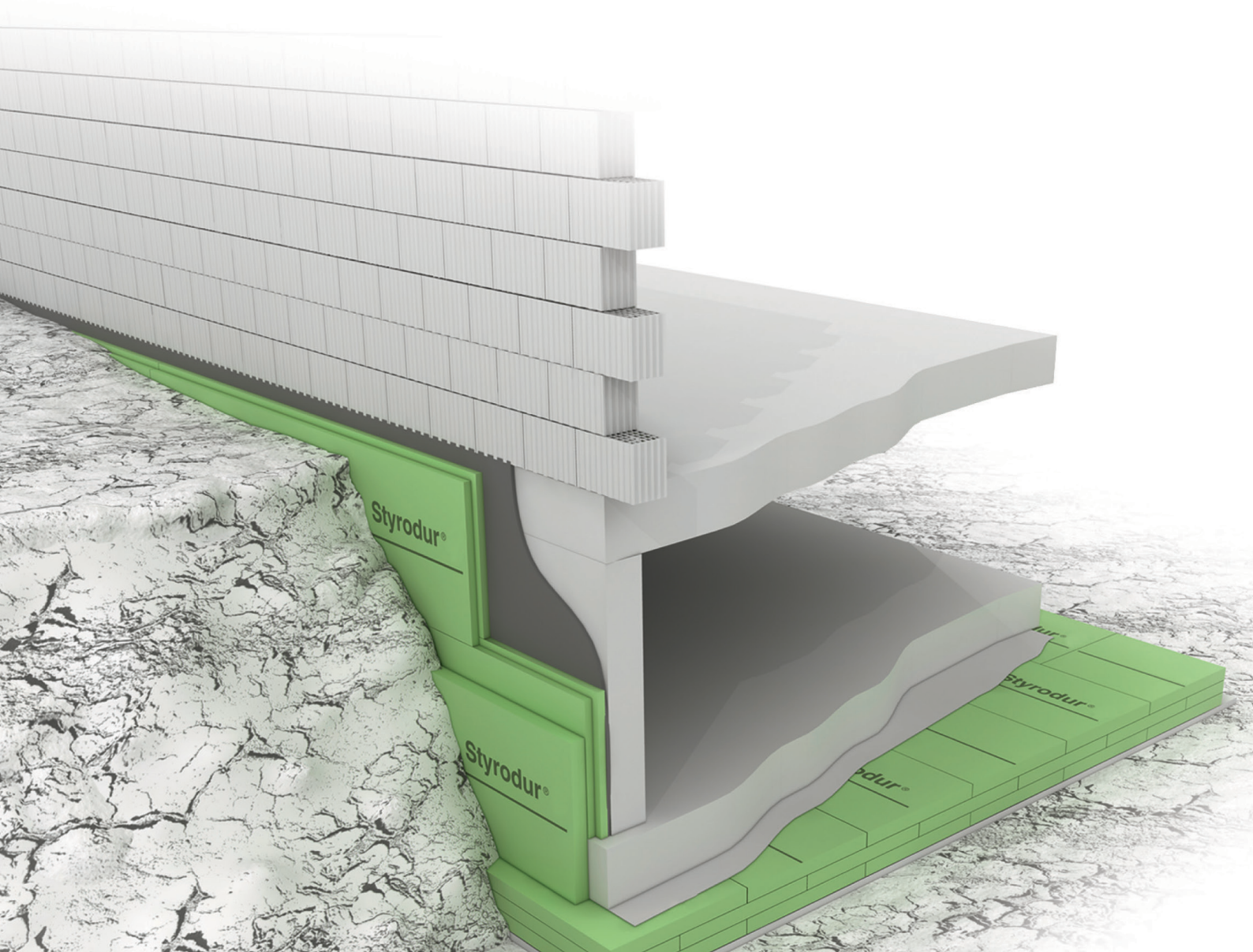
Safe. Strong.
Styrodur®

BASF
We create chemistry

Perimeter Insulation

Wall, Floor, Foundation Slab, Groundwater

www.styrodur.com



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1. Long-standing Trust in Styrodur®

With Styrodur, BASF can draw on 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. Styrodur stands for technology “made in Germany” and for unique, constantly evolving work on approvals.

This is why Styrodur has convinced generations of architects, craftsmen, builders, and building material suppliers of these benefits:

Environmental advantages:
- Environmentally friendly due to CO_2 production process with air as cell gas
- Reduction of carbon dioxide (CO_2) emissions thanks to excellent insulation performance
- Free of harmful blowing agents
- Polymeric flame retardant

Quality and safety advantages:
- Technology “made in Germany”
- Most technical approvals on the market
- Proven since 1964
- Protects the building construction from external forces such as heat, cold, and humidity
- Comprehensive production control and quality monitoring, documented by CE marking KEYMARK and Q-sign
- Long-lasting: if correctly installed, Styrodur outlasts the life expectancy of the building construction

Structural-physical advantages:
- Excellent insulation properties
- High compressive strength
- Very low water absorption
- Resistance to aging and decay
- Fulfils all structural-physical and building construction requirements in Europe’s various climate conditions

Processing advantages:
- Low dead weight
- Simple and practical processing with suitable saws or hot-wire cutting equipment
- Can be installed in all weather conditions
- No dust hazardous to health during mechanical processing
- Extensive product range
- Most diverse potential applications

Economic advantages:
- Strong market presence
- Fast availability and reliable partnerships thanks to Europe-wide logistics with professional customer service via local distributors
- Reduction of energy costs for heating and cooling
- Quick amortisation of the insulation investment with rising energy costs
- Increases the life span and raises the value of the building

2. Good Reasons in Favour of Basements

Building with basements is more economical
In relation to the building costs, a basement can improve the growth of the house value, since the resale value usually increases significantly.

Technical aspects underline the benefit of basements. The basement offers significant advantages in terms of construction.

For example:

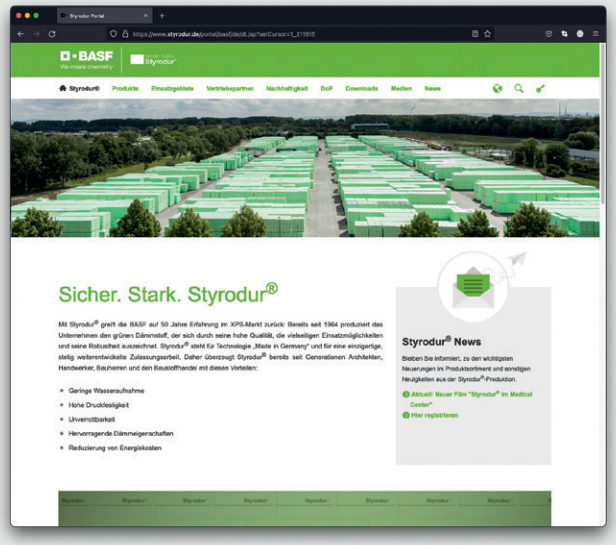
- House connection and the maintenance of fittings are less expensive.
- Sound insulation of terraced and semi-detached houses is higher.
- Small lots of land are better utilized.

Additional space in your home
A skilfully designed lower level can include:

- Quiet bedrooms
- Office spaces or workshops
- Spacious family rooms
- Saunas
- Storage rooms
- Entertainment rooms
- Technical rooms

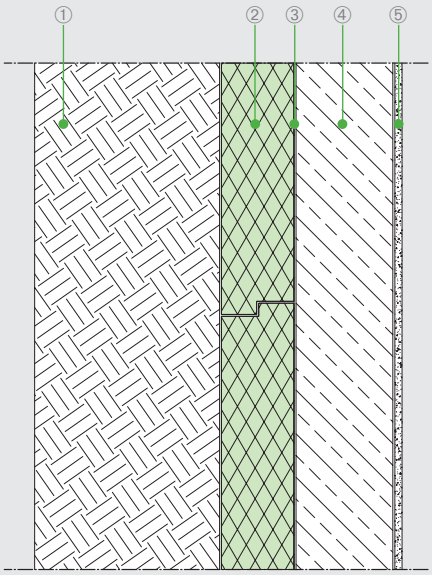
Modern building materials and components ensure more comfort due to reliable sealing and solid thermal insulation, as well as plenty of light and air.

Further information on Styrodur, such as the „Technical Data“ brochure, can be found on our website at www.styrodur.com.



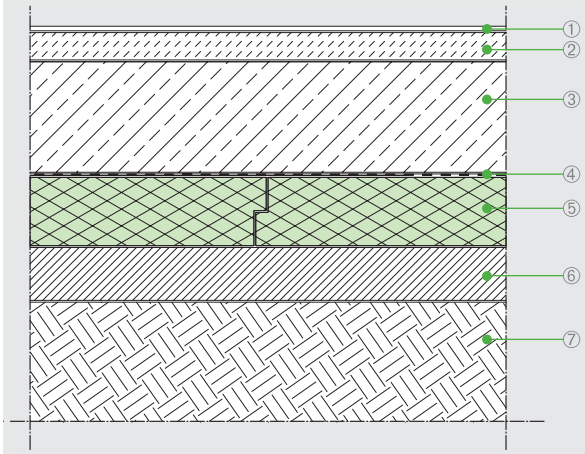
3. Perimeter Insulation

The perimeter insulation comprises the exterior thermal insulation of building elements with ground contact, e.g. exterior basement walls **(Fig. 1)** and basement floors **(Fig. 2)**. The distinguishing feature of perimeter insulation is that the thermal insulation layer is applied on the outside of the structural sealing.



① Ground
② Thermal insulation
③ Sealing barrier
④ Basement wall
⑤ Interior plaster

Fig. 1: Basement wall with exterior thermal insulation layer, adjacent to the ground.



① Floor covering
② Composite screed
③ Concrete floor slab
④ Sealing barrier
⑤ Thermal insulation
⑥ Blinding layer
⑦ Ground

Fig. 2: Lower room barrier with bottom thermal insulation layer, adjacent to the ground.

Perimeter insulation in areas with pressing water and standing seepage water (in groundwater) requiring technical approval

Styrodur has been approved for many years by the German Institute for Building Technology (DIBt) in Berlin/Germany for use as perimeter insulation in areas subject to long-term backwater or pressing water. In accordance with this approval, the Styrodur boards can be used on exterior basement walls with ground contact in single or double layers, and under static non-load-bearing building elements (basement floor slabs) in single, double, or triple layers. Styrodur 3035 CS may reach up to 3.5 m into the groundwater. Styrodur 4000 CS and Styrodur 5000 CS may be immersed up to 7.0 m in the groundwater. The structural sealing is implemented in line with the respective regulation - Waterproofing against outside pressing water and accumulating seepage water.

Perimeter insulation in areas with soil moisture and non-standing seepage water (above groundwater) according to standard and approval

DIN 4108-2 defines thermal insulation systems as perimeter insulation if the insulation boards are made of extruded polystyrene foam according to EN 13164, are installed as a single layer and not under building foundations, and if they are not continuously immersed in groundwater. The perimeter insulation with Styrodur boards above groundwater level therefore constitutes a construction conforming to the standards.

In compliance with the DIBt approval, Styrodur can be used as perimeter insulation on exterior basement walls with ground contact in single or double layers, and under static non-load-bearing building elements (basement floor slabs) in single, double, or triple layers.

Styrodur 3000 CS may be installed as perimeter insulation in a single layer (60 mm - 160 mm) in accordance with the DIBt approval.

Perimeter insulation under load-bearing foundation slabs (above groundwater)

Based on DIBt approval Z-23.34-1325, Styrodur can also be used under load-bearing foundation slabs. The insulation boards may be laid in up to three insulation layers with a total maximum thickness of 300 mm. Likewise, Styrodur 3000 CS can also be used as a single layer (60 - 120 mm) under load-bearing foundation slabs.

Perimeter insulation under load-bearing foundation slabs (in groundwater)

For perimeter insulation in areas with long-term backwater or pressing water (in groundwater), Styrodur 3035 CS and 3000 CS may reach up to 3.5 m into the groundwater. Styrodur 4000 CS and Styrodur 5000 CS may be immersed up to 7.0 m in the groundwater.

Perimeter insulation reduces heat loss at lower building closures and thereby enables a comfortable indoor climate in the basement area. The higher temperatures on the interior surfaces of walls and floors prevent condensation in the interior, which helps to avoid the musty odour frequently encountered in basement areas. For the user, this provides the following advantages:

- The indoor climate in the basement/lower level is improved.
- The temperatures on the inner surface of the basement walls rise.
- Condensation on the inside of the basement walls and basement floor is prevented. By this, preventing also the formation of mold.
- The user gains additional interior space.
- The value of the building is increased sustainably.
- The thermal insulation saves energy costs.
- Insulation layers can be applied without thermal bridges.
- The sealing barrier is protected.

Since the thermal insulation material of the perimeter insulation is extremely highly stressed by rainwater, earth pressure, and traffic loads, the materials are manufactured to meet the highest demands:

- High compressive strength
- Resistance to moisture
- Low thermal conductivity
- Resistance to decay
- Good and durable thermal insulation properties

Styrodur possesses these properties and is excellently suited for use as an insulation material in perimeter insulation.

4. Thermal Insulation Layer with Styrodur®

On horizontal and vertical surfaces, Styrodur boards are butted tightly in a bond formation **(Fig.3)**. Boards with a shiplap are particularly suited to prevent the formation of thermal bridges. They also protect the structural sealing from mechanical stresses.

Installation:
In accordance with DIBt approvals, Styrodur boards may be used

- in areas with soil moisture and non-standing seepage water (above groundwater) as well as
- in areas with pressing water and standing seepage water (in groundwater).

Installation is possible in one to three layers:

- On walls in one or two layers
- Under basement floors (static non-load-bearing) in one, two, or three layers
- Under foundation slabs (static load-bearing) in one, two, or three layers

The total thickness of the thermal insulation layer may not exceed:

- 400 mm on walls
- 400 mm under basement floors (static non-load-bearing)
- 300 mm under foundation slabs (static load-bearing)

The individual insulation boards must have the following thicknesses:

- Styrodur 3035 CS: 50 to 200 mm
- Styrodur 4000 CS: 60 to 160 mm
- Styrodur 5000 CS: 60 to 120 mm

For foundation slabs (static load-bearing) and multiple layering, the single board thickness may be up to a maximum of 120 mm.

In accordance with the DIBt approval, Styrodur 3000 CS and Styrodur 3000 SQ may be installed as a single layer in long-standing or pressing water up to an immersion depth of only 3.50 m.

Product recommendations:
On walls, under basement floors and foundation slabs:
- Styrodur® 3035 CS
- Styrodur® 4000 CS
- Styrodur® 5000 CS

Perimeter insulation in accordance with DIN 4108-2 in areas with soil moisture and single-layer insulation:
- Styrodur® 3000 CS
- Styrodur® 3000 SQ

In the base area:
- Styrodur® 2800 C/Q

General application notes
During the Styrodur board extrusion process, a smooth compressed foam membrane is formed on the surface of the boards.

The surfaces must be rough-textured in order to ensure a superior bond of adhesive mortar, plaster, or other mortars used in base insulation, for example. The surface of Styrodur 2800 C/Q is thermally embossed (honeycomb), providing good bond properties for plaster and concrete.

The proper execution of the building waterproofing is a prerequisite for the installation of Styrodur in perimeter insulation. DIN 18533 identifies different load cases for basement waterproofing depending on the moisture stress. The basements known as “white tanks” made from waterproof concrete require no additional waterproofing.

Fig. 3: Securing a two-layer perimeter insulation of Styrodur boards until the backfilling of the excavation pit.

5. Advantages of Styrodur® in Perimeter Insulation

There are many good reasons to use Styrodur in perimeter insulation:

- High compressive strength
- No need for additional protective layers
- Installation depth according to earth pressure, **Table 6**, page 22
- No restrictions concerning the minimum distance to passing traffic
- Perimeter insulation suitable for passive houses up to 400 mm
- No deterioration of thermal conductivity since virtually no moisture absorption
- Technical approval for use in groundwater
- Styrodur has proven itself for decades
- Expert reports on the long-term behaviour are available
- Processing advantages, as Styrodur does not require the time-consuming floating in bitumen for floor insulation, and wall insulation requires no additional protective layers
- No special protective measures are needed in frost-prone areas
- Non-cohesive soils do not require drainage
- Easy assembly bonding; full-surface and edge bonding and coating of the board joints is only necessary in groundwater
- The use of Styrodur 2800 C/Q with textured surface also facilitates the base insulation (see “Instructions for the Installation and Plastering of Extruded Rigid Polystyrene Foam Boards” in download area of www.styrodur.com)
- The textured surface of Styrodur 2800 C/Q also simplifies plastering in the base area (see “Instructions for the Installation and Plastering of Extruded Rigid Polystyrene Foam Boards” in download area of www.styrodur.com)
- In compliance with DIBt approval, Styrodur may also be installed under load-bearing foundation slabs, even if they reach up to 3.5 m (Styrodur 3035 CS and 3000 SQ) or 7.0 m (Styrodur 4000 CS and Styrodur 5000 CS) into the groundwater
- Styrodur is also approved for use in earthquake zones

The following information, installation suggestions, and configuration examples will surely be helpful in your planning and installation of Styrodur.

6. Perimeter Insulation in Areas with Soil Moisture and Non-standing Seepage Water (Above Groundwater)

6.1 Perimeter Insulation in Wall Areas

Waterproofing

Walls reaching into the ground can be made of concrete, waterproof concrete, or plastered brickwork. Building elements permeable to water must be fitted with waterproofing in line with DIN 18533 “Waterproofing of buildings”. The implementation of such measures depends on the level of exposure to moisture.

Perimeter insulation does not replace the structural sealing barrier. Walls made of waterproof concrete may be insulated directly without pre-treatment.

Structural sealing and adhesive products have to harmonise in terms of their chemical and physical properties and must be selected to suit the particular application.

For waterproofing with bitumen or when using bitumen membranes, it is recommended to use, among others, solvent-free two-component adhesive on bitumen-concrete basis or solvent-free epoxy glue.

The insulation boards should not be pressed into the not-yet-dry bituminous sealing layer for the following reasons:

- When pressing the boards into the sealing layer, parts of the sealing might come off. The integrity of the sealing barrier can thus no longer be guaranteed.
- Frequently used sealing materials on cold-bitumen basis can contain solvent components that may damage the insulation material. When applying cold-bitumen sealing materials, it is advisable to grant at least one week of airing time before attaching the insulation boards.

Bituminous coatings, putties, waterproof plasters, and sealing slurries that can at least withstand soil moisture and non-pressing water are used.

Bonding Styrodur boards

Prior to backfilling the excavation pit, the Styrodur boards must be secured to prevent any shifting or dislocation. This is usually done by gluing them to the sealed walls. The assembly bonding ensures that the insulation boards stick to the wall until they are ultimately held in place by the ground. It must be ensured that subsequent settling of the backfill soil does not cause harmful shear stress on the structural sealing barrier.

Bituminous adhesives are predominantly used for the point bonding of the assembly. Further information on the appropriate adhesive can be obtained from your building materials supplier or directly from the adhesive manufacturer.

Fig. 4: Tightly butted Styrodur boards make for perimeter insulation without thermal bridges.

Setting Styrodur boards

The insulation boards must be butted tightly to form a bond **(Fig. 4)**. The shiplap edges ensure a joint lock, which prevents the formation of thermal bridges. Moreover, the insulation boards must be positioned on a solid supporting surface (e.g. the projecting foundation).

When installed as a double layer, the two layers are to be joined using the point bonding method, with the joints being covered and the boards offset to each other **(Fig. 5)**.

Fig. 5: Point bonding the second layer of Styrodur boards with shiplap and offset joints.

6.2 Perimeter Insulation Under Basement Floors (Static Non-load-bearing)

Base

For horizontal perimeter insulation, the base on which the Styrodur boards are installed must be even and provide the necessary load-bearing capacity for the respective application **(Fig. 6)**. DIN 1054 “Subsoil—Verification of the safety of earthworks and foundations” must be taken into account when assessing the permissible load-bearing capacity of the building ground. This applies for both natural ground and backfill.

Fig. 6: Blinding layer of lean concrete for the installation of floor insulation.

The base surface must allow a level installation, even if Styrodur boards are laid on bedrock. A concrete levelling course should be considered for this purpose **(Fig. 7)**. A bedding layer of concrete must be properly levelled.

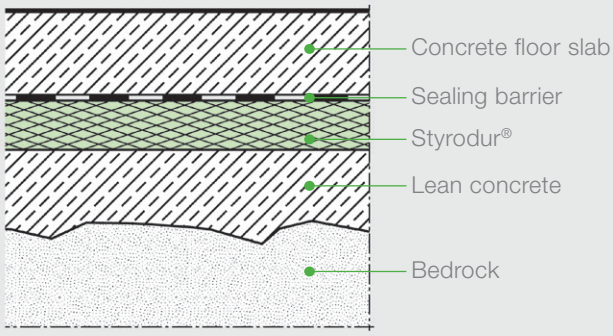


Fig. 7: Levelling course of lean concrete on bedrock.

Waterproofing

When sealing against moisture, DIN 18533 “Waterproofing of buildings” must be taken into account. Bitumen membranes, which require the sheet joints to be glued with hot bitumen, cannot be laid directly onto a layer of Styrodur because the hot bitumen will melt the Styrodur boards.

The use of solvent-containing cold bitumen is not recommended for bonding because the solvent partially dissolves Styrodur. Suitable sealing materials are membranes that can be conjoined either by solvent welding or hot-gas welding. ECB (ethylene copolymer bitumen) sealing membranes are highly recommended. PVC membranes containing plasticisers cannot be used in combination with Styrodur.

Laying Styrodur boards

When using Styrodur for thermal insulation **(Fig. 8)** under a non-load-bearing floor slab (no loads on rising structures) in accordance with DIN 4108, the following must be observed:

- Styrodur can be laid in up to three layers.
- The total thickness of the thermal insulation layer can be up to 400 mm.
- Only extruded foam boards with shiplap are permitted (Styrodur 3000 CS, Styrodur 3000 SQ, Styrodur 3035 CS, Styrodur 4000 CS, Styrodur 5000 CS).
- Styrodur is laid in a bond without cross joints.
- The board layers are installed with offset joints.
- A separation layer, such as a polyethylene film, is laid between the thermal insulation and the floor slab.
- Styrodur boards must not be used under static load-bearing single or strip foundations.

Fig. 8: Multi-layer installation of Styrodur boards under a floor slab according to DIBt approval Z-23.34-1325.

Reinforcement

Spacers have to be used for the support of the separately fitted bottom and top structural steel reinforcement. This can consist of appropriately shaped steel mesh fabric, pre-cast concrete, or plastic parts **(Fig. 9)**. The reinforcement is placed on the spacers **(Fig. 10)**. There should be no contact with the PE film. The risk of damaging the film is marginal.

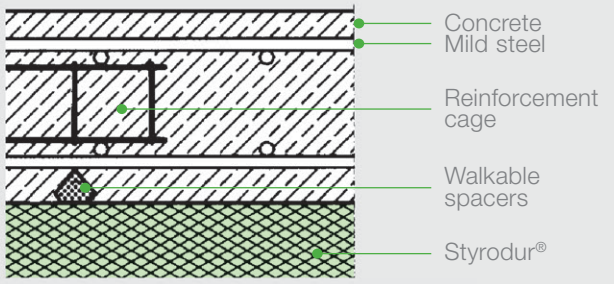


Fig. 9: Walkable spacers made of fibre-reinforced concrete for the bottom reinforcement and reinforcement cage of steel mesh fabric for the top reinforcement of the floor slab.

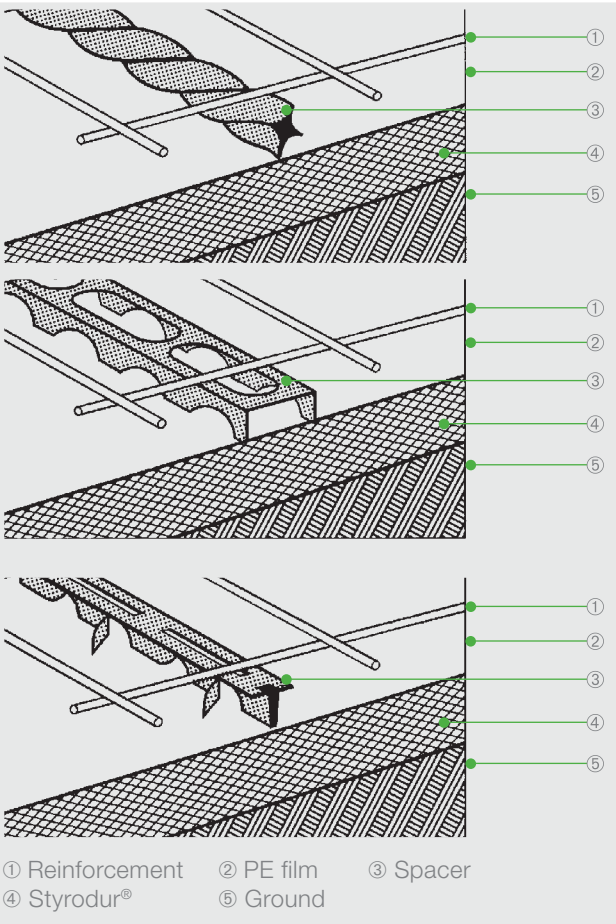


Fig. 10: Walkable plastic spacer for horizontal reinforcement. The height of the concrete cover is predetermined by the profile height.

6.3 Perimeter Insulation Under Foundations and Foundation Slabs (Static Load-bearing)

Lateral thermal insulation of foundations with Styrodur
The foundation sides can be insulated with Styrodur boards for thermal insulation and frost protection. This prevents frost penetration even under minimal-depth foundations of heated buildings **(Figs. 11 and 12).**

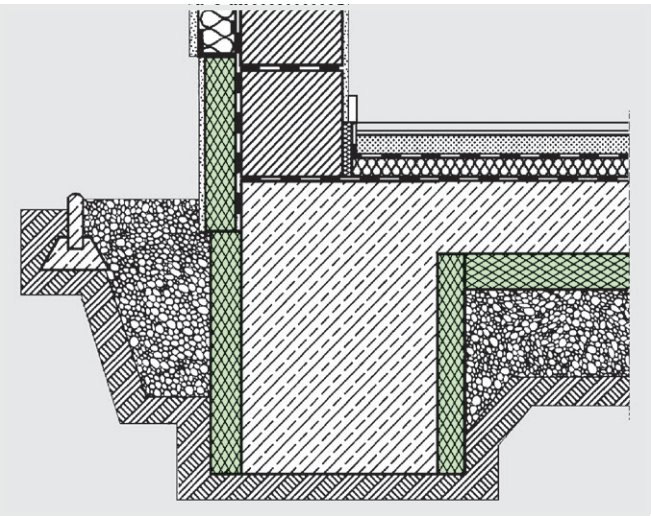


Fig. 11: Insulation of the foundation and connection to the external thermal insulation composite system (ETICS).

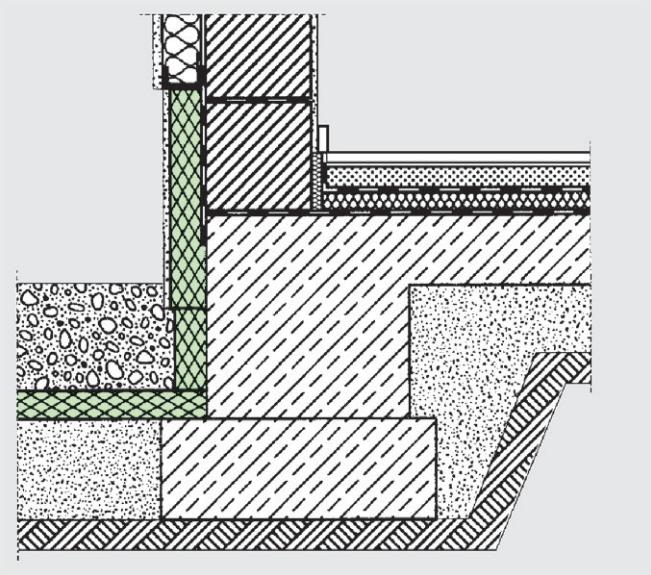


Fig. 12: Possibilities of insulating the foundation against frost.

Thermal insulation under load-bearing foundation slabs with Styrodur
Based on DIBt approval, Styrodur can also be used as load-bearing thermal insulation with up to three layers under foundation slabs. This is precisely where Styrodur meets all of the key requirements of thermal insulation: high compressive strength as well as resistance to decay and low water absorption.

Foundation slabs made of steel-reinforced concrete are becoming ever more common in the construction of homes and office buildings. It is recommended to install Styrodur boards underneath the entire foundation slab in order to prevent the formation of thermal bridges. The rising basement wall perimeter insulation connects directly to this base, preventing any thermal bridges. The benefit of this method is that the basement is completely and comprehensively enclosed in insulation material.

Frost protection
For frost protection, the thermal insulation is extended beyond the foundation slab area to prevent frost under the foundation or foundation slab **(Fig. 13)**.

Today, an increasing number of buildings without basements are constructed on foundation slabs while not considering the appropriate frost protection of the base. This bears the risk that temperatures beneath the foundation slab might drop below freezing during winter months. The consequences range from ice lenses to frost heave, depending on the condition of the soil, potentially causing damage to the building.

Frost protection measures prevent the penetration of frost under the floor slab **(Fig. 14)**. Horizontal thermal insulation is installed around the entire building at a depth of about 30 cm. If block paving is to be laid above the frost protection, its depth can be reduced to 20 cm.

Fig. 13: Frost protection.

Passive house standard

Climate with period of permanent frost < 40 days:

- Frost protection width = Styrodur board length b = 125 cm
- Insulation board thickness d = 8 cm
- Ground cover h = approx. 30 cm

Climate with period of permanent frost < 26 days:

- Frost protection width = Styrodur board length b = 60 cm
- Insulation board thickness d = 3 cm
- Ground cover h = approx. 30 cm

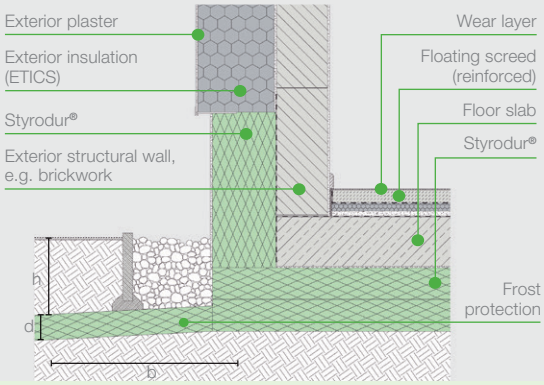


Fig. 14: Information on the design of frost protection.

When using Styrodurfor load-bearing thermal insulation under static load-bearing foundation slabs, the following is to be considered:

- Styrodur can be laid in up to three layers.
- The total thickness of the thermal insulation layer can be up to 300 mm.
- Only extruded foam boards with shiplap are permitted (Styrodur 3000 CS, Styrodur 3000 SQ, Styrodur 3035 CS, Styrodur 4000 CS, Styrodur 5000 CS).
- In the case of multiple layering, the stacked board layers may only be comprised of boards of the same type and compressive strength (Styrodur 3035 CS, Styrodur 4000 CS, Styrodur 5000 CS).
- Styrodur is laid in a bond without cross joints.
- The board layers are installed with offset joints.
- The extruded foam boards are to be laid on a blinding layer, e.g. C8/10 concrete or on a level, densely compacted gravel and sand base. The base must be sufficiently level.
- A single separation layer, such as a PE film above the insulation layer, or other suitable measures have to be considered to protect the insulation layer during the construction of the foundation slab.
- During installation, up to 20% of the rated value of the normal stress for the respective load case can be dispersed as horizontal forces via the Styrodur material.
- For the single- or multi-layer installation of extruded foam boards (Styrodur 3035 CS, Styrodur 4000 CS or Styrodur 5000 CS), the shear load due to horizontal earthquake effects must not exceed the value of 20% of the vertical load of the building.

Static prerequisites

For the verification of stability, the rated value of the compressive stress fcd of the extruded foam boards may be used as a maximum.

- Styrodur 3000 CS, board thickness 60-120 mm, fcd = 155 kPa
- Styrodur 3000 SQ, board thickness 60-240 mm, fcd = 185 kPa
- Styrodur 3035 CS, single- or multi-layer board thickness 50–120 mm fcd = 185 kPa
- Styrodur 3035 CS, single-layer board thickness 140–200 mm fcd = 170 kPa
- Styrodur 4000 CS, single- or multi-layer board thickness 60–120 mm fcd= 255 kPa
- Styrodur 4000 CS, single-layer board thickness 140–160 mm fcd = 230 kPa
- Styrodur 5000 CS, single-layer board thickness 60–120 mm fcd = 355 kPa
- Styrodur 5000 CS, multi-layer board thickness 60–120 mm fcd = 300 kPa

Settlement calculations

The settlement for a thermal insulation layer thickness of more than 120 mm must be considered for two borderline cases:

- Calculation for the intended building ground without consideration of the thermal insulation layer.
- Calculation for the intended building ground and the thermal insulation layer using the modulus of elasticity of the compressed extruded foam board after 50 years (taking into account the long-term creep deformation of the insulation material).
- Styrodur 3000 CS E_{50} = 6.000 kPa
- Styrodur 3000 SQ E_{50} = 6.000 kPa
- Styrodur 3035 CS E_{50} = 6.000 kPa
- Styrodur 4000 CS E_{50} = 9.000 kPa
- Styrodur 5000 CS E_{50} = 11.000 kPa

From a structural-physical standpoint and depending on the intended indoor climate, it may be necessary to install a vapour barrier on the warm side, or the top surface of the Styrodur layer. This interrupts the water vapour diffusion flow from the interior of the building towards the ground, which prevents condensation in the insulation material.

7. Perimeter Insulation in Areas with Pressing Water and Standing Seepage Water (in Groundwater)

In accordance with DIBt approvals, Styrodur boards may also be installed in areas of permanent or long-term pressing water (in groundwater).

7.1 Perimeter Insulation in Wall Areas

Waterproofing
The structural sealing must not be impaired in its function by the insulation layer in any way. The structure is waterproofed in compliance with DIN 18533 “Waterproofing against outside pressing water and accumulating seepage water” **(Fig. 15)**.

Commonly used are bitumen membranes and compounds, plastic and elastomer sealing sheets, metal bands, polymer-modified bitumen coatings, and waterproof concrete in the form of “white tanks”.

The adhesive manufacturer´s processing specifications must be observed

Fig. 15: Waterproofing the basement walls against pressing water.

Bonding Styrodur boards
When applying the adhesive, spread the mixed insulation board adhesive over the entire surface of the wall and the insulation board with an approx. 10 mm deep notched trowel **(Fig.16)**.

The adhesive manufacturer’s processing specifications must be observed.

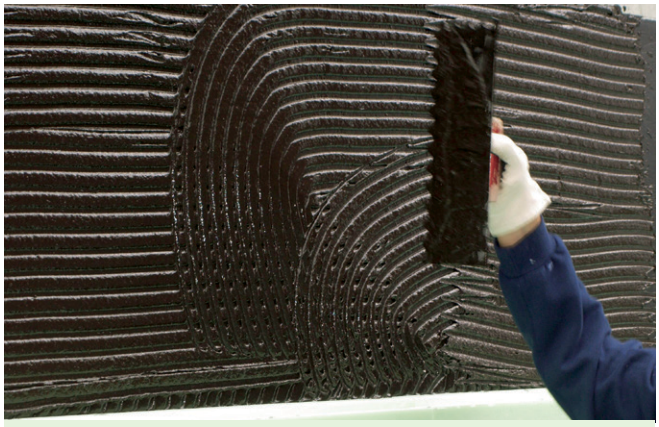


Fig. 16: Full-surface bonding of the insulation boards in areas with pressing water.

Setting the Styrodur boards and sealing the joints
Set the boards with a gap of 2 to 3 cm and push together to closely butt the joints. When creating the bond, avoid any cross joints. The shiplap edges ensure a joint lock, which prevents the formation of thermal bridges. Styrodur boards should be attached sufficiently tightly to the exterior wall to ensure that water does not run down the rear side of the thermal insulation. The boards must be bonded to the base with a suitable adhesive (see Adhesive selection). The side edges of the Styrodur boards are to be sealed all around with adhesive or an appropriate bituminous sealing compound for protection against water penetration **(Fig. 17)**.

The maximum immersion depth is 3.5 m for Styrodur 3000 CS, Styrodur 3000 SQ and Styrodur 3035 CS and 7.0 m for Styrodur 4000 CS and Styrodur 5000 CS.

Fig. 17: Setting the Styrodur boards and sealing the joints against pressing water.

Adhesive selection
Special adhesives must be used for the full-surface bonding of insulation boards on the outside of the structural sealing barrier in areas subject to permanent or long-term pressing water. The adhesive manufacturer's notes and instructions have to be observed.

Securing against uplift
The verification of security against uplift is given if one of the following points is complied with:

- The Styrodur boards have a full-surface bond with the substrate.
- With a maximum Styrodur insulation board thickness of 400 mm, the high water mark must not exceed 1 m below ground level.
- With a maximum Styrodur insulation board thickness of 200 mm, the groundwater level must be no higher than 0.5 m below ground level.
- Constructive measures are taken to secure against uplift. For example, the direct connection to an external thermal insulation composite system (ETICS) or to single-layer rising brickwork may be sufficient to secure against uplift.

When verifying security against uplift, it should be ensured that no harmful shear stress is introduced in the bituminous seal.

No additional measures against uplift are necessary with the "white tank" (waterproof concrete) construction method. The groundwater level may rise up to ground level. In well-draining soil and in the groundwater area, Styrodur can be installed without additional special drainage boards. Full-surface bonding to the building and the bonding or sealing of all board joints is necessary in groundwater.

7.2 Perimeter Insulation Under Basement Floors (Static Non-load-bearing) and Under Foundations and Foundation Slabs (Static Load-bearing)

The same information and instructions apply as described in this brochure under 6.2 and 6.3. The Styrodur boards may be installed in single, double, or triple layers.

8. Connections and Finishes

At the base points **(Fig. 18a and b)**, such as the lower starting point of the perimeter insulation, the Styrodur boards must be positioned such that slipping off due to settlement over time is prevented. The adhesive manufacturer's notes and instructions have to be observed.

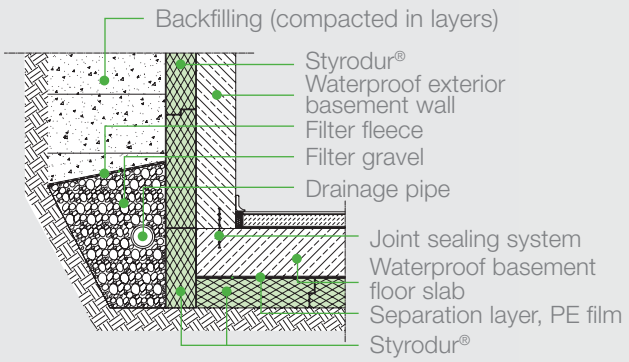


Abb. 18a: Base point of the perimeter insulation. Styrodur board rests on top of the foundation.

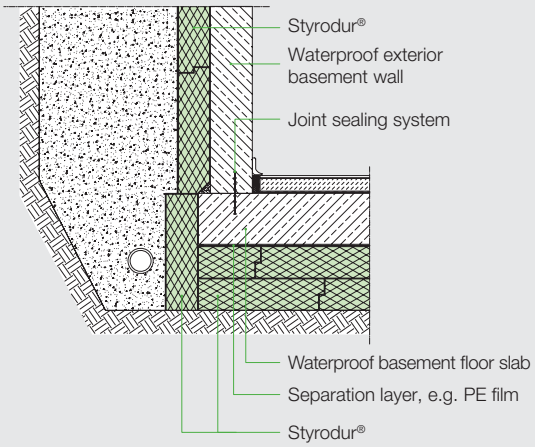


Abb. 18b: Connection of insulated floor slab to vertical exterior basement wall with Styrodur Hybrid.

Near windows, lintels, and window frames, the thermal insulation is to be free of thermal bridges **(Fig. 19)**. Lightwells have to be fitted such that the perimeter insulation is not interrupted and there are no thermal bridges.

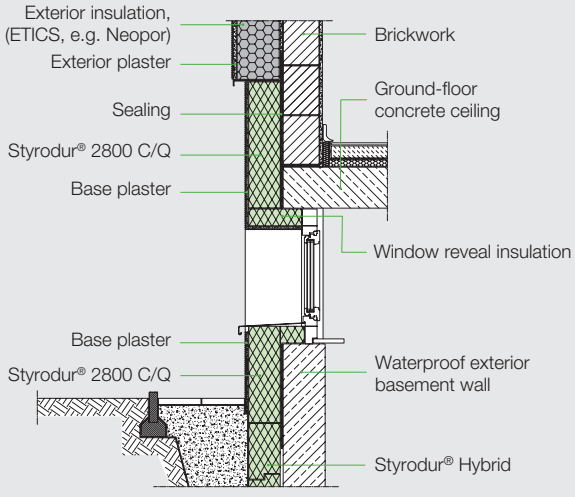


Fig. 19: Insulation in the window area, free of thermal bridges.

8.1 Lightwells

In order to avoid thermal bridges, lightwells should be thermally separated from the building, which in turn allows a variation of the lightwell width. One example are lightwells made of pre-cast concrete parts **(Fig. 20)**, set onto a bed of gravel and leaning on the perimeter insulation.

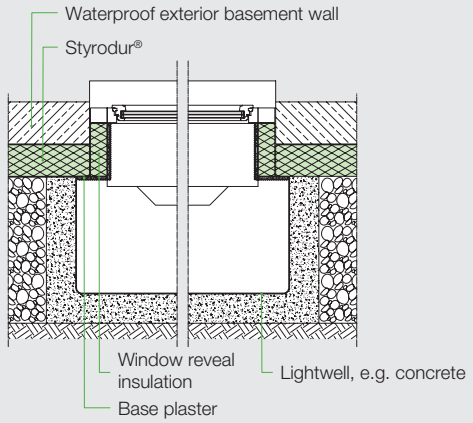


Fig. 20: Connection to a concrete lightwell.

Plastic lightwells also represent a good solution and are attached to the basement wall with screws penetrating the insulation **(Figs. 21** and **22)**.

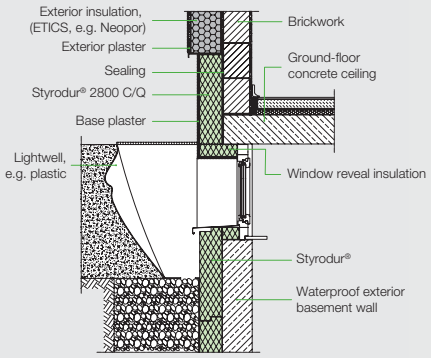


Fig. 21: Connection to a plastic lightwell, free of thermal bridges.

Fig. 22: Lightwell assembly on perimeter insulation.

9. Base Insulation

Insulation is also necessary in the base area of the basement between the surface of the ground and the rising, thermally insulated brickwork or the external thermal insulation composite system (ETICS) **(Fig. 23)**. Above ground level, Styrodur 2800 C/Q with its thermally structured surface is used if the surface will be plastered.

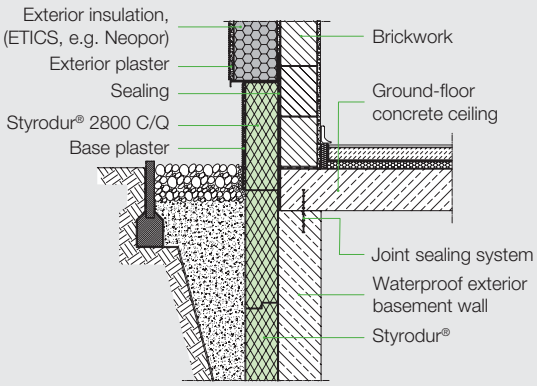


Fig. 23: Base area, perimeter insulation with external thermal insulation composite system (ETICS).

In the base area, the boards are preferably bonded across the full surface of the exterior wall with a construction adhesive or by means of the dot-bead method. Once the adhesive has cured, the Styrodur 2800 C/Q boards are dowelled with four plate anchors per board **(Fig. 24)**. The head diameter of the anchor must measure at least 60 mm. Styrodur boards without a thermally structured surface are not suitable for plastering (see Instructions for the installation and plastering of XPS at www.styrodur.com).

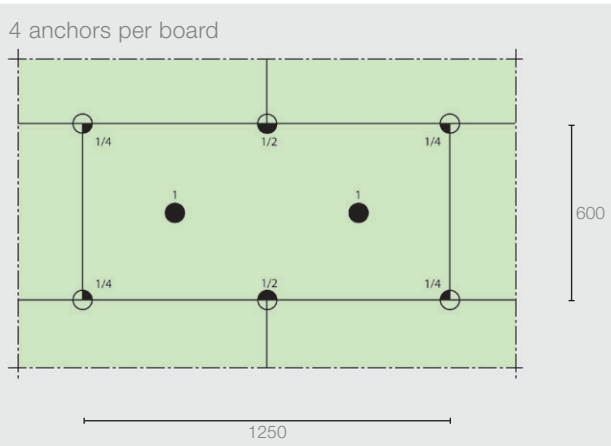


Fig. 24: Positioning and number of anchors (4 anchors per board) for subsequent attachment of Styrodur boards in the base area (dimensions in mm).

10. Insulation of Strip Foundations

When constructing insulated strip foundations, Styrodur boards can be positioned directly in the formwork and cast in concrete or used as permanent formwork **(Fig. 25)**.

For reinforced foundations, flat spacers should be used between the insulation and the reinforcement. Styrodur 3035 CS boards, which adhere to hardened concrete with insulation anchor pins, are suitable for concrete pouring. With timber formwork, the Styrodur boards can be secured to the formwork elements with clout nails **(Fig. 26)**.

In the case of steel or pre-fabricated formwork, it must be ensured by using appropriate fastening methods that the insulation boards do not come loose or shift during pouring or compacting of the concrete. DIN 1045-3 must be taken into account concerning the post-treatment, outfitting, and stripping of the concrete.

Fig. 25: Formwork with Styrodur.

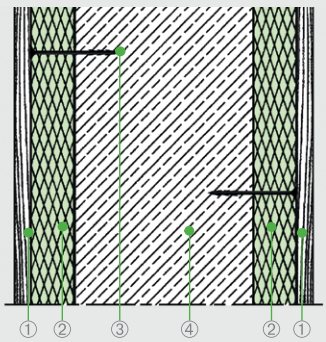


Fig. 26: Installation in formwork and securing of Styrodur 3035 CS boards with plastic ground pegs.

11. Drainage

Drainage is usually not necessary to protect the perimeter insulation. For special soil conditions, e.g. water-impermeable soil zone or specific building locations such as on a slope, drainage measures to remove surface and seepage water are required. In these cases, an overall drainage concept based on DIN 4095 “Drainage for the protection of structures” must be put into place **(Fig. 27)**. It consists of the surface drainage of the wall, drainage pipes, a gravel pack, filter fleece, inspection chambers, and a connection to the drainage or discharge system. The mere installation of insulating drainage boards is not sufficient.

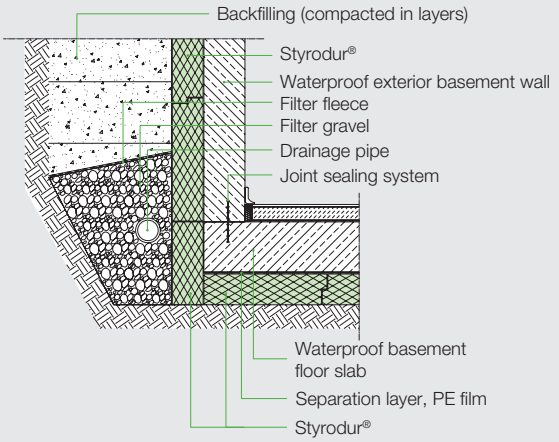


Fig. 27: Perimeter insulation structure combined with drainage system.

12. Backfilling of Excavation Pits

When the excavation pit is properly backfilled, the Styrodur boards require no additional protective layers. Minor damage to the surface of the boards will not affect the efficiency of the perimeter insulation. Care must be taken when backfilling to ensure that earth movement or settling do not cause harmful shear stress to the building waterproofing (full-surface bonding of the insulation boards, solid resting area at the base, glide coatings, etc.). The backfilling of the excavation pit **(Fig. 28)** is carried out in layers of about 40 cm, which are subsequently compacted **(Fig. 29)**.

Fig. 28: Layered backfilling

Fig. 29: Mechanical compacting

13. Thermal Insulation Layer with Styrodur® Hybrid

On vertical surfaces, Styrodur Hybrid boards are butted tightly in a bond formation **(Fig. 30)**. Boards with a shiplap are particularly suitable for preventing the formation of thermal bridges. They also protect the structure from mechanical stresses.

Installation:
In accordance with DIBt general construction type approval Z-23.33-2098 **(Fig. 31)**, Styrodur Hybrid may be installed:

- In areas with soil moisture and non-standing seepage water (above groundwater) as well as
- In areas with pressing water and standing seepage water (in groundwater).

The total thickness of the thermal insulation layer on walls should be 60–160 mm.

In accordance with the general construction type approval (CTA), Styrodur Hybrid may be installed in a single layer in long-term or constantly pressing water up to an immersion depth of 3.5 m. Styrodur Hybrid must not be used under floor slabs.

When calculating the thermal insulation, the following application-specific rated value of thermal conductivity must be used for Styrodur Hybrid according to the installation situation:

- In areas with soil moisture and non-standing seepage water: 0.034 W/(m·K)
- In areas with pressing water and standing seepage water: 0.039 W/(m·K)
- Thickness is determined by the nominal thickness minus the groove depth of 5 mm

Fig. 30: Installation of Styrodur Hybrid on the inside of the formwork

General information

During the Styrodur board extrusion process, a smooth compressed foam membrane is formed on the surface of the boards.

For a better adhesive bond with concrete, the surface must be profiled. Styrodur Hybrid has a surface that is mechanically machined on one side (longitudinal grooves) **(Fig. 32)**, which ensures a full-surface adhesive bond between Styrodur Hybrid board and concrete when the concrete is placed. This prevents water from running down the rear side of the thermal insulation.

Deutsches Institut für Bautechnik

DIBt

Eine vom Bund und den Ländern gemeinsam getragene Anstalt des öffentlichen Rechts

Zulassungs- und Genehmigungsstelle für Bauprodukte und Bauarten

Datum: Geschäftszeichen:

Allgemeine Bauartgenehmigung

Nummer:
Z-23.33-2098

Geltungsdauer
vom:
bis:

Antragsteller:
BASF SE
Carl-Bosch-Straße 38
67056 Ludwigshafen am Rhein

Gegenstand dieses Bescheides:
Perimeterdämmsystem im Verbund mit wasserundurchlässigen Beton-Kelleraußenwänden unter Verwendung von extrudergeschäumten Polystyrol-Hartschaumplatten "Styrodur Hybrid"

Der oben genannte Regelungsgegenstand wird hiermit allgemein bauaufsichtlich genehmigt.
Dieser Bescheid umfasst sechs Seiten und eine Anlage.

DIBt

DIBt | Kolonnenstraße 30 B | D-10829 Berlin | Tel.: +49 30 78730-0 | Fax: +49 30 78730-320 | E-Mail: dibt@dibt.de | www.dibt.de

Fig. 31: General construction type approval from DIBt, Berlin.

14. Advantages of Styrodur® Hybrid in Perimeter Insulation

There are many good reasons to use Styrodur Hybrid in perimeter insulation:

- High compressive strength.
- No need for additional protective layers.
- Installation depth according to earth pressure, up to a depth of 12 m.
- No deterioration of thermal conductivity since virtually no moisture absorption.
- Concreting in the formwork to a waterproof concrete wall is permitted by a general construction type approval.
- Processing advantages, as Styrodur Hybrid does not require the time-consuming subsequent step of being bonded to the entire surface of the exterior basement wall with bituminous sealing compound. This eliminates the need for large quantities of bituminous adhesives or sealing compounds.
- No special protective measures are needed in frost-prone areas.
- Non-cohesive soils do not require drainage.
- Simple processing. Only in groundwater is it necessary to seal the circumferential edges of the boards with suitable bituminous sealing compounds.
- Full-surface bonding of the Styrodur Hybrid boards to the waterproof concrete exterior basement wall secures against uplift. No additional measures to prevent uplift are necessary.

More information about Styrodur® Hybrid is available on our website www.styrodur.com, where you will also find brochures and videos.

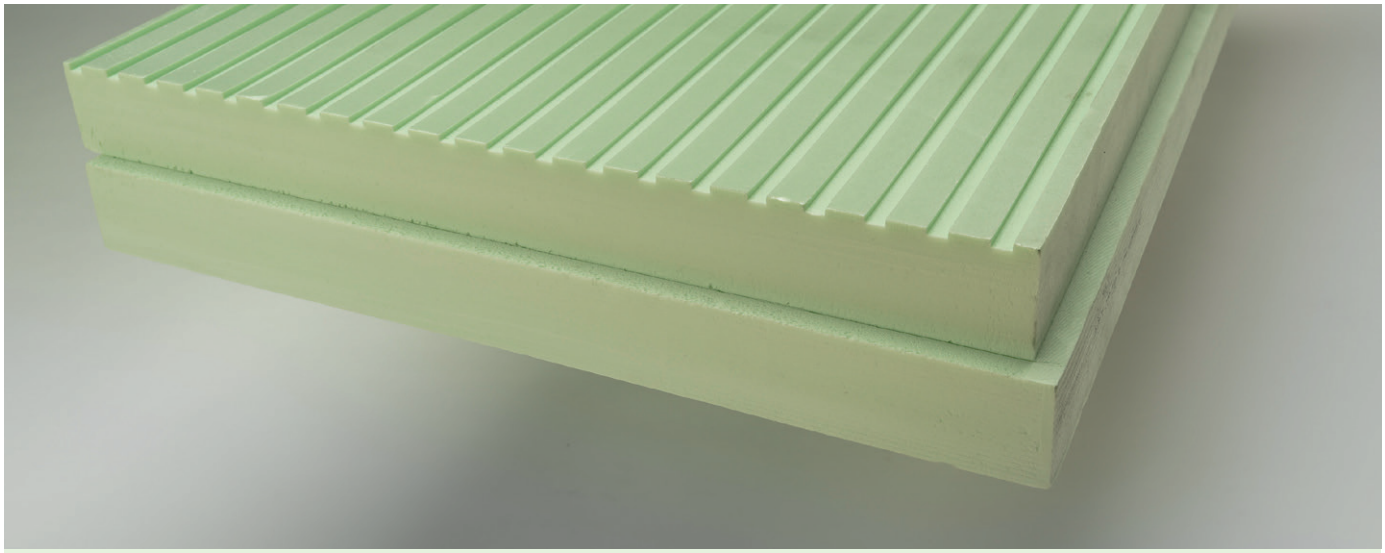


Fig. 32: Styrodur Hybrid board with longitudinal grooves on one face and shiplap edges.

15. Perimeter Insulation of Passive Houses with Styrodur®

In accordance with DIBt approvals, most Styrodur boards can be installed in one to three layers. This enables forward-looking and energy-efficient thermal insulation solutions, which have been state of the art in passive houses for many years. As an exception, Styrodur 3000 CS can only be in installed as single-layer (60 mm - 160 mm)

The ingress of water between the individual board layers and shifting of individual board layers is prevented by the load exerted by the floor slab and the building. When installing the insulation boards, cross joints must be prevented. A protective layer such as a PE film must be arranged between the uppermost insulation layer and the foundation slab.

15.1 Case Study: Triple-layer Installation of Styrodur® Under the Foundation Slab of Passive House

The case study shows a 570 m² floor slab according to the passive house standard. The insulation was installed in three layers according to technical approval for Styrodur under foundation slabs. Pre-fabricated insulating concrete forms (ICF) made from Styrodur were used at the edges of the reinforced concrete foundation slab under construction. They were arranged in straight and curved lines.

Cut-outs for penetrations were exactly dimensioned and installed with precision. The cavities between the edges and the pipes penetrating the insulation layer were sealed without creating thermal bridges using special PU foam. Aside from its static function, the foundation slab has an energetic role to perform within the building. It makes an active thermal contribution and serves as a heat accumulator to reduce the total energy consumption of the building.

Preparation of the floor slab

Fig. 33: A gravel bed as a blinding layer and levelling plane makes for a flat base. This base course is prepared and compacted in line with the requirements of the building ground and the instructions of the structural engineer.

Stopend formwork

Fig. 34: The arrangement and installation of linear edge elements is performed on the flat base according to the respective building installation plan.

Curved sections

Fig. 35: The factory-made, curved edge elements are aligned and installed to fulfil the required radii. This method also makes it possible to accurately and precisely construct curved foundation slabs.

Corners

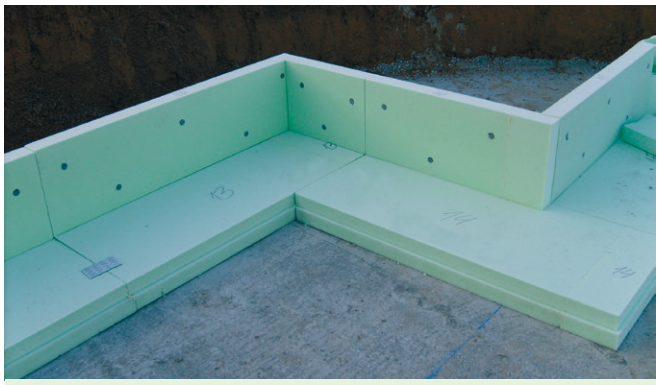


Fig. 36: The custom-fit pre-made and numbered corner elements kit ensures that the edge elements are laid with millimetre accuracy even with structured building footprints. This eliminates the time-consuming measuring and setting of the floor slab.

Horizontal ground insulation/frost protection

Fig. 37: Frost protection in accordance with EN ISO 13793 is necessary to avoid an expensive foundation extending down to the frost depth. It is added to the edge element in the factory and deployed as part of the horizontal ground insulation.

First layer

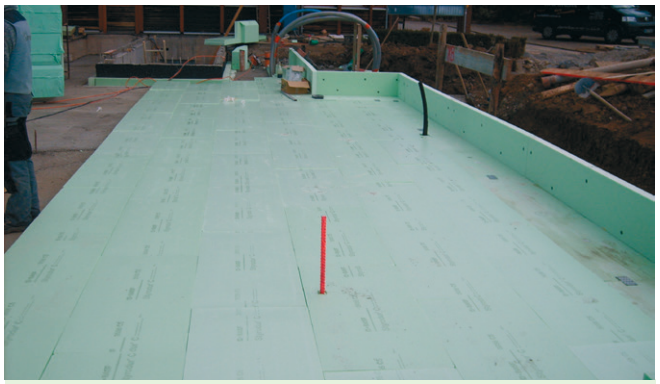


Fig. 38: The Styrodur boards with shiplap edges are laid in a loose bond in the first insulating layer. The point at which the installation begins and the laying direction is planned for the individual building and crafted to the assembly plans.

Second layer

Fig. 39: The second insulating layer, likewise of Styrodur boards with shiplap edges, is laid with the joints offset to the first layer of boards and also in a loose bond.

Accurate floor slab

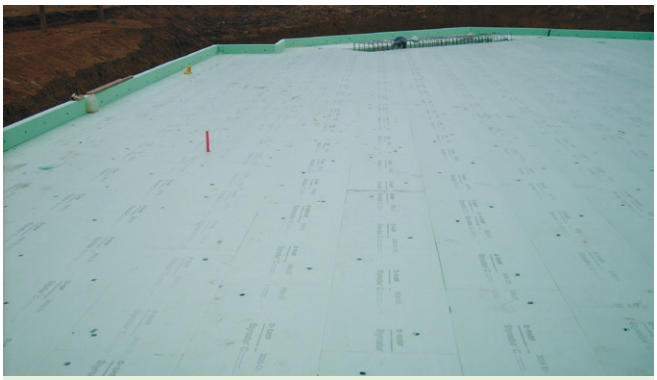


Fig. 40: Two major factors are important for a floor slab that is accurate and free of thermal bridges: the technically approved triple-layer Styrodur insulation and professional work preparation withstraightforward assembly and installation plans.

Convenient floor slab

Fig. 41: The thermally active floor slab serves as a large-scale heat accumulator and yields energy savings of up to 30 %. The reduction of the floor structure provides additional room height.

Cut-outs

Fig. 42: Cut-outs or penetrations are dimensioned according to structural requirements and local conditions. Any remaining cavities are sealed with special PU foam.

16. Construction Aids

16.1 Thermotechnical Dimensioning

Great demands are placed on the thermal insulation of building elements with ground contact of heated habitable rooms (see **Table 1**). Based on DIN 4108-2, for minimum thermal protection of exterior walls with ground contact a thermal resistance (R-value) of 1.2 (m^2·K)/W is stipulated. This corresponds to a thermal transmission coefficient (U-value) of 0.75 W/(m^2·K). For the lower building closure of habitable rooms in a building without basement that is immediately adjacent to the ground, a minimum thermal resistance (R-value) of 0.90 (m^2·K)/W is required.

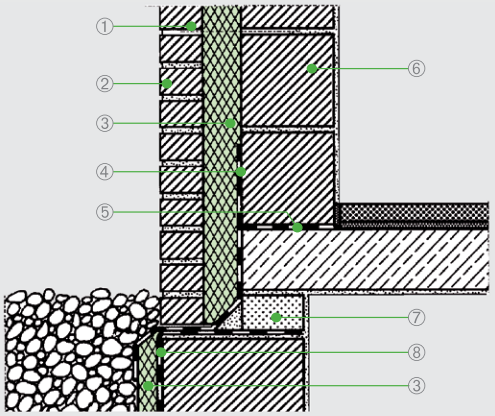
This corresponds to a thermal transmission coefficient (U-value) of 0.93 W/(m^2·K). These maximum thermal transmission coefficients must not be exceeded when the structural thermal insulation is calculated according to the energy balance method of the German Energy Saving Ordinance (EnEV). The requirements are met for the structures given as examples in **Table 2**.

Table 1: Minimum thermal insulation according to DIN 4108-2—requirements.

Building element adjacent to the ground	Thermal resistance [(m^2·K)/W] R-value	Thermal transmission coefficient [W/(m^2·K)] U-value
Wall	1.20	0.75
Floor	0.90	0.93

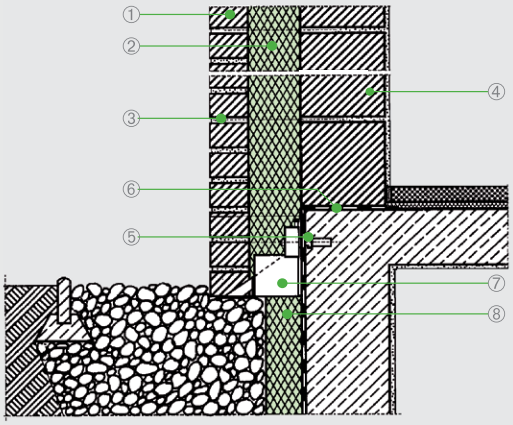
Table 2: Minimum thermal insulation according to DIN 4108-2—configurations.

Example	Construction		U-value [W/(m^2·K)]		Insulation layer thickness [mm]	
	Thickness [mm]	Building material	Non-insulated	Insulated	λ = 0.035 [W/(m·K)]	λ = 0.040 [W/(m·K)]
1	300	Concrete wall	3.7	< 0.75	40	50
2	20	Exterior plaster	1.8	< 0.75	30	40
	365	Sand-lime brick KSL-12-1, 8-12 DF				
	15	Interior plaster				
3	20	Exterior plaster	1.8	< 0.75	30	40
	300	Solid brick Mz-12-1, 8-5 DF				
	15	Interior plaster				
4	20	Exterior plaster	2.0	< 0.75	30	40
	300	Concrete block Hbn-12-1, 8-20 DF				
	15	Interior plaster				
5	120	Concrete floor	4.4	< 0.93	30	40



① Bohr-Drahtanker
② Vormauerung
③ Styrodur®
④ Sperrschicht
⑤ Abdichtung
⑥ Mauerwerk
⑦ Wärmedämmelement
⑧ Sperrschicht

Fig. 43: Anschluss der Perimeterdämmung am Mauerwerk mit Kerndämmung.



① Vormauerung
② Styrodur®
③ Bohr-Drahtanker
④ Mauerwerk
⑤ Sperrschicht
⑥ Abdichtung
⑦ Konsolanker
⑧ Styrodur®

Fig. 44: Anschluss der Perimeterdämmung am Mauerwerk mit Kerndämmung mit Konsolanker.

According to the EnEV, the annual primary energy demand of heated buildings is being limited. Planners are free to select the individual method to limit the annual primary energy demand of the building. It is therefore only possible to make recommendations with regard to insulating measures for building elements in contact with the ground. We suggest that basement walls with ground contact should be dimensioned to exhibit a U-value of ≤ 0.3 W/(m²·K). Perimeter insulation is advisable even for non-heated lower levels.

If the use of the basement is changed, retrofitting exterior insulation is extremely complex and expensive. The only true option under such circumstances is interior insulation. In the summer, when the outside air is warm and damp, rooms with exterior walls in contact with the ground run the risk of condensation on the inner surface of the exterior walls. The dew point temperature of the warm, damp summer air can be higher than the inner surface temperature of the basement walls. In this case, condensation forms on the inner surface of the exterior walls, which can lead to mould formation and a musty odour. Good thermal insulation of walls also contributes to improved hygrothermal performance.

Table 3: Thermal insulation—configurations.

Example	Construction		U-value [W/(m²·K)]		Insulation layer thickness [mm]	
	Thickness [mm]	Building material	Non-insulated	Insulated	λ = 0.035 [W/(m·K)]	λ = 0.040 [W/(m·K)]
1	300	Concrete wall	3.7	< 0.35	90	110
				< 0.30[1)]	110[1)]	130[1)]
2	20	Exterior plaster	1.8	< 0.35	80	100
	365	Sand-lime brick KSL-12-1, 8-12 DF		< 0.30[1)]	100[1)]	120[1)]
	15	Interior plaster				
3	20	Exterior plaster	1.8	< 0.35	80	100
	300	Sand-lime brick Mz-12-1, 8-5 DF		< 0.30[1)]	100[1)]	120[1)]
	15	Interior plaster				
4	20	Exterior plaster	2.0	< 0.35	90	110
	300	Sand-lime brick Hbn-12-1, 8-20 DF		< 0.30[1)]	100[1)]	120[1)]
	15	Interior plaster				
5	120	Concrete floor	4.4	< 0.35	100	110
				< 0.30[1)]	110[1)]	130[1)]

[1)] Recommendation

16.2 Hygrothermal Dimensioning

The exterior Styrodur thermal insulation, when used for perimeter insulation, is a functional design based on water vapour diffusion technology, as the water vapour diffusion resistance of the individual layers decreases towards the exterior. The thermal resistance of the individual layers increases from the interior to the exterior. An exterior thermal insulation layer is also advantageous in terms of protecting the external building elements of the basement from condensation. The insulated wall interior exhibits an increased surface temperature compared to a non-insulated building element, which contributes to comfortable living conditions. The risk of condensation forming on the interior wall surface is low. **Tables 3 and 4** indicate that in the case of perimeter insulation with an overall U-value of ≤ 0.35 W/(m²·K) on an undisturbed wall area, condensation water first appears at relative humidity above 90%.

16.3 Type Selection According to Installation Depth

The earth pressure on the thermal insulation boards rises with increasing installation depth. Thanks to the high permissible compressive load properties of Styrodur, the technical approval does not restrict the depth of installation. For greater installation depths, however, the Styrodur types with higher compressive strength are recommended. **Table 5** shows the different Styrodur types and their approved installation depths. They refer to the worst-case load scenario “earth pressure with silty sand”.

Table 4: Prevention of water condensation on basement walls at a room temperature of 20°C.

	Recommended insulation layer thickness [mm] dimensioned for ambient temperatures of	
Relative air humidity [%]	**– 10 °C**	**– 15 °C**
60	20	30
70	30	40
80	50	60
90	100	120

Table 5: Permanent compressive strength and maximum installation depth of the various Styrodur types.

Styrodur type	**3000 CS**	**3000 SQ**	**3035 CS**	**4000 CS**	**5000 CS**	**Hybrid**
Permissible permanent pressure 50 years at 23°C, kPa Deformation ≤ 2%	130	130	130	180	250	–
Maximum installation depth [m] Earth pressure without pressing water	**12**	**12**	**12**	**17**	**24**	**12**
Maximum installation depth in areas with permanent or long-term pressing water (in groundwater)	**3.50**	**3,50**	**3.50**	**7,00**	**7.00**	**3.50**

17. Information and General Technical Guidelines

- Styrodur should not be exposed to solar radiation for extended periods, particularly during summer months.
- If Styrodur is used under covers such as roofing sheets, films, or building protection mats, excessive heating could possibly occur during summer due to the absorption of sunlight, which might cause deformation of the Styrodur boards. It is therefore essential to immediately apply the appropriate protective layer in accordance with the flat roof guidelines.
- Styrodur insulation boards must be permanently protected against UV radiation. In order to avoid weathering of the surface and excessive heating, the boards should be protected from direct sunlight during prolonged outdoor storage. Brightly colored plastic films are suitable for this purpose.
- Styrodur is not resistant to all substances (see the “Chemical Resistance” brochure in download area of www.styrodur.com). The instructions of the adhesive manufacturer must be observed when selecting the adhesive.
- Adhesives suitable for the Styrodur boards and the corresponding application must be used for bonding. When selecting the adhesive, the information provided by the adhesive manufacturer regarding its suitability for bonding polystyrene foam must be observed.

18. Application Recommendations for Styrodur®

	Anwendungstyp nach DIN 4108-10 oder	Product properties according to DIN EN 13164 and DIN 4108-10						
		General	2800 C/Q	3000 CS/SQ	3035 CS	4000 CS/SQ	5000 CS/SQ	Hybrid
			CS(10\Y)	CS(10\Y)	CS(10\Y)	CS(10\Y)	CS(10\Y)	
	Allg.Bauart-genehmigung (aBG)/ETA		200 (20–60 mm)	300	300	500	700	300
			300 (80–200 mm)					
Perimeter[1] floor	*PB*	*wd*		dh	dh	ds	dx	
Perimeter[1] wall	*PW*	*wd*		dh	dh	ds	dx	dh
Perimeter[1] foundation slab	*see approval*	*wd*		dh	dh	ds	dx	
Perimeter[1] groundwater	*see approval*	*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	*see approval*	*wd*		dh	dh	ds	dx	
Parking roof	*see approval*	*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				

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

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

We create chemistry

Safe. Strong.
Styrodur®

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**

E-CPB/FM 2205 BE Styrodur® Perimeter insulation

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