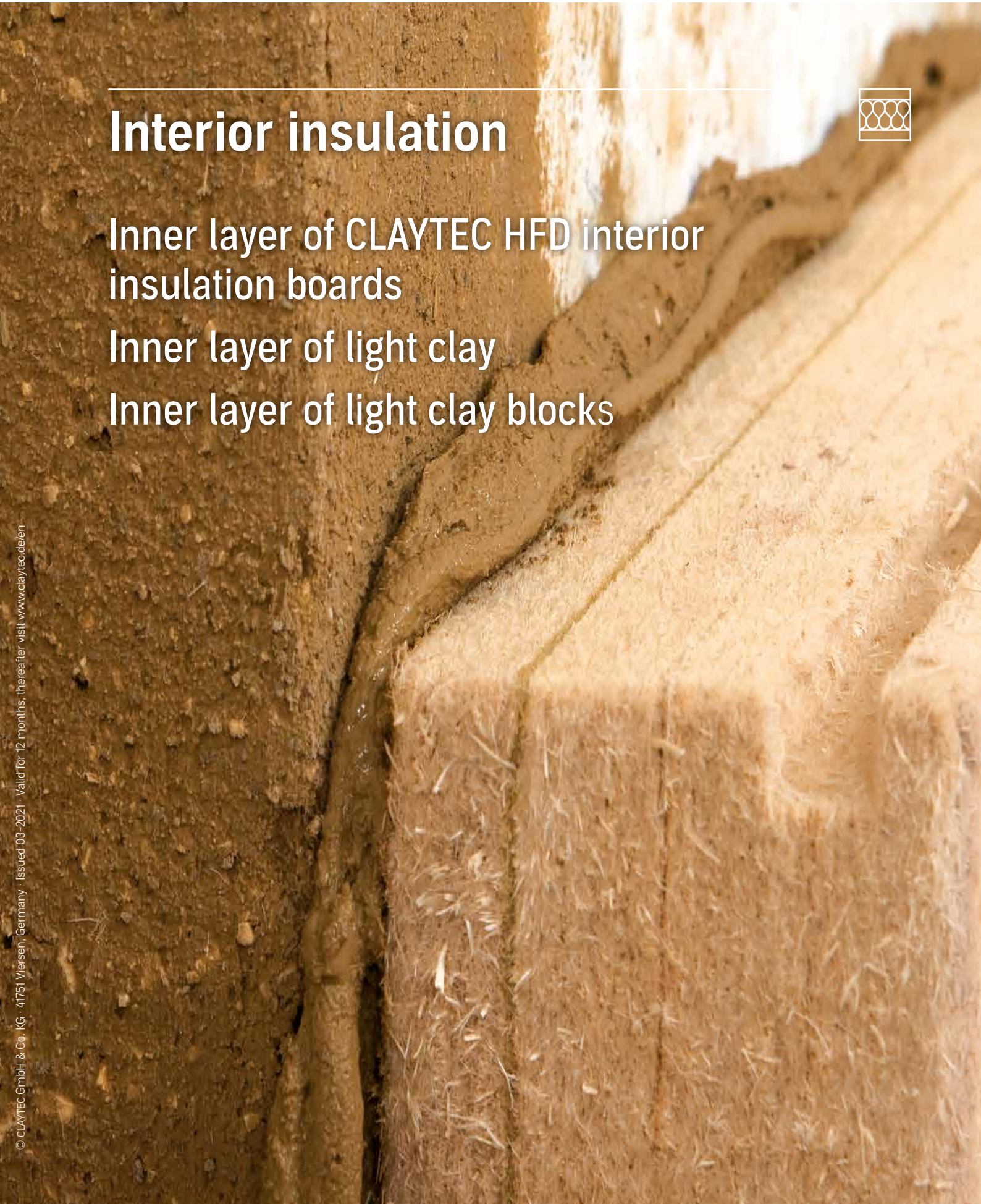
Worksheet

CLAYTEC®
Building with Clay



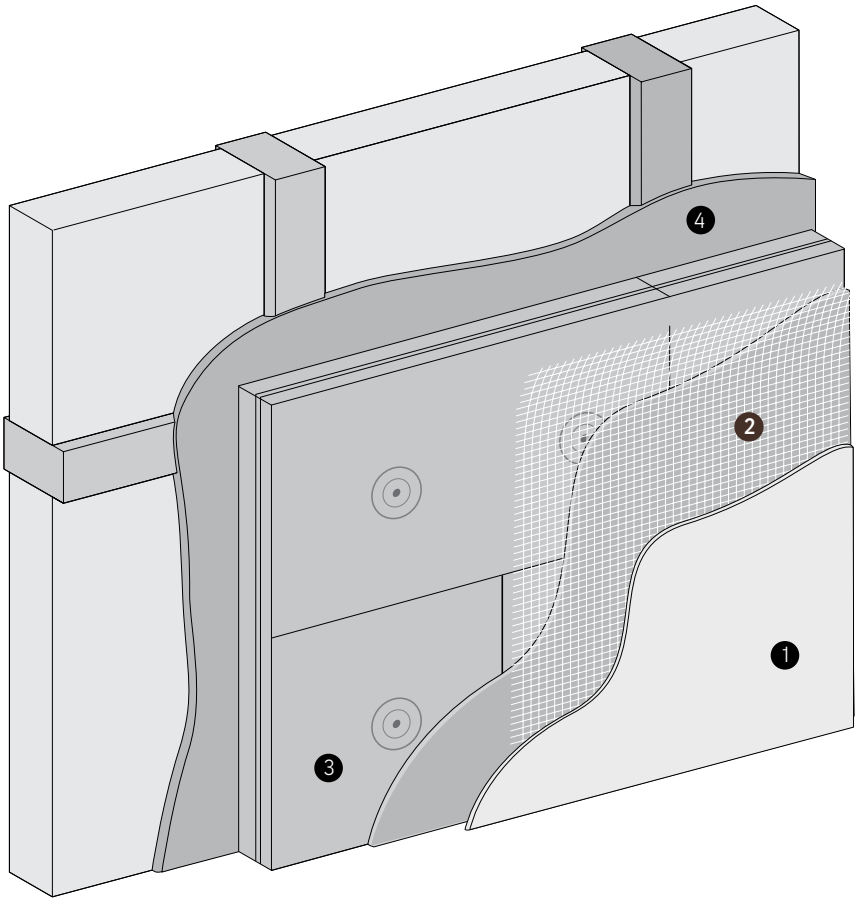
Interior insulation

Inner layer of CLAYTEC HFD interior insulation boards

Inner layer of light clay

Inner layer of light clay blocks

Inner layer of CLAYTEC HFD interior insulation boards



	Layer, product	Thickness	Item no.
1	Clay topcoat fine with coating or YOSIMA clay designer plaster	3 mm 2 mm	05.113, various various
2	Clay adhesive and reinforcing mortar or clay topcoat fine with flax or glassfibre mesh	3 mm	13.555 35.030 or 35.010
3	CLAYTEC HFD interior insulation board	40 mm, 60 mm (80 mm)	09.440, .460 (.480)
4	Levelling plaster if necessary Clay adhesive and reinforcing mortar	if necessary 10-35 mm 3 mm	05.030, .001 13.555

CLAYTEC wood fibre insulation boards (HFD), which are suitable for direct plastering, are attached with clay adhesive and reinforcing mortar to the inside of exterior walls that need to be insulated. Interior insulation systems are used as an alternative to exterior systems in the renovation and modernisation of buildings. They are suitable for historic brick buildings and all buildings that were built after 1900. This includes the numerous buildings with solid or cavity exterior walls from the 1920s and 30s, as well as the 1950s and 60s. Particular fields of use are historical buildings, half-timbered houses and other buildings with attractive facades that are worthy of preservation.

Inner layer of CLAYTEC HFD interior insulation boards

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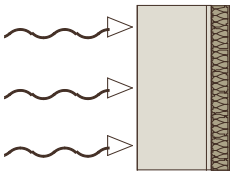
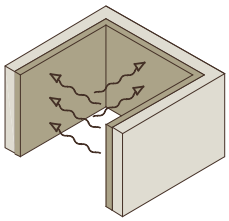
The long-term safety of the interior insulation with wood fibre insulation boards is based on experience, guaranteed building material properties and structural calculations. The Claytec interior insulation system is practice-oriented and has been tested down to the last detail.



Use of solar warming

There are a number of technical reasons that make interior insulation systems attractive:
The exterior walls can still be heated by solar (free) energy after the insulation work. They are not separated from this, as in exterior insulation. The higher temperature of the component has a very positive influence on the flow of energy through the wall.

Interior insulations allow rooms to heat up quickly because of the energy decoupling of the room air and the exterior wall mass. This is very accommodating for the habits of modern users. Even thin layers of insulation are effective here and have a positive effect on the overall energy consumption.

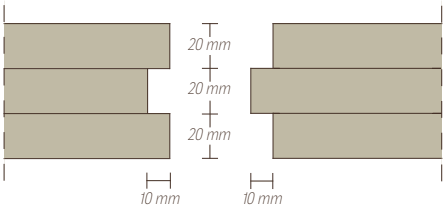


Rooms heat up quickly

Exterior insulations are often hard to connect to roofs or other parts of the building, a problem that does not arise with interior insulation. There are no costs for scaffolding and exterior plaster work. The incident light through the, often very small, windows in old buildings is only reduced slightly: Interior insulations allow sloping soffits, which are hard to realise both optically and structurally with exterior insulations. Furthermore, building law requirement (facades on property boundaries, distance spaces) may also rule out exterior insulating layers. Interior insulations also allow the insulation of partial areas, e.g. in owner-occupied flats or during renovations that can only be carried out room by room.

Compared to other clay construction insulation techniques, interior insulations of mortared insulation boards have a higher insulating effect with a lower layer thickness. This minimises any loss of useful living space. Drying times are short.

Although the thermal bridge effect of connecting parts of the building is a source of energy losses, it often poses no structural problems with CLAYTEC systems, as we will explain below.



Tongue-and-groove ensures a good bond and a level substrate for subsequent plastering.

Building materials
Levelling courses, that may also act as a mortar bed with a thickness of ≤ 1 cm, are ideally made with lightweight clay insulation plaster (CLAYTEC 05.036). This also contributes to the thermal insulation. Clay undercoat plaster (CLAYTEC 05.001, 10.010) is also very suitable, as is clay plaster Mineral (CLAYTEC 05.030, 10.030). Clay adhesive and reinforcing mortar (CLAYTEC 13.555) is used to stick these into place.

The insulation is made with CLAYTEC HFD interior insulation boards (CLAYTEC 0940-.480) and system fastening materials (CLAYTEC 35.130-.150).

Clay adhesive and reinforcing mortar always sets perfectly on any substrate; this can only be ensured by plastic additives with lime or cement adhesives. Clay adhesive is breathable and displays capillary action. Wood fibre insulation boards are made from softwood fibres. They can absorb large amounts of atmospheric moisture and store this temporarily. The mechanical flexibility helps minimise the risk of plaster cracks. The CLAYTEC format of 40 x 102 cm is ideal for renovating small areas.

Reed boards (CLAYTEC 34.010) have also proven their worth.

The material required for a levelling course (to produce a smooth surface) or a mortar bed

Item no.	Product	Boards/m².
09.440	CLAYTEC HFD interior insulation board 40 mm	2.6
09.460	CLAYTEC HFD interior insulation board 60 mm	2.6
09.480	CLAYTEC HFD interior insulation board 80 mm	2.6

Inner layer of CLAYTEC HFD interior insulation boards

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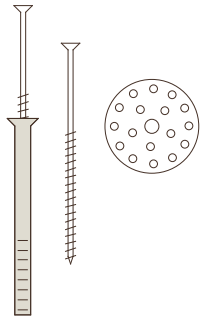
(to level and set the boards directly) is determined by the area and the average application thickness.

The mortar needed for notched plastering with clay adhesive and reinforcing mortar is 4.5 to 6 l/m². Please refer to the table for varieties, supply forms and yield of the various products.

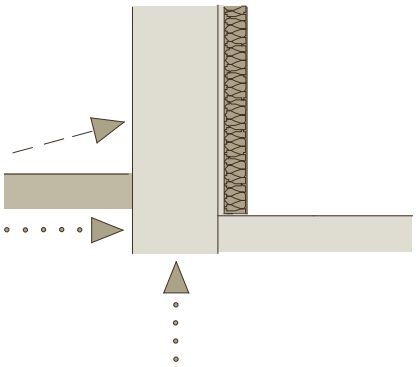
Item no.	Product	Delivery form	Yield
05.036	Clay insulation plaster	earth-moist 0.9 t Big Bag	675 l
05.001/.002/ .10.110	Clay undercoat plaster	earth-moist 1.0 t Big Bag/dry 1.0 t Big Bag/ 25 kg bag	600 l/625 l/16.7 l
05.030/10.030	Clay p. Mineral	earth-moist 1.0 t Big Bag/30 kg bag	600 l/20l
13.555	Clay adhesive	25 kg bag	17 l



CLAYTEC Fixing medium

We can supply galvanised steel screws or, depending on the substrate, rawlplugs as fastening material. Our insulation plates can be combined with both types and any length. TORX T30 bits are used to drive the screws.

Item no.	Product	Delivery form (SU)	Fix./m²
35.130/60 - .130/140	Screw 6 mm. L= 60, 80, 100, 120, 140 mm	Box of 100 pieces	approx. 6-8
35.140/100 - .140/160	Rawlplug 8 mm. L= 100, 120, 140, 160 mm	Box of 100 pieces	approx. 6-8
35.150	Insulating plate, thickness 60 mm	Box of 100 pieces	approx. 6-8



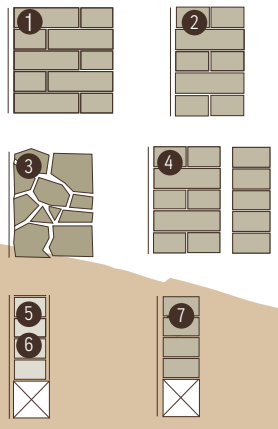
Risks from other sources of moisture

Moisture protection and insulating material thickness

The possibility of condensation forming in building components is often discussed in relation to interior insulation. What is important here is not just the possible amount of supposed water formation but also its position in the wall cross-section. Compared to other possible moisture stresses on the exterior wall, there is usually a low risk of condensation in the building component: The amounts of water that can be absorbed by rising damp, splashes and driving rain are generally much more important influencing variables. These risks thus have to be ruled out to ensure permanent freedom from damage.

U-values of different existing walls with and w/o insulation as orientation aid

Exterior wall	uninsulated U in W/m²K	with 40 mm U in W/m²K	with 60 mm U in W/m²K	with 80 mm U in W/m²K
1 Brick 36⁵ cm	1.36	0.61	0.48	0.40
2 Brick 24 cm	1.82	0.68	0.52	0.42
3 Natural stone 30 cm	2.82	0.79	0.58	0.46
4 Brick 24 cm (cavity)	1.28	0.60	0.47	0.39
5 Timber-frame construction 14 cm, clay (light)	1.20	0.57	0.46 *	0.38 *
6 Timber-frame construction 14 cm, clay	1.69	0.65	0.50 *	0.41 *
7 Timber-frame construction 14 cm, brick	1.93	0.68	0.52 *	0.42 *



*Not recommended for half-timbered facades exposed to weathering

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We always prefer insulation thicknesses of 40 mm or 60 mm. The table shows that improvements up to a factor of 4 can already be achieved with these thicknesses. And little space is lost. Insulating material thickness of 80 mm may be able to be proven by calculation in the walls under consideration. In these cases, however, you have to consider the possible risks from additional sources of moisture and at connections (e.g. support areas for ceiling beams, see below) very carefully, and the building project must always be supported by an experienced specialist planner.

We recommend insulation boards that are only 40 mm thick for half-timbered facades exposed to weathering.

Please see p. 10 and 11 for comments on moisture protection and the permissible rainwater stress on half-timbered facades as well as the leaflet 'Timber frame repairs according to WTA I: structural requirements on the half-timbered building.'

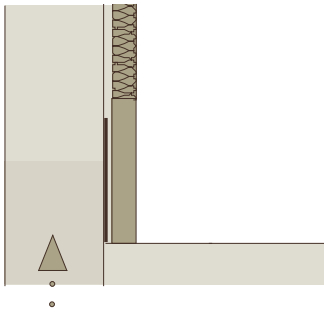
Moisture protection and insulating material thickness

The ground-level part of the wall must be tested for moisture penetration. Insulating materials made from plant raw materials must never be in contact with parts of the building that are permanently moist. Horizontal and/or vertical barriers as well as drying measures are required in the event of a high moisture load. Should these prove structurally impossible, a renovation on the inside with calcium silicate or foamed glass boards, according to good construction practice, may be needed.

An additional stress from structurally damaging salts must be seen as particularly critical because the salt can destroy the building materials in the inner layer. The hygroscopic effect can also cause additional moisture penetration. Salt contaminations are very frequent in old brick masonry and in stables.

Thick layers of old coatings and blocking layers such as tiles, paints and oil paints have to be removed from the inside of the wall to be insulated. Old plasters and/or multiple applications of wallpaper paste may also be impermeable and have a vapour-retarding effect. One simple way to check this is a wetting test: in this, water is applied with a roller. It the water is absorbed within a few minutes, this indicates good absorption properties, which can be interpreted as a sign of a sufficient breathability.

Lime and clay plasters as well as lime paints are breathable, apart from the aforementioned problems, and can be left on the building component. The same applies for gypsum plasters: a possible temporary loss of strength (gypsum rot) can be tolerated if condensation forms. The formation of expansive minerals (gypsum expansion) need not be feared in clay applications because they contain no cement phases.
The insulation boards can be covered with suitable moisture-proof drywall boards when tiling in splash zones around showers and baths. The moisture protection must be carried out very carefully on account of the organic nature of the boards. Tiled areas on interior insulation should always be kept to a minimum; see p. 10.



Base point with seal and foamed glass insulation

Adjacent parts of the building

Flanking insulation in the connecting area to exterior walls is often recommended for connecting interior walls and ceilings. The goal is to minimise the flow of energy and prevent critical cooling of the surfaces. You have to consider the jarring edge in the room and the considerable effort involved.

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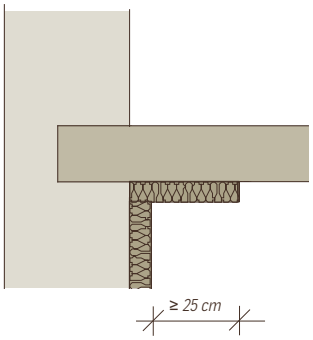
There is no denying the thermal bridge effect of the connecting part of the building. However, there is not usually a risk of surface condensation and mould growth on historic building materials such as wood and clay because their thermal conductivity is low. The same applies for bricks with gross densities of ≤ 1600 kg/m3.

Walls and ceilings of very thermally conductive building materials such as concrete should always be provided with flanking insulation. Particular care has to be taken if there has already been a mould infestation before the insulating measures. Caution continues to be the order of the day if forced airtight sealing measures have been carried out to minimise the exchange of air in winter. The same applies for poorly ventilated rooms with a permanently high atmospheric humidity.

The moisture absorption properties of wall and ceiling coatings with CLAYTEC clay plasters offer a considerable safety reserve to protect the surfaces of connecting parts of the building.

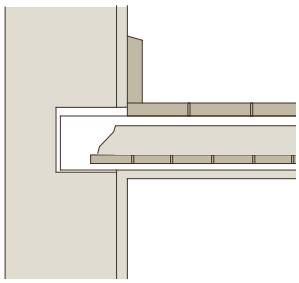


Flanking insulation for concrete if necessary; not usually needed for clay or brick

The opening and later filling of the visible underside of plastered ceilings and floorboards to perform insulation work is a demanding task and destroys historic structures. The ceiling construction of wood, straw clay or light fill materials and air inclusions is often not a structurally critical thermal bridge but only an energy weak point that may be tolerable. If the ceiling has to be opened anyway for structural reasons, the insulation should be installed between the ceiling beams. Any existing cavities behind trimmer beams that run parallel to existing walls must be filled in, e.g. with flax wool (CLAYTEC 35.050). Always insulate wall areas in cavities above suspended ceilings.

The support areas for timber beam ceilings are particularly critical points in solid constructions. Water can condense on the surfaces of the beams that have become cooler because of the insulation if a larger amount of warm and humid room air flows through the component because of leaks (e.g. through the cracks in the floorboards).

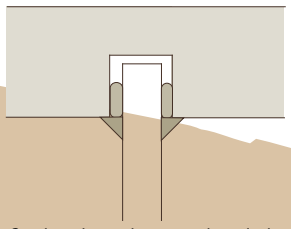
Because the exterior wall is more or less decoupled from the room heating by the interior insulation, masonry walls may take longer to dry after rainfall. Accordingly, the beam ends can remain moist for longer.



Support area of a typical, historic timber beam ceiling

The actual condition of the wooden beam in the support area should first be investigated. If damaged beam ends have to be replaced anyway, this should be carried out with due care. Avoid direct contact with the support area in the masonry in particular; the beams are laid on a separation layer (e.g. bituminised cardboard). The wood should not come into contact with the masonry in the other areas either; there should always be a slight gap. The connection on the inside should be airtight as far as possible.

If the wood is intact, the risk of the inflow of air, e.g. through joints in the covering, should be investigated. Where floors have with largely closed joints and facades have apparently leak-free exterior surfaces, these do not necessarily have to be included. We would like to warn against the destruction of airtight layers on the underside in the form of intact wall and ceiling plasters.



Seal with sealing wool and clay adhesive and reinforcing mortar (with a lath on the wood if necessary)

The theoretically 'perfect' detailed solution is often only allegedly better than the existing situation. If you decide to open the upper side of the ceiling, the joints between the masonry and beams can initially be filled with flax sealing wool (CLAYTEC 35.050). You should aim for

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the best possible airtightness of the connection by coating with clay plaster mortar. Sealing by means of adhesive tapes is very often unsatisfactory in irregular old buildings. Mortar has the additional advantage of capillary action.

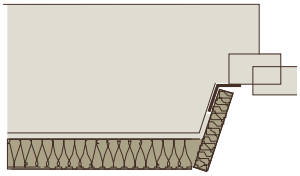
The advice above applies correspondingly for the support areas of ceiling beams in timber-frame constructions. However, these may be far less problematic because they are either exposed, and thus always dry faster, or are clad in clay or lime mortar that has a good capillary action.

Window and door soffits should be insulated wherever possible. Depending on how much space is available, CLAYTEC lightweight clay insulation plaster (CLAYTEC 05.036) or CLAYTEC wood fibreboard panels (HFA) of varying thicknesses can be used. The insulation helps increase the surface temperature in these areas so as to prevent condensation on surfaces. Flows of air through window frame connections must be prevented (airtightness). Particular care has to be taken if mould has appeared in the soffit area before the insulation measures. Thin mineral insulation boards are recommended in very critical cases.

Connections to existing parts of the building are often complex tasks that necessitate the assistance of an experienced specialist planner.

Art. no.	Product	Thickness
09.009	Claytec HFA thin	8 mm
09.221	CLAYTEC HFA N+F	20 mm
09.226	CLAYTEC HFA maxi	25 mm

CLAYTEC wood fibreboards (HFA) to insulate soffits



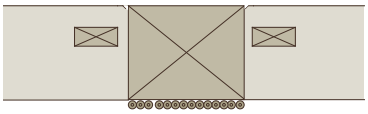
Airtight seal and insulation in the window soffit

Mortaring the boards

Interior insulation with insulation boards assumes largely level surfaces. A layer of plaster may have to be applied as a levelling course. CLAYTEC lightweight clay insulation plaster, clay undercoat plaster with straw or mineral clay plaster are suitable for this purpose.

A layer of old or new plaster is also important for long-term protection against moisture: condensation that forms on the outside of the insulation is absorbed and transported by this. It also acts as a distribution layer for smaller amounts of driving rain that penetrate to a certain extent from the outside.

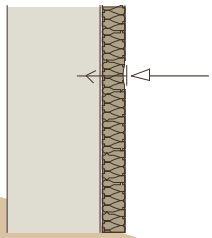
A better adhesion of plaster on half-timbered walls with very broad beams can be achieved by stapling on a strip of reed matting St 70 (CLAYTEC 34.001). Working in reinforcing mesh prevents cracks and thus contributes to the prevention of leaks (wind- and airtightness). All wooden parts must be covered fully and not too thinly (5-10 mm).



Reed matting on a broad beam

The building components and substrates to be insulated must no longer be moist. **Levelling courses must be left to dry before installing the boards** to prevent prolonged moisture stress on the building components in the initial period. If the levelling course is not too thick (≤ 10 mm), it can be used directly as a mortar bed to press in the boards.

Otherwise the boards are stuck in place with a thin layer of lime clay adhesive and reinforcing mortar (CLAYTEC 13.555). The adhesive is applied to the rear of the boards using a toothed spatula (rectangular serrations 10 mm). If an additional layer is applied to the wall, both layers are applied with a toothed spatula (rectangular serrations 5-6 mm) in an offset crosswise manner. A two-sided adhesion is particularly strong and consistent; soffit boards in particular must be installed by this method. Apply the adhesive so that a thin layer of mortar still remains in the area of the serrations.



Pressing down boards with the help of rawlplugs or screws

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The insulation board is pressed firmly into the mortar bed or freshly applied adhesive and pressed down. **Ensure an all-over contact with the substrate (at least 80% of the area) with no defects wherever possible.** The grooves in the adhesive are greatly reduced by pressing down and are not defects. The tongue-and-groove joint of the CLAYTEC HFD interior insulation board ensures a very level plastering substrate, even in joint areas.

Apart from the mechanical function, this all-over adhesion has a further important function, namely to prevent warm and humid room air from flowing behind the boards. The subsequent fastening with screws or plugs not only serves to ensure stability, but also to guarantee thethe all-over bond. The boards are pressed firmly into the adhesive by this fastening.

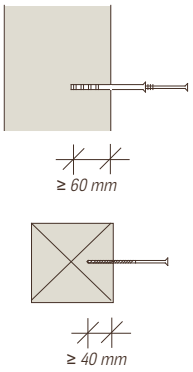
The insulation boards are fixed in the brick masonry of the exterior wall with Rawlplugs (CLAYTEC 35.140/100-160). Screws (CLAYTEC 35.130/60-140) are used with half-timbered walls for fastening in the timberwork and clay infills. **Rawlplugs of approx. 60 mm** should engage with the existing wall with solid substrates. In firm wood substrates, the screws only have to be anchored to a depth **of approx. 40 mm** Longer screws may need to be used in a clay substrate, depending on its strength. Screw or drill into clay infills carefully and avoid any vibrations. The type and length of the fastenings is determined by the frequently changing substrates in old buildings. It is advisable to always have several and sufficiently long fastener types on the building site.

Each board is fastened at at least two points with insulating plates (CLAYTEC 35.150). These lie vertically in the middle. The horizontal distance to the edge is approx. 25 cm, the gaps between them is thus approx. 50 cm. The distance to the edge of the fastening should not be less than 60 mm (spacing to the edge) if possible. The insulating plates are tightened in place until their surfaces for the later application of the thin layer of plaster are flush with the surface of the boards if possible.

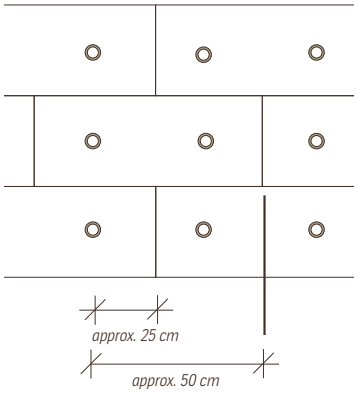
The tongue-and-groove joint of the Claytec insulation boards guarantee a good continuous bond and helps prevent cracks in the plaster.

The boards are usually cut to size with a jigsaw or handheld circular saw, though other tools are also suitable. Laying usually begins in the bottom left corner of the wall. The left vertical tongue is cut off the first board. The boards can be smoothed to the depth off the groove at the floor connection to avoid cavities. This can also be achieved by coating with clay mortar. Mitre joints are not necessary in the corners of rooms. The risk of cracks in the corners of rooms can be minimised by interlocked laying.

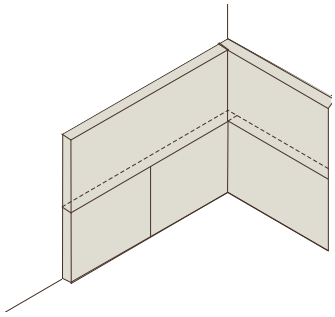
The boards are arranged in a bond formation, i.e. offset without any continuous vertical joints. The offset must be at least 25 cm. The vertical and horizontal limits of door and window openings must not continue through board joints. This must be taken into account at the very start of work; an alternative remedy is to cut smaller sizes.



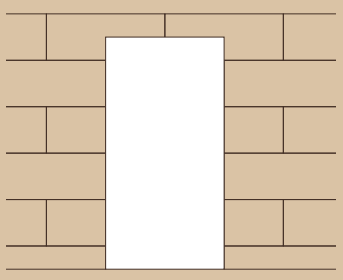
Anchorage depths



Screw spacing, board spacing



Interlocked laying in room corners



Arrangement of boards at openings

Inner layer of CLAYTEC HFD interior insulation boards

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Subsequent processing

You do not usually have to observe any specific drying times before plastering; subsequent work can be carried out quickly. If using a mortar bed (thickness of ≤ 10 mm), however, this must be sufficiently firm.

If necessary, fill gaps of ≥ 1 mm in width with CLAYTEC clay adhesive and reinforcing mortar or clay topcoat fine and leave to dry. Carefully dust panels.

Thin layer coating: The surfaces are coated with a 3 mm layer of clay adhesive and reinforcing mortar. This can also be sprayed on using a plastering machine; if this application method is used, rest periods are not necessary. Flax or glassfibre meshes are spread flat and worked into the surface while it is still wet. Properly apply YOSIMA clay designer plaster after drying. Produce the reinforcement layer very carefully for the YOSIMA colour clay surfacer or the CLAYFIX clay paint system (= fill the drill holes and indentations before starting and allow these points to dry); it is more advisable to apply a thin layer of clay topcoat fine.

Thick layer coating: Pre-treat the areas with RED primer. Apply clay undercoat plaster with straw, clay plaster mineral or SanReMo to the walls in a layer thickness not exceeding 8 mm. Flax or glassfibre meshes are spread flat and worked into the surface while it is still wet. Leave to dry. The max. possible thickness of the overall layer of plaster is 15 mm.

Wall panel heating: Prepare the areas with RED primer or by notched plastering using clay adhesive and reinforcing mortar. Leave to dry. Before starting, spray one of the above clay mortars onto the surface to a maximum thickness of 8 mm. After drying, fill the gaps as far as the pipe clamp for the wall heating. Apply heat to dry the entire basecoat layer. For further instructions, refer to the CLAYTEC 'Clay plasters worksheet'.

Note: The absorption property of wood fibre insulation boards is much lower than that of solid building materials such as bricks, which is why safe drying has to be planned and monitored very carefully with thick layers of plaster; see CLAYTEC 'Clay plasters worksheet'.

The complete plaster structure on the room side should be executed in such a way that leaks are minimised. A good airtight seal can normally be achieved in solid buildings. Particular care must be taken when plastering visible ceiling beams. Half-timbered houses very often cannot be made absolutely airtight at a reasonable cost and effort. Nevertheless, leaks should be eliminated as far as possible by good plastering technique, e.g. by coating joints. Detailed information on the structure, processing and surface treatment of clay plaster can be fond in the CLAYTEC 'Clay plasters worksheet'.

The surfaces must only be covered with vapour-permeable coatings. Tiling should be kept to an absolute minimum; cladding large areas with tiles is not allowed.

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Electrical installations

Avoid any electrical installations in the insulating layer at all costs. Alternatively, we recommend special base sections or that the installations be laid in side walls. If installations are unavoidable in CLAYTEC HFD interior insulation boards, pay attention to the following instructions:

- Lay cable beneath the insulation, e.g. in levelling courses.
- Only single or double electrical sockets are recommended. The thermal bridges produced by multiple sockets are too large.
- Sockets from Kaiser-Elektro with airtight, elastic sealing membranes are recommended as airtight electrical sockets (Art. nor. 1055-21).
- Airtight flush-mounted sockets must be embedded on their sides and rears completely with clay adhesive and reinforcing mortar or a fast-setting tile adhesive, etc.
- Cables must be laid airtight from the cold to the warm side of the interior insulation; wiring conduits are not suitable.

Fastening special single loads

Large loads such as radiators and wall cabinets must be fastened through the insulation board into the wall structure or onto built-in squared timber. Smaller loads such as pictures, lamps, wall hearting panels etc. are fastened in place with screw-in fasteners that are screwed into the plastered insulation board. 39 mm long screw-in fasteners, for example, are suitable for this. More details can be found in the CLAYTEC/TOX "Firm hold in clay" brochure at www.claytec.de.

Moisture protection, solid walls one and two-layer 1-4, lined half-timbered walls 5-7

Illustrative hygrothermal simulations were carried out for the examples shown. They were performed in consideration of a high driving rain stress in regions of Germany far from the coast and guaranteed impermeability to driving rain in accordance with WTA leaflet 6-5:2014-04. A structural review by a specialist planner on-site can assess the interior insulation for the particular property in the actual given circumstances. If the building is located > 680 m amsl, the structural feasibility must be checked separately.

Moisture protection, visible timber frames not weathered 5-7

No hygrothermal simulations are available. 40 and 60 mm thick interior insulations have, however, proven their practical worth over the years. What is decisive is the exclusion of more than just sporadic weathering. An in-situ assessment by a specialist planner is also strongly recommended in this case. If the building is located > 680 m amsl, the structural feasibility must be checked separately.

Moisture protection, half-timbered walls, visible timber frames weathered 5-7

We recommend a 40 mm thick interior insulation for visible timber frames that are exposed to weathering as described in the following section. The objective here is a compromise between the requirements of the Wissenschaftlich-Technische Arbeitsgemeinschaft für Bauwerkserhaltung und Denkmalpflege e.V. (Scientific Engineering Consortium for Conservation of Constructions and Monuments) on moisture protection for visible timber frames and DIN 4108 on minimum thermal protection. The insulation requires no certificate with respect to the limitation of the amount of condensation.

Inner layer of CLAYTEC HFD interior insulation boards

CLAYTEC®

Explanations of the permissible rainwater stress on half-timbered facades

In the opinion of the WTA and other experts, visible half-timbered walls should only be exposed to limited rainwater stress. The driving rain load on facades with visible timber frames should be less than 140 l/m² per annum. The limit value roughly corresponds to stress group I according to DIN 4108.

The exposure should be tested critically, especially in regions with driving rain stress groups II and III according to DIN 4108. The actual weathering load on a facade can only ever be assessed in specific individual cases. Criteria include:

- Location, exposed in the countryside or protected, e.g. in settlement centres
- Cardinal direction (exposed to weather / opposite side)
- Condition of the infill and beam surfaces
- Percentage of beams damaged by weathering
- Condition of the facades of the surrounding building
- Traces of earlier formwork or plasters on the entire timber-frame area

We recommend 40 mm thick insulation boards for half-timbered facades with the aforementioned limited rainwater load. Facades exposed to a higher stress should be protected against the effects of weathering by cladding or all-over plasters.

Sound insulation

Sound insulation values Rw in dB w/o and with inner layers according to calculations by the SWA-Institute, Aachen (extrapolated from measured values and theoretical assumptions)

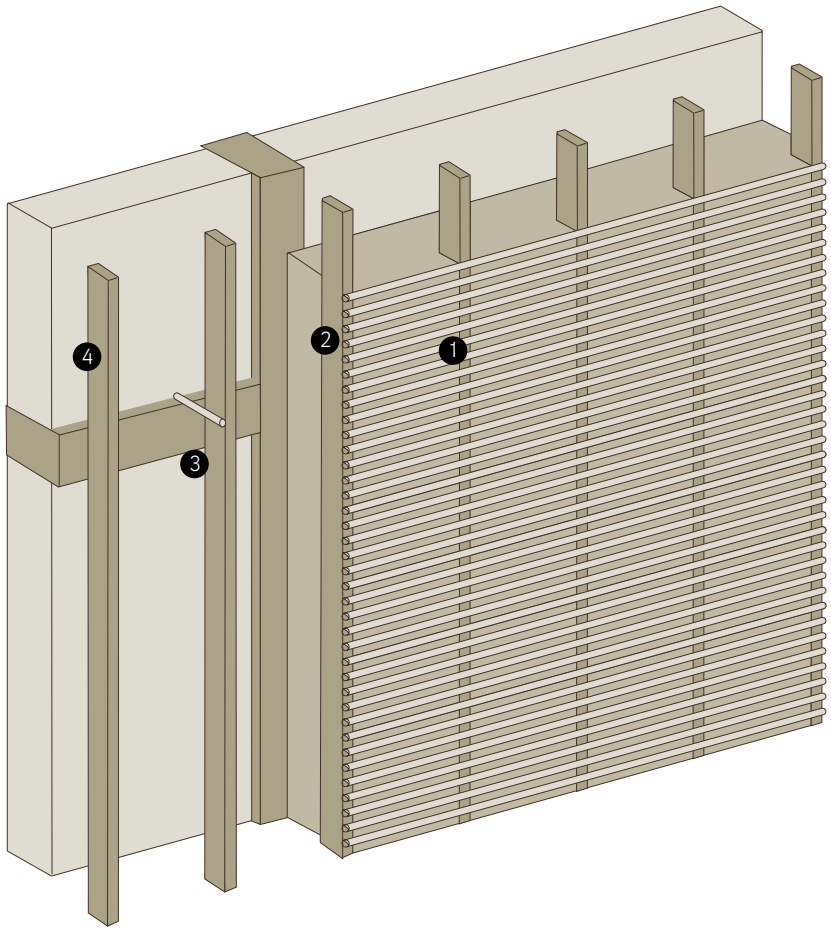
	Uninsulated wall	**Wood fibre insulation board 60 mm**	**Reed board 20 mm**	
Timber frame, clay infill approx. 1,000 kg/m³	41	44	34-38	42
Timber frame, brick infill	45	48	38-42	46
Timber frame, rubble infill	47	50	40-44	48
Solid wall 24 cm, old brick etc.	50	53	43-47	51

Please note:

The information in the worksheet only applies if the Claytec building materials described here are used as complete system solutions. Systemic functional reliability can no longer be assumed in the event of any deviations. The system also includes all topcoats and coatings on the room side.

The information in the worksheets is based on many years of experience in the execution of clay construction work and the use of our products. No legal obligation can be derived from this. Adequate experience as a craftsman and the necessary skills from the relevant building trades are assumed. The latest version of the worksheet is always valid; this is available from www.claytec.de if necessary.

Inner layer of light clay



	Wall structure	Dimensions	CLAYTEC Products
1	Reed matting St 70	--	34.001
2	Light clay	Thickness = 10-15 cm	03.011, 03.040
3	Fixing	--	--
4	Battens e.g. 24 x 48 mm	--	

The inside of exterior walls is insulated light clay that is installed between an existing exterior wall and a lost formwork.

This technique is used as an alternative to exterior insulation with historic visible timber frames and constructions that are left visible from the outside. This filling technique has its merits wherever large irregularities, deviations from the vertical or horizontal or projections and recesses from existing exterior walls have to be compensated for. The timber-frame beams, even where they are of very different thicknesses, can easily be accommodated in the shell. Light clay is an easily malleable building material that can be used to safely fill the numerous cavities and gaps in a timber-frame construction.

Light clay is installed when moist. The material must be given enough time to dry unhampered by inappropriate formwork materials; also make sure that the material is not applied too thickly.

Inner layer of light clay

CLAYTEC®

Building materials

The building materials needed are light clay, woodchip (CLAYTEC 03.011) or light clay, expanded clay (CLAYTEC 03.040) as well as reed matting St 70 (CLAYTEC 34.001). The light clay is supplied ready for installation in an earth-moist to malleable consistency and must be used within two weeks of delivery. 1 m^3 of light clay, woodchip in a Big Bag is enough for approx. 0.9 m^3 of the finished building component, light clay, expanded clay is hardly compacted. The substructure is usually made from 24x48 mm or 30x50 mm roof battens. Approx. 6 m is needed for each m^3 of wall area; this includes the needs for auxiliary structures, window surrounds etc.

Workability time

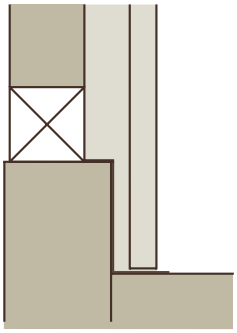
Initial situation and preparation

Rising damp

The ground-level part of the wall must be tested for long-term moisture penetration. Experience has shown that the inner layers have a certain tolerance to moisture stresses. Where there is a high moisture load, horizontal or external vertical barriers are required. If this is not possible, the only alternative is an interior seal with bitumen or the like. In many specific cases, the condensation that can then theoretically form is negligible, though a critical assessment is needed in every individual case.

Salinity

An additional stress in the ground-level part of the wall from structurally damaging salts must be seen as particularly critical because the salt can destroy the building materials in the inner layer. The hygroscopic effect can also cause additional moisture penetration. Salt contaminations are very frequent in old brick masonry and in stables. Elementary measures such as seals on the inside may simply cause the salt to rise higher in the wall. Accordingly, there are hardly any alternatives to horizontal or external vertical barriers.



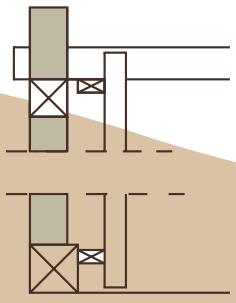
Example of a base point

Apart from aforementioned interior sealing of the lower part of the wall, which may be necessary in individual cases, thick layers of old coatings and blocking layers such as tiles and paint, including oil paint, must be removed from the inside of the wall being insulated. Lime and clay plasters and lime paints, on the other hand, can be left on the building component.

If the inner layer is based on building materials with a capillary action such as concrete, and if the risk of rising damp cannot be excluded with absolute certainty, the lower contact area must be protected by installing bituminised cardboard or film. Proceed in a similar way to laying down wooden thresholds.

Ceiling breakthroughs

You must decide in each individual case whether to create more freedom to build by removing the areas around the edges of the ceiling. This makes filling-in easier. But it also leads to removal costs and, in the case of a listed building, the loss of its historical status. Aspects of wind- or airtight seals must also be considered in this context.



Batten construction

Building the light clay shell

To begin with, horizontal battens are fastened to the existing exterior structure at the top and bottom room-by-room. These help with the vertical and horizontal alignment for the later substructure and also define the thickness of the shell. Of course, the shell can also be executed with no vertical and horizontal alignment.

The max. possible thickness of the light clay shell is limited to 15 cm for drying reasons. The inner shell may be built up to a max. thickness of 20 cm with exterior walls made from breathable building materials with a good capillary action such as straw clay, clay blocks or historic bricks.

Inner layer of light clay

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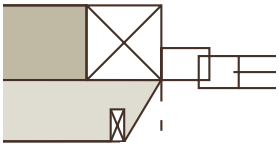
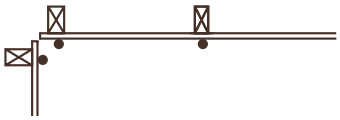
The vertical battens of the substructure are fastened at the top and bottom to the horizontal battens or sill and frame beams. The spacing between the vertical battens is 30-35 cm. The window and door connection methods must be specified at least roughly for the battens. Sloping window soffits can compensate for the disadvantages of the increased thickness of the wall as regards the incidence of light and impression of lightness. The soffit angle, however, should not be below 30 degrees. Windows and door sills are made with squared timber. Remember when installing the battens on the inner corners of the light clay shell that the formwork from both directions requires an end support.



Window connection ≤ 30°

The substructure must be connected to the existing wall firmly and be resistant to tensile forces. The vertical battens should be secured against the tensile stress that arises during filling in the middle of their length (every 1.20 m at most). This can be by means of wooden slats, galvanised wire or galvanised perforated strip.



Formation of inner corners

The 70-stem reed matting is clamped to the vertical battens with galvanised wire, 1.2-1.6 mm thick; the stems lie horizontal. The clips must be galvanised and at least 25 mm in length; they should be 5-7 cm apart. The height of the segments to be filled is up to 30-50 cm. The left and right ends of the reed matting must rest on a batten, or may protrude slightly beyond this; the mats cannot be jointed in the open areas. Clayboards are unsuitable as lost formwork.

Abutment against the substructure.

No joints in open areas!

Light clay is easy to shovel and transport; inclined elevators, for example, are suitable for lifting this to heights on the building sites. The material is shovelled or forked into place and compacted with a simple tool (part of a batten etc.) until the shell is full and free from cavities. Do not compact light clay with a tamper; the objective is not the densest possible packing. Check the quality of the fillings and the adequate fastening of the reed matting frequently at the start of work.

Gaps at soffits and lintel can be planked with formwork boards (to be removed after filling) or wood wool boards (that remain on the building component as laths). If they are less than 6 cm wide, no lateral formwork is needed.

Gap at soffits etc. ≥ 6 cm

The shell should be filled as close as possible up to the ceiling from above. The final upper strip is plugged from the front; the reed matting is finally stapled into place as a lath in this area too. Ceiling beams that extend through into the weathered area must be carefully clad and backfilled. If this work is performed well, you do not have to worry about any shrinkage or subsequent sagging of the light clay shell.

On the upper floors and if there is no floor slab on the ground floor, the weight of the inner shell can be borne by squared timber that is screwed into place or by a plank laid on the ceiling beams. This foundation often only has to bear part of the load, the inner shell also rests on upstands such as the framework rail.

Load transfer

Variant: light clay, woodchip, with travelling formwork

Travelling formwork can also be used that is made from boards or formwork panels and removed immediately after the light clay has been installed. However, this very often results in a more insecure plaster base because the light clay is not necessarily compacted enough to produce a sufficiently firm surface.

Inner layer of light clay

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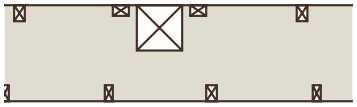
Subsequent stabilisation of the light clay is more complicated and expensive than the work with a lost formwork from reed matting. A great deal more work is also needed for travelling formwork than formwork made from reed matting.

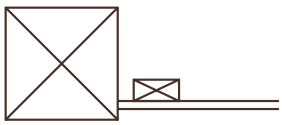
Variant: complete wall cross-section from lightweight clay insulation plaster
The complete wall cross-section of timber-frame constructions can also be made from light clay, e.g. if repairs to the timber frame have necessitated the partial removal of the old infills.



Sketch of wall structure

The max. installation thickness is limited to 30 cm for drying reasons. The exterior and interior formwork must be made of reed matting that does not hamper drying.

The exterior battens can be executed as stakes in a beam groove. The stems of the reed matting can run horizontally or vertically, the stakes are usually vertical and the reed matting is horizontal. The clearance between the front edge of the beam and the centre of the groove is 3-4 cm so as to allow a sufficiently thick layer of plaster (approx. 1.5 cm from the front edge of the reeds). The stakes should not be more than 1.0 m in length and they should be no more than 30 cm apart (axial spacing). A gap of 1-2 cm must be left between the lateral stakes and the beam. Those stakes on the edges must also be clamped in the beam groove. Due to the risk of a water-retaining gap between the surfaces of the battens and beams, these should never be nailed of screwed to the beams.



Clearance between stakes and timber-frame beams

The reed matting must be trimmed carefully to fit the timber frame. It is fastened in the same way as on the inside, but with stainless steel wire.

Filling with light clay must be carried out very carefully, particularly beneath horizontal beams, and continuously up to the outermost reed matting without any cavities.

The light clay must be absolutely dry before applying the exterior plaster.

Drying
The drying time must be taken into account when planning the building period; one general rule of thumb is to allow approx. 8-12 weeks. In the past, the installation of light clay was only recommended in the warm weather season (April to September). Thanks to today's technology such as mechanical drying and heating on building sites, work with light clay can now also be performed in winter. What is absolutely necessary in every case, however, is to ensure a constant draught during the drying period (24 hours a day!) so that moisture-absorbing outdoor air can flow over the entire surface of the interior wall without interruption. This is particularly important in the hot and humid summer months; the room must be very well ventilated because the air is not able to absorb as much moisture as normal. Mould that increasingly appears in later summer is always a sign that drying has taken place too slowly. In this case, you must intensify drying immediately. The easiest and safest solution is to make drying of the building the responsibility of the executing clay construction company.

Mould formation

Inner layer of light clay

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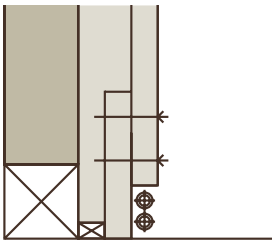
Interior plaster

Plastering can be carried out when the inner shell is visibly dry. The layer of interior plaster must be used to minimise leaks. In the majority of cases, a half-timbered house cannot be made absolutely airtight. Nevertheless, leaks must be sealed to the best of your ability, e.g. by manual methods such as grouting joints or painting over defects. The CLAYTEC 'Clay plasters worksheet' describes which clay plaster structures are suitable.

Freedom from leaks

Any questions?

Vertical shafts for installations can be produced when installing the battens. A recess in the area of the formwork's base point can also be produced with not great effort that can then be used as a horizontal duct for electrical wiring, sanitary or heating pipes. Structurally acceptable thermal insulation and protection against condensation must also be guaranteed in the area of these conduits.



Shaft for installations at base point

Electrical wiring can be laid horizontally in the gaps in the reed matting, and can be fastened vertically to the battens. The openings for flush-mounted sockets are produced by cutting away the reed stems and hollowing out the light clay, the sockets are plastered into place and can also be screwed into place through their rear panel. Naturally, all of the cables and pipes can also be installed before the shell is made.

Electrics

Pictures or small shelves can be hung using long wood screws (≥ 6 x 140 mm) that grip well in the structure of chips and additives. A plank or squared timber should be used for radiators, wall cabinets etc. Heavy objects can also be fastened in place with injection anchors.

Fixtures

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Inner layer of light clay

Thermal insulation

U-values with and w/o inner layers

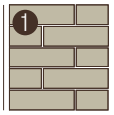
Exterior wall	uninsulated	with thickness = 10 cm U in W/m²K	with thickness = 15 cm U in W/m²K
1 Brick 36[5] cm	1.36	0.75	0.62
2 Brick 24 cm	1.82	0.87	0.69
3 Natural stone 30 cm	2.82	1.05	0.80
4 Timber-frame construction 14 cm, clay (light)	1.20	0.70	0.58
5 Timber-frame construction 14 cm, clay	1.69	0.82	0.66
6 Timber-frame construction 14 cm, brick	1.93	0.87	0.69
7 Timber-frame construction 14 cm, natural stone	2.66	0.96	0.74

Sound insulation

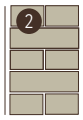
Sound insulation values w/o and with inner layers according to calculations by the SWA-Institute, Aachen (extrapolated from measured values and theoretical assumptions)

Exterior wall	uninsulated Rw in dB	with thickness = 10 cm Rw in dB	with thickness = 15 cm Rw in dB
2 Brick 24 cm	50	53	54
4/5 Timber-frame construction 14 cm, clay	41	46	47
6 Timber-frame construction 14 cm, brick	45	48	49
7 Timber-frame construction 14 cm, natural stone	47	50	51

Interior plaster
Brick 1,600 kg/m³



Interior plaster
Brick 1,600 kg/m³



Interior plaster
Brick 2,200 kg/m³

Interior plaster
Clay 700/1,200 kg/m³
Exterior plaster (lime)

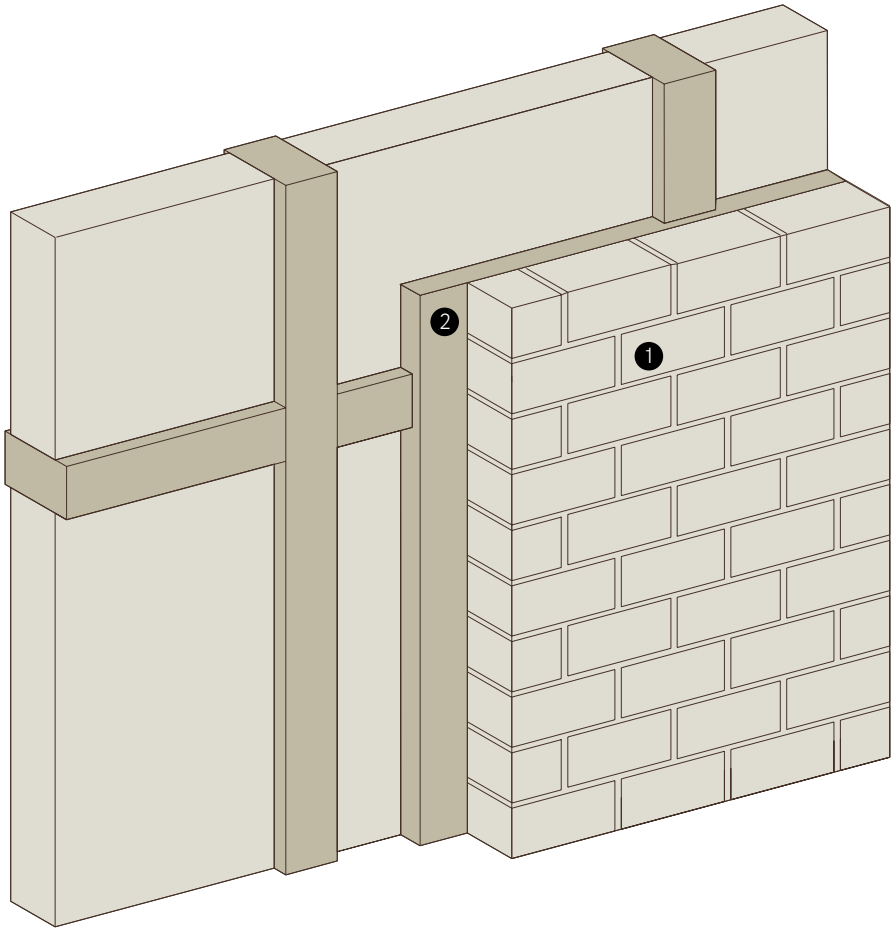
Interior plaster
Brick 1,600 kg/m³

Interior plaster
Natural stone 2,200 kg/m³

Please note:

The information in the worksheets is based on many years of experience in the execution of clay construction work and the use of our products. No legal obligation can be derived from this. Adequate experience as a craftsman and the necessary skills from the relevant building trades are assumed. The latest version of the worksheet is always valid; this is available from www.claytec.de if necessary.

Inner layer of light clay blocks



	Wall structure	Dimensions	CLAYTEC Products
1	Light clay blocks	Thickness = 11.5 cm	07.013
2	Light clay masonry mortar	Thickness = 1 cm	05.022

A masonry shell of light clay blocks and light clay masonry mortar half a block thick (11.5 cm) is built on the inside of exterior walls. The shell between the new masonry and existing exterior wall is filled lightly with clay masonry mortar.

This technique is used as an alternative to exterior insulation with historic visible timber frames and other facades that are to retain their appearance. The advantage of masonry shells is the conventional and familiar craftsmanship and the possibility of fast subsequent processing. With a gap between the layers, the numerous small cavities and gaps in a timber-frame construction or other old building are safely filled with malleable clay mortar.

Inner layer of light clay blocks

CLAYTEC®

The inner layer is joined to the existing exterior wall with a direct contact, capillary action layers are designed in an interlocking pattern that ensures the safe removal of condensation or smaller amounts of driving rain that may enter the structure through timber-frame areas and beam joints.

No air layers

Building materials

The materials for the masonry are clay blocks of application class I or II such as the light clay block 700 2DF (CLAYTEC 07.013) and lightweight clay masonry mortar (CLAYTEC 05.022). 33 2DF blocks and approx. 20 l or mortar are needed for each m² of wall area and you should include 3-4% of breakages when calculating quantities for all types of clay blocks. Lightweight clay masonry mortar is installed when earth-moist. A Big Bag of loose material produces 700 l of finished masonry mortar. The material is also used to fill the gap between the layers, something that has to be taken into account when calculating the quantities.

	NF 1200	2DF 700
Blocks pcs.	50	33
Mortar needs l	27	20

Block & mortar needs per m² depending on the block format

Initial situation and preparation

The masonry shell can be based on a floor slab or strip footing on the ground floor. On the upper floors, you may have to install a suitably dimensioned timber construction that is firmly fixed to the supporting structure; the structural design should be checked in every case.

Load transfer

A backfill that is installed when wet should be approx. 1 cm thick. In the case of very uneven walls, the area therefore has to be levelled before starting work, e.g. with lightweight clay insulation plaster (CLAYTEC 05.036), clay undercoat plaster with straw (CLAYTEC 05.001, div.) or even lightweight clay masonry mortar. The levelling courses must be allowed to dry before work is continued.

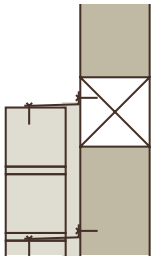
Surface levelling

Building the inner layer

Processing clay blocks and clay mortar is no different to normal masonry work. The requirements of the proper use of materials also apply. Special attention must be paid flush jointing in clay block masonry; horizontal joints with insufficient mortar filling lead to severe settlements with the relatively soft clay masonry mortar. The vertical and horizontal joints should not be larger than 1.0-1.5 cm.

Processing

The gap between the layers is filled completely and free from cavities over the course of the masonry work. We recommend that the inner layer be joined to the exterior wall by means of galvanised wire anchors to stabilise the structure during work. An easier solution is to screw perforated installation strips into the blocks with Spax screws (horizontal joints) and into the infills (screws > 10 cm) or timber-frame beams. The gap between the layers can then be filled with mortar without the newly built shell breaking. Suitable measures must always be taken to prevent the layers from buckling as of a slenderness of h/d > 15.

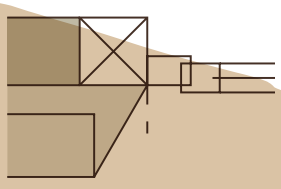


Fixing the facing wythe

Do not build a layer up too high in one go because otherwise the moist, and therefore soft, clay mortar would be pressed together under the weight of the rising wall. This would lead to settlements. The following can be taken as a rule of thumb: 2 m of wall height on one day.

Avoiding settlements

Sloping window soffits can partly compensate the disadvantages of the increased thickness of the wall (and thus depth of the soffit) as regards the incidence of light and impression of lightness. The soffit angle, however, should not be below 30 degrees. Windows and door sills are usually made with squared timber.



Window connection ≤ 30°

Inner layer of light clay blocks

CLAYTEC®

Interior plaster

Plastering can be carried out when the masonry is visibly dry. Leaks should be minimised by not only filling the gap between the layers but also, and in particular, by the way plastering is carried out on the room side. In the majority of cases, a half-timbered house cannot be made absolutely airtight. Nevertheless, leaks must be sealed to the best of your ability, e.g. by manual methods such as grouting joints or painting over defects. The CLAYTEC 'Clay plasters worksheet' describes which clay plaster structures are suitable.

Freedom from leaks

Any questions?

Vertical shafts for installations can be recessed when building the inner layer. The gap between the layers is also a good way to lay electrical wiring, plumbing or heating pipes. Subsequent horizontal slitting of the halfblock layer is at best only possible to a very limited extent; in exceptional cases you should bear in mind the relatively low strength of the remaining cross-section of the lightweight clay block masonry. The openings for flush-mounted sockets are drilled with conventional diamond bits. The sockets are plastered into place and can also be screwed to the exterior wall through their rear panel. Normal household items such as pictures or small shelves can be hung using long wood screws (≥ 100). Squared timber should be used for radiators, wall cabinets and similar loads; these must be fixed firmly to the supporting structure.

Installation lines

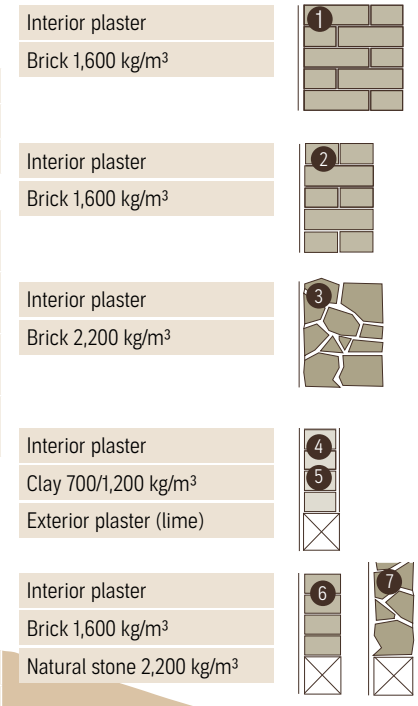
Electrics

Fixtures

Thermal insulation

U-values with and w/o inner layers

Exterior wall	uninsulated	with masonry thickness = 11[5] cm of 700 2DF U in W/m²K
1 Brick 36[5] cm	1.36	0.74
2 Brick 24 cm	1.82	0.85
3 Natural stone 30 cm	2.82	1.02
4 Timber-frame construction 14 cm, clay (light)	1.20	0.68
5 Timber-frame construction 14 cm, clay	1.69	0.81
6 Timber-frame construction 14 cm, brick	1.93	0.85
7 Timber-frame construction 14 cm, natural stone	2.66	0.94



Sound insulation

Sound insulation values w/o and with inner layers according to calculations by the SWA-Institute, Aachen (extrapolated from measured values and theoretical assumptions)

Exterior wall	uninsulated Rw in dB	with masonry thickness = 11[5] cm of 700 2DF Rw in dB
2 Brick 24 cm	50	53
4/5 Timber-frame construction 14 cm, clay	41	47
6 Timber-frame construction 14 cm, brick	45	50
7 Timber-frame construction 14 cm, natural stone	47	51

Please note:

The information in the worksheets is based on many years of experience in the execution of clay construction work and the use of our products. No legal obligation can be derived from this. Adequate experience as a craftsman and the necessary skills from the relevant building trades are assumed. The latest version of the worksheet is always valid; this is available from www.claytec.de, for example, if necessary.

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