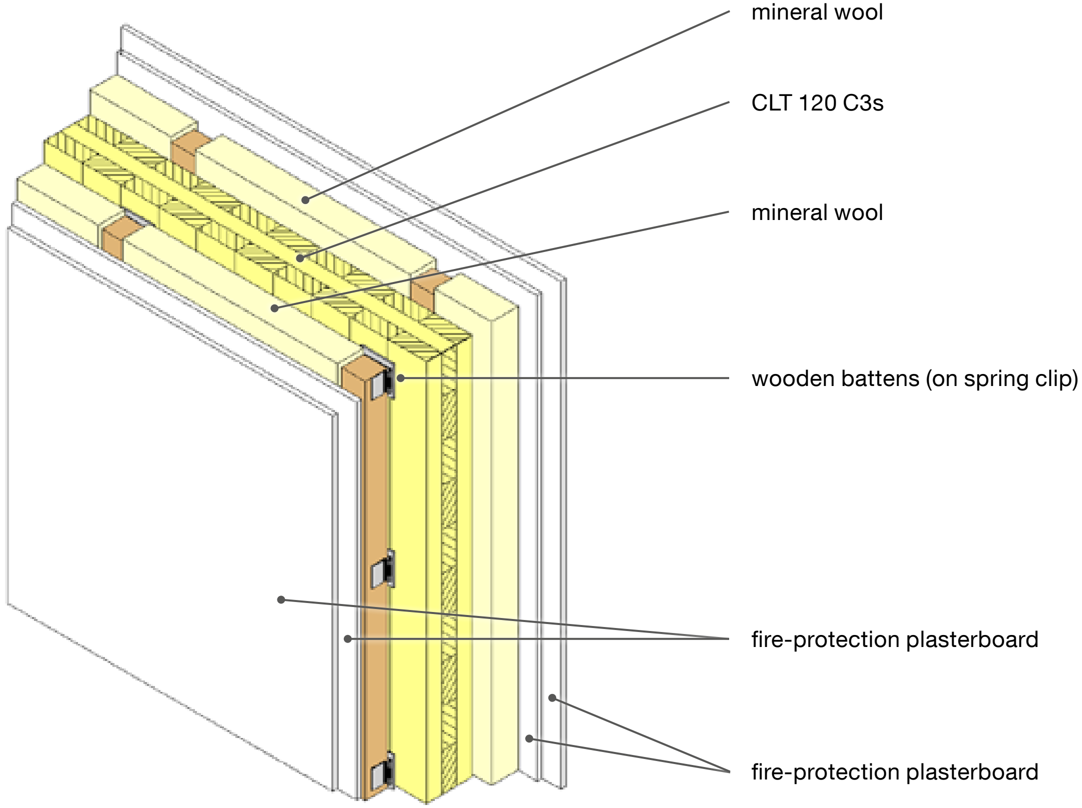
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.20**	**58**

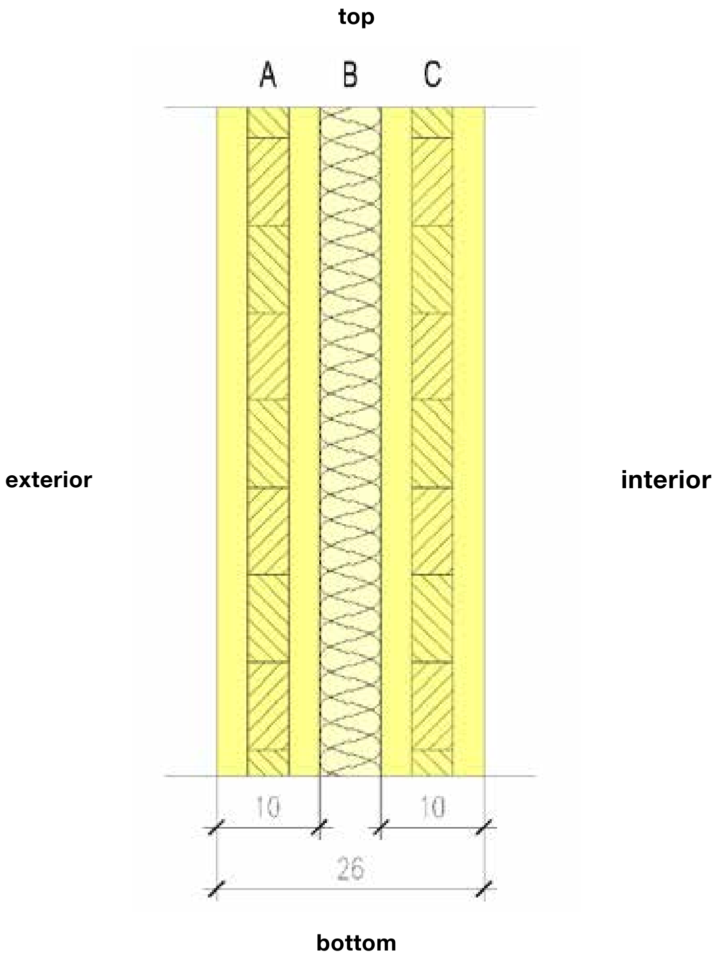
Component design

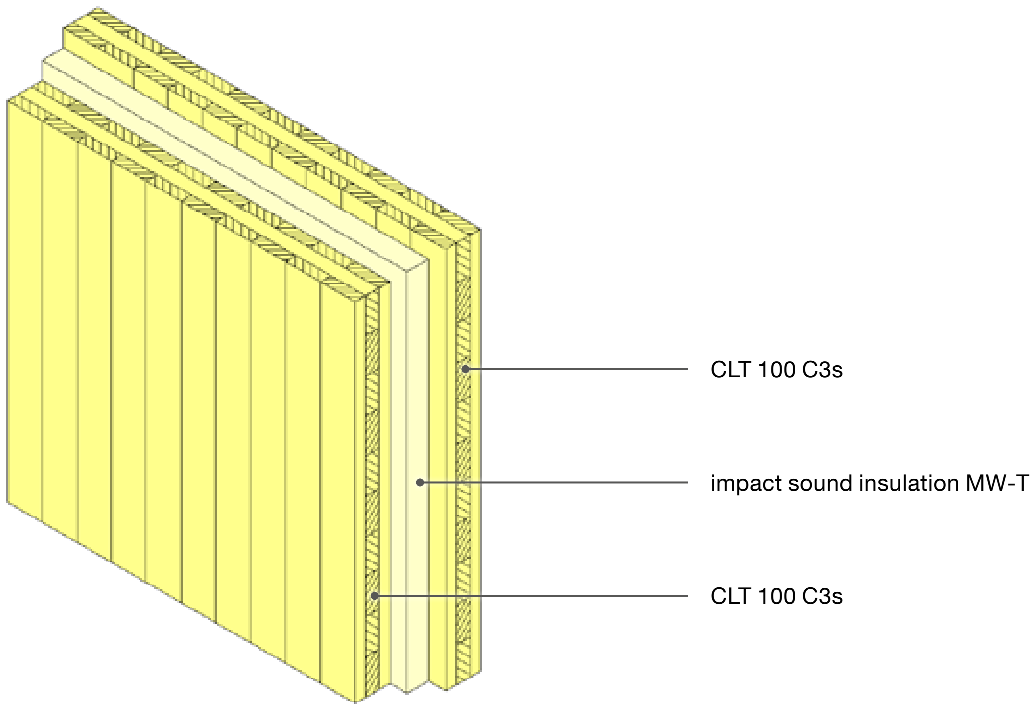
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	2.5	0.250	—	800	A2
B	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
C	mineral wool	7	0.035	—	18	A1
D	CLT 120 C3s	12	0.110	50	470	D
E	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
F	mineral wool	7	0.035	—	18	A1
G	fire-protection plasterboard	2.5	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
2 × 7	REI 120	35	0.20	adequate	22.8	58	—

7. Partition wall — Variant 7 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	0.26	52

Component design

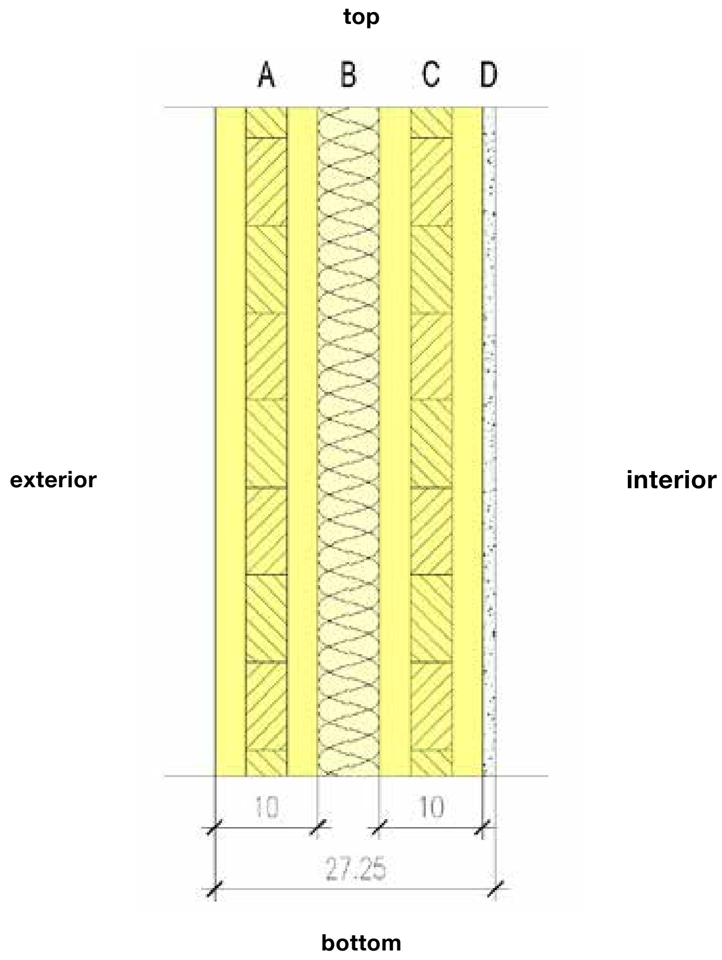
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	CLT 100 C3s	10	0.110	50	470	D
B	impact sound insulation MW-T	6	0.035	1	68	A1
C	CLT 100 C3s	10	0.110	50	470	D

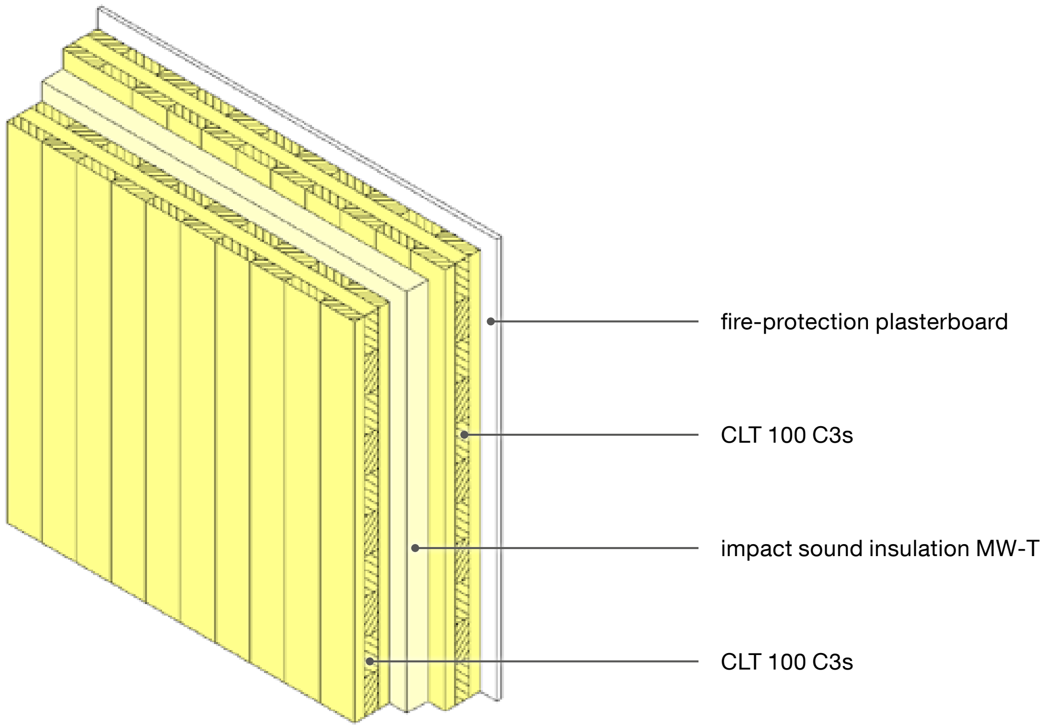
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
6	REI 90 EI 120	35	0.26	adequate	34.2	52	–

Component designs

8. Partition wall — Variant 8 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.26**	**54**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	CLT 100 C3s	10	0.110	50	470	D
B	impact sound insulation MW-T	6	0.035	1	68	A1
C	CLT 100 C3s	10	0.110	50	470	D
D	fire-protection plasterboard	1.3	0.250	—	800	A2

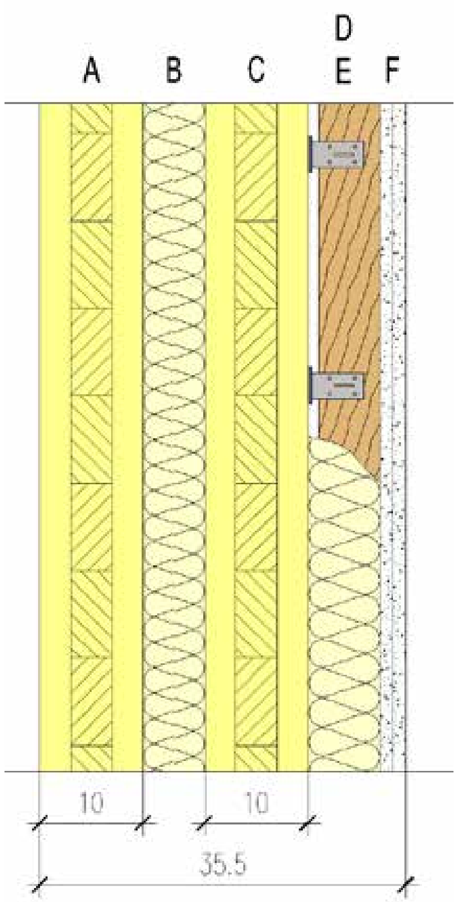
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
6	REI 90 EI 120	35	0.26	adequate	38.4	54	—

9. Partition wall — Variant 9 of 17

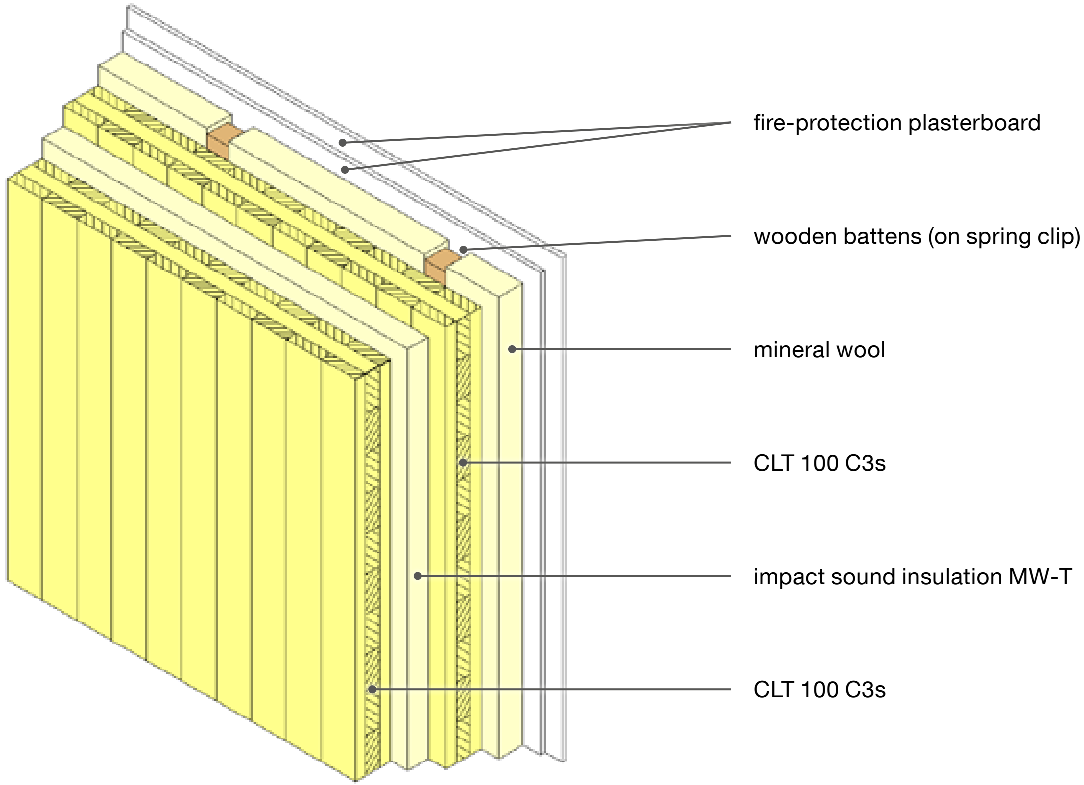
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.19**	**66**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	CLT 100 C3s	10	0.110	50	470	D
B	impact sound insulation MW-T	6	0.035	1	68	A1
C	CLT 100 C3s	10	0.110	50	470	D
D	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
E	mineral wool	7	0.035	1	18	A1
F	fire-protection plasterboard	2.5	0.250	—	800	A2

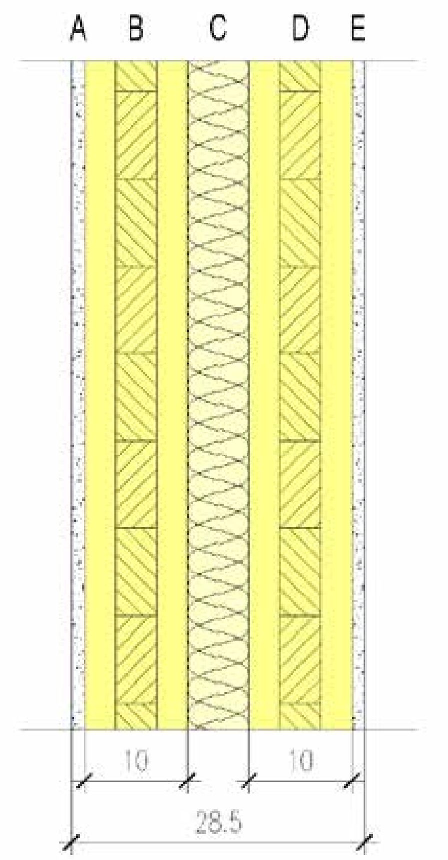
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
7 + 6	REI 120	35	0.19	adequate	23.1	66	—

10. Partition wall — Variant 10 of 17

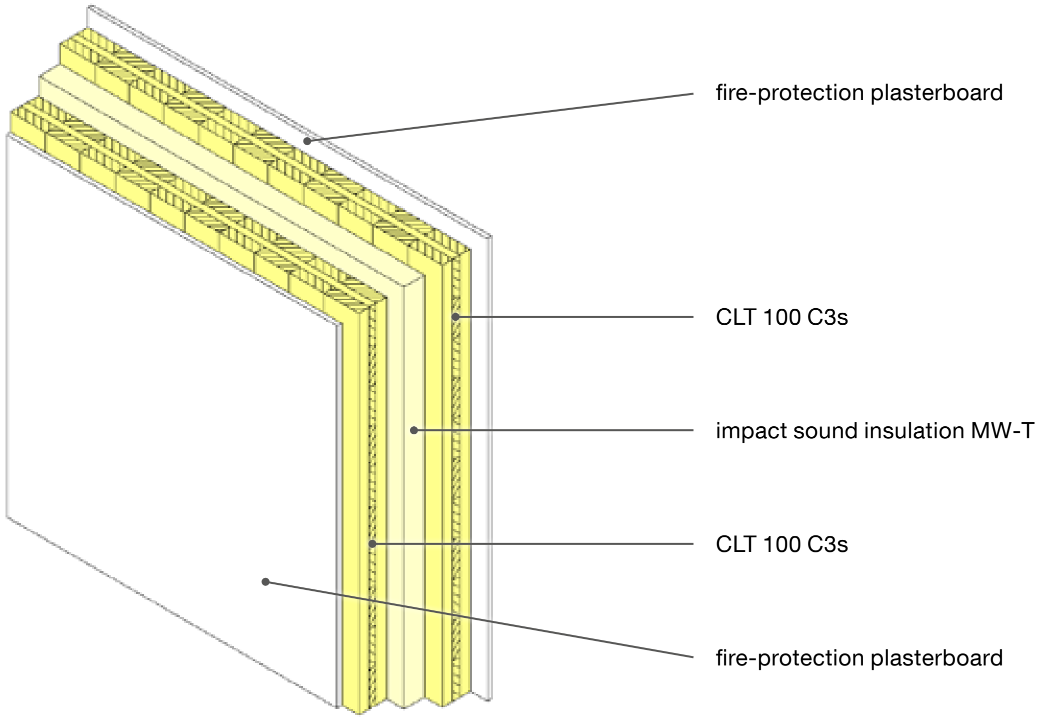
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	0.26	60

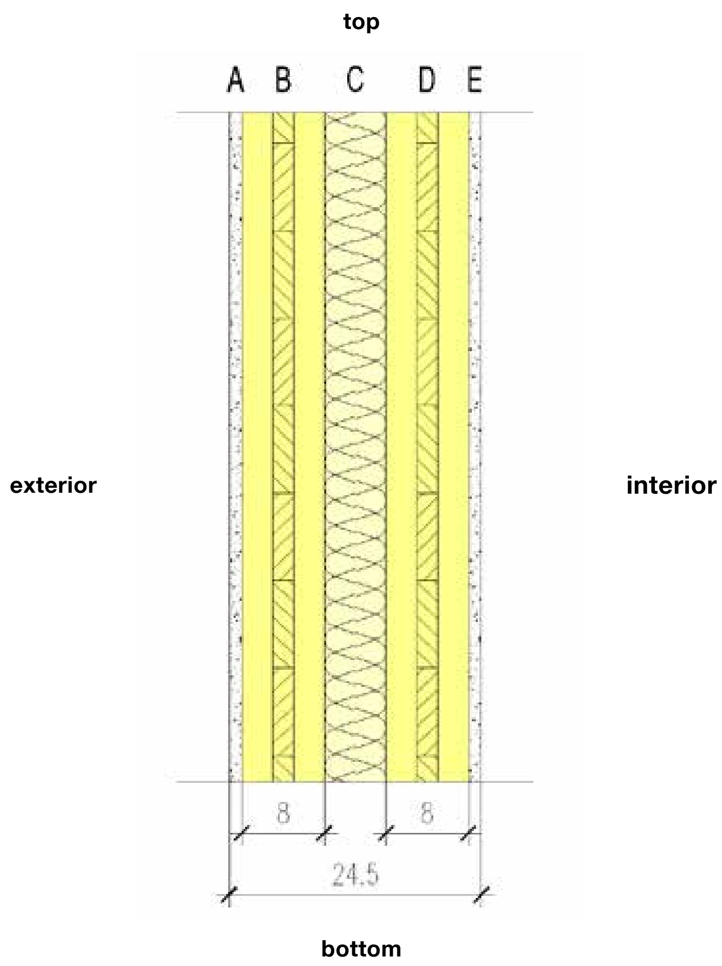
Component design

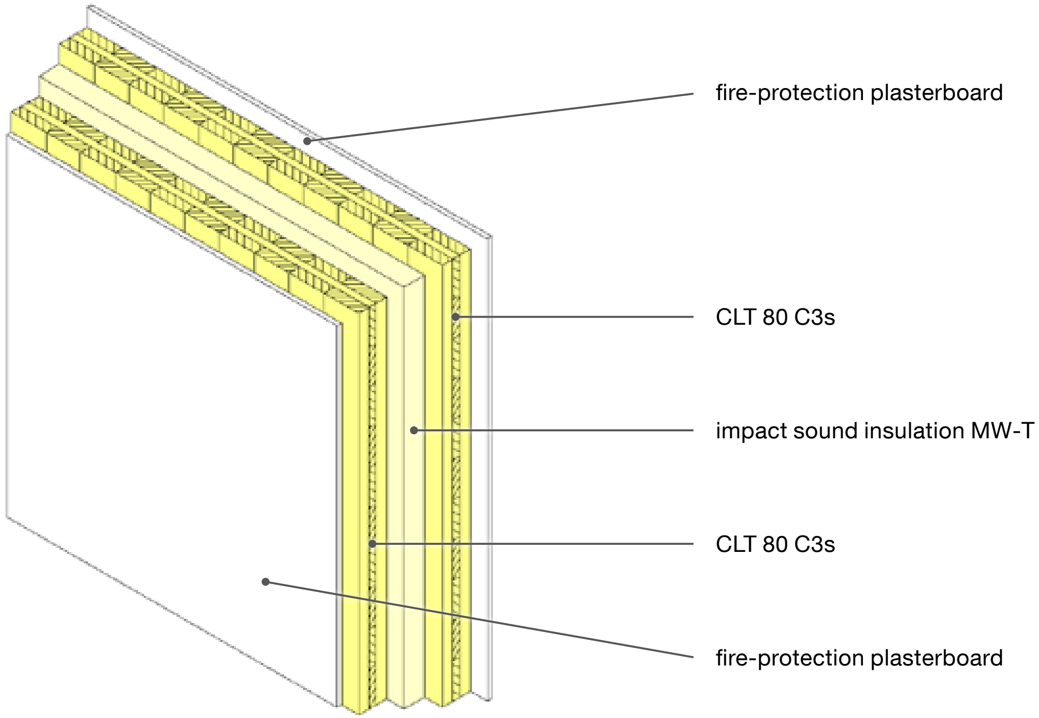
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	—	800	A2
B	CLT 100 C3s	10	0.110	50	470	D
C	impact sound insulation MW-T	6	0.035	1	68	A1
E	CLT 100 C3s	10	0.110	50	470	D
F	fire-protection plasterboard	1.3	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
6	REI 90 EI 120	35	0.26	adequate	38.4	60	—

11. Partition wall — Variant 11 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.26**	**60**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	µ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	–	800	A2
B	CLT 80 C3s	8	0.110	50	470	D
C	impact sound insulation MW-T	6	0.035	1	68	A1
D	CLT 80 C3s	8	0.110	50	470	D
E	fire-protection plasterboard	1.3	0.250	–	800	A2

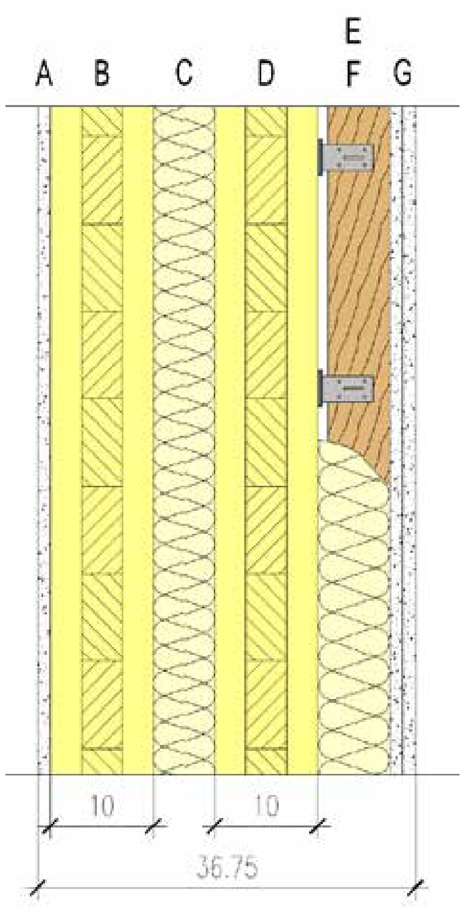
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
6	REI 90 EI 120	35	0.26	adequate	38.4	60	–

12. Partition wall — Variant 12 of 17

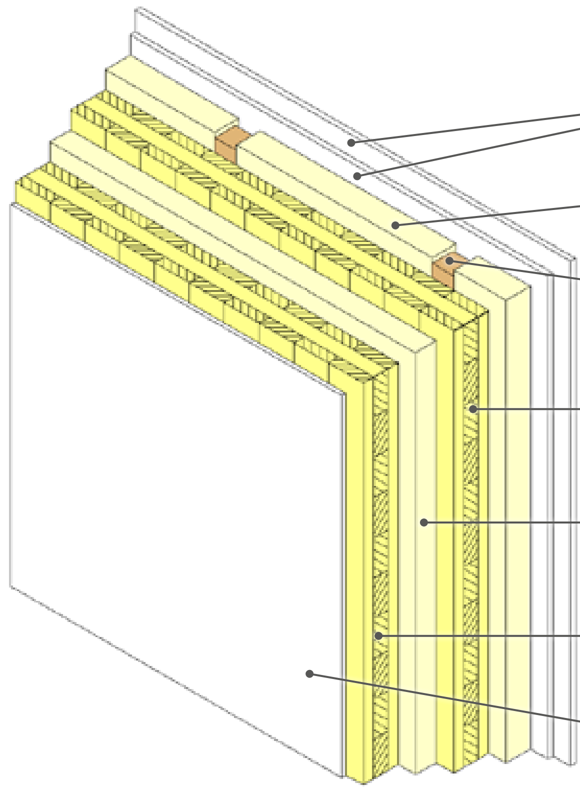
top

exterior



interior

bottom



Fire resistance (REI)	U-value (W/m^2K)	Acoustic (R_w)
REI 120	0.18	67

Component design

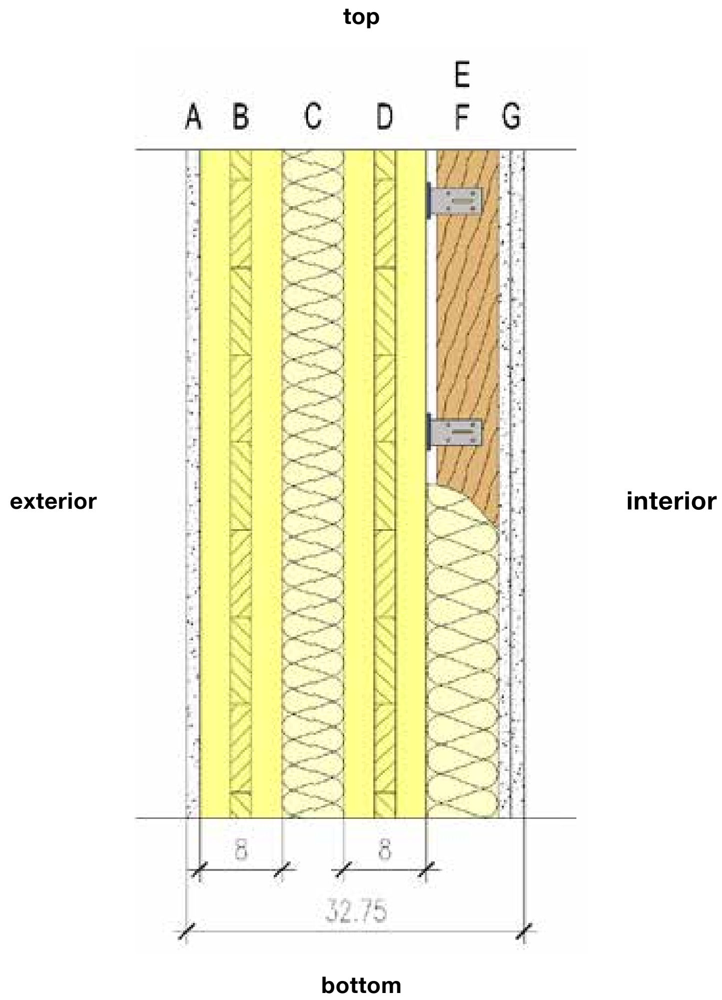
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m^3]	Flammability category
A	fire-protection plasterboard	1.3	0.250	—	800	A2
B	CLT 100 C3s	10	0.110	50	470	D
C	impact sound insulation MW-T	6	0.035	1	68	A1
D	CLT 100 C3s	10	0.110	50	470	D
E	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
F	mineral wool	7	0.035	1	18	A1
G	fire-protection plasterboard	2.5	0.250	—	800	A2

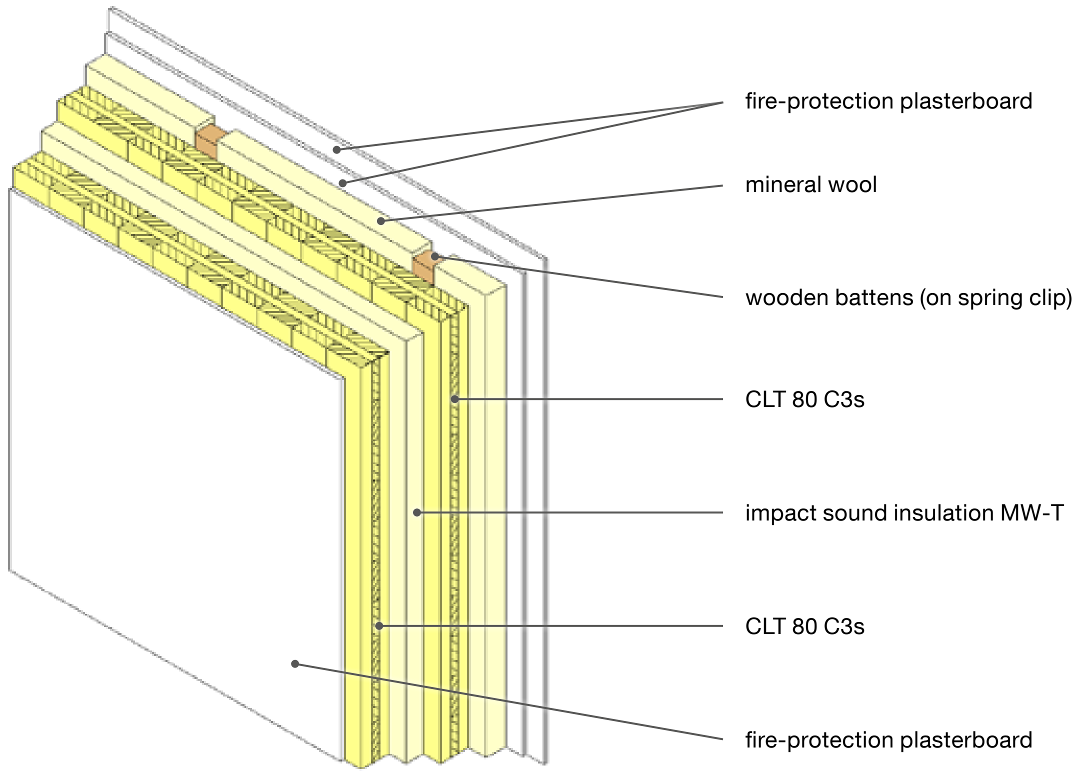
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m^2K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m^2]	R_w	$L_{n,w}$
7 + 6	REI 120	35	0.18	adequate	23.1	67	—

Component designs

13. Partition wall — Variant 13 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.20**	**66**

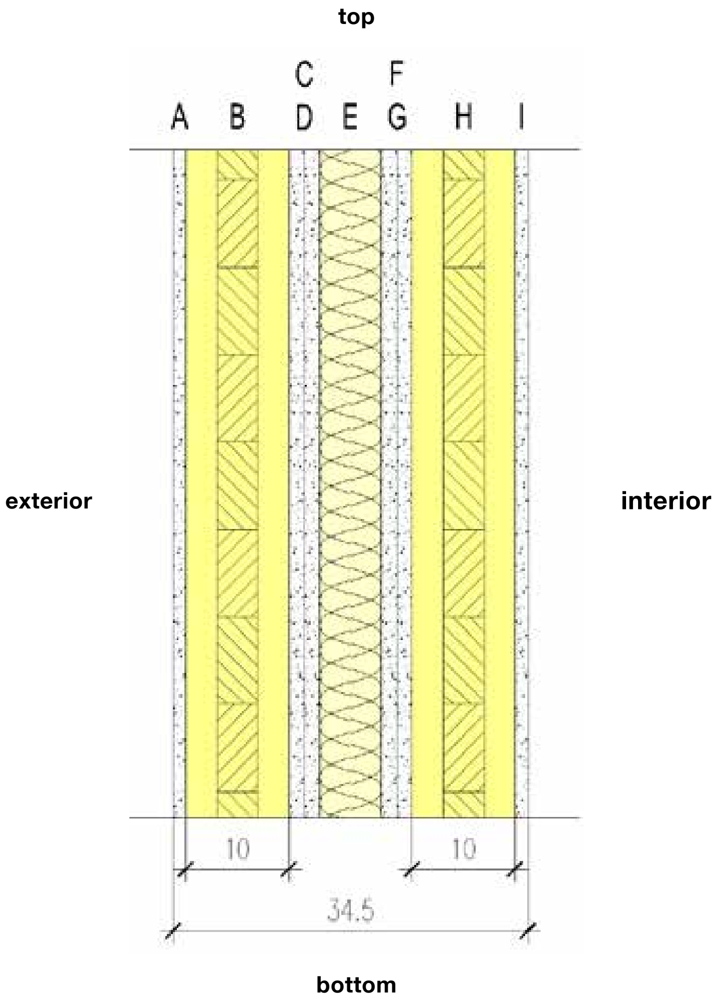
Component design

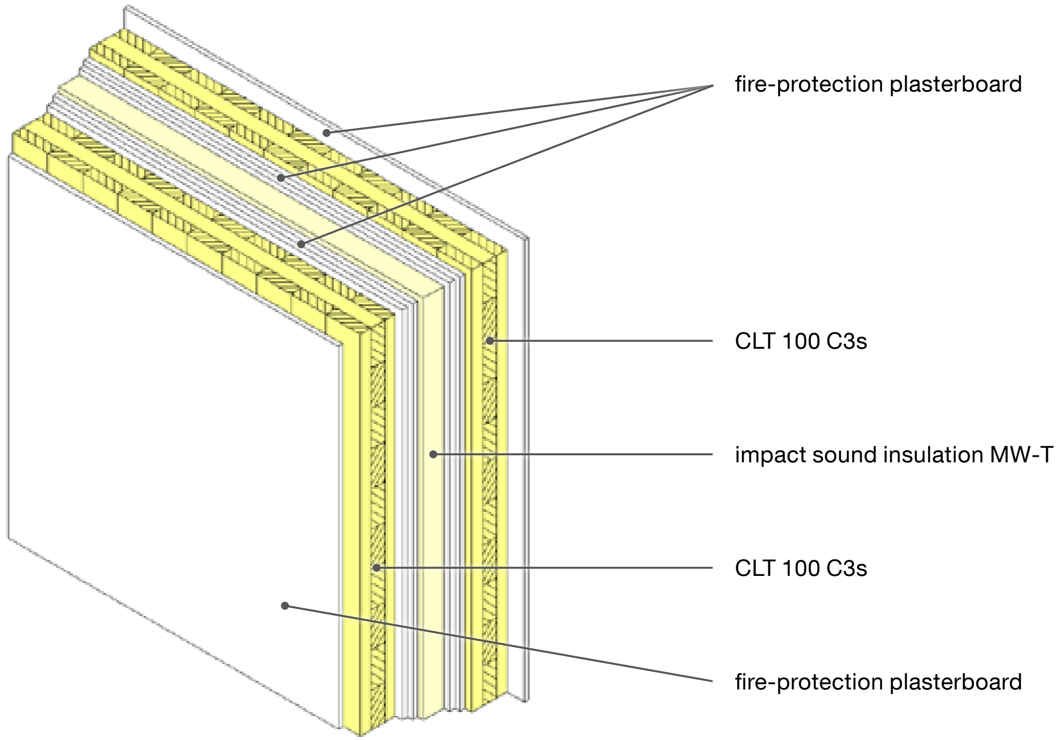
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	–	800	A2
B	CLT 80 C3s	8	0.110	50	470	D
C	impact sound insulation MW-T	6	0.035	1	68	A1
D	CLT 80 C3s	8	0.110	50	470	D
E	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
F	mineral wool	7	0.035	1	18	A1
G	fire-protection plasterboard	2.5	0.250	–	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
7 + 6	REI 90 EI 120	35	0.20	adequate	14.9	66	–

14. Partition wall — Variant 14 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	0.24	70

Component design

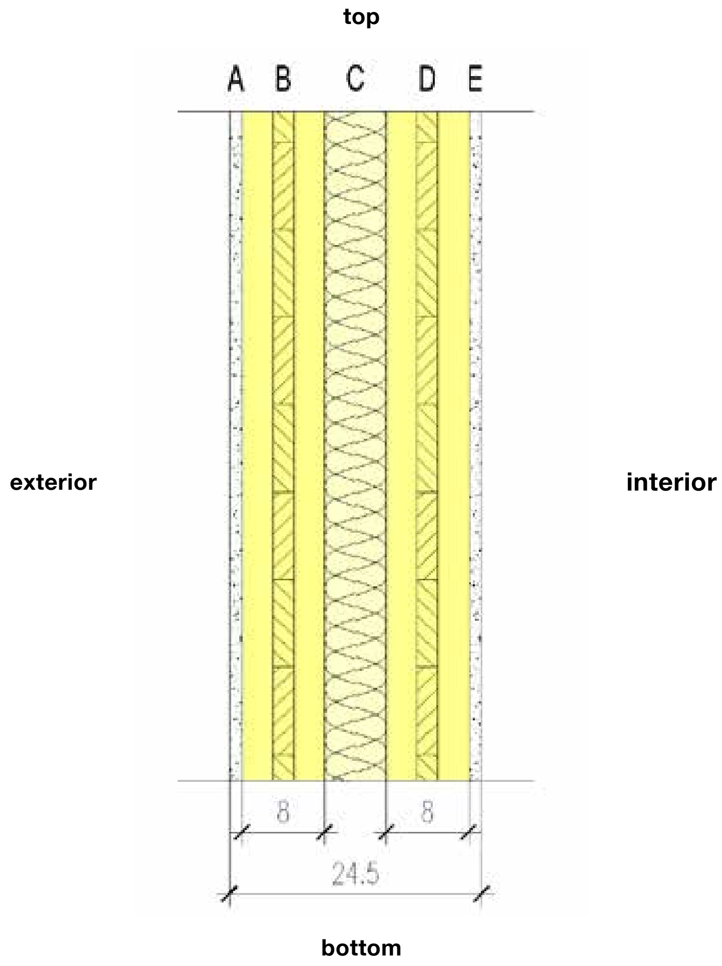
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	–	800	A2
B	CLT 100 C3s	10	0.110	50	470	D
C	fire-protection plasterboard	1.5	0.250	–	800	A2
D	fire-protection plasterboard	1.5	0.250	–	800	A2
E	impact sound insulation MW-T	6	0.035	1	68	A1
F	fire-protection plasterboard	1.5	0.250	–	800	A2
G	fire-protection plasterboard	1.5	0.250	–	800	A2
H	CLT 100 C3s	10	0.110	50	470	D
I	fire-protection plasterboard	1.3	0.250	–	800	A2

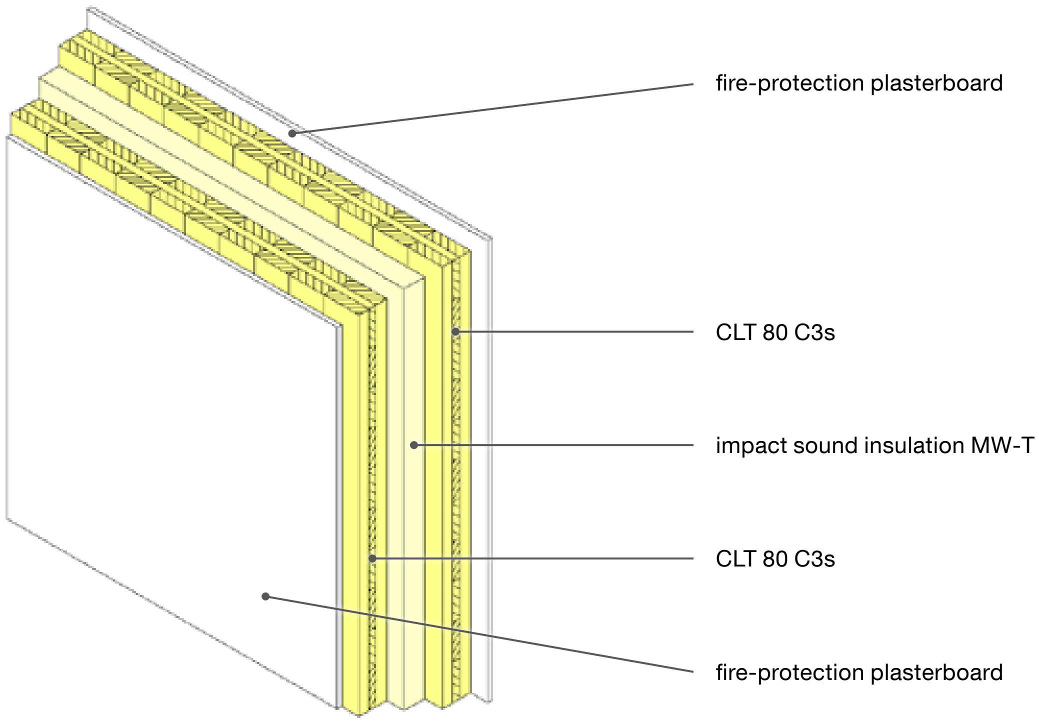
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
6	REI 90 EI 120	35	0.24	adequate	36.8	70	–

Component designs

15. Partition wall — Variant 15 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.27**	**60**

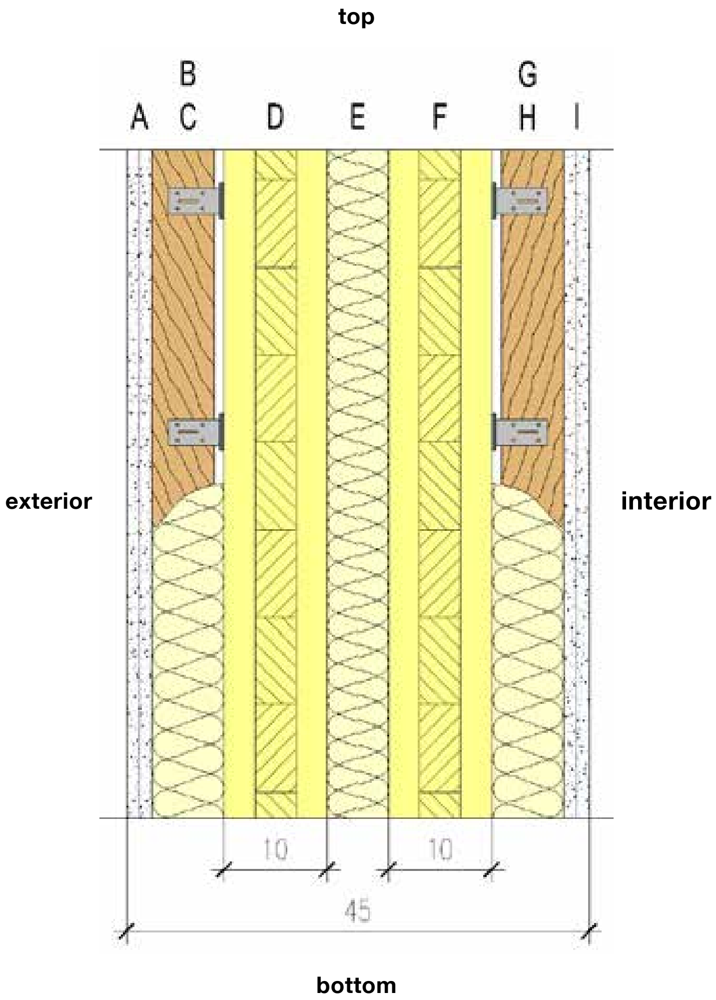
Component design

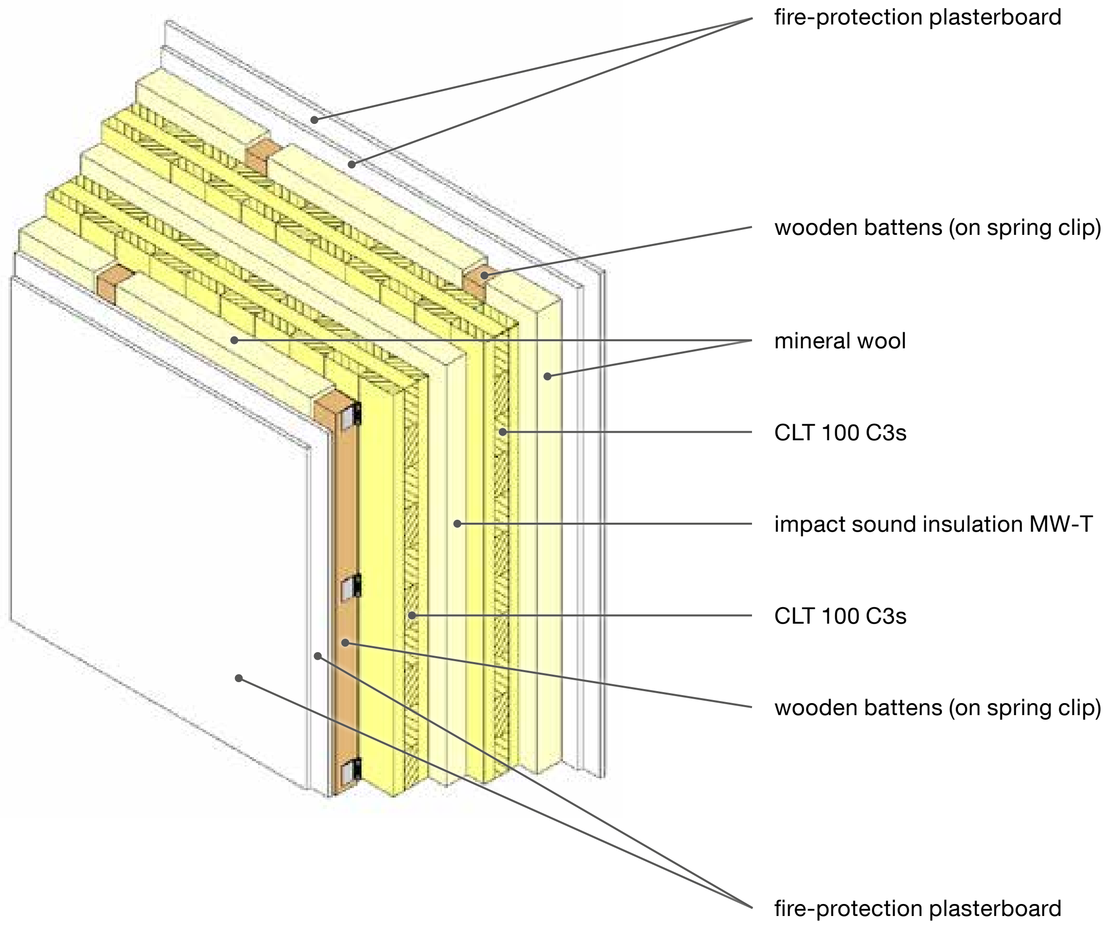
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	1.3	0.250	–	800	A2
B	CLT 80 C3s	8	0.110	50	470	D
C	impact sound insulation MW-T	6	0.035	1	68	A1
D	CLT 80 C3s	8	0.110	50	470	D
E	fire-protection plasterboard	1.3	0.250	–	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
6	REI 90 EI 120	35	0.27	adequate	39.4	60	–

16. Partition wall — Variant 16 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.14**	**69**

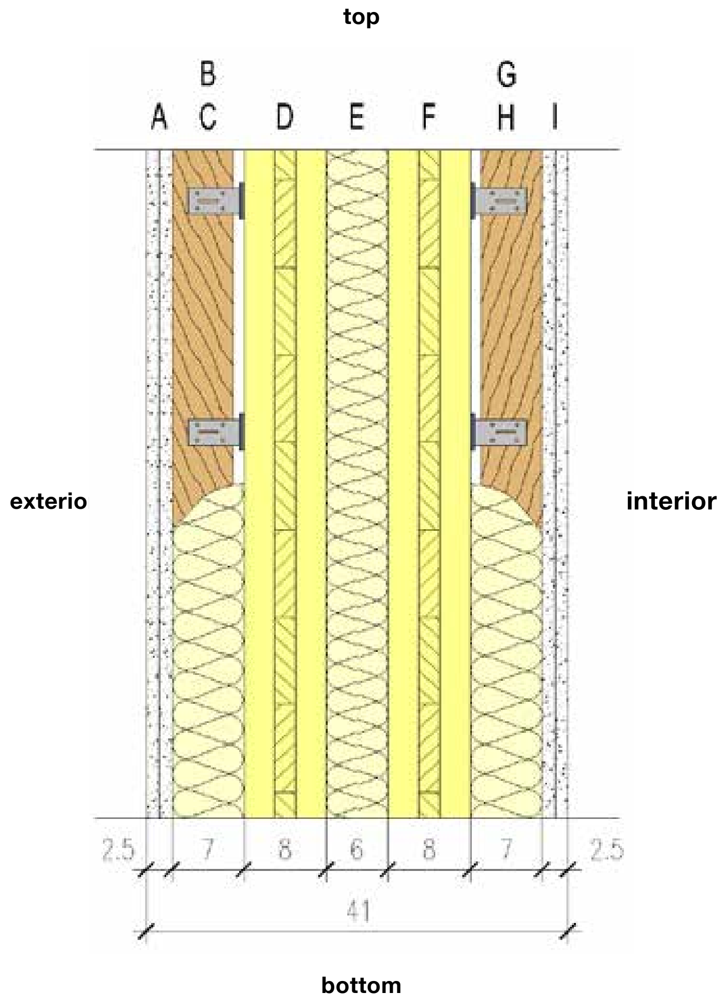
Component design

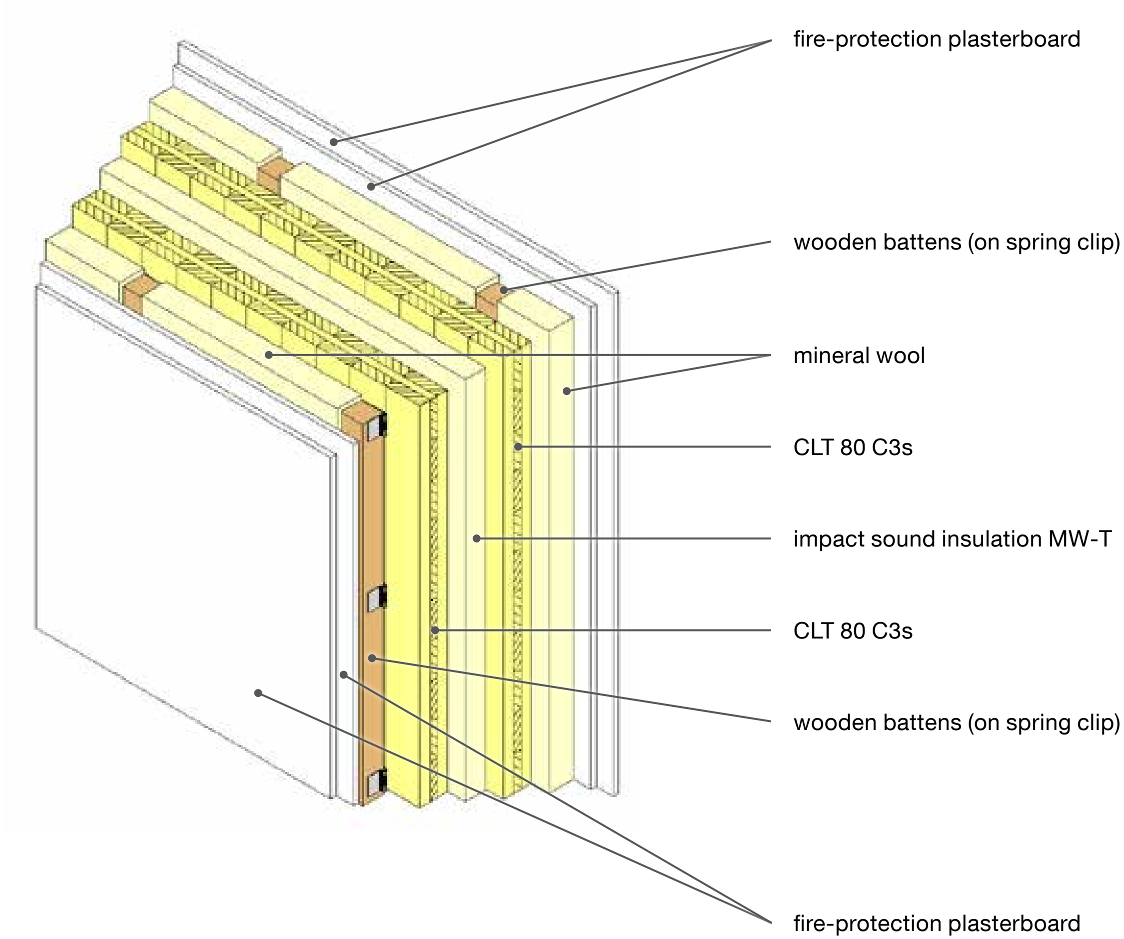
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	2.5	0.250	–	800	A2
B	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
C	mineral wool	7	0.035	1	18	A1
D	CLT 100 C3s	10	0.110	50	470	D
E	impact sound insulation MW-T	6	0.035	1	68	A1
F	CLT 100 C3s	10	0.110	50	470	D
G	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
H	mineral wool	7	0.035	1	18	A1
I	fire-protection plasterboard	2.5	0.250	–	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
2 × 7 + 6	REI 120	35	0.14	adequate	23.1	69	–

17. Partition wall — Variant 17 of 17





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 120	**0.14**	**69**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	µ	ρ [kg/m³]	Flammability category
A	fire-protection plasterboard	2.5	0.250	—	800	A2
B	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
C	mineral wool	7	0.035	1	18	A1
D	CLT 80 C3s	8	0.110	50	470	D
E	impact sound insulation MW-T	6	0.035	1	68	A1
F	CLT 80 C3s	8	0.110	50	470	D
G	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
H	mineral wool	7	0.035	1	18	A1
I	fire-protection plasterboard	2.5	0.250	—	800	A2

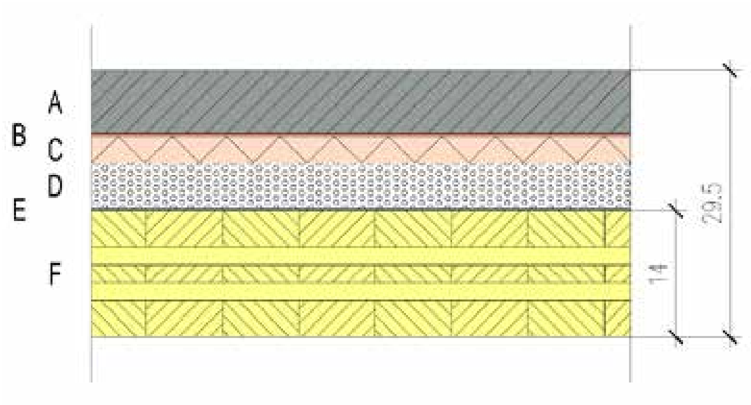
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
2 × 7 + 6	REI 90 EI 120	35	0.15	adequate	23.1	68	—

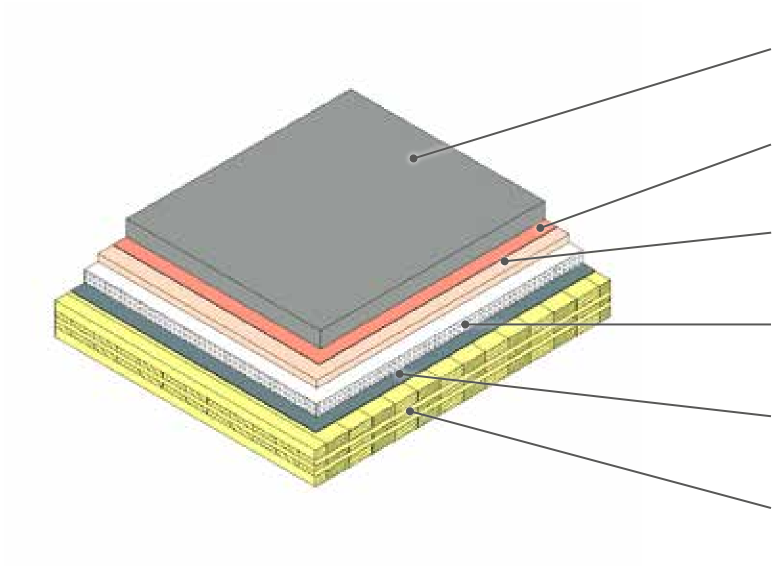
Floor slabs

1. Floor slab — Variant 1 of 6

top



bottom



Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	**0.35**	**55**

Component design

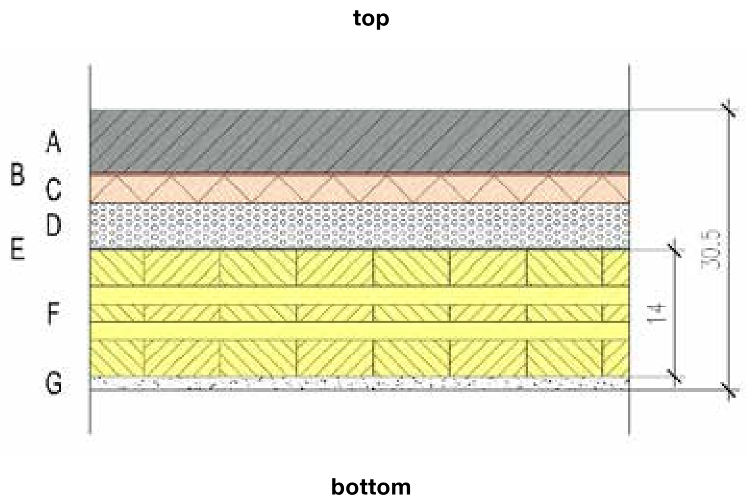
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	cement screed	7	1.330	50–100	2,000	A1
B	plastic separation layer	—	0.200	100,000	1,400	E
C	EPS sandwich panel	3	0.04	60	18	E
D	EPS fill (bound)	5	—	—	—	—
E	trickle protection at joints	—	0.2	423	636	E
F	CLT 140 L5s	14	0.110	50	470	D

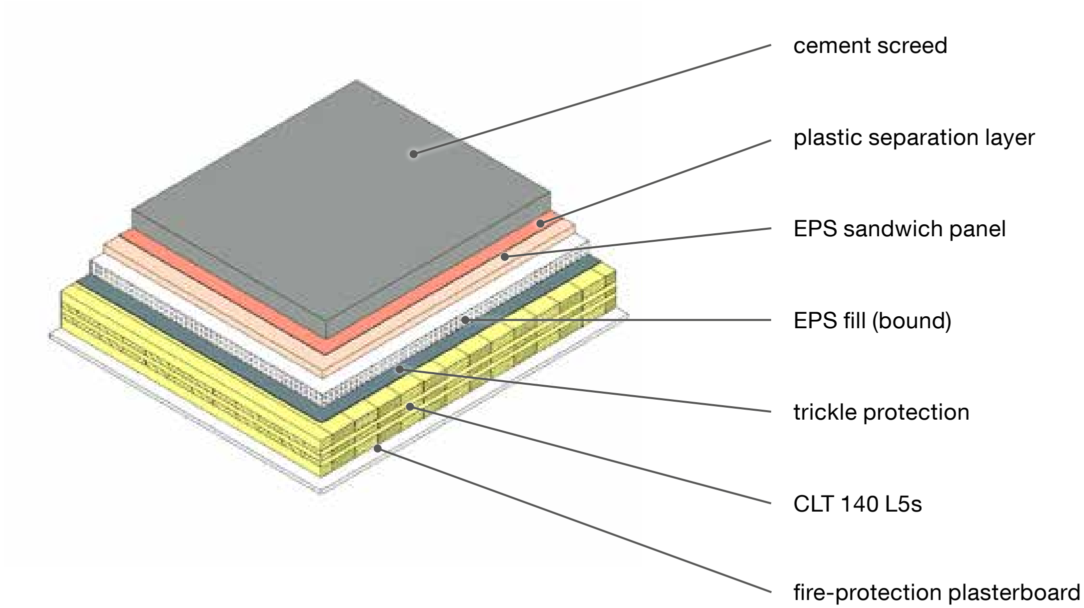
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
8	REI 60	5	0.35	adequate	32.5 (inner) 140.3 (outer)	55	60

Component designs

2. Floor slab — Variant 2 of 6





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.35**	**56**

Component design

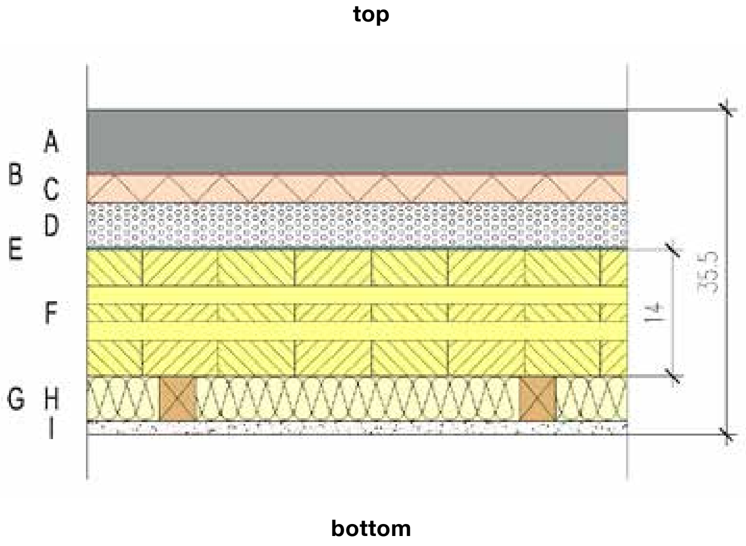
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	cement screed	7	1.330	50–100	2,000	A1
B	plastic separation layer	—	0.200	100,000	1,400	E
C	EPS sandwich panel	3	0.04	60	18	E
D	EPS fill (bound)	5	—	—	—	—
E	trickle protection at joints	—	0.2	423	636	E
F	CLT 140 L5s	14	0.110	50	470	D
G	fire-protection plasterboard	1.5	0.250	—	800	A2

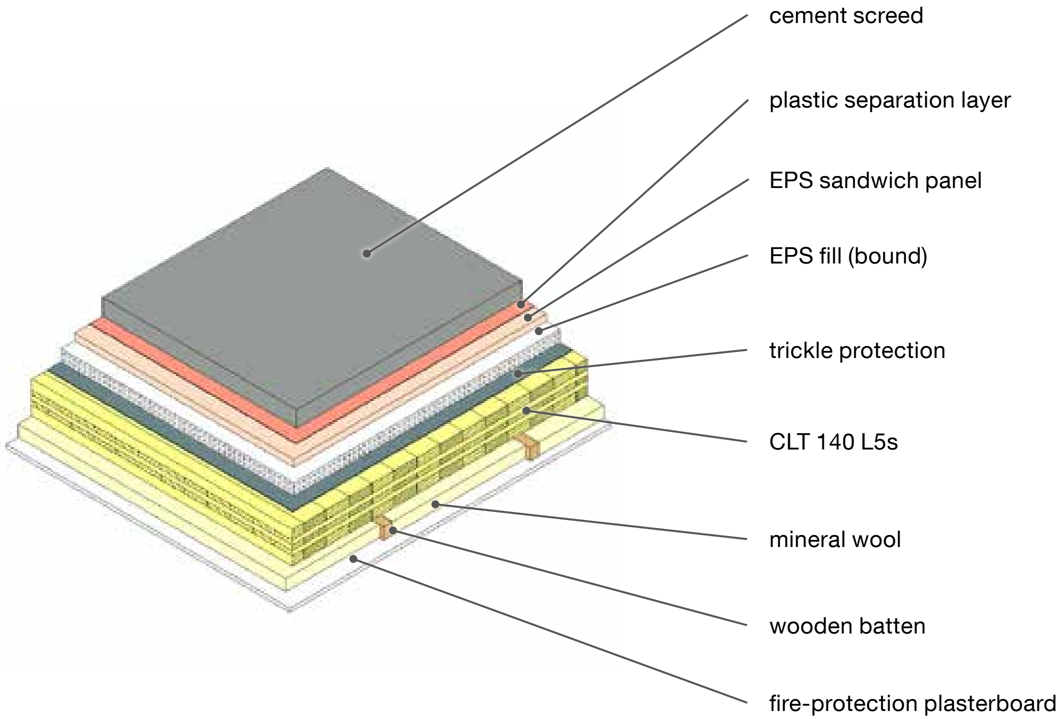
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
8	REI 60	5	0.35	adequate	32.5 (inner) 140.3 (outer)	56	59

Component designs

3. Floor slab — Variant 3 of 6





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	0.24	60

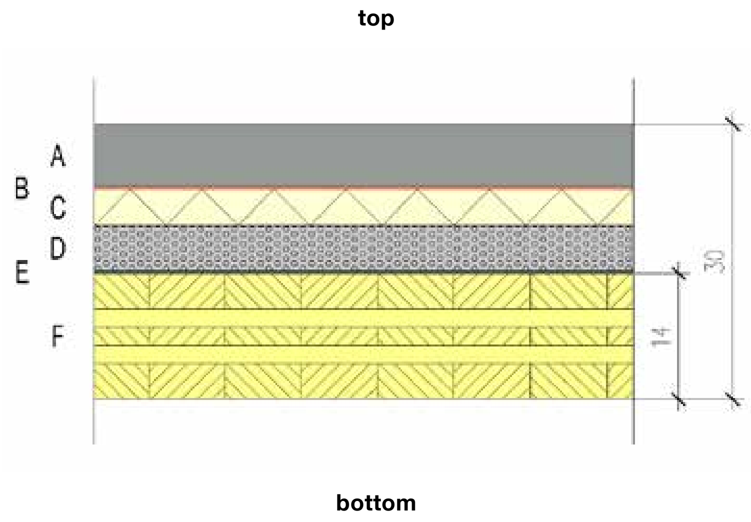
Component design

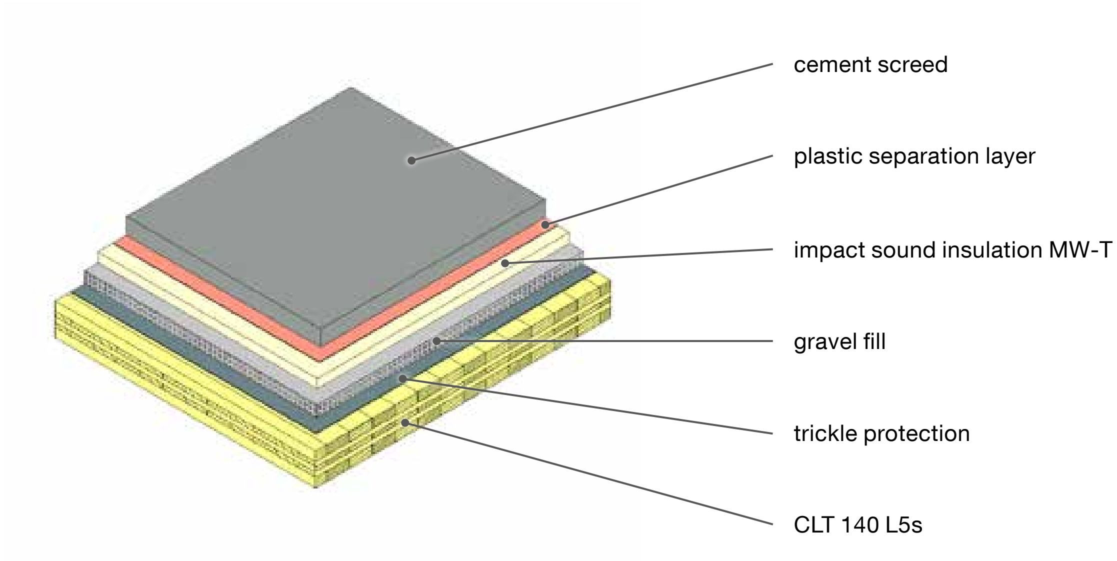
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	cement screed	7	1.330	50–100	2,000	A1
B	plastic separation layer	—	0.200	100,000	1,400	E
C	EPS sandwich panel	3	0.04	60	18	E
D	EPS fill (bound)	5	—	—	—	—
E	trickle protection at joints	—	0.2	423	636	E
F	CLT 140 L5s	14	0.110	—	470	D
G	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
H	mineral wool	5	0.035	—	18	A1
I	fire-protection plasterboard	1.5	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
8	REI 90	5	0.24	adequate	16.5 (inner) 140.4 (outer)	60	55

4. Floor slab — Variant 4 of 6





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	0.37	58

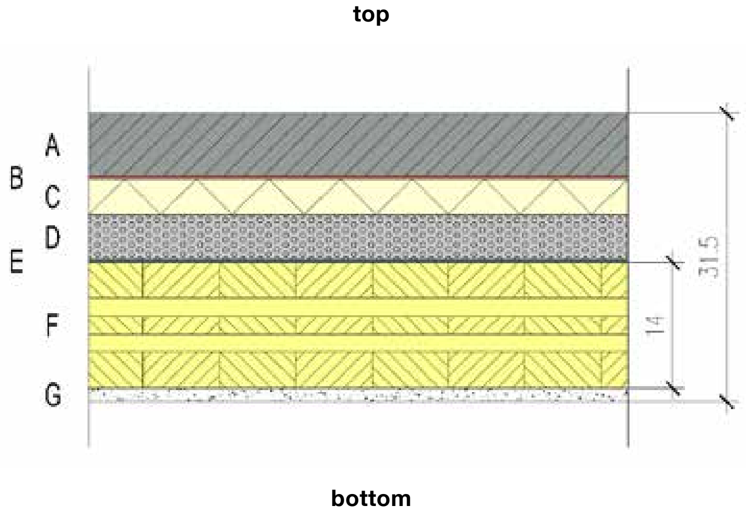
Component design

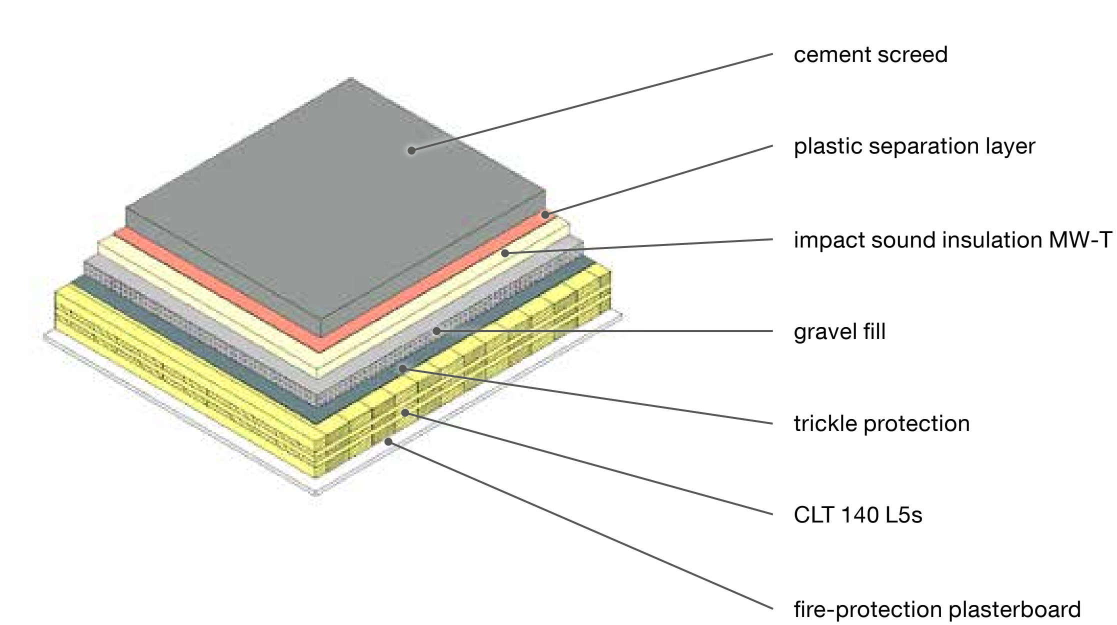
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	cement screed	7	1.330	50–100	2,000	A1
B	plastic separation layer	—	0.200	100,000	1,400	E
C	impact sound insulation MW-T	4	0.035	1	68	A1
D	gravel fill	5	0.7	2	1,800	A1
E	trickle protection at joints	—	0.2	423	636	E
F	CLT 140 L5s	14	0.110	50	470	D

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
8	REI 60	5	0.37	adequate	32.0 (inner) 139.3 (outer)	58	51

5. Floor slab — Variant 5 of 6





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.36**	**59**

Component design

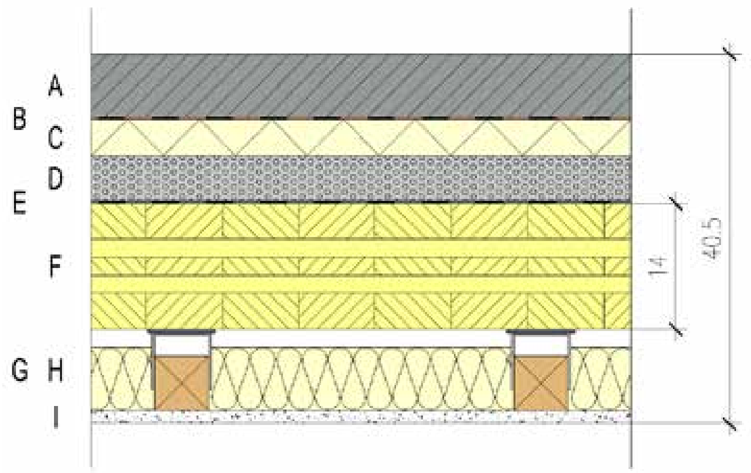
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	cement screed	7	1.330	50–100	2,000	A1
B	plastic separation layer	—	0.200	100,000	1,400	E
C	impact sound insulation MW-T	4	0.035	1	68	A1
D	gravel fill	5	0.7	2	1,800	A1
E	trickle protection at joints	—	0.2	423	636	E
F	CLT 140 L5s	14	0.110	50	470	D
G	fire-protection plasterboard	1.5	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
5	REI 90	5	0.36	adequate	37.5 (inner) 139.3 (outer)	59	50

6. Floor slab — Variant 6 of 6

top



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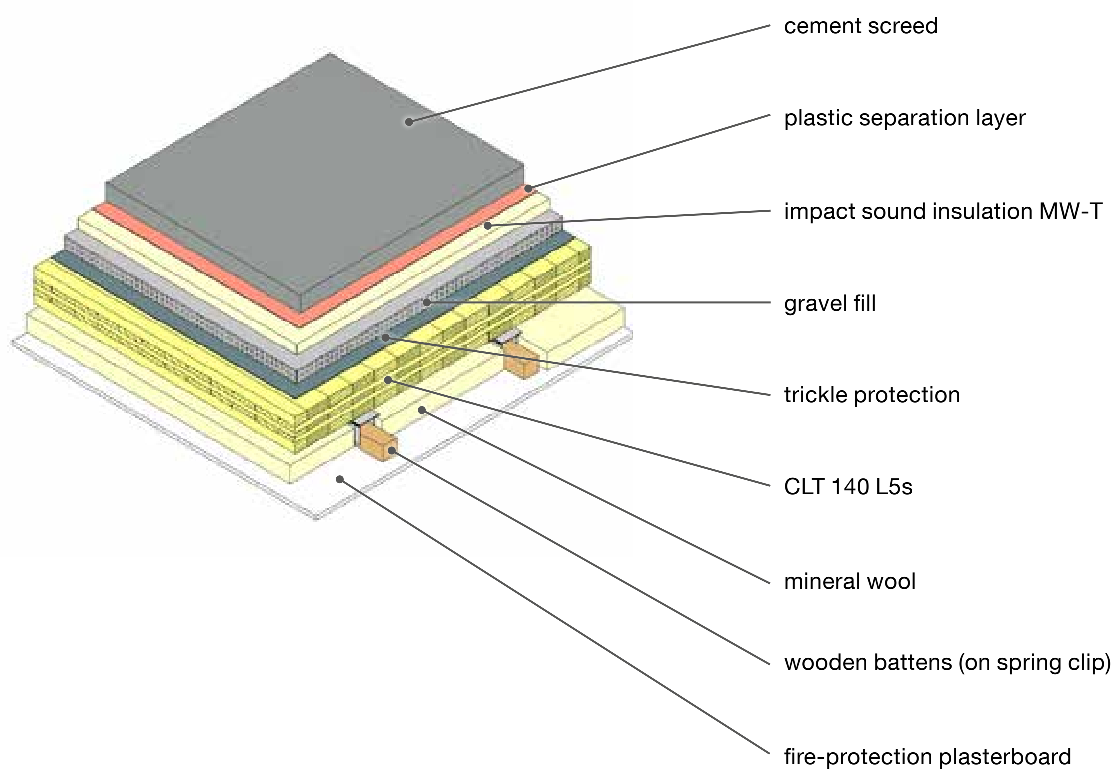


Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.23**	**65**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	cement screed	7	1.330	50–100	2,000	A1
B	plastic separation layer	—	0.200	100,000	1,400	E
C	impact sound insulation MW-T	4	0.035	1	68	A1
D	gravel fill	5	0.7	2	1,800	A1
E	trickle protection at joints	—	0.2	423	636	E
F	CLT 140 L5s	14	0.110	50	470	D
G	wooden battens 6/6 | e = 62.5 cm	6	0.130	50	500	D
H	mineral wool	7	0.035	1	18	A1
I	fire-protection plasterboard	1.5	0.250	—	800	A2

Structural-physical analysis

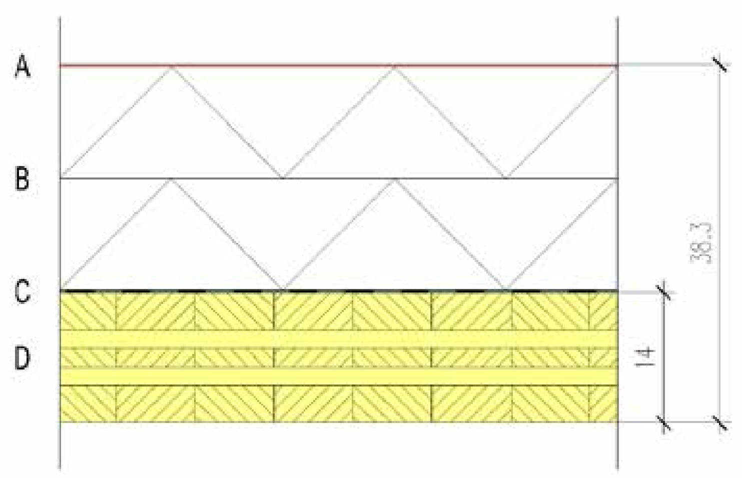
Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
5	REI 90	5	0.23	adequate	16.4 (inner) 139.3 (outer)	65	45

Component designs

Roofs

1. Roof — Variant 1 of 6

top



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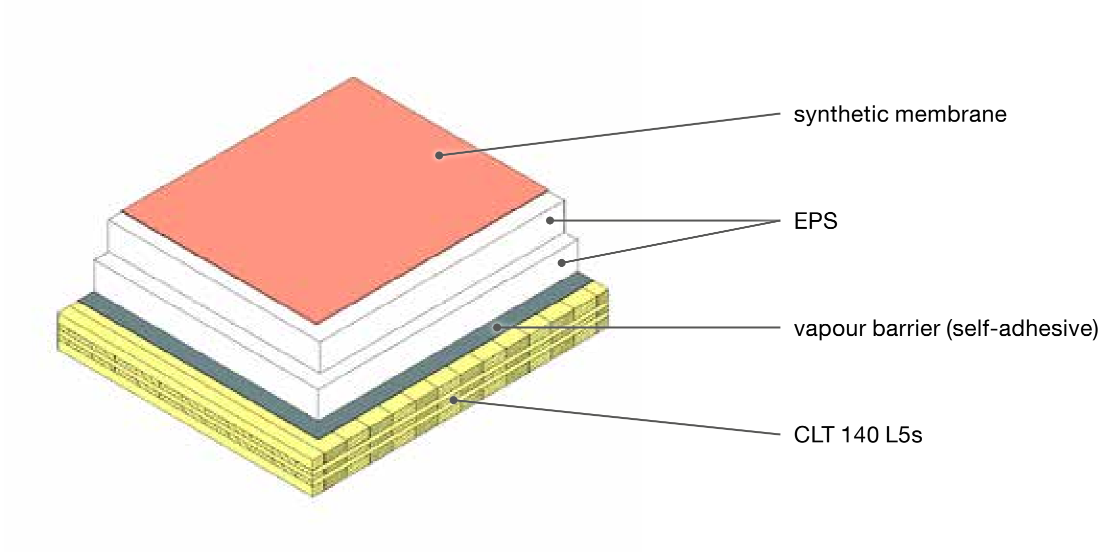


Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	0.13	36

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	synthetic membrane	0.3	–	40,000	680	E
B	EPS (2 layers)	24	0.038	60	30	E
C	vapour barrier (self-adhesive)	–	–	1,500	–	–
D	CLT 140 L5s	14	0.110	50	470	D

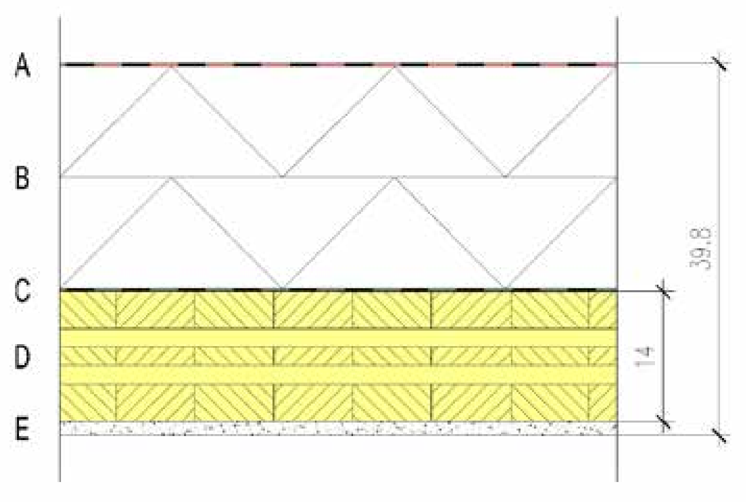
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
24	REI 60	5	0.13	adequate	32.5	36	–

Component designs

2. Roof — Variant 2 of 6

top



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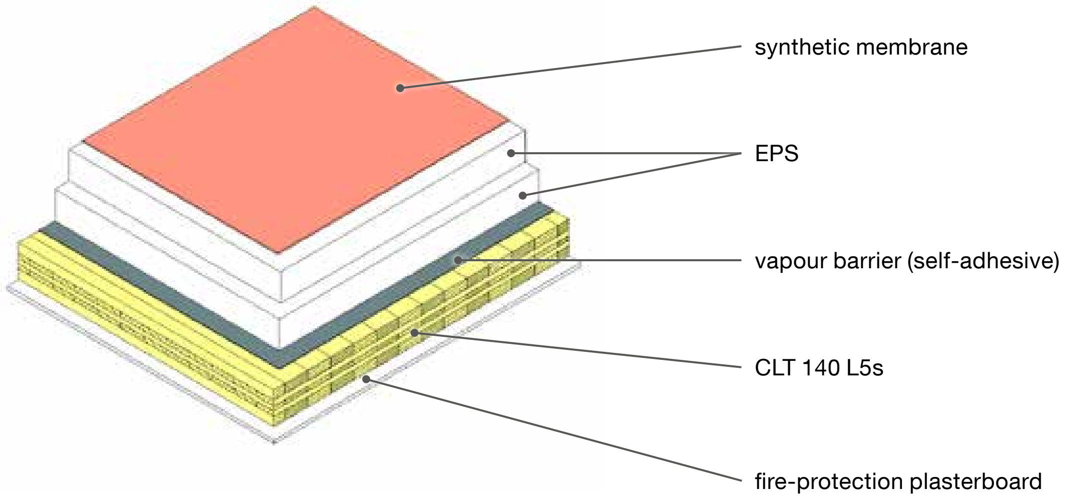


Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.13**	**37**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	µ	ρ [kg/m³]	Flammability category
A	synthetic membrane	0.3	—	40,000	680	E
B	EPS (2 layers)	24	0.038	60	30	E
C	vapour barrier (self-adhesive)	—	—	1,500	—	—
D	CLT 140 L5s	14	0.110	50	470	D
E	fire-protection plasterboard	1.5	0.250	—	800	A2

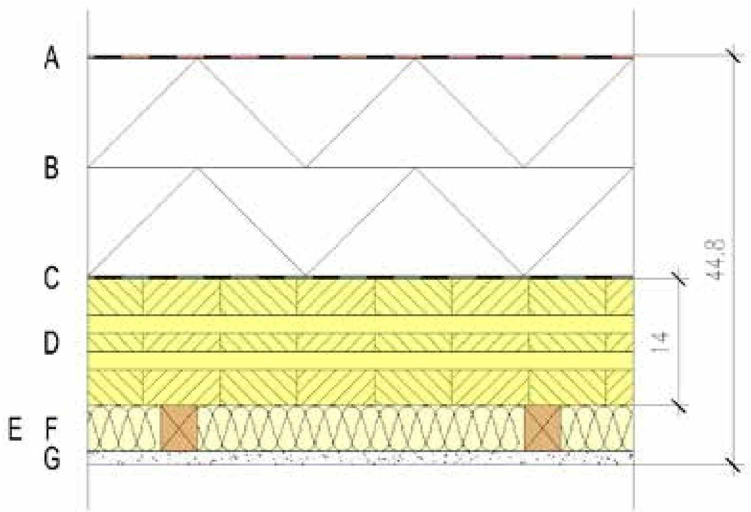
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
24	REI 90	5	0.13	adequate	36.7	37	—

Component designs

3. Roof — Variant 3 of 6

top



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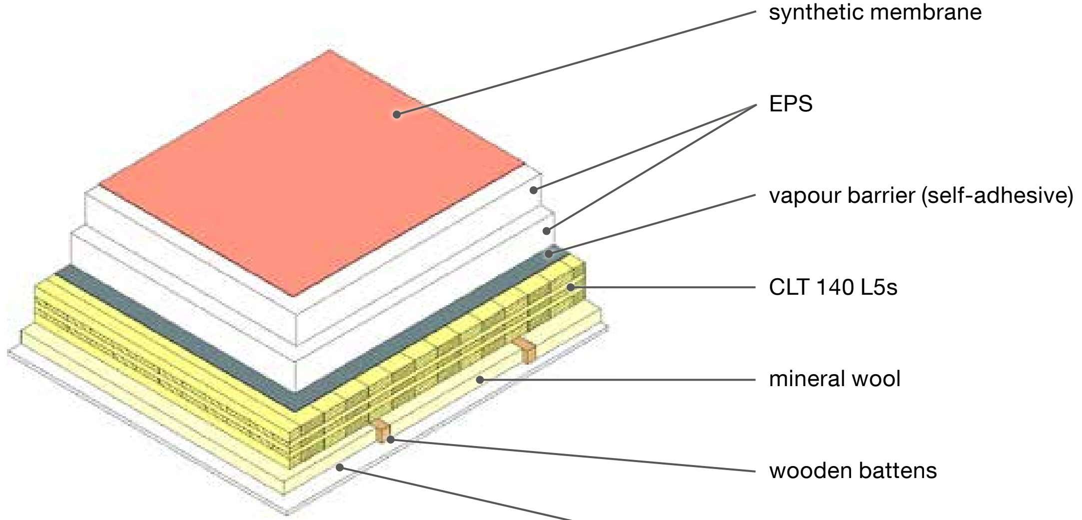


Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.11**	**43**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	µ	ρ [kg/m³]	Flammability category
A	synthetic membrane	0.3	—	40,000	680	E
B	EPS (2 layers)	24	0.038	60	30	E
C	vapour barrier (self-adhesive)	—	—	1,500	—	—
D	CLT 140 L5s	14	0.110	50	470	D
E	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
F	mineral wool	5	0.035	—	18	A1
G	fire-protection plasterboard	1.5	0.250	—	800	A2

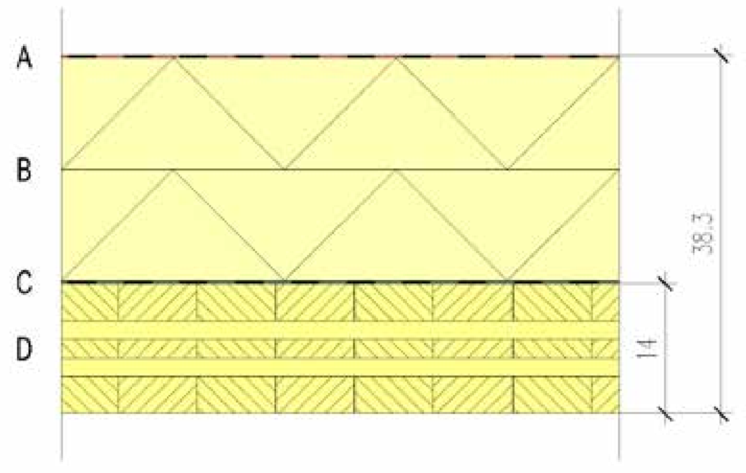
Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
24	REI 90	5	0.11	adequate	14.7	43	—

Component designs

4. Roof — Variant 4 of 6

top



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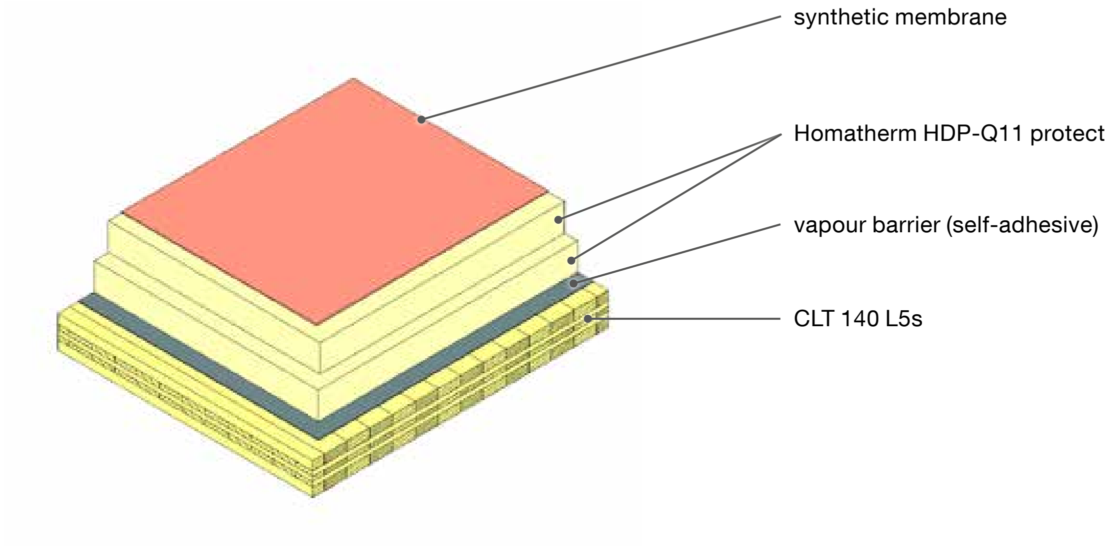


Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 60	0.13	38

Component design

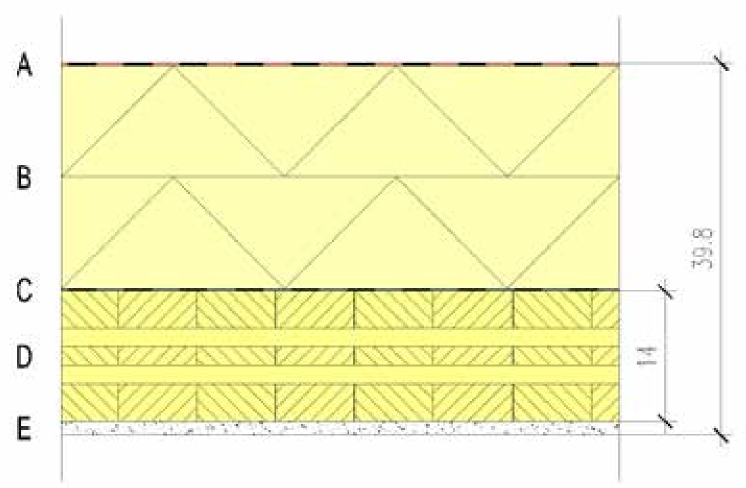
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	synthetic membrane	0.3	–	40,000	680	E
B	Homatherm HDP-Q11 protect (2 layers)	24	0.039	3	140	E
C	vapour barrier (self-adhesive)	–	–	1,500	–	–
D	CLT 140 L5s	14	0.110	50	470	D

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
24	REI 60	5	0.13	adequate	32.5	38	–

5. Roof — Variant 5 of 6

top



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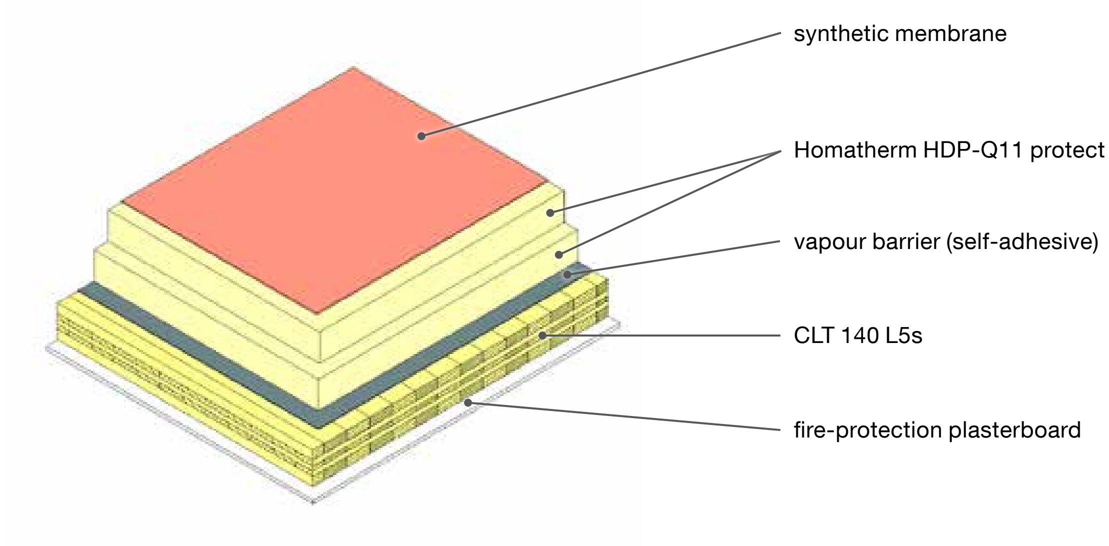


Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.13**	**39**

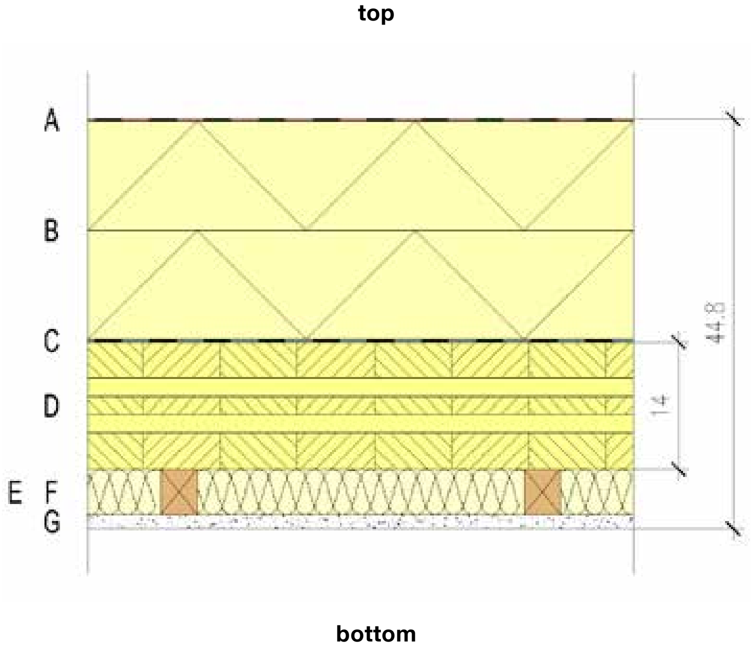
Component design

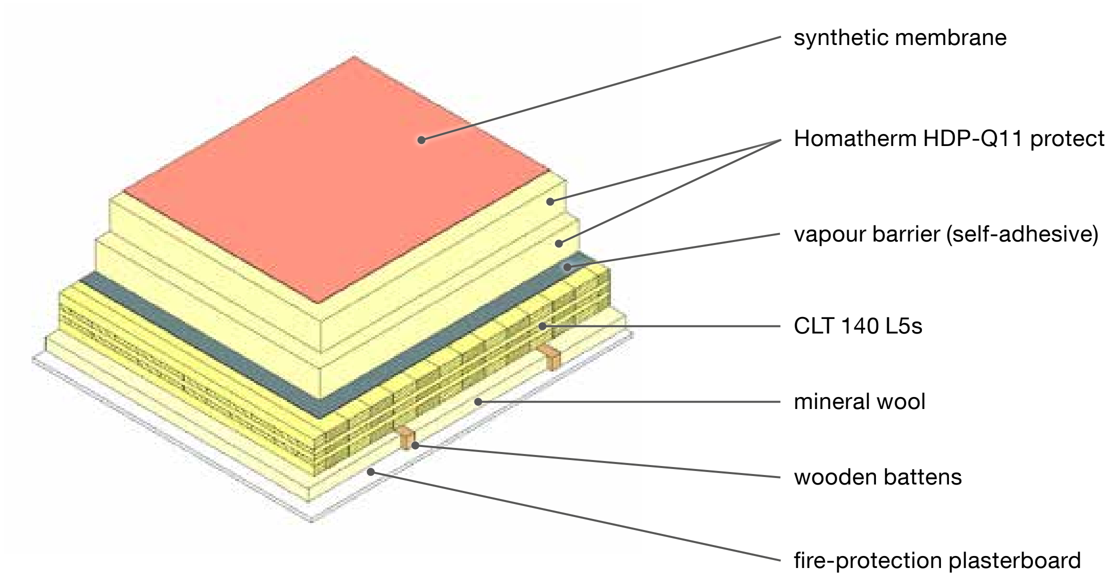
	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	synthetic membrane	0.3	–	40,000	680	E
B	Homatherm HDP-Q11 protect (2 layers)	24	0.039	3	140	E
C	vapour barrier (self-adhesive)	–	–	1,500	–	–
D	CLT 140 L5s	14	0.110	50	470	D
E	fire-protection plasterboard	1.5	0.250	–	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
24	REI 90	5	0.13	adequate	36.7	39	–

6. Roof — Variant 6 of 6





Fire resistance (REI)	U-value (W/m²K)	Acoustic (R_w)
REI 90	**0.11**	**45**

Component design

	Material	Thickness [cm]	λ [W/(mK)]	μ	ρ [kg/m³]	Flammability category
A	synthetic membrane	0.3	—	40,000	680	E
B	Homatherm HDP-Q11 protect (2 layers)	24	0.039	3	140	E
C	vapour barrier (self-adhesive)	—	—	1,500	—	—
D	CLT 140 L5s	14	0.110	50	470	D
E	wooden battens 40/50 | e = 62.5 cm	5	0.130	50	500	D
F	mineral wool	5	0.035	—	18	A1
G	fire-protection plasterboard	1.5	0.250	—	800	A2

Structural-physical analysis

Insulation thickness [cm]	Fire protection I → O		Thermal performance			Acoustic performance	
	Fire resistance	Load [kN/m]	U-value [W/m²K]	Permeability	Thermal mass $m_{w,B,A}$ [kg/m²]	R_w	$L_{n,w}$
24	REI 90	5	0.11	adequate	14.7	45	—

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