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Wall Insulation

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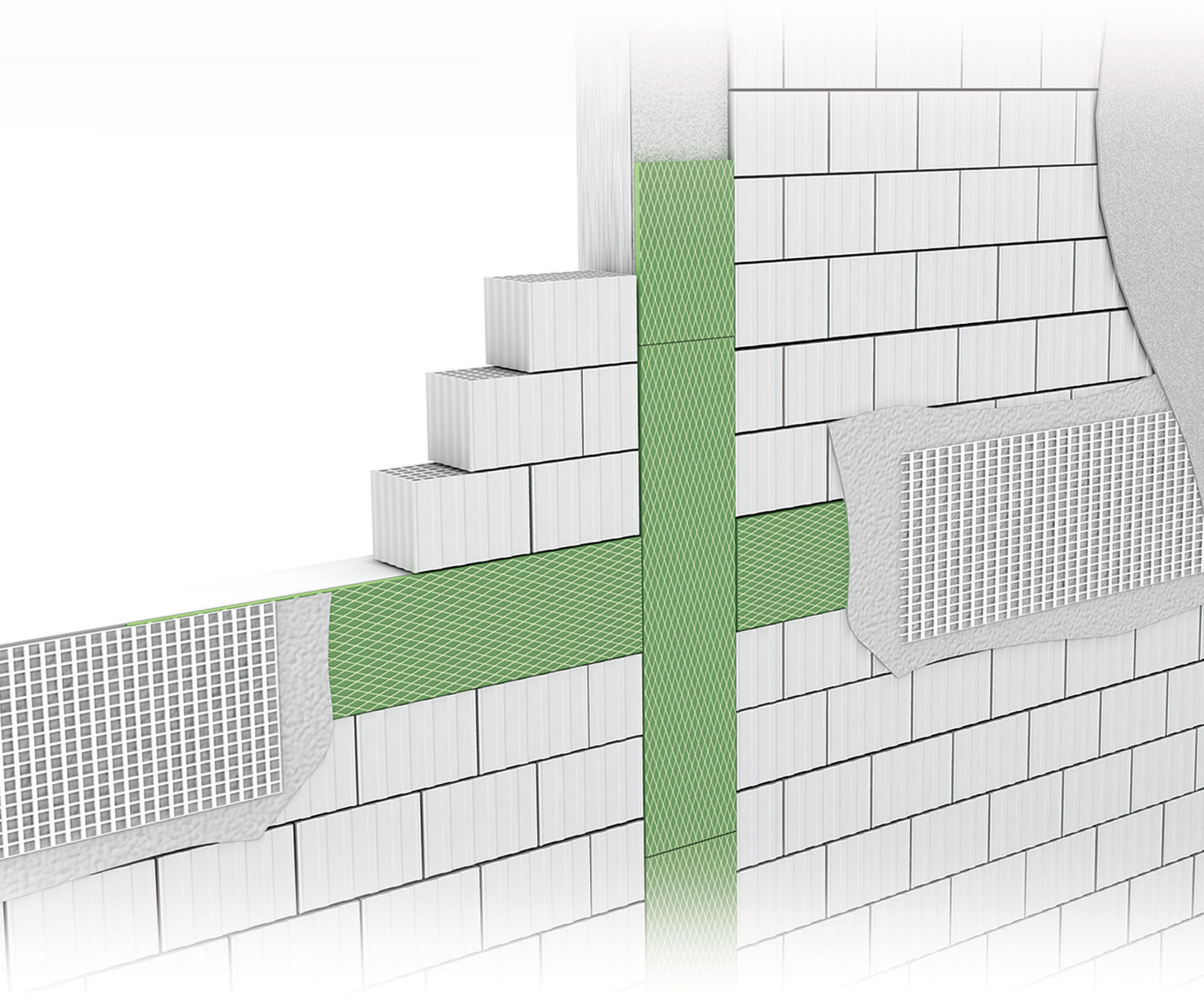

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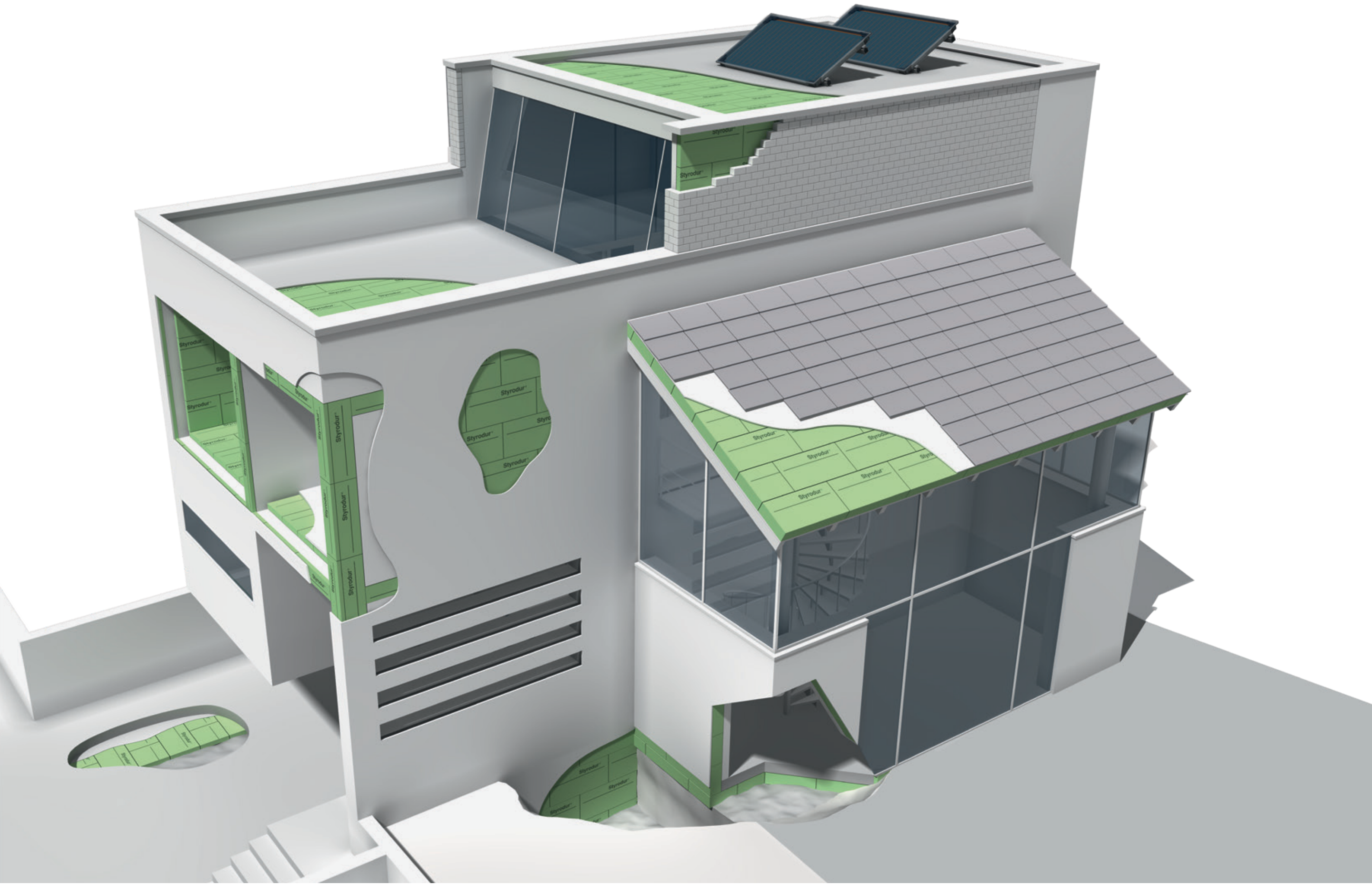


With Styrodur, BASF can draw on over decades of experience in the XPS market: since 1964, the company has been producing the green insulation material, which is set apart by its high quality, versatile applications, and robustness. This means that building insulation made of Styrodur can outlast generations.

Thanks to its high compressive strength, low water absorption, durability, and resistance to decay, Styrodur has become a synonym for XPS in Europe. The compressive strength is the main differentiating feature of the various types of Styrodur.

Optimal thermal insulation with Styrodur offers a quick return on investment for builders as a result of reduced energy consumption. It contributes to a healthy living environment and protects the building construction from external influences such as heat, cold, and humidity, thereby increasing the lifespan and value of the structure.

Styrodur is manufactured in accordance with the requirements of the European standard DIN EN 13164, and its fire behaviour is classified as Euroclass E according to DIN EN 13501-1. The quality of the product is monitored by Forschungsinstitut für Wärmeschutz e.V. (German research institute for thermal insulation).

2. Thermal Bridges

Thermal bridges are limited areas in building elements in which the heat loss is greater than in other parts. Examples are concrete building elements within the brickwork, such as embedded ceilings, window and door supports, ring beams, bracing supports, overhangs, or base areas of the basement. These are differentiated in structural or materialrelated thermal bridges.

Depending on the geometry of certain building element constructions and around component connections, the heat-dissipating external surface can be several times larger than the heat-absorbing interior surface. As a result, the heat loss through these elements per unit area is higher than through the rest of the building envelope. These are referred to as geometrical thermal bridges.

In practice, geometrical, structural, and material-related thermal bridges frequently overlap, which significantly increases the risk of damage and impairment.
The increase in

- The heating energy consumption of the building rises.
- Due to the increased heat loss around thermal bridges, the temperatures on the interior surfaces of the components are lower. In certain circumstances, this might lead to condensation and mould formation, and therefore to structural damage as well as a possible health threat to inhabitants.

The prevention of thermal bridges is therefore not only essential in terms of energy efficiency, but also from a hygiene and health perspective. With regard to building elements, the prevention of thermal bridges is a prerequisite for the long-term conservation and functional reliability of buildings.

Fig. 1: Thermal bridge insulation of concrete building elements:
– Verge – Roof ridge – Ring beam
– Window lintel – Ceiling edge

Fig. 2: Thermal insulation with Styrodur 2800 C/Q on the ceiling edge.

2.1 Geometrical Thermal Bridges

Geometrical thermal bridges occur where the heat-absorbing interior surface is smaller than the heat-dissipating exterior surface. The temperature of the interior surfaces in these areas is thus lower than around the adjacent exterior building elements. This type of thermal bridge is characterised by a two- or three-dimensional heat flow, which is the case in building corners, for example. Flat roof attics, projecting balconies, canopies, or bays also constitute geometrical thermal bridges **(Fig. 3)**.

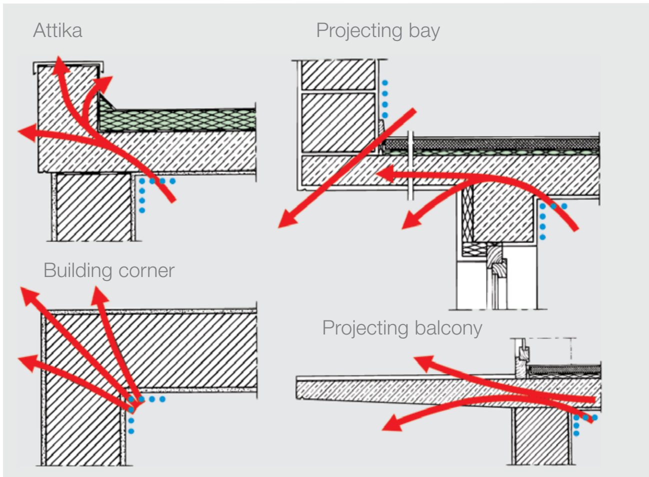


Fig. 3: Geometrical thermal bridges.

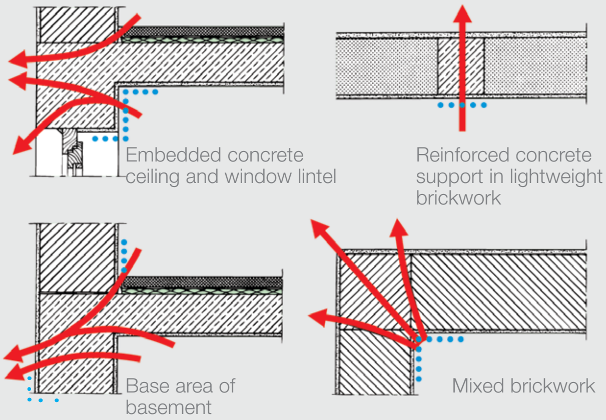


Fig. 4: Structural and material-related thermal bridges.

2.2 Structural and Material-related Thermal Bridges

Structural or material-related thermal bridges occur when materials with lower thermal conductivity are combined with materials with high thermal conductivity in exterior building elements **(Fig. 4)**.

2.3 Negative Effects of Thermal Bridges

With the increasing use of thermal insulation, each individual thermal bridge in the building envelope becomes ever more crucial. Depending on the level of insulation and the building transition areas, up to half of the building's transmission heat loss is caused by thermal bridges. The major negative effects of thermal bridges are as follows:

- Increased heating energy requirement
- Interior surfaces with lower temperatures
- Risk of condensation
- Possible damage to building element
- Danger of mould formation, causing health threats

When calculating the energy requirement of a building, the effects of thermal bridges may be included by means of the thermal bridge compensation values and taken into account in the dimensioning of the heating system. To avoid any risks, however, all thermal bridges must be examined in detail during the planning and construction stages and eliminated through appropriate constructive measures, such as targeted thermal bridge insulation.

The following examples and instructions are provided for the prevention of thermal bridges.

3. Thermal Bridge Insulation with Styrodur®

In general, thermal bridges are not visible on the facade of a building. Thermal weak points can only be detected with the help of thermography. In the case of the office building shown in **Figure 5**, the thermography identifies the non-insulated concrete framework and the non-insulated hall door on the ground floor as thermal weak points **(Fig. 6)**.

In accordance with DIN 4108 "Thermal protection and energy economy in buildings, part 2: Minimum requirements to thermal insulation", a minimum thermal resistance value is required for the different exterior building elements.

Fig. 5: Photograph of an office building.

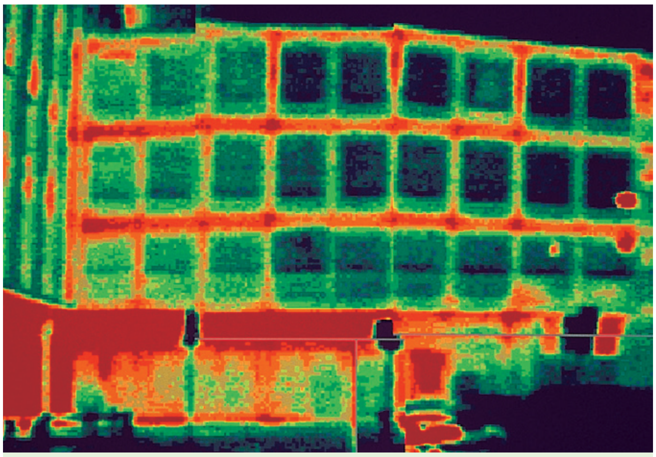


Fig. 6: Thermogram of an office building.

See also: "Information about the installation and plastering of extruded rigid polystyrene foam boards with rough or honeycomb surface as thermal bridge insulation".
Available at www.styrodur.com.

If these minimum values are not fulfilled, for example around the concrete elements, the thermal resistance of these elements can be adapted to that of the thermally insulating brickwork by installing the textured Styrodur 2800 C/Q boards on the exterior of the building.

An example of this is the embedded ceiling area in exterior walls. As the ceiling support is only required to be 17.5 cm deep, the installation of Styrodur in the thermal bridge area of the embedded concrete ceiling does not present a structural challenge, even for thin walls of only 24 cm. Even around concrete elements, the same theoretical U-value is achieved by using Styrodur boards with a thickness of 5 cm as it is for brickwork with good thermal insulation.

This type of thermal bridge insulation with Styrodur is completely sound from a structural engineering and structuralphysical perspective and offers several advantages:

- Avoidance of unnecessary heat loss around concrete elements
- Increased temperatures on room-side surfaces
- Prevention of condensation and mould formation

3.1 Styrodur 2800 C/Q for Thermal Bridge Insulation

As a consequence of the extrusion process during manufacture, Styrodur boards have a smooth compressed foam membrane on the surface. This foam membrane lacks sufficient adhesive properties for bonding applications with concrete, adhesive mortar, or plaster. Therefore, specific types of Styrodur have been manufactured for these applications. The surface of Styrodur 2800 C/Q is thermally embossed (honeycomb). According to the leaflet “Information about the installation and plastering of extruded rigid polystyrene foam boards”, Styrodur 2800 C/Q can be used as a plaster base. When insulating concrete surfaces in brickwork walls and base areas of basements, Styrodur 2800 C/Q is processed in the same way as for thermal bridge insulation. It is vital to ensure that the insulation boards are always installed with offset joints and are butted tightly.

Styrodur 2800 C/Q has smooth edges. The concrete lintels of windows and doors, structural building elements, protruding wall elements, corners, and so forth, usually are the thermal weak points of the building envelope and can be insulated with thermally embossed Styrodur.

Advantages of Styrodur 2800 C/Q
The honeycomb thermal embossing of the Styrodur 2800 C/Q surface ensures the adhesive bond on concrete. Thanks to this adhesive strength in combination with concrete, additional support anchors (plastic nails) are generally not necessary, when Styrodur 2800 C/Q is inserted into the formwork and set in concrete. The special texture also makes for a significantly improved adhesive bond with interior and exterior plaster as well as with adhesive mortar.

The advantages of Styrodur 2800 C/Q compared with Styrodur types with foam membrane as well as with other insulation materials are:

Fig. 7: Thermal bridge insulation with Styrodur 2800 C/Q.

- Excellent adhesive bond with concrete
- Additional support anchors (plastic nails) are rarely necessary (see Stripping)
- Quick and economical installation
- No risk of mix-up with foam membrane boards
- Resistant to water
- No moisture expansion
- Pre-coating of thermal insulation boards not necessary after stripping
- Storage at construction site, independent of weather conditions
- Simple and practical processing with appropriate saws or hot-wire cutting equipment
- Even complicated details can be accurately implemented

Application of Styrodur Types with Foam Membrane
Styrodur boards with a smooth foam membrane surface are not suitable for adhesive applications with concrete, for securing to a mineral substrate using adhesive mortar, or for exterior plastering. The smooth foam membrane does not allow an adequate adhesive bond with plaster, adhesive mortar, or concrete.

However, thermal bridge insulation is principally conceivable in constructions that do not require exterior plastering or adhesion to concrete. In these cases, it is possible to use Styrodur 3035 CS/SQ, which has a foam membrane surface.

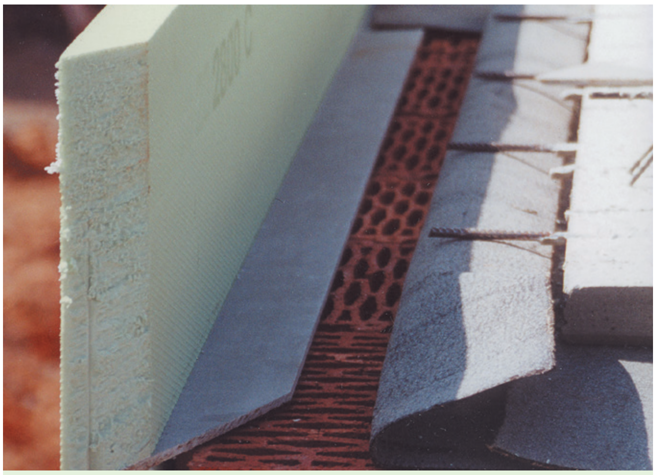


Fig. 8: Ceiling edge formwork with Styrodur 2800 C/Q.

4. Application Notes

4.1 Installation of Thermal Bridge Insulation

The application of Styrodur 2800 C/Q as thermal bridge insulation is particularly easy as well as time- and cost-effective if the following notes and instructions are observed.

Laying Styrodur boards
Depending on the size of the thermal bridge area and the type of Styrodur used, the following is to be taken into account when installing Styrodur boards:

- For large-size thermal bridges, the Styrodur® boards should be laid with offset joints in a bond formation **(Fig. 9)**.
- For small-size thermal bridges, such as in ceiling supports, strips of insulation board are laid along the ceiling edge

In practice, the configuration shown in **Figure 10** of the small-size thermal bridge insulation at ceiling edge height is quite common. The interior wall surface temperature increases with thermal bridge insulation in the corner area, for instance from 10.4°C to 14.9°C.

However, there is still a significant level of heat loss at the edges of the concrete ceiling support (ceiling edge). In the thermographic image in **Figure 11**, the heat loss is clearly visible as indicated by the lighter colour below and above the ceiling.

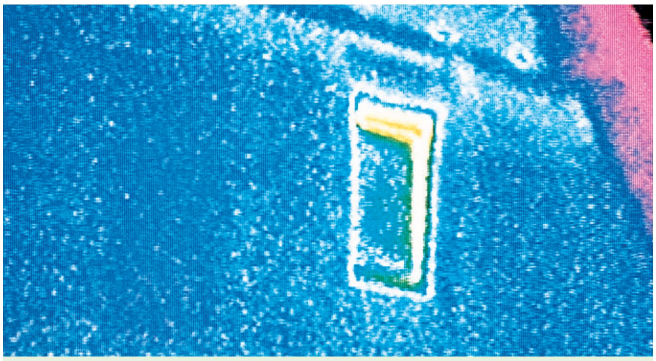


Fig. 11: Thermogram of thermal bridge around the ceiling support.

Optimal thermal insulation is achieved if the layer of brickwork above and below the embedded ceiling is included in the thermal bridge insulation, as shown in **Figure 12**.

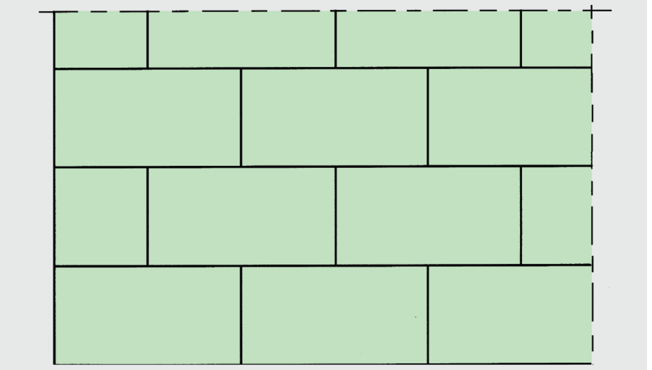


Fig. 9: Installation pattern of Styrodur boards in a bond formation with offset joints. Cross joints should be avoided.

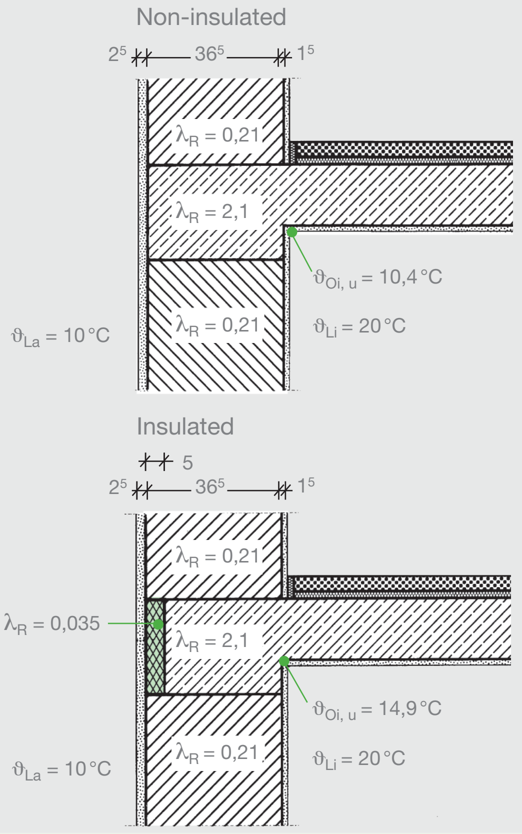


Fig. 10: Ceiling support with respective temperatures on the interior surface without and with thermal bridge insulation with Styrodur 2800 C/Q; thickness 5 cm.

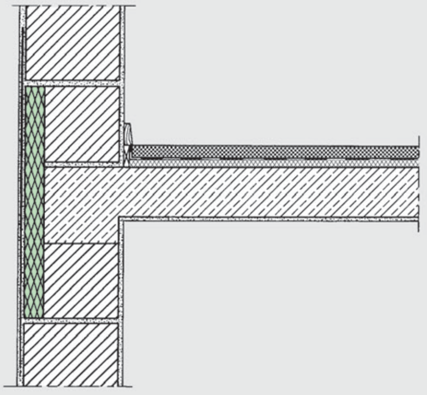


Fig. 12: Optimal thermal bridge insulation around the ceiling support.

Installation of Styrodur 2800 C/Q in the formwork
Prior to placing the concrete, the Styrodur 2800 C/Q boards are installed or laid in the formwork with offset and tightly butted joints. The boards are secured to the wood formwork using clout nails to ensure stability and prevent floating when the concrete is placed **(Fig. 13)**. The nail length should not exceed the thickness of the insulation layer by more than 5 to 10 mm. In the case of steel formwork, the boards are secured with double-sided adhesive tape or with suitable PU adhesive foam.

The textured surface of Styrodur 2800 C/Q usually guarantees a frictional connection between the insulation boards and the concrete without the need for additional adhesion. The adhesive strength averages 0.2 N/mm^2, which is sufficient to bear the loads of the plaster system. In comparison, the EOTA (European Organisation for Technical Approvals) guidelines require a minimum adhesive strength between adhesive and insulation board of ≥ 0.08 N/mm^2 for thermal insulation composite systems (ETICS) with an arearelated mass of 30 kg/m^2.

Additional plastic nails are generally not required to guarantee the required adhesive strength with concrete when using Styrodur 2800 C/Q.

In critical cases, such as winter construction sites or short stripping times, support anchors are also used with Styrodur 2800 C/Q boards to provide additional securing **(Fig. 14)**. The number of support anchors, their arrangement on the insulation boards, and the necessary anchor depth are shown in **Figures 15 and 16**.

In general, plastic nails with round heads and a minimum head diameter of 30 mm are suitable. The plastic nails must be long enough to ensure a minimum anchor depth of 50 mm in the concrete **(Fig. 15).**

There is no regulation on the required number of support anchors for Styrodur. Based on DIN 1102 “Wood-wool slabs, use—processing”, it is recommended to use six anchors per board or five anchors per 1.25 m strip of insulation **(Fig. 16)**.

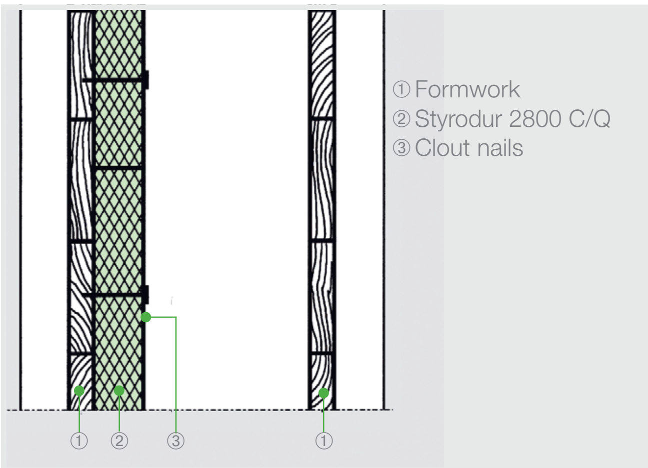


Fig. 13: Securing Styrodur 2800 C/Q boards to wood formwork using clout nails.

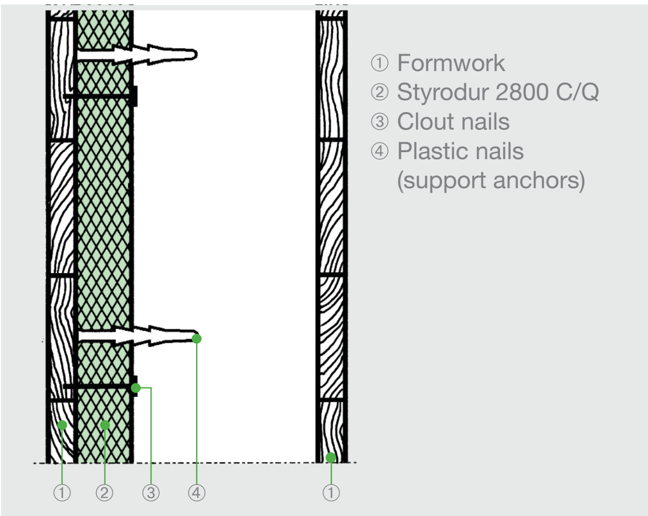


Fig. 14: Securing Styrodur 2800 C/Q boards to wood formwork using clout nails and support anchors (plastic nails) for anchoring in concrete in critical cases.

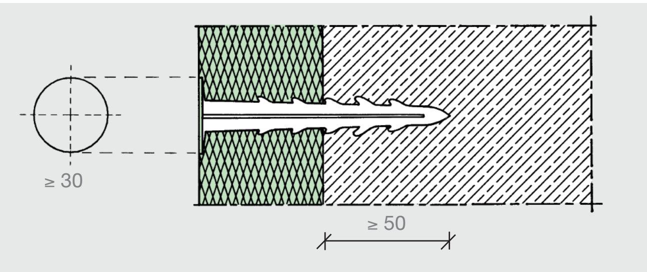


Fig. 15: Plastic nails for additional anchoring of Styrodur 2800 C/Q (units in mm).

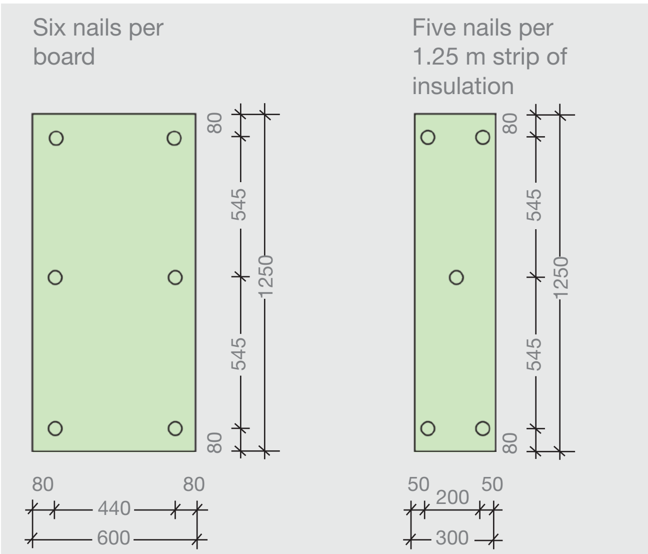


Fig. 16: Possible number and arrangement of plastic nails when installing Styrodur 2800 C/Q boards in concrete formwork (units in mm).

4.2 Renovation

Subsequent installation of Styrodur boards
At times it may be necessary to subsequently install Styrodur 2800 C/Q boards around the base area after the perimeter insulation **(Fig. 17)**. The substrate has to be examined prior to installation. This is necessary to ensure the proper adhesive bond between the substrate and Styrodur. The adhesive strength can be adversely impacted by loose plaster, sanding concrete, a layer of dust on the substrate, or residues of formwork oil. According to VOB (German Construction Contract Procedures), the substrate examination should be performed by the contractor as part of his auditing and notification duty.

Fig. 17: Subsequent base insulation with Styrodur 2800 C/Q.

Any necessary rework of the substrate is the responsibility of the pre-contractor as part of his warranty.

The Styrodur boards must be butted tightly with a suitable adhesive mortar using the dot-bead method and subsequently secured with anchors.

Provided that the substrate is sufficiently level, it is preferable to opt for full-surface bonding and supplementary anchoring.

4.3 Anchoring

Polyamide anchors with metal expanding screws, which are approved by the German Institute for Building Technology (DIBt), are a suitable option for anchoring. The anchoring depth must be 50 mm and the plate diameter at least 60 mm. A total of four anchors are required per board, which results in eight fastening points per board **(Fig. 18)**.

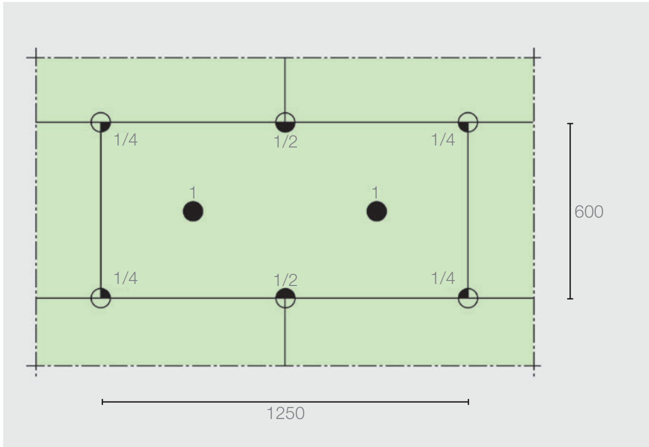


Fig. 18: Number and arrangement of anchors for subsequent anchoring (units in mm).

4.4 Adhesive Mortar

Suitable adhesive mortars are paste or powder construction adhesives based on mineral binders or synthetic dispersion additives. The adhesives harden through dehydration and should not be used at temperatures below 4°C. The instructions of the adhesive manufacturer should be followed.

4.5 Stripping

If the stripping times are very short or if parts of the required cement are replaced with fly ash, six plastic nails per board or five nails per 1.25 m of insulation must be used **(Figs. 15 and 16)**. Additional plastic nails are also required for reinforced concrete supports with a small concrete cross section.

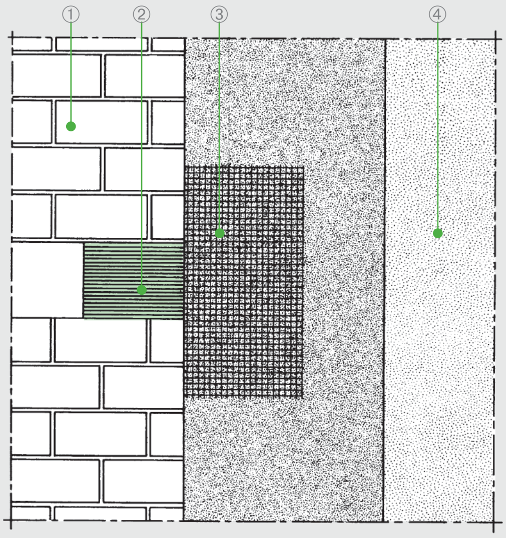
In case the board joints are not butted tightly and cement slurry permeates, it must be removed (chiselled out), if necessary, on account of its thermal bridge effect. The board joints must be filled with insulation material, such as polyurethane (PUR) form-sprayed foam. The same process must be followed for unsealed attachments to brickwork.

5. Plastering Around Insulation Boards

5.1 Plaster System Components

Styrodur 2800 C/Q boards with honeycomb surface are suitable for plastering.

The components and various layers of the plaster system have to be adapted to each other and to the substrate. The suitability of each component and of the system for the plastering of Styrodur must be established by the system provider. **Figure 19** depicts the components of a ceiling edge insulated with Styrodur.



① Thermally insulating brickwork
② Styrodur 2800 C/Q with horizontally combed plaster bonding bridge
③ Plaster base with glass fibre reinforcement mesh
④ Final coat

Fig. 19: Structure of plastering on top of a ceiling edge insulated with Styrodur 2800 C/Q.

Reinforcement fabric

An alkali-resistant glass fibre fabric mesh with a minimum tensile strength in warp and weft of 1500 N per 5 cm must be used as reinforcement fabric. Fabrics with higher tensile strengths increase reliability. For the specific application of “larger concrete shear walls in thermally insulating brickwork”, it is advisable to use a glass fibre fabric mesh with a minimum tensile strength of 2000 N per 5 cm.

Even surface reinforcement cannot completely rule out the risk of crack formation, but it can minimise it drastically.

Plaster base and fasteners

The plaster base must be made of stable, spot-welded, and galvanised wire mesh. Appropriate fastening elements are to be used in accordance with the manufacturer’s guidelines to secure it to the load-bearing base.

In this specific case, ribbed expanded metal is not recommended as a plaster base, because it can only absorb the plaster loads in one direction. Moreover, the metal ribs would weaken the plaster strength and possibly cause cracks.

Plastering mortar

It is best to use pre-mixed dry mineral mortar that is subject to production monitoring by the manufacturer.

Styrodur 2800 C/Q boards can be plastered in different ways. In all cases, the plaster must consist of several layers (e.g. floating, reinforcement plaster, exterior plaster). The different layers of plaster form a plaster system. The following requirements must be met:

- Solid adhesion of the entire plaster system to the Styrodur 2800 C/Q boards
- Strong bond between the plaster layers
- Uniformly absorbing plaster base for the exterior plaster on top of brickwork and Styrodur 2800 C/Q

Reference:
The “Instructions for the installation and plastering of extruded rigid polystyrene foam boards with rough or honeycomb surface as thermal bridge insulation” is available to download from www.styrodur.com. This information applies to the planning of thermal bridge insulation measures and the installation of XPS in accordance with DIN EN 13164 with rough or honeycomb surfaces. The instructions are not valid for XPS boards with smooth surfaces, expanded boards (EPS), or thermal insulation composite systems (ETICS).

5.2 Plaster Base

The properties of the plaster base must guarantee a longterm, solid bond with the plaster. Styrodur 2800 C/Q boards therefore require a special treatment, such as a pre-treatment with a priming coat or a bonding bridge, the use of a special plastering mortar, or the application of a plaster base.

The composition of the plaster base is vital for the adhesion of the plaster. According to VOB, Part C, DIN 18530, the examination of the Styrodur 2800 C/Q surfaces to be plastered, including the surrounding brickwork, should be performed by the contractor as part of his auditing and notification duty. Any necessary rework of defective substrate (joints filled with cement slurry, open joints, loose boards, boards not laid in a bond, etc.) must be performed by the pre-contractor as part of his warranty.

Pre-treatment of plaster base

Foam plastics are not resistant to the long-term effects of UV radiation from sunlight. After longer exposure to weather (around eight weeks, depending on the solar radiation), the surface of the Styrodur boards starts to turn brown and chalks.

As the erosion dust works as a separating agent between the plaster and foam, surfaces that have been damaged by UV radiation have to be brushed clean of dust with, for example, a steel broom.

It is recommended that this task is included in the specification for the plastering job and executed as necessary following the decision of the site management.

The boards must be laid flush with the brickwork. Any projecting parts of the board have to be subsequently evened out with suitable tools.

Application of Styrodur boards with foam membrane

Smooth Styrodur boards with foam membrane are not suitable for plastering (see VOB, Part B, § 4, No. 3).

If already-installed smooth boards need to be plastered, they have to be additionally secured with anchors approved by the building authorities with a plate diameter of 60 mm, as shown in **Figure 18**. The foam membrane must be removed mechanically with suitable tools, in order to achieve a rough surface. After the plaster base has been pre-treated in this way, the boards can be plastered.

5.3 Types of Plastering

Depending on the size of the board surface to be plastered, Styrodur 2800 C/Q boards can be plastered in different ways. **Table 1** lists the different types of plastering recommended for each application.

For many years, various plaster systems have been on the market that are also tried and tested for the plastering of Styrodur. In consultation with the manufacturer of the plaster system, other types of plastering than those listed in **Table 1** might be feasible.

Floating with reinforcement fabric (type 1)

Plastering type 1 – floating with reinforcement fabric – is only suitable for small-size insulation strips. The individual steps of the procedure are as follows:

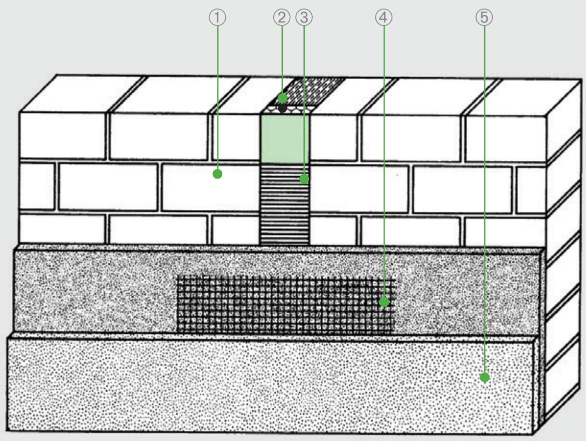
First, a mineral, plastic-coated plaster bonding bridge is applied to the Styrodur boards and combed horizontally with a coarse notched trowel (**Figs. 20** and **21)**. The plaster bonding bridge should be approximately 5 mm thick, and at least 2 mm in recesses. Depending on the weather conditions, the minimum standing time should be one to three days. Next, the floating is applied (lightweight plaster according to DIN 18550, Part 4) in standard thickness (15 to 20 mm). Reinforcement fabric is embedded without any creases in the upper third section (tensile-loaded zone) of the floating layer **(Fig. 22)**. The fabric has to overlap by at least 100 mm in the joint area and at least 200 mm on adjoining building elements. Corners of windows and doorways must be additionally reinforced with diagonally aligned strips of the same reinforcement fabric **(Fig. 23)**. The minimum standing time of the floating with reinforcement fabric is three weeks, followed by, if necessary, the application of the exterior plaster and a levelling course.

Table 1: Types of plastering according to the size of the board surface to be plastered

Application	Floating with reinforcement (type 1)	Fabric filling (type 2)	Plaster base (type 3)
Insulation strip width ≤ 60 cm	Suitable	Suitable	Suitable
Larger areas	Unsuitable	Refer to system manufacturer for suitability	Suitable

Fig. 20: Window lintel in thermally insulating brickwork; horizontal combing of the plaster bonding bridge.

Fig. 22: Application of floating and glass fibre reinforcement mesh on top of insulated concrete elements.



① Thermally insulating brickwork
② Styrodur 2800 C/Q
③ Horizontally combed plaster bonding bridge
④ Plaster base with glass fibre reinforcement mesh
⑤ Final coat

Fig. 21: Structure of plastering on top of reinforced concrete support bracing insulated with Styrodur 2800 C/Q.

Fabric filling (type 2)
Plastering type 2 is suitable for plastering small-size as well as large-size surfaces of Styrodur insulation.

A mineral, plastic-coated bonding bridge is applied to the Styrodur boards horizontally using a coarse notched trowel **(Fig. 21)**. The layer should be approximately 5 mm thick, and at least 2 mm in recesses. Depending on the weather conditions, the minimum standing time should be between one and five days. Next, the floating (lightweight plaster according to DIN 18550, Part 4 or DIN EN 998-1) is applied in standard thickness (approx. 15 mm). The minimum standing time of the floating is one day per millimetre of thickness. On top of the floating layer, a mineral reinforcing mortar with a thickness of 5 to 8 mm is spread over the entire surface in which a reinforcement fabric (fabric filling) is embedded without creases. The fabric has to overlap by at least 100 mm in the joint area and at least 200 mm on adjoining building elements.

Corners of windows and doorways must be reinforced additionally with diagonally aligned strips of the same reinforcement fabric **(Fig. 20 and 22)**. The minimum standing time of the fabric filling is one day per millimetre of thickness of reinforcement plaster. The exterior plaster can then be applied in various surface designs.

For grated exterior plaster, it may be necessary to apply a levelling course to the floating. The levelling course should be the same colour as the exterior plaster to prevent the reinforcing mortar from showing through.

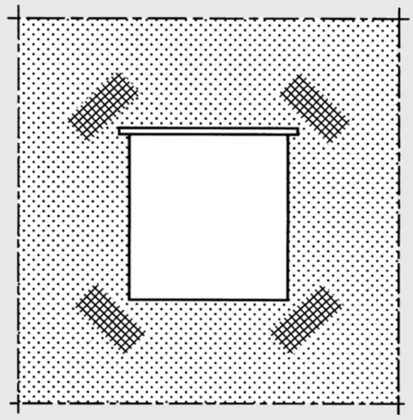


Fig. 23: Additional diagonal reinforcement on window corners.

Fig. 24: Horizontally combed bonding bridge on Styrodur insulation.

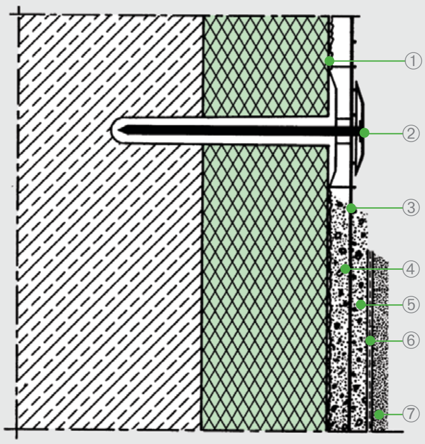
Fig. 25: Large-size ground floor insulation with Styrodur boards.

Plaster base (type 3)
Plastering type 3 is suitable for the plastering of large-size surfaces of Styrodur insulation. It is preferred by manufacturers of plaster systems who have limited experience with plastering extruded foam boards.

A mineral, plastic-coated bonding bridge is applied to the Styrodur boards horizontally using a coarse, notched trowel **(Fig. 26)**. The layer should be approximately 5 mm thick, and at least 2 mm in recesses.

Depending on the weather conditions, the minimum standing time should be between one and five days. The plaster base is applied thereafter.

In the case of reinforcement across the full surface, nine spacer anchors are used per square metrel **(Fig. 27)** into which the galvanised, spot-welded wire mesh is hooked. As a result, the plaster has a frictional connection to the loadbearing base. The spacing anchors secure the reinforcement mesh approximately 7 to 8 mm from the plaster base. The overlap of the reinforcement is 100 mm. Ring clasps are used to secure the overlaps **(Fig. 28)** in order to prevent shifting or springing of the slack, overlapping part when the plaster is applied.



① Pre-coating (bonding bridge)
② Plaster spacing anchorl
③ Reinforcement mesh
④ Plaster base
⑤ Filling compound
⑥ Glass fibre reinforcement mesh
⑦ Finishing coat

Fig. 26: Profile of possible plastering structure with plaster base for large-size Styrodur insulation.

For all three plastering types, a levelling course (priming coat) is advisable for decorative plaster with a groove structure to prevent the floating (reinforcement layer) from showing through.

To prevent diagonal cracks in the plaster, corners of openings **(Fig. 23)** must be additionally secured with diagonal reinforcement strips.

Instead of the bonding bridge, pre-mixed dry mortar with adhesion-improving additives may be applied to the Styrodur boards after the application of the plaster base. The standing time recommended by the manufacturer is to be observed.

The plaster base is then applied according to type 1 or the fabric filling according to type 2. Afterwards, continue as described in type 1 or type 2.

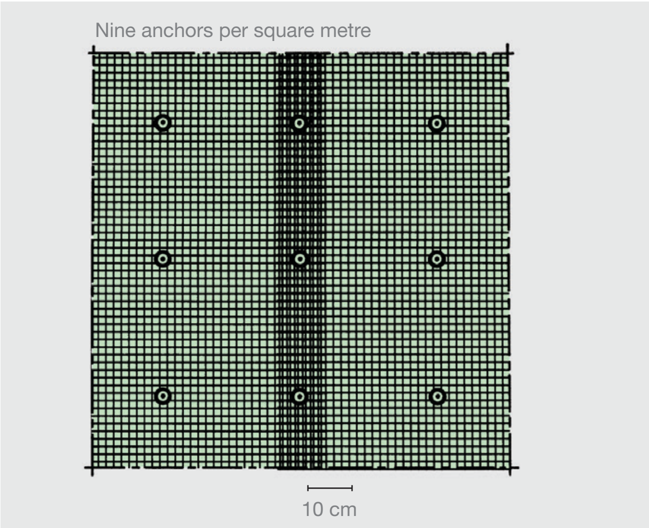


Fig. 27: Full-surface reinforcement with wire mesh as plaster base (Nine anchors per square metre).

5.4 Plastering Around the Base Area

To prevent thermal bridges in the base area, the thermal insulation should exceed the perimeter insulation beyond the ground level and extend to the rising thermally insulating brickwork or to the external thermal insulation composite system (ETICS).

As the perimeter insulation is usually implemented with foam membrane boards, a different material and laying system must be used along the ground level. Along these edges, it is preferable to use a suitable adhesive mortar over the entire surface when installing the Styrodur 2800 C/Q boards. If the base is very uneven, the boards should be tightly butted with offset joints using the dot-bead method and anchored. Plastering can then be applied on top of this surface as described below.

Reinforcing mortar is applied to the whole surface of the insulation layer (at least 5 mm thick), and the reinforcement fabric is embedded in the middle **(Fig. 29)**.The fabric must be installed without creases and overlap by at least 100 mm in the joint area. Once the first fabric filling has hardened sufficiently (after a minimum of one day), a second layer of fabric filling is applied. The exterior plaster can be added once the second fabric filling has hardened properly (after a minimum of one week).

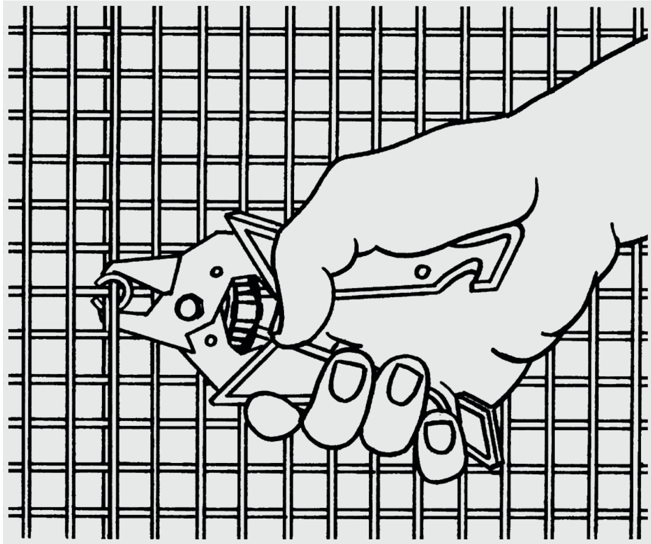


Fig. 28: Overlapping mesh is secured against shifting using ring clasps with a spacing of 20 cm.

Fig. 29: Application of the glass fibre fabric mesh to the plaster base of the base insulation.

Instead of this process, the fabric filling (type 2) described on page 14 may be used. Other types of plastering require the approval of the plaster system manufacturer.

It should be noted that based on the latest technology, exterior base plasters on thermal insulation boards are applied in accordance with Mortar Group P II (highly hydraulic lime mortar or lime-cement mortar), which deviates from DIN 18550 (P III, cement mortar). Cement mortar as per Mortar Group P III would be too hard for the relatively soft insulation base and subject to excessive crack formation. P II mortar used for base plastering is also water-repellent and frost-proof, but it is not as hard as P III mortar and therefore more suitable for soft bases such as aerated concrete.

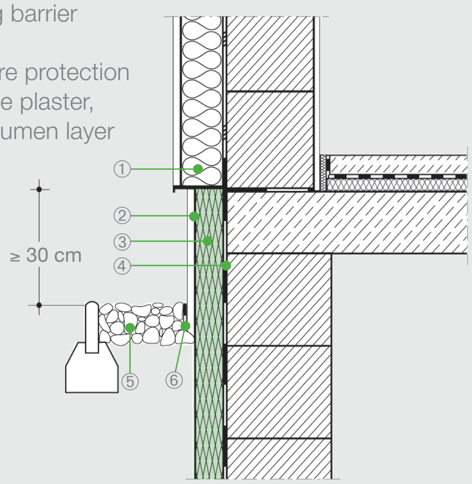


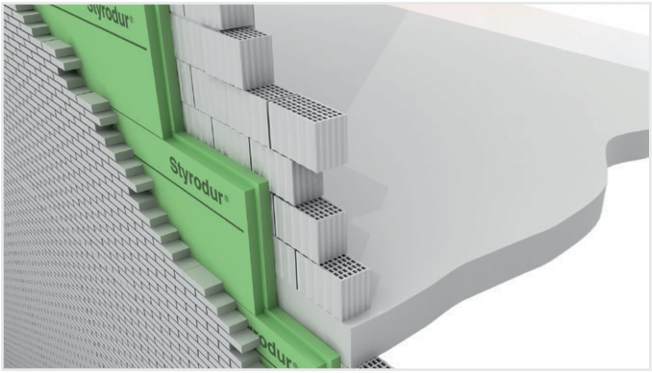
Fig. 30: Base area with Styrodur 2800 C/Q, base plaster, and gravel bed.

The plaster has to be protected from stagnant water and must therefore not be in direct contact with the adjacent ground. It is best to separate the ground and the base of the building with a gravel bed **(Fig. 30)**. Appropriate protection measures should be applied on top of the finished base plaster (e.g. bitumen layer, drainage boards, or dimpled sheeting).

When renovating the bases of old houses, Styrodur boards should be glued to the base using a dot-bead method or, where the substrate is sufficiently level, by full-surface glue application to the strongly adherent old base surface **(Fig. 31)**. The Styrodur boards should additionally be anchored.

Fig. 31: Renovation of old building: installation of Styrodur 2800 C/Q boards using a dot-bead method.

6. Cavity Insulation with Styrodur®



Cavity walls represent a traditional construction method in many regions of Europe. The low water absorption, excellent thermal insulation properties, and durability of Styrodur enable the installation between the two withes even without an air layer.

The use of cavity walls with cavity insulation made of Styrodur is a most effective way of thermally insulating exterior walls **(Fig. 32 - 35)**. This construction method has proven itself for decades in areas with specific weather conditions, such as the wet and windy Northern European coastline..

For cavity insulation, we recommend Styrodur 3035 CNE, Styrodur 3035 CS/SQ, and Styrodur 3035 CS.

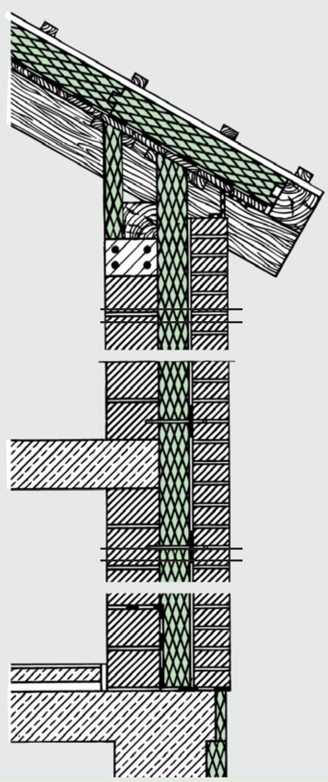


Fig. 32: Styrodur in cavity walls without air layer.

6.1 The System

The task of a load-bearing interior wall is to carry the static loads of the roof and ceiling as well as the wind load. In standard two-storey residential buildings, the wall thickness measures 24 cm or 17.5 cm. For economical reasons, the load-bearing wall is dimensioned as thick as necessary and as thin as possible.

The thermal insulation layer provides the thermal insulation of the building and must be firm and dimensionally stable. Good thermal insulation material is characterised by low thermal conductivity and low moisture absorption. Moisture increases the thermal conductivity of insulation materials. In cavity walls, moisture can get to the insulation material from the inside as well as from the outside: from the inside as water vapour due to the diffusion of room moisture through the load-bearing wall, and from the outside through unsealed joints. This cannot be avoided with the limited thickness of the face masonry shell measuring 11.5 cm or at times even 9 cm. Therefore, insulation materials that absorb practically no moisture at all are most suitable.

Cavity exterior walls can be constructed with or without an air layer between the face masonry shell and the insulation layer.

Fig. 33: Cavity insulation with face masonry bricks that are 9 cm wide.

Fig. 34: Cavity insulation with Styrodur.

The facing formwork, made of materials such as frost-proof clinker or sand-lime brick, offers weather protection. Anchors are used to connect the facing formwork and the load-bearing wall to each other.

6.2 Implementation

In practice, cavity walls with Styrodur insulation are mostly configured without an air layer. There are two possibilities:

Walled-in anchors

The wire anchors are L-shaped. The nook is walled in the joint of the interior formwork, and the end of the wire protrudes vertically. After the insulation board, locking plate, and dripping edge are installed, the free end is bent horizontally at a right angle so that the nook fits into one of the joints of the rising face masonry shell. This is the case for the common integer ratio of brick heights between the exterior and face masonry shells.

Drill anchors

When using tongue-and-groove insulation boards, it is easier to work with drill anchors **(Fig. 35)**. These anchors can be rooted in the brick, offering greater pull-out resistance compared with joint anchoring. Obviously, the joint locations in the face masonry shell must be taken into account when securing the anchors.

Even with this type of construction, a small air gap will form between the face masonry shell and the insulation material, which allows for the alignment of the face masonry shell. The joint mortar between the lining bricks should be flattened towards the outside so that the insulation boards can lie flush.

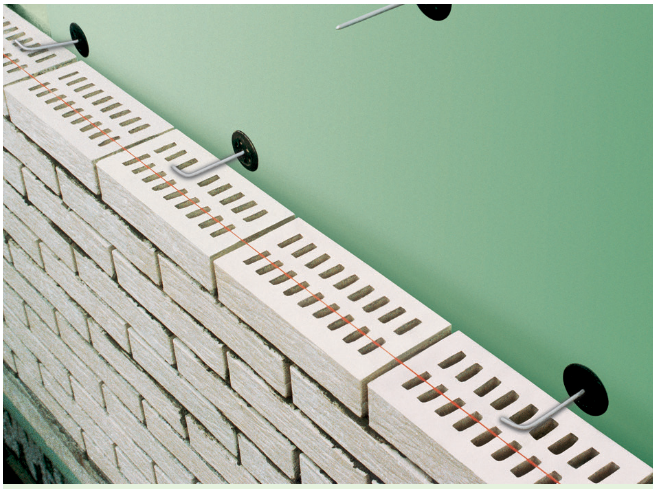


Fig. 35: Face masonry shell made of sand-lime bricks and secured with drill anchors.

Important note:
The information submitted in this publication is based on our current knowledge and experience and is referring only to our product and its properties at the time of going into print. It does not imply any warranty or any legally binding assurance regarding the condition of our product. Attention must be paid to the requirements of specific applications, especially the physical and technological aspects of construction and building regulations. All mechanical drawings are basic outlines and have to be adapted to each application.

7. Application Recommendations for Styrodur®

	Application type according to DIN 4108-10 or technical approval	Product properties according to DIN EN 13164 and DIN 4108-10						
		General	2800 C/Q	3000 CS	3035 CS/SQ	4000 CS	5000 CS	Hybrid
			CS(10\Y)	CS(10\Y)	CS(10\Y)	CS(10\Y)	CS(10\Y)	
			200 (20–60 mm) 300 (80–200 mm)	300	300	500	700	300
Perimeter[1] floor	*DIBt Z-23.5-223, PB*	*wd*		dh	dh	ds	dx	
Perimeter[1] wall	*DIBt Z-23.5-223, PW*	*wd*		dh	dh	ds	dx	dh
Perimeter[1] foundation slab	*DIBt Z-23.34-1325*	*wd*		dh	dh	ds	dx	
Perimeter[1] groundwater	*DIBt Z-23.5-223*	*wd*		dh	dh	ds	dx	dh
Living area floor	*DEO*		dm	dh	dh			
Industrial and refrigerated warehouse floor	*DEO*		dm	dh	dh	ds	dx	
Cavity insulation	*WZ*	*tf*	dm	dh	dh			
Interior insulation	*WI*	*tf*	dm					
Permanent formwork	*WAP*	*tf*	dm					dh
Thermal bridges	*WAP*	*tf*	dm					
Base insulation	*WAP*	*wf*	dm					
Plaster base	*WAP*	*wf*	dm					
Inverted roof	*DUK*	*wd*		dh	dh	ds	dx	
Duo / plus roof	*DUK*	*wd*		dh	dh	ds	dx	
Patio roof	*DUK*	*wd*		dh	dh	ds	dx	
Green roof	*DIBt Z-23.4-222*	*wd*		dh	dh	ds	dx	
Parking roof	*DIBt Z-23.4-222*	*wd*				ds[2]	dx	
Conventional flat roof[3]	*DAA*	*wf*		dh	dh	ds	dx	
Parapets / rising building elements	*DAA*	*wf*	dm	dh	dh			
Basement ceiling / underground garage ceiling	*DI*	*tf*	dm	dh				
Attic ceiling	*DEO*	*tf*	dm	dh	dh			
Pitched roof	*DAD*	*wf*	dm	dh				
Drywall composite board	*WI*	*tf*	dm					
Sandwich core	*–*	*tf*	dm					
Artificial ice rink	*–*	*wd*		dh	dh	ds	dx	
Road transport infrastructure / rail construction	*–*	*wd*		dh	dh	ds	dx	

Styrodur: product approval: DIBt Z-23.15-1481, extruded polystyrene foam according to DIN EN 13164

[1] Insulation with ground contact
[2] Not under composite stone pavement
[3] With protective layer over sealing barrier

dm = 200 kPa, dh = 300 kPa, ds = 500 kPa, dx = 700 kPa

Styrodur® – A Strong Product Line

With the Styrodur® product line, BASF offers the ideal insulation solution for almost every application.

Styrodur® 2800 C/Q
The thermal insulation board with an embossed honeycomb pattern on both sides and smooth edges for applications in combination with concrete, plaster, and other top coats.

Styrodur® 3000 CS/SQ
The innovative multipurpose thermal insulation board with smooth surfaces and shiplap for almost all applications in structural and civil engineering and with uniform thermal conductivity across all board thicknesses.

Styrodur® 4000/5000 CS/SQ
The extremely compression-proof thermal insulation board with smooth surfaces and shiplap for applications that require maximum compressive strength.

Styrodur® 3000 BMB
The multipurpose thermal insulation board produced using renewable instead of fossil raw materials with the same technical properties as conventional Styrodur CS/SQ, which helps to save resources and reduce CO_2 emissions.

Styrodur® Hybrid
The thermal insulation board with longitudinal grooves on one side and a shiplap for use as perimeter insulation for concrete pouring with waterproof concrete exterior basement walls.

Up-to-date technical information is available on our website: **www.styrodur.com**

Find your local distribution partners on our homepage.

E-CPB/FM 2310 BE Styrodur® Wall Insulation