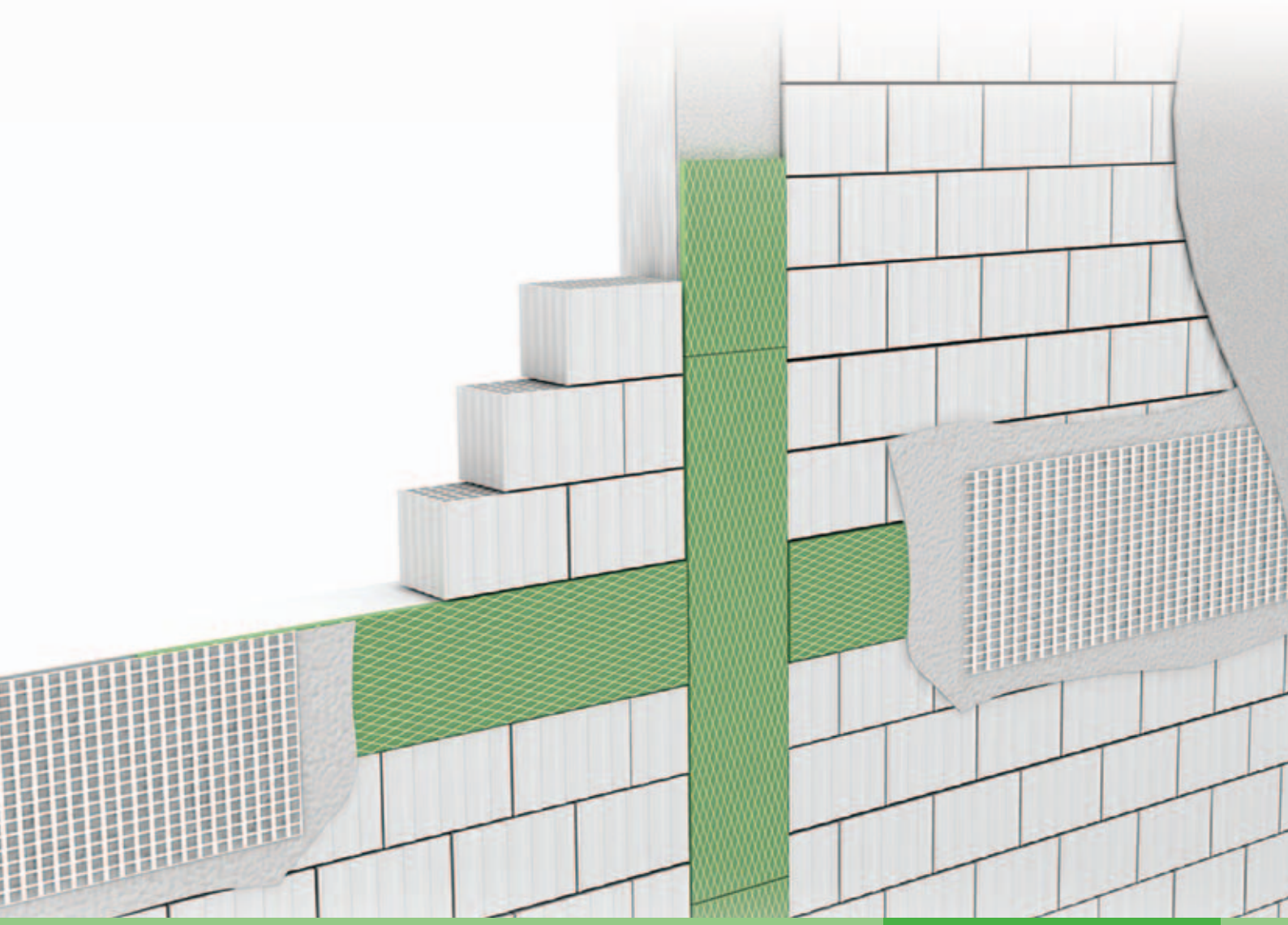
Styrodur® C
Europe's green insulation

# Wall Insulation



BASF
The Chemical Company

# Contents Overview

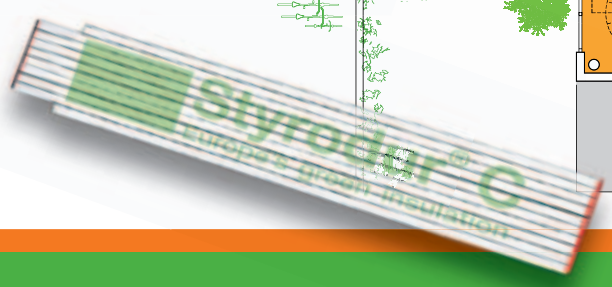

## 1. Styrodur® C Thermal Insulation

Styrodur® C is BASF's environmentally friendly, extruded polystyrene rigid foam. It is free of CFC, HCFC, and HFC and makes an important contribution toward reducing emissions of carbon dioxide ($CO_2$).

Due to its high compressive strength, low moisture absorption, durability, and resistance to decay, Styrodur C has become synonymous with XPS in Europe. The compressive strength is the main distinction between the various Styrodur C types.

Effective thermal insulation with Styrodur C reduces energy consumption with the result that the investment in thermal insulation can be offset within a short period of time. It makes for healthy and comfortable living and protects the building from the effects of moisture as well as high and low temperatures.

Styrodur C is manufactured in accordance with the requirements of the European standard DIN EN 13 164. In terms of fire protection, it has been classified as Euro-class E in accordance with DIN EN 13501-1. It is quality-controlled by Wärmeschutz e.V. and has been granted the approval no. Z-23.15-1481 by the DIBt, an institute of the Federal and Laender Governments for a uniform fulfillment of technical tasks in the field of public law.

## 2. Cold Bridges

Cold bridges are limited areas in which the heat loss of the building is higher than in other parts. Examples for those areas are concrete units within the brickwork, e. g., embedded ceilings, lintels (window and door), ring beams, reinforced support systems, corbels, or basement courses. They can be divided into construction-specific and material-specific cold bridges.

Due to the geometry of certain constructions, the exothermic outside surface of a building can be several times larger than the endothermic inside surface.
In theses parts of the building, the heat loss is considerably higher than in other parts. Such structures are referred to as geometrically determined cold bridges.

In practice, geometrically determined cold bridges as well as construction- or material-specific cold bridges overlap in many cases, which drastically increases the risk of damages.

The increase of heat loss due to cold bridges can result in the following:

- Demand for heat energy rises.
- Due to the increased heat loss around the cold bridges, temperatures along the inside surface of the building are lower, which can cause the formation of condensate and mildew. Both can lead to constructional damages and may pose a serious health threat.

Therefore, it is absolutely necessary to avoid the formation of cold bridges, not only for economical reasons, but also for hygienic and sanitary ones.

**Fig. 1:** Insulation of cold bridges in concrete units:
– verge – ridge support – ring beam
– lintel – edge of ceiling

**Fig. 2:** Insulation with Styrodur® 2800 C at the ceiling edge.

## 2.1 Geometrically Determined Cold Bridges

If the endothermic interior surface is smaller than the exothermic exterior surface, we speak of a geometrically determined cold bridge. Around those areas, the temperatures of the interior surface are lower than those around the adjoining exterior units. Such cold bridges are characterized by a two- or three-dimensional heat flow, which is the case at the corners of a building, for instance. Flat roof parapets, projecting balconies, projecting roofs or bays also constitute geometrically determined cold bridges **(Fig. 3)**.

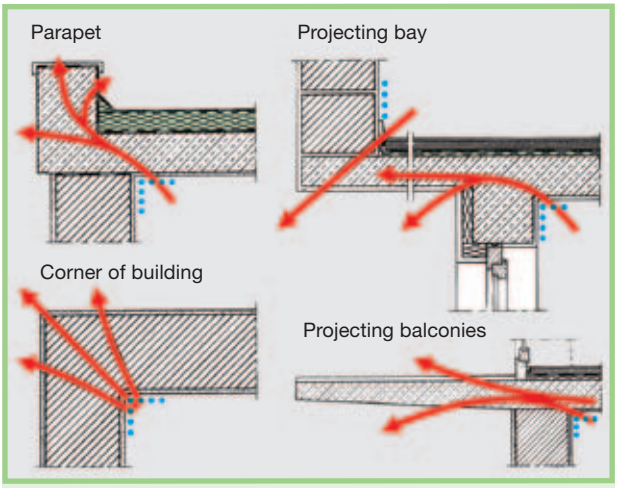



**Fig. 3:** Geometrically determined cold bridges.

## 2.2 Construction- and Material-specific Cold Bridges

The combination of materials with a low thermal conductivity and materials with a high thermal conductivity in exterior building units leads to the formation of construction- and material-specific cold bridges **(Fig. 4)**.

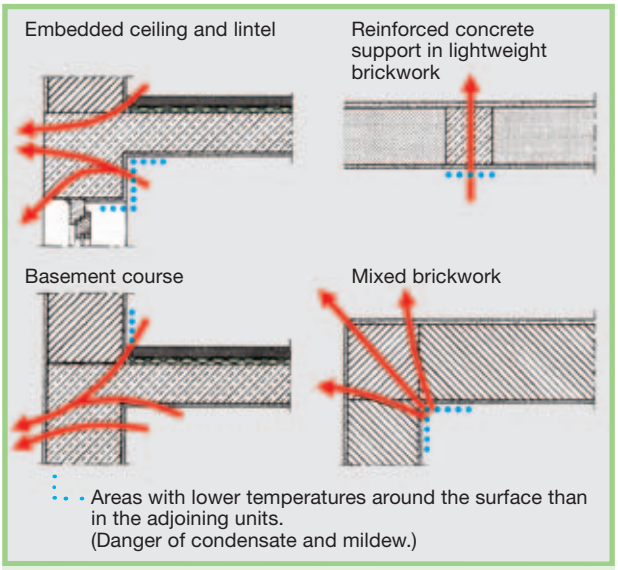



**Fig. 4:** Construction- and material-specific cold bridges.

## 2.3 Negative Effects of Cold Bridges

With increased thermal insulation, each cold bridge within the building envelope becomes more significant. Cold bridges can cause up to 50% of the building's heat loss, depending on the insulation level and the structure of the adjoining units. The basic negative effects of cold bridges are:

- Rise in heat energy demand.
- Indoor surfaces with lower temperatures.
- Danger of condensation.
- Risk of damages to building units.
- Danger of mildew, causing serious health threats.

When calculating the energy demand of a building, the effects of cold bridges can be included in the "correction values for cold bridges" and considered in the dimensioning of the heating system. In order to avoid the risks, however, all cold bridges have to be examined in detail and eliminated by means of constructional measures, e. g., systematic cold bridge insulation.

Examples and instructions of how to avoid cold bridges are given in the following.

## 3. Cold Bridge Insulation with Styrodur® C

Generally, cold bridges are not visible on the facade of a building. Only the infrared image points to the weak spots. In the case of an office building, shown in **Fig. 5**, the thermography shows an uninsulated concrete skeleton of the building as well as the uninsulated gates on the ground floor as being the weak spots of the building **(Fig. 6)**.

Article two of the German standard DIN 4108 regulates minimum values of thermal conductivity for various exterior units. If these minimum values are not fulfilled, e. g., around the concrete units of a building, the thermal transmission coefficient of those units can be adapted to the one of the insulated brickwork by means of installing Styrodur® 2800 C boards with surface stamping.

**Fig. 5:** Photograph of an office building.

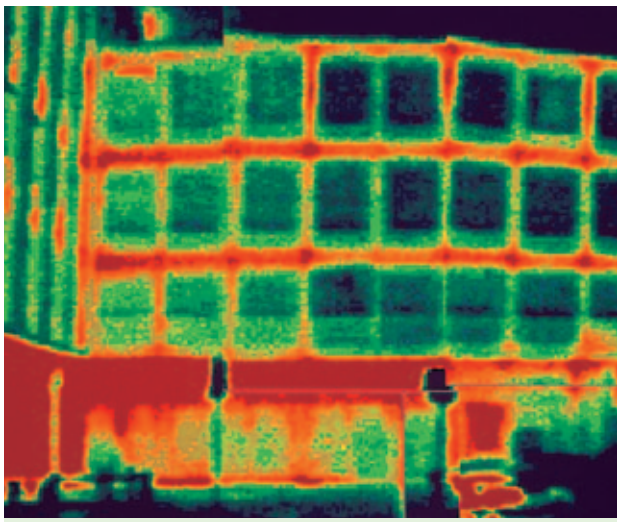


**Fig. 6:** Infrared image of the same office building.

See also: “Information about the installation and plastering of extruded polystyrene rigid-foam boards with coarse or embossed surfaces—cold bridge insulation.”
Find it here: www.styrodur.com

Take for example the area around the ceilings embedded into the exterior walls. Because the ceiling support is only required to be 17.5 cm deep, no static complications will be caused by the installation of Styrodur C boards, even for thin walls of only 24 cm. Even around the areas of concrete units, with 5 cm-thick Styrodur C boards the same theoretical U value as in well-insulated brickwork can be achieved.

Regarding the specifications of construction and building physics, cold bridge insulation with Styrodur C is efficient and may provide the following advantages:

- No unnecessary heat loss around concrete units.
- Higher temperatures on the interior surfaces.
- No formation of condensate and mildew.

### 3.1 Styrodur 2800 C for Insulation of Cold Bridges

As a consequence of the extrusion process during manufacture, Styrodur C comes with an even, compressed surface referred to as foam membrane. For adhesive applications with concrete, adhesive mortar, or other kinds of plaster, this foam membrane lacks the necessary adhesive strength. Therefore, we produce special Styrodur C types for these kind of applications. The surface of Styrodur 2800 C boards is textured by means of thermal embossing (honeycomb weave). According to the leaflet “Information about the installation and plastering of extruded polystyrene rigid-foam boards,” Styrodur 2800 C can be used as a plaster base.

For the insulation of concrete units in brickwork and basement courses, Styrodur 2800 C is applied along the lines of cold bridge insulation. It is vital that the insulation boards are installed with staggered joints and tight slotting.

Styrodur 2800 C features clean edges. Often lintels of windows or doors, constructive units, overhanging wall units, corners, etc. make up the weak spots of thermal insulation in the building envelope and can be insulated with thermally embossed Styrodur C. For example, LohrElement E. Schneider GmbH from Gemünden, Germany, offers preconstructed formwork for ceiling edges made of Styrodur 2800 C.

See also: www.lohrelement.de

### Advantages of Styrodur® 2800 C

The honeycomb embossing of the Styrodur® 2800 C boards guarantees adhesive strength on concrete, which generally is so strong that no additional support anchor (plastic nails) is necessary. The special embossing also makes for better adhesive strength on interior and exterior plaster as well as on adhesive mortar.

**Fig. 7:** Cold bridge insulation with Styrodur® 2800 C.

The advantages of Styrodur 2800 C compared to Styrodur C types with foam membrane, including alternative thermal insulation materials, are:

- High adhesive strength on concrete.
- Additional support anchors (plastic nails) are rarely necessary (see formwork).
- Quick and cost-saving installation.
- No risk of mix-up with foam membrane insulation boards.
- Resistant to water.
- No moisture expansion.
- Precoating of thermal insulation boards is not necessary.
- Storage at building site is possible, independent of weather conditions.
- Processable with customary tools for wood working.
- Even complicated details are easy to implement.

### Application of Styrodur C types with foam membrane

Styrodur C boards with foam membrane are not suitable for adhesive applications with concrete, adhesive mortar on mineral soils, or for exterior plastering. The clean surface drastically diminishes the adhesive strength with the plaster, adhesive mortar, or concrete.

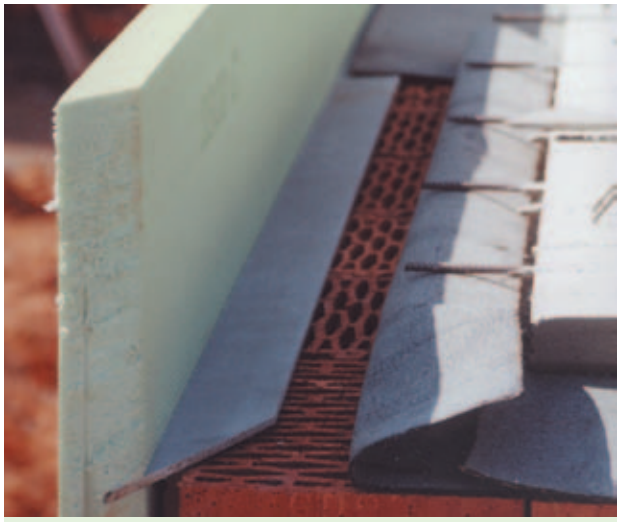


**Fig. 8:** Formwork for ceiling edges with Styrodur 2800 C.

Generally, though, cold bridge insulation without the requirements of adhesive strength on mortar or exterior plastering are conceivable. In those cases, it is possible to use Styrodur 3035 CS with foam membrane.

## 4. Applications

### 4.1 Construction of Cold Bridge Insulation

The installation of Styrodur 2800 C is very easy as well as time- and cost-saving if the following instructions are observed.

### Installation of Styrodur C boards

Depending on the size of the cold bridge area and the Styrodur C type, the following instructions must be observed when installing Styrodur C boards:

- For larger cold bridges (insulated area > 5 m²), the Styrodur C boards must be installed with staggered joints **(Fig. 9)**.
- For small cold bridges, e. g., ceiling support, strips of the insulation board are installed at the ceiling edges.

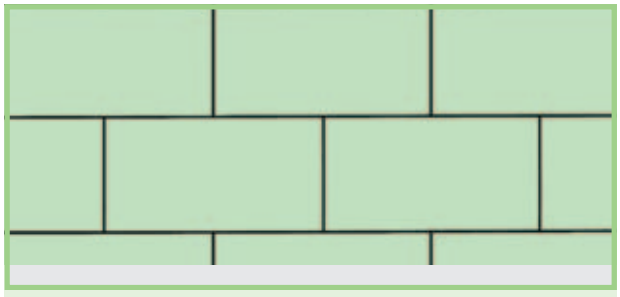


**Fig. 9:** Pattern of Styrodur C boards with staggered joints. Avoid cross joints.

In practice, the cold bridge insulation shown in **Fig. 10** (small size, around ceiling edge) is most common. Due to the cold bridge insulation around the corners, the temperatures of the interior wall surface rise from 10.4°C to 14.9°C.

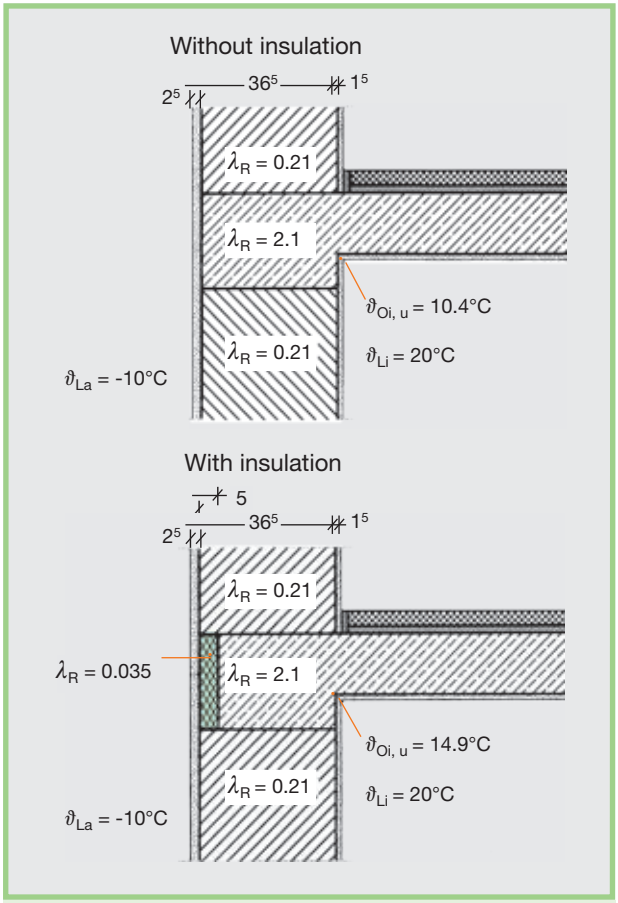



**Fig. 10:** Ceiling support with respective temperatures of the interior surface, without and with cold bridge insulation with Styrodur® 2800 C, 5 cm thick.

However, there still remains a significant heat loss around the edges of the concrete ceiling support. In the infrared image, these areas are highlighted by the lighter and darker colors above and below the ceiling **(Fig. 11)**.

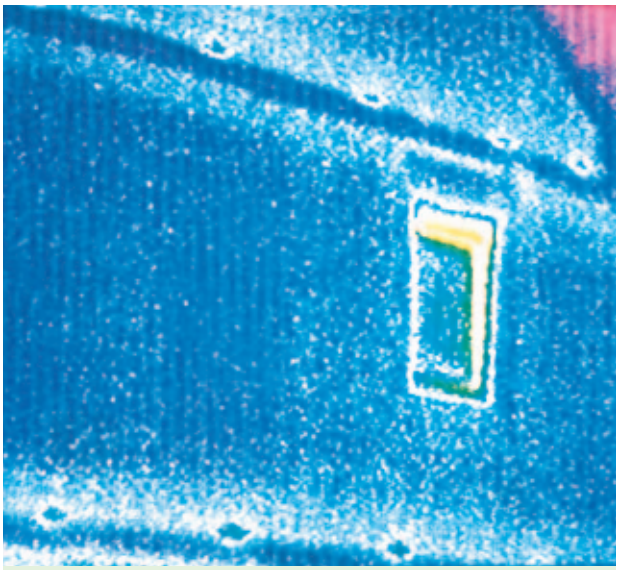


**Fig. 11:** Infrared image of a cold bridge around the ceiling support.

The ideal thermal insulation is guaranteed if the brickwork above and below the embedded ceiling is included in the cold bridge insulation as shown in **Fig. 12**.

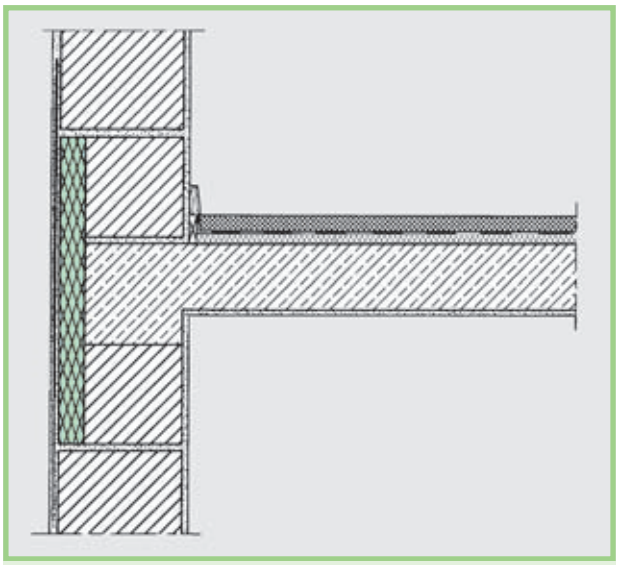


**Fig. 12:** Ideal cold bridge insulation around the ceiling support.

## Placement of Styrodur® 2800 C boards in the formwork

Before the placing of concrete, the Styrodur® 2800 C boards are positioned in the formwork with staggered and compact joints. They are fixated to the wood formwork with clout nails to ensure that they do not shift or float when the concrete is placed **(Fig. 13)**. The nail length should exceed the thickness of the boards by more than 5 to 10 mm. In the case of steel formworks, the boards are fixated with double-sided adhesive tape.

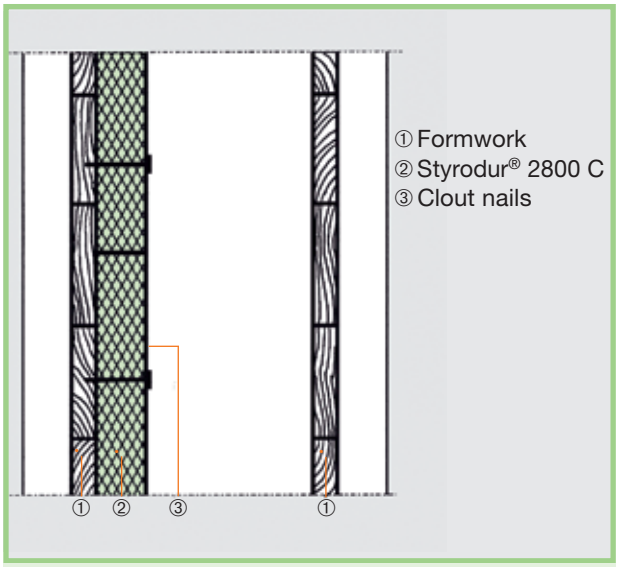



**Fig. 13:** Fixation of Styrodur® 2800 C boards to wood formwork with clout nails.

The embossed surface of the Styrodur 2800 C boards usually guarantees a frictional connection between the insulation boards and the concrete without additional fixation. The adhesive strength averages 0.2 N/mm$^2$.

In comparison, the guidelines of EOTA (European Organization for Technical Approvals) demand a minimum adhesive strength between adhesive and insulation board of ≥ 0.08 N/mm$^2$ for a mass per unit area of 30 kg/m$^2$.

Generally, no additional plastic nails are required to guarantee the necessary adhesive strength of Styrodur 2800 C boards on concrete.

Additional support anchors are only used for Styrodur 2800 C in critical cases, e. g., winter construction sites or short stripping times **(Fig. 14).**

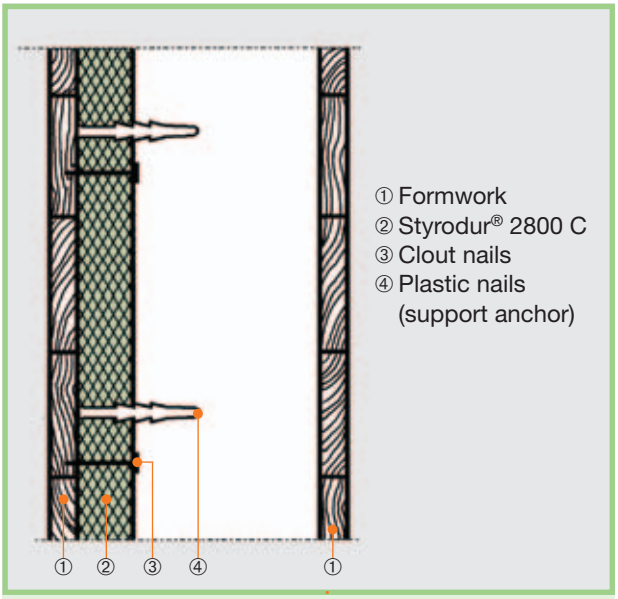



**Fig. 14:** Fixation of Styrodur 2800 C boards to wood formwork with clout nails and support anchors (plastic nails) as mounting to concrete in critical cases.

The number of support anchors, their arrangement on the insulation boards, and the necessary penetration of the anchors are shown in **Figs. 15 and 16**.

In general, it is advisable to use plastic nails with round heads and a minimum diameter of 30 mm. They must be long enough to guarantee a minimum penetration depth of 50 mm **(Fig. 15)**.

There is no regulation on the minimum amount of support anchors for Styrodur® C. Based on the German standard DIN 1102 concerning the processing of wood-wool slabs, it is recommended to use 6 anchors per board, or 5 anchors per 1.25 m strip of insulation **(Fig. 16)**.

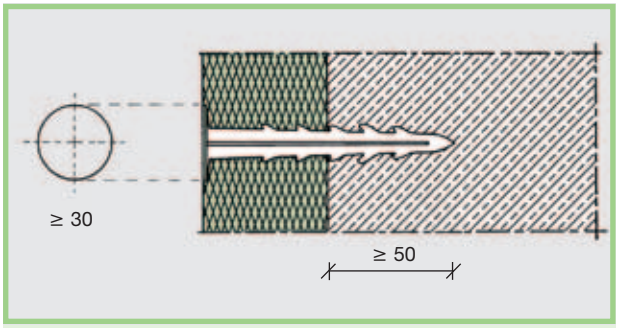



**Fig. 15:** Plastic nails for additional anchoring of Styrodur® 2800 C (units in mm).

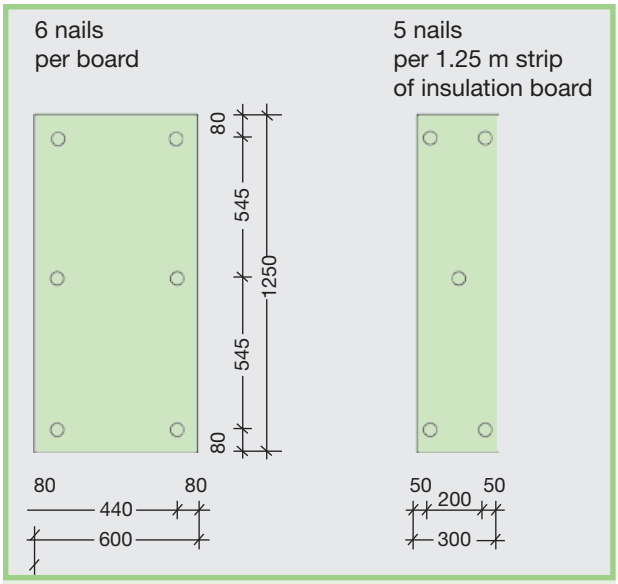



**Fig. 16:** Possible amount and arrangement of plastic nails when placing Styrodur 2800 C boards in the concrete formwork (units in mm).

## 4.2 Reconstruction

### Subsequent installation of Styrodur® C boards

At times it is necessary to subsequently install Styrodur 2800 C boards around the base course adjoining the perimeter insulation **(Fig. 17)**. Before installing the boards, it is necessary to examine the ground to guarantee proper adhesive strength between the surface and the Styrodur C boards. The adhesive strength could be diminished by loose plaster, sanded concrete, a layer of dust, or residues of formwork oil. According to VOB (German Construction Contract Procedures), the ground examination must be carried out by the contractor as part of his auditing and notification duty.

**Fig. 17:** Subsequent base insulation with Styrodur 2800 C.

Any necessary rework of the ground must be performed by the precontractor as part of his warranty assurance.

The boards must be installed with the appropriate adhesive mortar, slotted tightly, and additionally fixated with dowels.

## 4.3 Doweling

Suitable for doweling are polyamide dowels with metal expanding screws, as approved by the DIBt. The anchoring depth should be at least 50 mm; the diameter of the head 60 mm, with four dowels per board, which adds up to 8 fixation points per board **(Fig. 18)**.

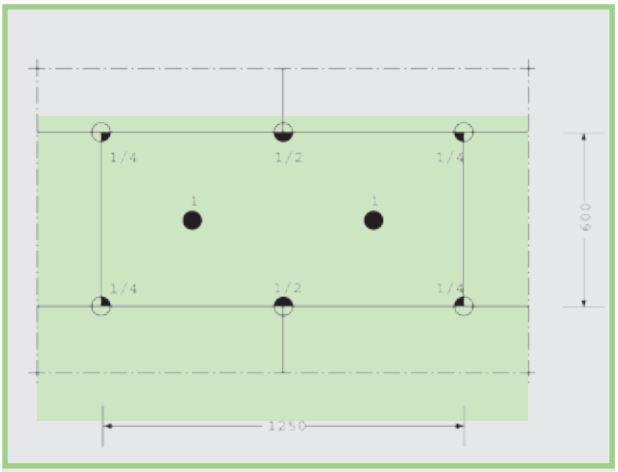



**Fig. 18:** Number and arrangement of dowels for subsequent doweling (units in mm).

## 4.4 Adhesive Mortar

Suitable adhesive mortars are construction adhesives—paste-like or in powder form—on the basis of mineral binders or synthetic dispersion additives. The adhesives harden through dehydration and should not be used at temperatures below +4°C.

## 4.5 Stripping

If the stripping time is very short or if parts of the cement are substituted with flue ash, it is necessary to use 6 plastic nails per board or 5 nails per 1.25 m of insulation strip **(Figs. 15 and 16)**. Additional plastic nails are required for reinforced concrete support with a thin cross section.

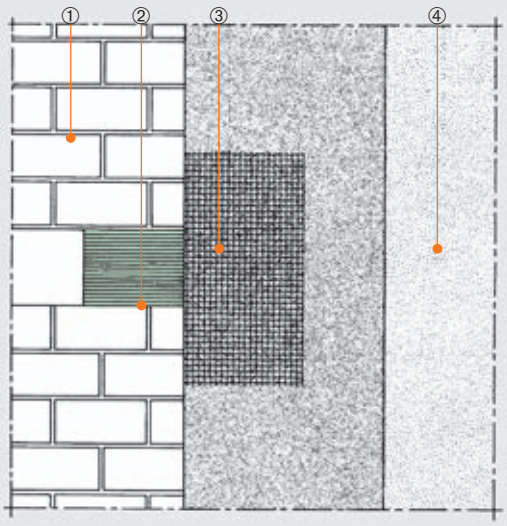
If the grooves are not slotted tightly and grout permeates, it has to be removed (chiseled out) to prevent a cold bridge formation. The grooves have to be sealed, e. g., with polyurethane foam (PUR foam). The same process is required for unsealed attachments to brickwork.

# 5. Plastering Around Insulation Boards

## 5.1 Components for Plastering

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

The components and various layers of plastering have to be adapted to each other and the ground. The suitability of each component as well as of the system has to be accounted for by the provider. **Fig. 19** illustrates the components of a ceiling edge insulated with Styrodur C.




① Heat-insulating brickwork
② Styrodur® 2800 C with horizontally combed plaster bonding bridge
③ Foundation plastering with fiberglass reinforcement grid
④ Final layer

**Fig. 19:** Structure of plastering above the edge of a ceiling insulated with Styrodur® 2800 C.

### Reinforcement fabric

The reinforcement fabric must consist of an alkali-resistant fiberglass grid with a minimum tensile strength (warp and weft) of 1500 N/5 cm. Higher tensile strengths increase the reliability. For larger concrete shear walls in heat-insulated brickwork, it is advisable to use a fiberglass grid with a minimum tensile strength of 2000 N/5 cm.

Planar reinforcement cannot completely rule out the risk of tearing, but it does minimize it drastically.

### Plaster base and fixation elements

The plaster base must be made of stable, spot-welded, and galvanized wire mesh. Fixation is to be carried out on supporting ground using corresponding fixation elements, based on the manufacturer's guidelines.

In this specific case, it is not recommended to use rib lath as an exterior plaster base since it can only absorb the plaster loads in one direction. Moreover, the metal ribs could cause tearing, which would weaken the plaster stability.

### Plaster

It is best to use mineral dry mortar that is subject to continuous monitoring by the manufacturer.

Styrodur® 2800 C boards can be plastered in different ways. In any case, the plaster has to consist of more than one layer, e. g., floating, reinforcement, and finishing coat. The different layers make up a plastering system. The following requirements must be met:

- Solid adhesion of the whole plastering system on the Styrodur 2800 C boards.
- Solid adhesion between each layer.
- Creation of uniformly absorbing foundation for the finishing coat on top of brickwork and Styrodur 2800 C.

## 5.2 Plaster Base

The foundation must be modeled in a way to guarantee a long-term solid bond with the plaster. The Styrodur 2800 C boards thus require a special treatment. Either by means of a pretreatment with a priming coat or a bonding bridge, the use of a specially mixed plaster, or the application of a plaster base.

The structure of the foundation is vital for the adhesion of the plaster. According to VOB Part C, DIN 18530, the contractor is obliged to examine the Styrodur 2800 C units that are to be used, as well as the surrounding brickwork, as part of his inspection and notification duty. Any necessary rework of defective foundations (grout inside the grooves, open grooves, loose boards) must be performed by the precontractor as part of his warranty assurance.

### Pretreatment of the foundation

Foam plastics are not resistant to the long-term effects of the sun's UV rays. After being exposed to the elements for longer periods of time (approx. eight weeks, depending on the intensity of the sun), the surface of the Styrodur C boards begins to turn brown and starts chalking.

Since the erosion dust functions as a separating agent between the plaster and the foam plastic, surfaces damaged by UV rays have to be brushed clean with a steel broom.

It is recommended to account for this task in the tender for the plastering job and to execute it, depending on the site management's decision.

### Application of Styrodur® C boards with foam membrane

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

If it is necessary to plaster already installed boards, they have to be additionally fixated with dowels (Ø 60 mm), as approved by the building authorities **(Fig. 18)**. The foam membrane must be removed mechanically, e. g., with a plane for aerated concrete, in order to achieve a rough surface. The boards can be plastered once this pretreatment is completed.

## 5.3 Types of Plastering

Depending on the size of the surface, the Styrodur 2800 C boards can be plastered in various ways. **Index 1** shows different versions for each application.

For many years, various plastering systems have been on the market that are suitable for the plastering of Styrodur C. In accordance with the manufacturer, systems other than those listed in **Index 1** may be applicable.

**Index 1:** Different applications depending on the size of the surface to be insulated.

| Application | Floating with reinforcement (Type 1) | Filling (Type 2) | Plaster base (Type 3) |
|---|---|---|---|
| Insulation strip ≤ 60 cm | suitable | suitable | suitable |
| Larger areas | not suitable | ask manufacturer about suitability | suitable |

## Floating with reinforcement (Type 1)

Type 1—floating with reinforcement—is only suitable for small-sized insulation strips. The individual steps of the procedure are as follows:

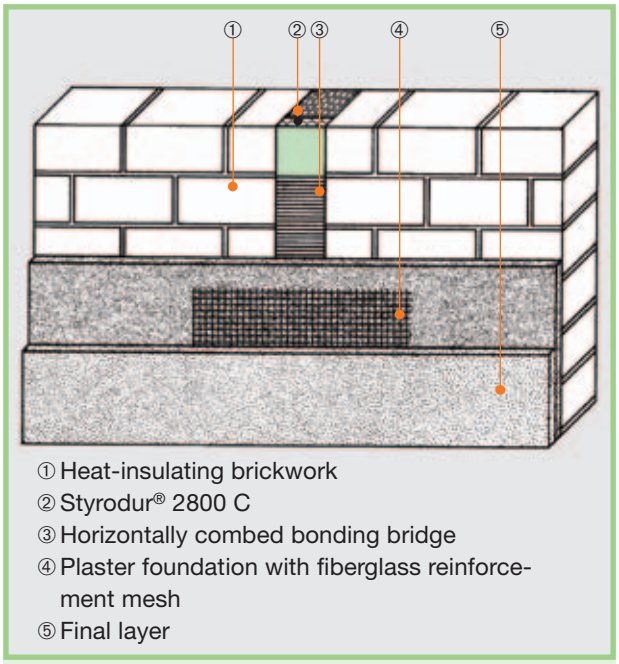
First, a polymer-modified bonding bridge is applied onto the Styrodur® C boards and combed horizontally with a notched trowel **(Figs. 20 and 21)**. The bonding bridge should be at least 5 mm thick, 2 mm in recesses. Minimum immobilization time should be between one to three days, depending on atmospheric conditions.

Then the floating is applied (lightweight plaster according to DIN 18550, Part 4) in standard thickness (15–20 mm). In the upper third section of the floating (tensile-loaded zone), reinforcement fiber (crease-free) is embedded **(Fig. 22)**. The fiber has to overlap at least 100 mm around the joint area and 200 mm on adjoining construction units. Corners of windows and doorways must be additionally reinforced with diagonally aligned strips of the same fiber material **(Fig. 23)**.

The minimum immobilization time of the floating with reinforcement fiber should be three weeks followed by, if necessary, the application of the finishing coat and a leveling course.

**Fig. 20:** Window lintel in heat-insulating brickwork; horizontal combing of the bonding bridge.

**Fig. 22:** Applying floating and fiberglass reinforcement mesh on top of insulated concrete units.




① Heat-insulating brickwork
② Styrodur® 2800 C
③ Horizontally combed bonding bridge
④ Plaster foundation with fiberglass reinforcement mesh
⑤ Final layer

**Fig. 21:** Structure of plaster on top of bracing, reinforced concrete support, insulated with Styrodur® 2800 C.

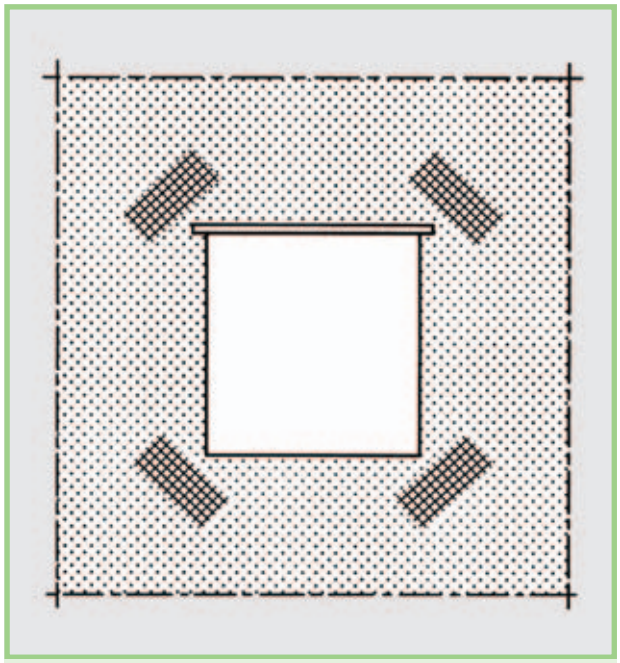


**Fig. 23:** Additional diagonal reinforcement around the corners of the window.

### Plastering with reinforcement fabric (Type 2)

Type 2 is suitable for small-sized as well as large-sized Styrodur® C insulations.

A mineral, polymer-modified bonding bridge is applied horizontally on the Styrodur C boards with a notched trowel **(Fig. 24)**. The bonding bridge should be at least 5 mm thick, 2 mm in recesses. Minimum immobilization time should be between one to five days, depending on atmospheric conditions. Then the floating is applied (lightweight plaster according to DIN 18550, Part 4, or DIN EN 998-1) in standard thickness (approx. 15 mm). The minimum immobilization time of the floating is one day per mm. On top of the floating, a mineral reinforcement mortar is spread over the whole surface (5–8 mm thick) with an embedded reinforcement fiber (crease-free).

The fiber has to overlap at least 100 mm around the joint area and 200 mm on adjoining construction units.

Corners of windows and doorways must be additionally reinforced with diagonally aligned strips of the same fiber material **(Fig. 25)**. The minimum immobilization time of the floating with reinforcement fiber should be at least one day per mm of reinforcement layer. Then the finishing coat can be applied in various surface designs.

When using grated surfaces, it may be necessary to apply a leveling course on top of the floating. The leveling course should be of the same color as the finishing coat to keep the reinforcement mortar from shining through.

**Fig. 24:** Horizontally combed bonding bridge on Styrodur® C insulation.

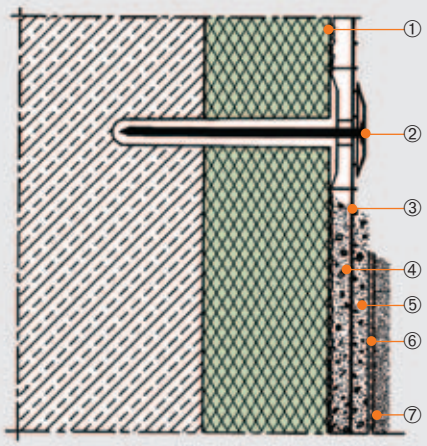
**Fig. 25:** Large-sized ground floor insulation with Styrodur C boards.

Type 3 is suitable for large-sized insulation with Styrodur® C. Manufacturers of plastering systems with little or no experience in plastering extruded foam boards prefer this version.

A mineral, polymer-modified bonding bridge is applied horizontally on the Styrodur C boards with a notched trowel **(Fig. 26)**. The bonding bridge should be at least 5 mm thick, 2 mm in recesses.

Minimum immobilization time should be between one to five days, depending on atmospheric conditions. Then the plaster base is applied.

On the full-sized reinforcement, 9 dowels are applied into which the galvanized, spot-welded wire mesh is hooked **(Fig. 27)**. The plaster now has a fractionized connection with the foundation. The dowels, functioning as spacers, fixate the reinforcement mesh approx. 7 or 8 mm above the plaster foundation. The reinforcement mesh overlaps by 100 mm. The overlapping parts must be secured with metal rings to prevent shifting or springing when the plaster is applied.




① Prespraying (bonding bridge)
② Plaster spacer
③ Reinforcement mesh
④ Plaster foundation
⑤ Smoothing cement
⑥ Fiberglass reinforcement mesh
⑦ Finishing coat

**Fig. 26:** Profile of possible structure for plastering with plaster base and large-sized insulation with Styrodur® C.

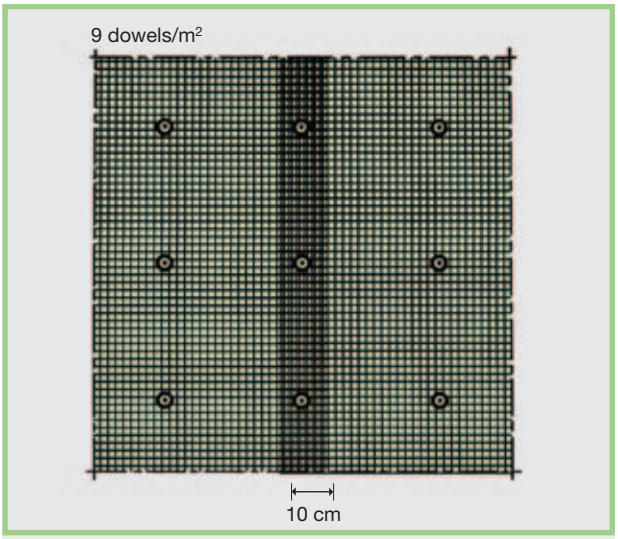



**Fig. 27:** Full-sized reinforcement with wire mesh for plaster base (9 dowels per m²).

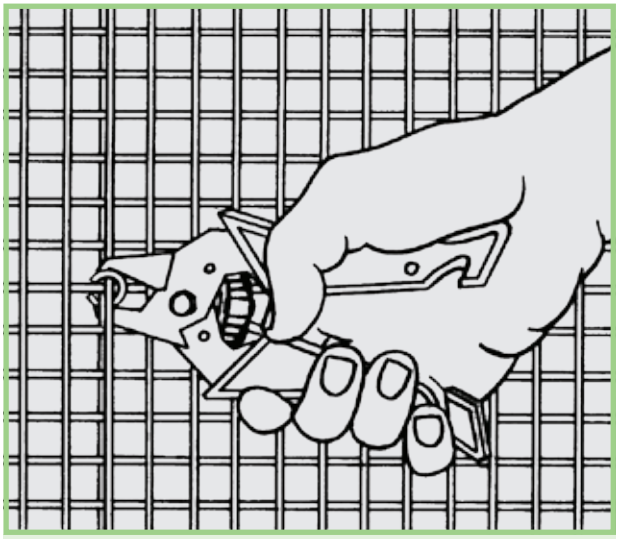


**Fig. 28:** Overlapping mesh is secured against shifting with metal rings (20 cm spacing).

Important for all types: For patterned plaster, e. g., with a combed structure, it is advisable to apply a leveling course (priming coat) in order to keep the plaster foundation from shining through.

To avoid diagonal tearing of the plaster, open corners must be additionally secured with diagonal reinforcement strips **(Fig. 23)**.

Instead of the bonding bridge, dry mortar can be applied on top of the Styrodur® C boards after the application of the plaster base. Please follow the manufacturer's instructions concerning the minimum immobilization time.

Now apply the floating (Type 1) or the reinforcement material (Type 2) and proceed according to the instructions for Type 1 or 2.

## 5.4 Base Course Plastering

To avoid cold bridges around the base course area, the thermal insulation should exceed the perimeter insulation of the ground and extent all the way to any heat insulating brickwork or the external thermal insulation composite system.

If insulation boards with foam membrane have been used for of the perimeter insulation, a different material and laying system must be used along the upper edges. Above the upper edges, the Styrodur 2800 C boards are laid—slotted tightly with staggered joints—and doweled. On top of them, plastering can be applied as described.

On top of the insulation layer, a reinforcement mortar is spread over the whole surface (at least 5 mm) with an embedded reinforcement fiber (crease-free). The fiber must overlap at least 100 mm around the joint areas. Once this first layer has hardened (after a minimum of one day), a second layer is applied following the same instructions. The finishing coat can be applied after the second layer has hardened, which takes at least one week.

**Fig. 29:** Application of the fiberglass grid on the plaster foundation of the base course.

Instead of this process, the use of reinforcement material (Type 2, page 15) can be implemented. Other alternatives have to be approved by the manufacturer of the plastering system.

It is important to consider that nowadays exterior base course plastering on thermal insulation boards does not follow the German standard DIN 18550 (P III, cement mortar), but is rather executed with the Mortar Group P II (highly hydraulic lime mortar or lime-cement mortar). Cement mortar of the Mortar Group P III would be too hard for the relatively soft insulation ground and subject to excessive tearing. P II mortar used for base course plastering is also water-repellent and resistant to frost, but not as hard as P III mortar and therefore suitable for rather soft grounds such as aerated concrete.

The plaster has to be protected from standing water and must not be in direct contact with the soil. It is best to separate the soil and base course with a gravel bed **(Fig. 30)** and take preventive measures on top of the base course plastering, e. g., a bitumen layer, drainage boards, or a water-proof membrane.

For the reconstruction of the base course around old buildings, Styrodur® C boards are glued to the base by means of dot-and-bead application **(Fig. 31)**. On sanding or slightly adherent surfaces, the Styrodur C boards must be dowelled in addition.

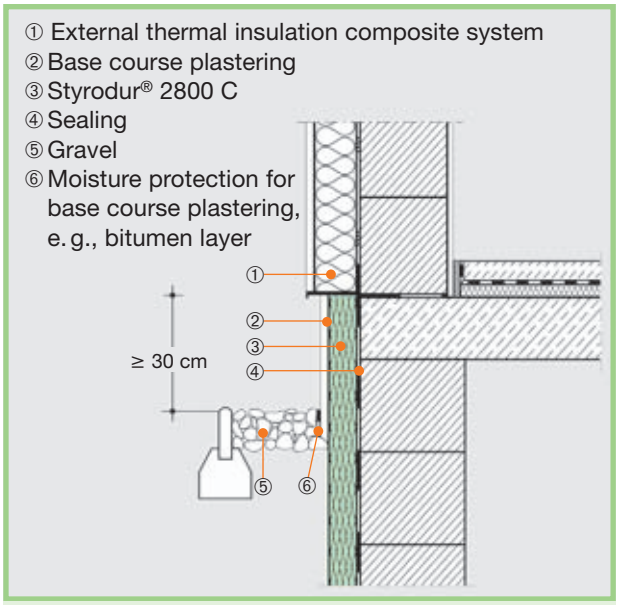



**Fig. 30:** Base course with Styrodur® 2800 C, base course plastering, and gravel bed.

**Fig. 31:** Reconstruction of an old building: Styrodur 2800 C boards are applied (dot-and-bead application).

## 5.5 Indoor Plastering

Apply a bonding bridge on the Styrodur® 2800 C boards in accordance with the guidelines of the manufacturer.

After a drying time of between one to three days, the cement or lime plaster is applied **(Fig. 32)**. It should be approx. 10 mm thick, with an embedded reinforcement material **(Fig. 33)**.

In accordance with the German standard DIN 1102, the fiber has to overlap at least 100 mm around the joint area and 200 mm on adjoining construction units. Apply the plaster using the wet-on-wet method **(Fig. 34)**.

If lime or lime cement is used as indoor plaster, a mineral, polymer-modified bonding bridge must be applied first.

**Fig. 32:** Applying the first layer of bonding plaster (10 mm).

**Fig. 34:** Applying the second layer of plaster (5 mm), using the wet-on-wet method.

**Fig. 33:** Applying the fiberglass reinforcement mesh on the whole surface. The layers should overlap approx. 100 mm.

It is also possible to glue gypsum plaster boards to the Styrodur® 2800 C boards in line with the thin-bed method. The adhesive mortar is applied with a notched trowel all around the edges. In addition, a layer of mortar is applied lengthwise to each third of the board.

Styrodur 2800 C is also a suitable foundation for laying tiles using the thin-bed method.

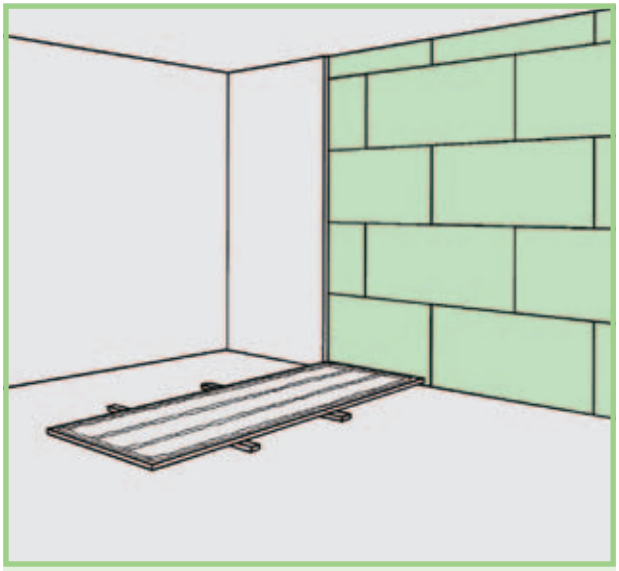


**Fig. 35:** Adhesion structure of the gypsum plaster board on Styrodur® C.

It is always advisable to calculate the water-vapor diffusion when applying indoor insulation. It might be necessary to install a vapor barrier to avoid condensate within the construction **(Index 2)**.

**Index 2:** Necessity of a vapor barrier, depending on the wall construction, for 4 cm Styrodur® C indoor insulation and 1.5 cm indoor plastering ($S_d$ = 4.15 m).

| Wall construction | Vapor barrier |
|---|---|
| heavy masonry | necessary |
| lightweight masonry (concrete, natural stone, clinker) $r_{max}$ = 1000 kg/m³ | not necessary |

The vapor barrier must be applied on the warm side between the insulation material and the plaster. Complete vapor-barrier systems are available and can be applied as follows:

- A reinforced aluminum sheet is glued to the Styrodur C boards with a solvent-free polyurethane solution adhesive. The panels must overlap at least 100 mm.
- The aluminum sheet is covered with a priming coat, which acts as a bonding bridge and a protective layer against the alkalinity of the plaster. This foundation can either be plastered with synthetic resin plaster or tiled using the thin-bed method.

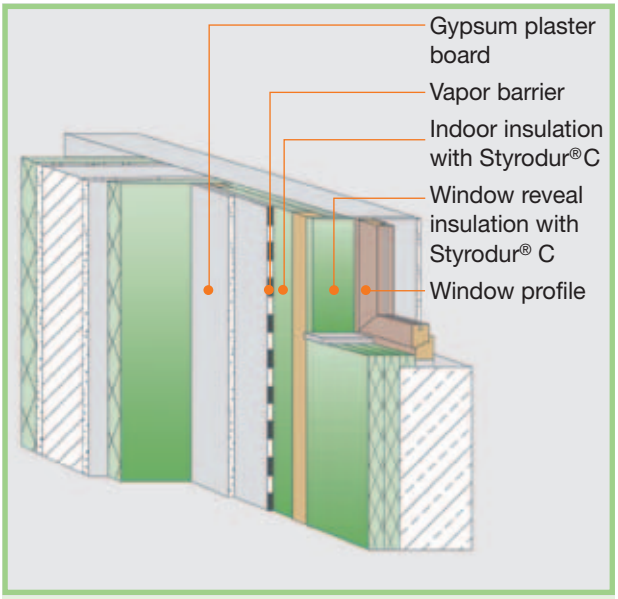
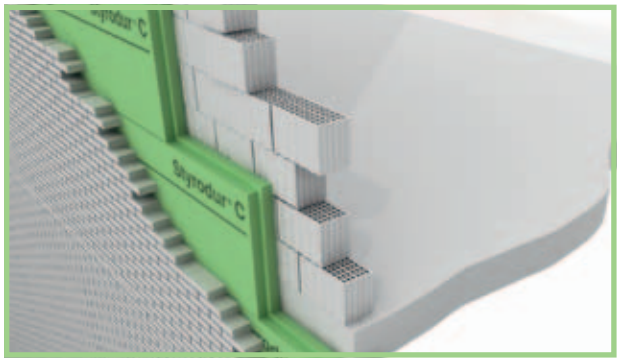



**Fig. 36:** Indoor insulation with Styrodur C adjoining a window.

## 6. Cavity Wall Insulation with Styrodur® C




Cavity wall designs are very common in many regions of Europe. Since Styrodur® C features low water absorption, high thermal insulation values, and a resistance to decay, it is suitable for the installation in cavity walls without locking air inside.

Cavity wall insulation is a very effective construction for heat-insulated exterior walls **(Fig. 39)**, which is especially widespread in regions with rather rough weather conditions, e. g., the rainy and windy coastal regions of Northern Europe.

For cavity wall insulation, we recommend Styrodur 3035 CN and Styrodur 3035 CS.

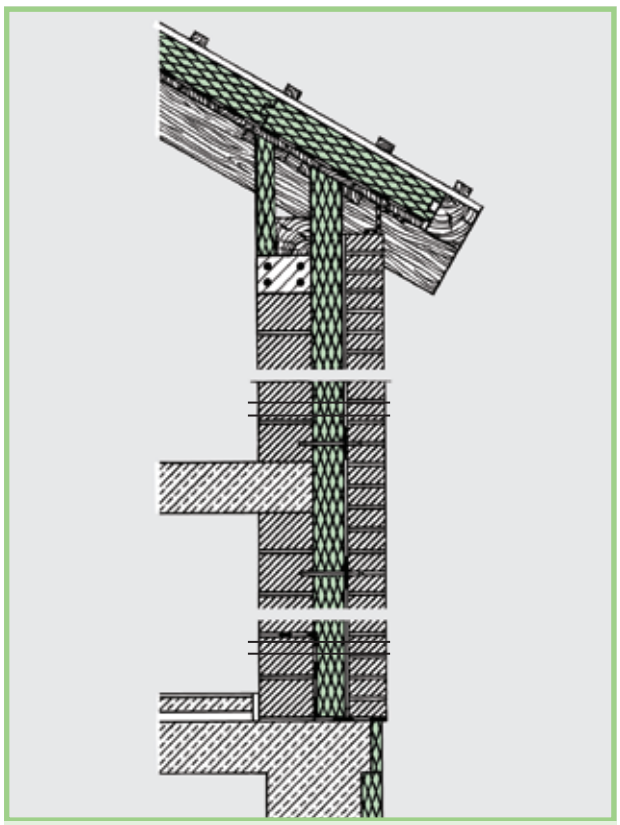


**Fig. 37:** Styrodur® C in cavity wall without air locked inside.

### 6.1 The System

According to the German standard DIN 1053, an interior wall must carry the static loads of the roof and ceilings as well as the wind load. In an average two-story building, the walls are 24 cm thick, or 17.5 cm if you forgo the horizontal slots for service pipes. For economical reasons, the load-bearing wall is designed as thick as necessary and as thin as possible. The thermal insulation layer must be stable and resistant to deformation. A good thermal insulation board provides low thermal conductivity and moisture absorption. Moisture will increase the thermal conductivity of the boards. In a cavity wall construction, moisture can get to the insulation boards from the outside as well as from the inside; from the inside in form of water-vapor diffusing from the humidity inside through the load-bearing walls, and from the outside in form of water penetrating through open grooves. With the exterior wall being only 11.5 cm or at times 9 cm thick, this cannot be avoided. For such cases, it is recommended to use thermal insulation boards that practically absorb no water at all.

**Fig. 38:** Cavity wall insulation with brick construction (9 cm) for exterior wall.

**Fig. 39:** Cavity wall insulation with Styrodur C.

According to the standards DIN 1053-1 and 1996-11, double-layer exterior walls can be designed both with and without an air layer between the front wall and the insulation layer. In the case of core insulation without an air layer, the distance between the wall layers must not exceed 150 mm. The facing layer should have open butt joints at the bottom to allow the discharge of permeated humidity.

The facing, mostly consisting of clinker or sand-lime brick, provides weather protection. Five anchors per square meter are used to fixate a 11.5 cm-thick facing to the load-bearing wall.

## 6.2 Implementation

In practice, the construction of cavity walls with Styrodur® C insulation (without an air layer) is implemented in accordance with German standards DIN 1053-1 and 1996-11, Page 1, Item 5.2.1. Only the additional installation of the insulation layer calls for special measures. Since the insulation boards must be 60 cm thick and contain 5 wall ties per square meter, these anchors must penetrate the insulation boards.

There are two possibilities:

### Walled-in anchor

The wire anchors are L-shaped. The nook is walled in the groove of the inner wall, the rest of the anchor protrudes vertically. After the installation of the insulation board, the locking plate, and the dripping edge, the free end is bent horizontally into a right angle so that the nook fits into a groove of the above-grade outer wall. This is the case with the general integer ratio of brick sizes of the outer and inner wall.

### Wall ties

When using groove-and-tongue insulation boards, it might be easier to work with wall ties **(Fig. 40)**. These can be doweled into the stone, which enables a much higher pullout strength compared to doweling into the groove. Naturally, the locations of the outer wall grooves must be taken into account before fixating the wall ties.

Even with this construction, a slight air gap will form between the outer wall and the insulation board. It allows for the alignment of the outer wall. The joint mortar between the stones of the inner wall should be flattened on the outside for the insulation boards to fit in evenly.

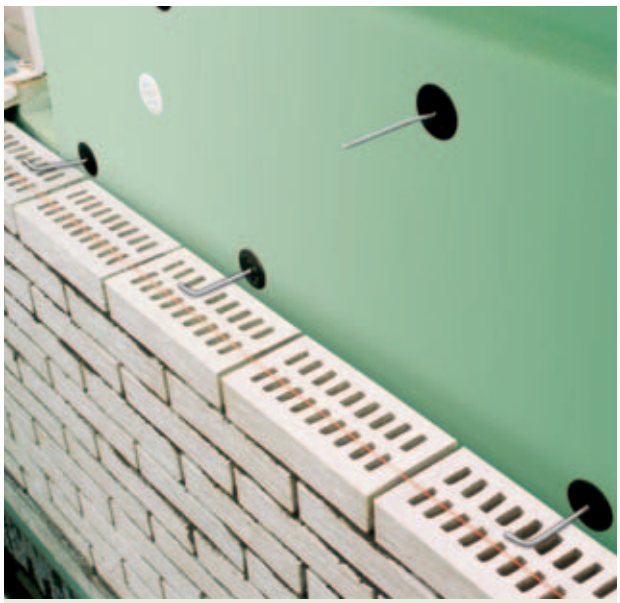


**Fig. 40:** Outer wall made of sand-lime brick; fixation with wall ties.

# 7. Reconstruction of Sanitary Equipment with Styrodur® C

## 7.1 Styrodur C and Tiling

Many apartments built in the post-war era as well as during the 60s and 70s have bathrooms that require reconstruction. New technologies, higher standards, and the need for a more pleasant, comfortable, and friendly bathroom environment are the main reasons.

For a quick, clean, and professional reconstruction of bathrooms, so-called tile elements, damp room elements, and rigid-foam structures have proved to be valuable. The combination of an extruded polystyrene rigid-foam core (Styrodur® C) and a double-sided coating of fiberglass mortar provides a solid, water-proof, heat-insulating ground that is resistant to decay and suited for all kinds of tiles.

## 7.2 Suitable for Every Foundation and Application

In cases of mixed masonry, cracked foundations, or ones with load-bearing capacities, tile elements can level out all unevenness, thus creating the perfect ground for the laying of tiles. Even on top of old tiles, existing layers of paint, or plaster, these inherently stable tile elements can be applied easily, safely, and permanently.

Tiles are decorative and easy to clean. New applications and arrangements are constantly developed in more traditional areas such as bathrooms, restrooms, and wet areas, as well as kitchens, cafeterias, or laboratories. The versatility of tiling elements becomes even more apparent in new application areas such as shop fitting or the catering sector.

## 7.3 Multiple Applications

Whether you build, reconstruct, or refurbish, for the laying of tiles you need materials that are durable and resistant. Tile elements are not only a good choice for substructures in walls or floors, they can also be used for complete bathroom designs. Covers of bathtubs and showers, dividing walls, or washbasins can just as easily be installed as storage areas, shelves, or intermediate floors. The alternatives are numerous and, depending on the strain, tile elements of different thicknesses can be used.

## 7.4 Handling of Tiles

These days, working with tiles requires efficiency, quickness, and accuracy at the same time. All these demands are being met by tile elements and all necessary operations stay in the hands of your tiler. Due to the solid and yet easy-to-cut materials, even the most complicated cuts and cutouts can be handled with the usual tools.

For the laying of the elements, both the thin-bed and the medium-bed method can be used. In wet areas, the tiles are covered with a layer of liquid sealant, simply and permanently. Edges and areas of contact are thoroughly glued. Only a few additional tools are required for professional implementation.

### Properties at a glance

- Low weight and high stability
- Uncomplicated and efficient handling
- Various applications and designs
- Resistant to moisture and decay
- Heat-insulating
- High economic efficiency
- Few additional tools required

**Fig. 41:** Example of tile elements with Styrodur® C: bathroom (www.pr1mus.de).

## 8. Recommended Applications Styrodur® C

| Styrodur® C | 2500 C | 2800 C | 3035 CS | 3035 CN | 4000 CS | 5000 CS |
|---|---|---|---|---|---|---|
| Perimeter[1] floor slabs | | | ■ | | ■ | ■ |
| Perimeter[1] basement walls | | | ■ | | ■ | ■ |
| Perimeter[1] load-bearing floor slabs | | | ■ | | ■ | ■ |
| Perimeter[1]/subsoil water areas | | | ■ | | ■ | ■ |
| Domestic floor | ■ | ■ | ■ | | | |
| Industrial and refrigerated warehouse floors | ■ | ■ | ■ | | ■ | ■ |
| Cavity walls | ■ | | ■ | ■ | | |
| Internal walls | | ■ | | | | |
| Lost formwork | | ■ | | | | |
| Cold bridges | | ■ | | | | |
| Exterior basement wall insulation | | ■ | | | | |
| Plaster base | | ■ | | | | |
| Inverted flat roofs | | | ■ | | ■ | ■ |
| Duo roofs/Plus roofs | | | ■ | | ■ | ■ |
| Promenade roofs | | | ■ | | ■ | ■ |
| Roof gardens | | | ■ | | ■ | ■ |
| Parking decks | | | | | ■[2] | ■ |
| Conventional flat roofs[3] | ■ | | ■ | | ■ | ■ |
| Parapet walls | ■ | ■ | ■ | | | |
| Basement ceiling/Underground garage ceiling | | ■ | | | | |
| Attic ceiling | | | ■ | | | |
| Pitched roofs | ■ | ■ | | ■ | | |
| Ceilings | ■ | | | ■ | | |
| Drywall composite board | | ■ | | | | |
| Sandwich panels | ■ | ■ | | | | |
| Warehouses | ■ | | ■ | ■ | ■ | ■ |
| Ice rinks | | | ■ | | ■ | ■ |
| Road transport infrastructure/Rail construction | | | ■ | | ■ | ■ |

Styrodur® C: Product approval: DIBt Z-23.15-1481,
extruded polystyrene foam conforming to EN 13164
Free of HFC

[1] = Insulation in direct contact with the ground

[2] = Not for installation under concrete paving stones

[3] = With protective layer over the sealing

# Styrodur® C—A Strong Product Line

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

### Styrodur 2500 C
- The light thermal insulation board with smooth surface and smooth edges for applications with normal compressive strength requirements.

### Styrodur 2800 C
- The thermal insulation board with embossed honeycomb pattern and smooth edges for application in combination with concrete, plaster, and other covering layers.


### Styrodur 3035 CS
- The all-round thermal insulation board with smooth surface and overlap is suitable for almost all applications in structural and civil engineering.

### Styrodur 3035 CN
- The long thermal insulation board with smooth surface and groove and tongue for quick, thermal bridge-free installation.

### Styrodur 4000/5000 CS
- The extremely compression-proof thermal insulation board with smooth surface and overlap for applications with highest compressive strength requirement

### Styrodur HT
- The light green, high temperature-resistant thermal insulation board for all areas of application with thermal loads of up to 105 °C.
  Further information: www.styrodur.com

### Styrodur NEO
- The silver-gray thermal insulation board with an up to 20% better insulating performance thanks to the use of graphite as an infrared absorber, as patented by BASF.
  Further information: www.styrodur.com

**Note:**
The data contained in this publication are based on our current knowledge and experience. In view of the many factors that may affect processing and application of our product, these data do not relieve processors from carrying out their own investigations and tests; neither do these data imply any guarantee of certain properties, nor the suitability of the product for a specific purpose. Any descriptions, drawings, photographs, data, proportions, weights, etc. given herein may be changed without prior notice and do not constitute the agreed contractual quality of the product. It is the responsibility of the recipient of our products to ensure that any proprietary rights and existing laws and legislation are observed.

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